

TFG3900A Series
Function/Arbitrary Waveform Generators

Brief Introduction

With Direct Digital Synthesis technique (DDS), large scale integrated circuits and soft-core embedded system (SOPC), high sampling rate 500MSa/s, TFG3900A series are of the excellent technical performances and powerful function characteristics which are necessary for the fast measurement. TFT-LCD interface can show the illustration of output waveform and parameters. Keypads and knob are convenient for operation. The introduction of main characteristics is following:

- Dual independent output channels: CHA and CHB, with the same characteristics. Good isolation for case and connector housing of output, Sync, and Modulate Input.
- Dual channel operation: Couple frequency, amplitude and offset of two channels, also combine two outputs into CHB connector.
- Real arbitrary generation point by point, excellent accuracy and prevent aliasing.
- Multi-waveform: 5 standard waveforms, 5 user-defined waveforms and 50 built-in arbitrary waveforms.
- Plentiful modulation: AM, FM, PM, PWM, SUM, FSK, QFSK, 4FSK, PSK, QPSK, 4PSK, ASK, OSK.
- Built-in 350MHz frequency counter to measure frequency, period, pulse width, duty cycle and cycle numbers of external signal.
- Support to store and recall instrument state with user-defined names.
- Allow the external trigger signal when modulating, sweeping and bursting.
- Calculation function: to select frequency, period, App, RMS and dBm.
- Communication port: LAN, USB device and USB host.

Packing List

TFG39××A Function/Arbitrary waveform generator	1
3-core power cord	1
BNC testing cable	1
CD	1

In This Book

This manual is available for three models under TFG3900A series –TFG3908A, TFG3912A, and TFG3916A, of which the Sine frequency limits are 80MHz, 120MHz and 160MHz.

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

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

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

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

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

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

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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 chapter 1. If more complicated functions are needed or meet difficulties in operation, please read Features and Functions in chapter 3.

1.1 Prepare the waveform generator for use

1.1.1 Check the list of supplied items

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

1.1.2 Connect the power

Turn on the instrument only the following conditions are met,

Power: AC 100 ~ 240 V

Frequency: 45 ~ 65 Hz

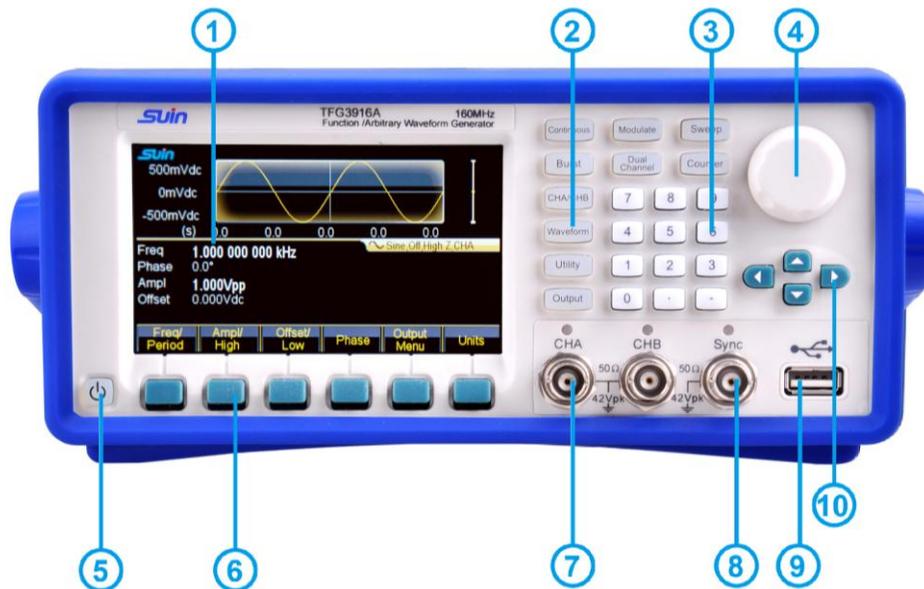
Power consumption: < 30VA

Temperature: 0 ~ 40°C 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.

1.2 Front/Rear panels at a Glance



Front panel

- 1. Display 2. Function Keys 3. Numeric Keypad 4. Knob 5. On/Off Switch
- 6. Menu Operation Softkey 7. CHA/CHB Output 8. Sync Connector
- 9. USB Port 10. Arrow Keys



Rear panel

1. Counter
2. External Clock Input
3. Internal Clock Input
4. Modulate Input / Trig Input / Output of CHB
5. Modulate Input / Trig Input / Output of CHA
6. LAN port
7. Fan
8. Power Socket
9. On/Off Swtich
10. USB Device

Chapter 2 Front-panel Menu Operation

2.1 Reference

2.1.1 Keypad description

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

10 function keys:

【Continue】 【Modulate】 【Sweep】 【Burst】 【Dual Channel】 【Counter】 【CHA/CHB】 【Waveform】 【Utility】 【Output】 .

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

12 keys in numeric keypad:

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

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

Four arrow keys:

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

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

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

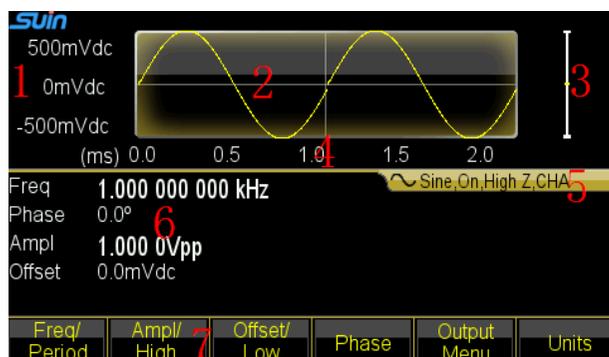
2.1.2 Display description

The display screen is divided into three sections:

Top section: output waveform

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

Bottom section: display of menu or unit.

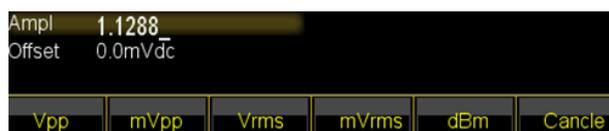


1. Voltage Scale
2. Waveform
3. Amplitude
4. Time Scale
5. Output Information
6. Working Parameters
7. Operation Menu

2.2 Number Entry

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

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



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

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

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



2.3 Basic Operation

2.3.1 To select the output channel

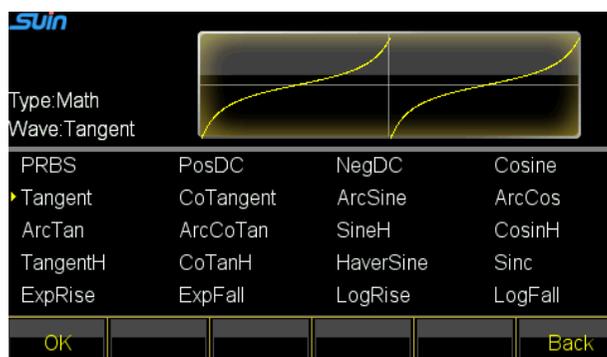
Press **【CHA/CHB】** key to open desired channel configuration screen. Note that fonts of channel name, mode and waveform were indicated by different color (yellow for CHA and blue for CHB). Use softkey together with knob or numeric keypad to set the waveform and parameters of desired channel. Enable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

2.3.2 To select a waveform

Press **【Waveform】** key to see the first page of the option list Sine, Square, Ramp, Pulse, Arbitrary and Noise. If select Arbitrary option, there are some operations for arbitrary waveform. Select one desired waveform to see the waveform diagram under Continuous mode.



Press **【Waveform】** key again to back to current menu.



2.3.3 To set duty cycle

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

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



2.3.4 To set Frequency

For example, specify a frequency to 2.5kHz.

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



2.3.5 To set Amplitude

For example, specify amplitude to 1.6Vrms.

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



2.3.6 To set offset

For example, specify an offset to -25mVdc.

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



2.3.7 To output an AM waveform

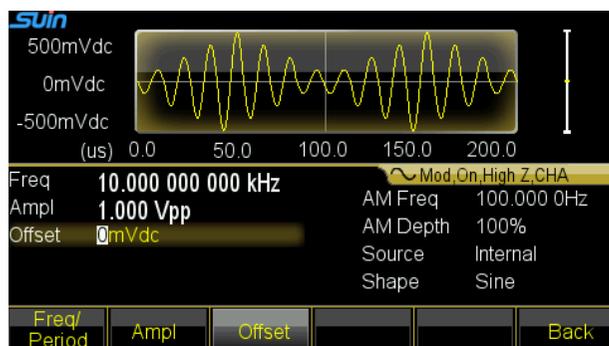
A modulated waveform consists of a carrier and a modulation waveform. In AM, for example, you want to output an AM waveform with 80% modulation depth, the carrier will be 10kHz and the modulation waveform will be a 10Hz Ramp wave.

1. Select AM

Press **Modulate** key and then select **AM** softkey by pressing the **Mod Type** softkey.

2. To set Carrier frequency

Press **Carrier** to enter into the parameter setting. Then press **Freq** softkey, enter 10 kHz with the numeric keypad or the knob and arrow keys. Press **kHz** softkey to finish entering the number.



3. To set the modulation depth

Press **Return** key to back to parameter setting and press the **Depth** softkey and then set the value to 80% using the numeric keypad or the knob and arrow keys. Press **%** softkey finish entering the number if you are using the numeric keypad.

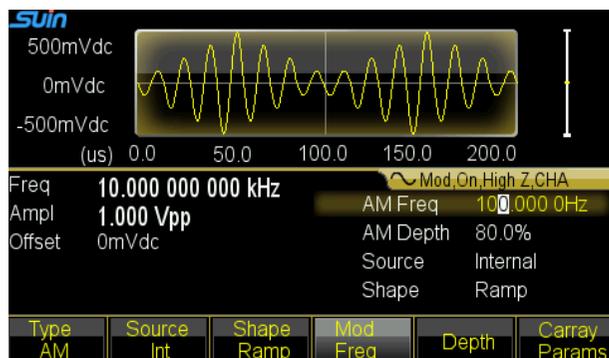
4. To set modulating waveform frequency

Press **AM Freq** softkey and then set the value to 10 using the numeric keypad and finally press **Hz** softkey.

5. To select the modulation waveform shape

Press the **Shape** softkey then press **Ramp** key to set the shape of modulating waveform as Ramp.

- To set AM parameters by knob or arrow keys



2.3.8 To output an Sum waveform

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

- Select Sum

Press **【Modulate】** key and then select **〔Sum〕** softkey by pressing the **〔Mod Type〕** softkey.

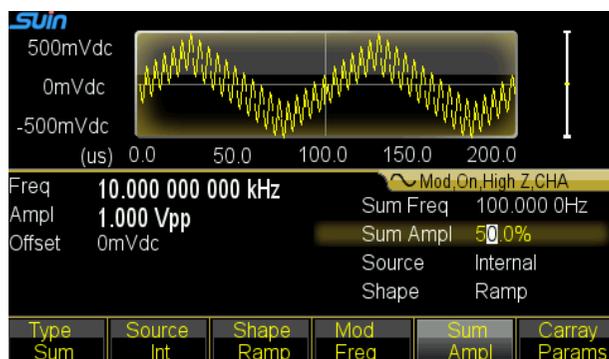
- To set the Sum amplitude

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

- To select the modulation waveform shape

Press the **〔Shape〕** softkey then press **【Ramp】** key to set the shape of modulating waveform as Ramp.

- Generator output a sum waveform as preset modulating parameters and you also can adjust amplitude of summed ramp by **【<】** or **【>】** keys.



2.3.9 To output a FSK waveform

If you want to output a FSK waveform with hop frequency to 300Hz, with an FSK rate of 50Hz,

1. Select FSK

Press **【Modulate】** key and then select **〔FSK〕** softkey by pressing the **〔Mod Type〕** softkey.

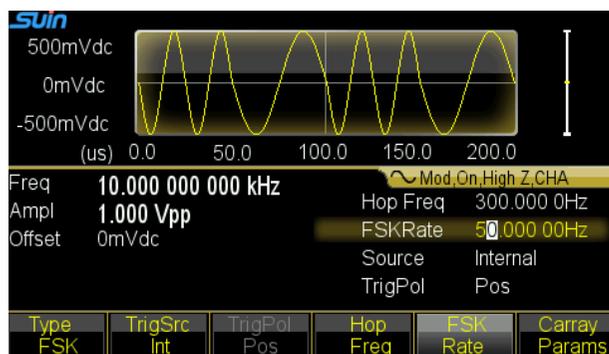
2. Set the hop frequency

Press the **〔Hop Freq〕** softkey then set the value to 300Hz using the numeric keypad or the knob and arrow keys.

3. Set the FSK rate

Press the **〔Hop Rate〕** softkey then set the value to 50Hz using the numeric keypad or the knob and arrow keys.

4. Set the hop frequency and FSK rate by knob or arrow keys.



2.3.10 To output a Frequency Sweep

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

1. Select Frequency sweep

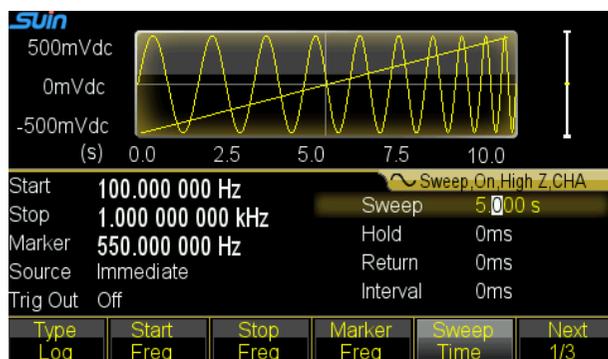
Press **【Sweep】** key and then verify that the Sweep is selected in default.

2. Select sweep time

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

3. Select sweep mode

Press the **〔Mode Line/Log〕** softkey and then verify that the logarithmic sweep mode is currently selected on the first softkey.



2.3.11 To output a Burst waveform

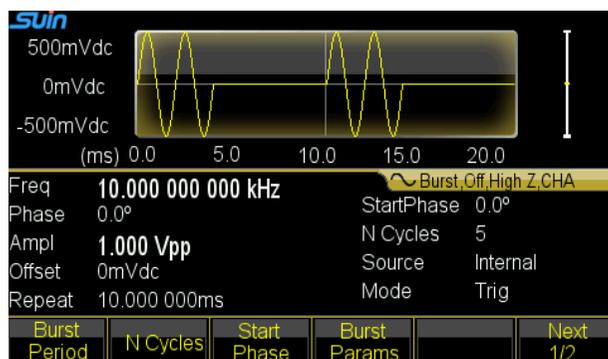
If you want to output a five-cycle wave with a 10ms burst period, continuous or manual signal trigger.

1. Press **【Burst】** key then burst menu is shown in the screen of the current channel.
2. Press **【Burst Mode】** and select the 'Triggered'.
3. Press **〔Burst Period〕** softkey then set the value to 10ms using the numeric keypad or the knob and arrow keys.
4. Press **〔N Cycle〕** softkey then set the value to 5 using the numeric keypad or the knob.

Press the **〔Ok〕** softkey to finish data entry if you are using the numeric keypad.

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

intervals.



You also can generate signal burst (still with 5 cycles) by selecting **Manual Trig** under pressing \llbracket Source Int/Ext \rrbracket softkey. Then each time you press \llbracket Manual Trig \rrbracket softkey, one five-cycle burst will be output. Press number depends on the desired burst number.



2.3.12 Frequency Coupling

If you want to couple frequencies between the two channels,

1. Press **【Dual Channel】** key. The dual channel menu is shown in the current screen.
2. Press the \llbracket Freq Cpl \rrbracket softkey to turn frequency coupling on. Then press \llbracket More \rrbracket softkey to configure frequency coupling.
3. Press **【Continuous】** key to configure CHA frequency, just because channel frequencies can be linked with a constant ratio or difference between them, CHB frequency will be changing as CHA changes.

2.3.13 Frequency Counter

If you want to measure a frequency of external signal,

1. Press **【Counter】** key to enter into Counter mode and display the counter menu and count results.
2. Input measured signal through 'Counter' connector at rear panel.

3. Press [Meas Type] softkey, the generator begin to measure then display the measured frequency value.
4. For Square input, press [Duty cyc] softkey to enable the duty cycle measurement and display the duty cycle.

Chapter 3 Features and Functions

This chapter makes it easy to look up details about a particular feature of the waveform generator. It also covers the front-panel operations. You should read Chapter 2 'Front-panel Menu Operation' first and master the basic operation so as to get a better understanding for this chapter.

3.1 Working Mode

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

There are six working modes for the waveform generator,

While,

CHA and CHB both cover four modes: continuous output, modulate output, sweep output and burst output.

Notice that the modulate output covers thirteen types: AM, FM, PM, PWM, SUM, FSK, QFSK, 4FSK, PSK, QPSK, 4PSK, ASK, OSK.

And sweep output covers three types: Frequency Linear Sweep, Frequency Logarithm Sweep and Frequency List sweep.

3.2 Continuous Output

3.2.1 Waveform Selection

The waveform generator can output 150 waveforms, see below table,

No.	Waveform	No.	Waveform
Standard Waveforms 5			
00	Sine	03	Pulse
01	Square	04	Noise
02	Ramp		
Math Waveforms 36			
05	PRBS	23	LogRise
06	PosDC	24	LogFall
07	NegDC	25	PosSquare
08	Cosin	26	NegSquare
09	Tangent	27	PosCube
10	CoTangent	28	NegCube
11	ArgSine	29	SquareRoot
12	ArgCos	30	PosRecipro
13	ArgTan	31	NegRecipro
14	ArgCoTan	32	PNRecipro
15	SineH	33	BiRecipro
16	CosinH	34	PosSemicirc
17	TangentH	35	NegSemicirc
18	CoTangentH	36	Gaussian
19	HaverSine	37	Maxwell
20	Sinc	38	Lorentz
21	ExpRise	39	Laplace
22	ExpFall	40	Besell
Linear Waveforms			
41	PosPulse	59	PNTriangl
42	NegPulse	60	HiLoTri
43	PN_Pulse	61	LoHiTri
44	PosBiPulse	62	PosRiseRamp
45	NegBiPulse	63	PosFallRamp
46	PNBiPulse	64	RiFaRamp

47	PMulPulse	65	NegRiseRamp
48	NMulPulse	66	NegFallRamp
49	PNMulPulse	67	FaRiRamp
50	WidePulse	68	Trapezia
51	NarrowPulse	69	RiseStair
52	WiNaPulse	70	FallStair
53	HiLoPulse	71	RiFaStair
54	RisePulse	72	RiStariRamp
55	FallPulse	73	FaStariRamp
56	RiFaPulse	74	Spiry
57	PosTriangl	75	Swallow
58	NegTriangl	76	Chair
Combine Waveforms 40			
77	PAllSine	97	SineFSK
78	NAllSine	98	SinePSK
79	PHalfSine	99	SineSum
80	NHalfSine	100	SineSweep
81	SiAmplCut	101	AmplInc
82	BiAmplCut	102	AmplDec
83	SiPhaselCut	103	BurstNoise
84	BiPhaselCut	104	BurstSine
85	SinePulse	105	LowPass
86	NoisePulse	106	HighPass
87	BiHarmo	107	BandPass
88	TriHarmo	108	BandPit
89	FourthHarmo	109	PulseOSC
90	FifthHarmo	110	PulseOver
91	SineFM	111	PNCircle
92	SineAM	112	Tripagoda
93	SquareAM	113	Candela
94	NoiseAM	114	ExpSquare

95	PulsePWM	115	ExpSine
96	SineFSK	116	TanSquRoot
Special Waveforms 32			
117	TanArcTan	133	Cardiac2
118	ReciInvReci	134	NearQuake
119	HarmInvHarm	135	FarQuake
120	BiReciHarm	136	Blast
121	BiReciCircle	137	Shake
122	CubeGause	138	LandScape
123	TanHarm	139	Cloud
124	HalfBiReci	140	Camel
125	Charge	141	User_arb1
126	Stress	142	User_arb2
127	HeatTreat	143	User_arb3
128	MulHarm	144	User_arb4
129	Syntony	145	User_arb5
130	Stereo	146	User_arb6
131	RainFall	147	User_arb7
132	Cardiac1	148	User_harmo
Edit Waveform 1			
149	Edit_wave		

(1) 00~04 are standard common used waveforms.

05~140 are built-in waveforms which are used in special occasion.

141~147 are user-defined arbitrary waveforms, allows to be saved by users after creating with software.

148 is used to save the user-defined harmonic wave.

149 is edit waveform, used to edit and modify arbitrary wave or harmonic wave. If not save, the data will be lost once exit this function.

- (2) Press **【Waveform】** key to see the waveform menu, select Sine, Square, Ramp, Pulse or Noise from the options. Press **[[Arb]]** key and then **[[Built-in]]** option to select built-in waveforms from 150 waveforms.

Built-in waves have five types: Standard, Math, Linear, Combine and Special. Press the option to enter into the waveform list and then select desired waveform by left/right key or knob. Finally press **[[Confirm]]** to output selected waveform from the output port, the sketch also be shown at the display.

Press **[[Back]]** key to return to type menu and you can select other types of built-in waveform again. Press **[[Back]]** key again to exit the built-in waveform menu. Or press **【Waveform】** key to return to current function window.

- (3) The selected waveform diagram is shown but which is just a sample one with lower resolution. Observe and test the output waveforms using oscilloscope.

3.2.2 Duty Cycle (Square or Pulse)

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

$$10\text{ns} \leq (\text{Duty Cycle} \times \text{Period}) \leq (\text{Period} - 10\text{ns})$$

3.2.3 Pulse Width and Edge Time

The pulse width represents the time from the 50% threshold of the rising edge of the pulse to the 50% threshold of the next falling edge. After selecting the pulse function, press the **[[Pulse Width]]** softkey. Then use the knob or numeric keypad to enter the desired pulse width. The pulse width usually remains unchanged if the Square frequency is changing, but

will be limited by the edge time if output frequency is too high, which should comply with the below formula:

$$10\text{ns} \leq \text{Pulse Width} \leq \text{Period} - 10\text{ns}$$

The edge time represents the time from the 10% threshold of rising/falling edge to 90% of which. If select Pulse waveform in continuous menu, press \llbracket Edge Time \rrbracket to select the Edge parameter to set. The edge time setting will be also limited by pulse width, which should comply with the below formula:

$$\text{Edge Time} \leq 0.625 \times \text{Pulse Width}$$

$$\text{Edge Time} \leq 0.625 \times \text{Duty Cycle} \times \text{Period}$$

3.2.4 Symmetry (Ramp)

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

3.2.5 Set Frequency

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

To set the output frequency, press the **【Continuous】** key, then the \llbracket Freq/Period \rrbracket softkey for the selected function. Then use the knob or numeric keypad to enter the desired frequency. Or press \llbracket Freq/Period \rrbracket softkey again to set using Period. For internally

applying to frequency synthesis, the display period value is the conversed one from enter value.

3.2.6 Set Amplitude

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

$$V_{pp} = \text{High} - \text{Low} \quad \text{High} = \text{Offset} + V_{pp}/2 \quad \text{Low} = \text{Offset} - V_{pp}/2$$

In continuous menu, press softkey $\llbracket \text{Ampl/High lev} \rrbracket$ to set amplitude or high level. Press softkey $\llbracket \text{Offset/Low lev} \rrbracket$ to set dc offset or low level.

3.2.7 Amplitude Limitation:

The output amplitude is limited by following factors. Once over the limitation, the generator will modify the setting as its allowed maximum within the limitation.

- (1) Limit Level: press $\llbracket \text{Output Menu} \rrbracket$ softkey and then $\llbracket \text{High Lev Limit} \rrbracket$ softkey specify the limit value of high level. Press $\llbracket \text{Low Lev Limit} \rrbracket$ softkey specify the limit value of low level. Even if wrong operation that exceed the limit value, the generator won't be damage and perform within the limit value. But if specify the high level value to be +10Vdc and low level to be -10Vdc, the limit function won't work anymore.
- (2) DC offset: except that set DC offset as 0, the amplitude is only limited by limit level, otherwise, which is further limited by DC offset, as following regulation:

$$\text{DC offset} + V_{pp}/2 \leq \text{High Limit}$$

$$\text{DC offset} - V_{pp}/2 \geq \text{Low Limit}$$

- (3) Frequency: if frequency high enough, allowed maximum amplitude will be limited (refer to chapter 5, Specifications)

(4) Channel Bandwidth: the output amplitude will decrease if frequency is higher. So flatness compensation will be needed to ensure the accurate amplitude in continuous output. But for other functions, once the frequency over 10MHz, the amplitude will decrease.

(5) For the arbitrary waveform generator, if Vpp don't reach to full range, the display value is not agreed with the output value.

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

(1) In continuous mode, press **[Ampl Unit]** select units if current waveforms and load condition allows. Different unit key will enable the different format displaying.

(2) For different waveforms, the convert relationship between Vrms and Vpp is subject to, see below table:

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

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

$$\text{dBm} = 10 \times \log_{10}(P/0.001), \text{ while, } P = (\text{Vrms})^2 / \text{Load}$$

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

Vpp	Vrms	dBm
10.0000 Vpp	3.5356 Vrms	23.979 dBm
6.3246 Vpp	2.2361 Vrms	20.000 dBm
2.8284 Vpp	1.0000 Vrms	13.010 dBm
2.0000 Vpp	707.1 mVrms	10.00 0dBm
1.4142 Vpp	500.0 mVrms	6.9897dBm

632.5 mVpp	223.6 mVrms	0.00 dBm
282.9 mVpp	100.0 mVrms	-6.9879dBm
200.0 mVpp	70.7 mVrms	-10.000 dBm
10.0 mVpp	3.5 mVrms	-36.020 dBm

3.2.9 Set DC offset

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

$$\text{Low Limit} + V_{pp}/2 \leq \text{Offset} \leq \text{High Limit} - V_{pp}/2$$

If the specified offset out of the range, the waveform generator will automatically adjust it to the maximum DC voltage allowed with the amplitude specified.

If set amplitude to 0.2mVpp, high level limit to +10Vdc and low level limit to -10Vdc, then the offset can be set within $\pm 10V$ range. The waveform generator become the DC power supply and can output DC voltage signal. But the thing to be noted is that the output impedance is 50 Ω .

3.2.10 Set Phase

Press **[Phase]** softkey to select 'Phase' then set the desired phase using the numeric keypad or knob. Output phase means the phase difference between output signal and synchronous signal, and output signal advance to synchronous signal.

If frequency is same for CHA and CHB, press **[Output Menu]** softkey to select **[Phase Sync]** to make the synchronous signal of CHA and CHB are with same phase. So it's easy to calculate the phase difference of two channels on basis of the phase setting for CHA and CHB.

3.2.11 Set Polarity

In continuous mode, press **[Output Menu]** and then **[Polarity]** softkey to set the polarity of

output signal.

- (1) If select Normal, it means output waveform same as sketch. Take Sine for example, normal polarity means output waveform start from zero phase and voltage goes rising.
- (2) If select Inverse, it means output waveform will be take voltage 0V as axes, and generates the vertical image opposite to Normal polarity.
- (3) Polarity setting has no influence to DC offset volts and Sync signal.

3.2.12 External Load

In continuous mode, press **[[Output Menu]]** and then **[[Load]]** softkey to set the external load.

- (1) The waveform generator has a fixed output impedance of 50Ω , the actual volts value at the load is the standoff ration that load impedance to 50Ω . If change output termination setting to higher, the standoff ratio will more approximate to 1, the error between actual volts at the load and displayed amplitude or offset will become more less. But if external load too lower, the actual volts will be not agreed with displayed value.
- (2) In order to make actual volts be agreed with display value, you should set suitable external load.

Press **[[50Ω]]** key to set external load as 50Ω .

Press **[[High Z]]** key to set external load as High Z.

Press **[[Impedance]]** key to set external load as desired value.

When setting of external load changes, the amplitude and offset display also changes, but the actual output never change. Now you connect an external load to output termination and make the actual value equals to setting, the actual voltage on load will be same as the displayed value.

- (3) When power on, the default external load is High Z.
- (4) Note that most output termination are not totally resistive, because the inductive impedance and capacitive impedance vary with frequency, especially when frequency

high, that the variation can't be ignored. If actual impedance of output termination are not confirmed, you can change the setting of 'Load' gradually and make the actual volts are in line with displayed value, then final setting value for 'Load' is the actual impedance.

3.2.13 Output Control

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

3.2.14 Data Out of Range

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

3.3 Frequency Modulation (FM)

In FM, carrier frequency varies with the instantaneous voltage of modulating waveform.

Press **【Modulate】**key to enter into the Modulating output mode, the working mode displays as Mod. Then press **[[Type]]** and select FM mode, displaying the FM sketch and FM menu.

3.3.1 Set Carrier

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

3.3.2 Frequency Deviation

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

$$\text{Carrier frequency} - \text{Frequency deviation} > 0$$

$$\text{Carrier frequency} + \text{Frequency deviation} < \text{upper limit frequency of waveform generator}$$

3.3.3 Modulating Waveform Frequency

After selecting FM, press \llbracket FM Freq \rrbracket softkey then enter the desired value. Usually the modulating waveform frequency should be set far less than the carrier frequency.

3.3.4 Modulating Waveform Shape

Press \llbracket Shape \rrbracket softkey then select 'Shape' to set. Press \llbracket Waveform Menu \rrbracket to select the desired waveforms in above table as modulating waveform. Finally, return to FM menu.

3.3.5 Modulating Source

The waveform generator will accept an internal or external modulation source for FM. Press \llbracket Source Int/Ext \rrbracket softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The frequency deviation is same as actual value if amplitude 5Vpp, dc offset 0Vdc signal level present on the rear-panel <Mod In> connector.

3.4 Amplitude Modulation (AM)

In AM, carrier amplitude varies with the instantaneous voltage of modulating waveform.

Press **【Modulate】**key to enter into the Modulating output mode, the working mode displays as Mod. Then press **[[Type]]** and select AM mode, displaying the AM sketch and AM menu.

3.4.1 Set Carrier

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

3.4.2 Modulation Depth

Press **[[Depth]]** softkey then set desired depth using knob or numeric keypad. The modulation depth is expressed as a percentage and represents the extent of the amplitude variation. If the maximum amplitude of modulating carrier is expressed as A_{max} , the minimum amplitude A_{min} , setting value of amplitude as A and modulation depth as M , the relationship among the four factors are expressed as following:

$$A_{max} = (1+M) \times A / 2.2 \quad A_{min} = (1-M) \times A / 2.2$$

Therefore,

$$M = (A_{max} - A_{min}) \times 1.1 / A$$

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

3.4.3 Modulating Waveform Frequency

Press **[[AM Freq]]** softkey to set the value of AM frequency. Usually the modulating frequency should be far lower than carrier frequency.

3.4.4 Modulating Waveform Shape

Press **[[Shape]]** softkey then select 'Shape' to enter the desired wave. Press Waveform Menu key, then select one of most waveforms in above as modulating waveform. Finally, return to modulating menu.

3.4.5 Modulating Source

The waveform generator will accept an internal or external modulation source for AM. Press `[[Source Int/Ext]]` softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The Modulating Depth is same as actual value if amplitude 5Vpp, dc offset 0Vdc signal level present on the rear-panel <Mod In> connector.

3.5 Phase Modulation (PM)

In PM, carrier phase varies with the instantaneous voltage of modulating waveform.

Press `【Modulate】` key to enter into the Modulating output mode, the working mode displays as Mod. Then press `[[Type]]` and select PM mode, displaying the PM sketch and PM menu.

3.5.1 Set Carrier

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

3.5.2 Phase Deviation

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

3.5.3 Modulating Waveform Frequency

Press `[[PM Freq]]` softkey then set the desired value using knob or keypad. Usually the modulating frequency should be far lower than carrier frequency.

3.5.4 Modulating Waveform Shape

Press [Shape] softkey then select 'Shape' to enter the desired wave. Press Waveform Menu key, then select most waveforms from above table as modulating waveform, but some waveforms are not available. Finally, return to modulating menu.

3.5.5 Modulating Source

The waveform generator will accept an internal or external modulation source for PM. Press [Source Int/Ext] softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The phase deviation is same as actual value if amplitude 5Vpp, dc offset 0Vdc signal level present on the rear-panel <Mod In> connector.

3.6 Pulse Width Modulation (PWM)

In PWM, carrier phase varies with the instantaneous voltage of modulating waveform.

Press [Modulate] key to enter into the Modulating output mode, the working mode displays as Mod. Then press [Type] and select PM mode, displaying the PWM sketch and PWM menu.

3.6.1 Set Carrier

Firstly, set the frequency, amplitude and offset of Carrier Waveform. In PMW mode, the generator will set carrier as pulse automatically and the pulse width of carrier changes along with transient voltage and only allows the pulse for carrier.

3.6.2 Pulse Width Deviation

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

width plus deviation. If at negative peak value, the pulse width of output signal equals to setting value of pulse width decrease a deviation.

3.6.3 Modulating Waveform Frequency

Press \llbracket PWM Freq \rrbracket softkey then set the desired value using knob or keypad. Usually the modulating frequency should be far less than carrier frequency.

3.6.4 Modulating Waveform Shape

Press \llbracket Shape \rrbracket softkey then select 'Shape' to enter the desired wave. Press Waveform Menu key, then select one of most waveforms from above table as modulating waveform, but some waveforms are not available. Finally, return to modulating menu.

3.6.5 Modulating Source

The waveform generator will accept an internal or external modulation source for PWM. Press \llbracket Source Int/Ext \rrbracket softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The pulse width deviation is same as actual value if amplitude 5Vpp, dc offset 0Vdc signal level present on the rear-panel <Mod In> connector.

3.7 Sum Modulation

In Sum Modulation, the instantaneous voltage of output waveform is the sum voltage of carrier and modulating waveform.

Press **Modulate** key to enter into the Modulating output mode, the working mode displays as Mod. Then press \llbracket Type \rrbracket and select SUM mode, displaying the sum modulating sketch and SUM menu.

3.7.1 Set Carrier

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

3.7.2 Sum Amplitude

Press \llbracket Sum Ampl \rrbracket and select Sum Ampl parameter to set the sum amplitude value. The sum amplitude represents the amplitude of the signal added to the carrier (in percent of carrier amplitude). When sum amplitude at 100%, amplitude of modulating waveform is a half of amplitude of carrier waveform. When sum amplitude at 0%, amplitude of modulating waveform is 0, then amplitude of carrier waveform will be half of setting value for carrier waveform.

3.7.3 Modulating Waveform Frequency

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

3.7.4 Modulating Waveform Shape

Press \llbracket Shape \rrbracket softkey then select 'Shape' to enter the desired wave. Press Waveform Menu key, then select one of most waveforms from above table as modulating waveform, but some waveforms is not available. Finally, return to modulating menu.

3.7.5 Modulating Source

The waveform generator will accept an internal or external modulation source for Sum. Press \llbracket Source Int/Ext \rrbracket softkey. It's available to set modulating frequency and modulating waveform if 'Internal' source is selected. But if you select External source, the carrier waveform is modulated with an external waveform. The sum amplitude is same as actual

value if amplitude 5Vpp, dc offset 0Vdc signal level present on the rear-panel <Mod In> connector.

3.8 Frequency -Shift Keying Modulation (FSK)

In FSK mode, output signal hop between Carrier Frequency and Hop Frequency, the hopping rate decided by FSK rate.

Press **【Modulate】** key then select the FSK mode. The FSK modulating waveform sketch and FSK menu will be both displayed. The selection of FSK mode includes FSK, QFSK, and 4FSK.

3.8.1 Set Carrier

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

3.8.2 Hop Frequency

FSK modulation is similar to FM that modulating waveform is Square. And hop frequency is similar to frequency deviation. But the difference is that, frequency deviation is the frequency of carrier wave plus or minus deviation value, whose setting range is relational with the frequency of carrier wave, while hop frequency has no relationship with it. Press **[[Hop Freq]]** softkey to set the desired value of hop frequency.

- (1) FSK allows to be set hop frequency, which the carrier frequency and hop frequency output by turns.
- (2) 4FSK allows to be set for three hop frequencies, carrier frequency and three hop frequencies output in sequence 1, 2, 3.
- (3) QFSK also allows to be set for three hop frequencies, carrier frequency and three hop frequencies output randomly.

3.8.3 FSK rate

To set the FSK rate, press `[[FSK Rate]]` or `[[4FSK Rate]]` or `[[QFSK Rate]]` softkey. Then use the knob or numeric keypad to enter the desired rate. FSK rate is generally lower than carrier frequency.

3.8.4 Trigger Source

Press `[[Trigger]]` softkey. When Internal source selected, generator takes internal source and shift rate setting is available. When External source selected, generator takes external source and shift rate setting is disabled. Details refer to Chapter 3.14.

3.9 Phase Shift Keying Modulation (PSK)

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

Press **【Modulate】** key then select the PSK mode. The PSK modulating waveform sketch and PSK menu will be both displayed. The selection of PSK mode includes PSK, QPSK, and 4PSK.

3.9.1 Set Carrier

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

3.9.2 Hop Phase

PSK modulation is similar to PM that modulating waveform is Square. And hop phase is similar to phase deviation. Press `[[Hop Phase]]` softkey to set the desired value of hop phase.

- (1) PSK allows being set hop phase, which the carrier phase and hop phase output by turns.
- (2) 4PSK allows to be set for three hop phases, carrier phase and three hop phases output in sequence 1, 2, 3.

- (3) QPSK also allows to be set for three hop phase s, carrier phase and three hop phase s output randomly.

3.9.3 PSK Rate

To set the PSK rate, press \llbracket PSK Rate \rrbracket or \llbracket PFSK Rate \rrbracket or \llbracket QPSK Rate \rrbracket softkey. Then use the knob or numeric keypad to enter the desired rate. FSK rate is generally lower than carrier frequency.

3.9.4 Trigger Source

Press \llbracket Trigger \rrbracket softkey. When Internal source selected, generator takes internal source and shift rate setting is available. When External source selected, generator takes external source and shift rate setting is disabled. Details refer to Chapter 3.14.

3.10 Amplitude Shift Keying Modulation (ASK)

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

Press **【Modulate】** key then select the ASK mode. The ASK modulating waveform sketch and ASK menu will be both displayed. The selection of ASK mode includes ASK and OSK.

3.10.1 Set Carrier

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

3.10.2 Hop Amplitude

In ASK, press \llbracket Hop Ampl \rrbracket softkey and select Hop Ampl parameter to set the value. The default setting for OSK hop amplitude is 0, so there is no Hop Ampl menu for OSK.

3.10.3 Hop Time

In OSK, press [Hop Time] softkey and select Hop Time parameter to set the value. Hop Time represents the period of amplitude increases from 0 to maximum or decreases from maximum to 0. In ASK, default hop time is 0 without menu option.

3.10.4 ASK Rate

Press [ASK Rate] or [ASK Rate] softkey to set the value, that is modulating frequency, which is far lower than carrier frequency.

3.10.5 Trigger Source

Press [Trigger] softkey. When Internal source selected, generator takes internal source and shift rate setting is available. When External source selected, generator takes external source and shift rate setting is disabled. Details refer to Chapter 3.14.

3.11 Frequency Sweep

Press **[Sweep]** key to enter the sweep mode. The frequency sweep sketch and menu will be both displayed.

3.11.1 Set Sweep Signal

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

3.11.2 Sweep Mode

Press [Sweep Mode] to select Linear or Log for sweeping.

- (1) 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.

- (2) 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.

3.11.3 Start Frequency and Stop Frequency

Press the `[Start Freq]` or `[Stop Freq]` softkey. Then use the knob or numeric keypad to enter the desired frequency.

- (1) To sweep up in frequency, set the start frequency less than the stop frequency.
- (2) To sweep down in frequency, set the start frequency be greater than the stop frequency.

3.11.4 Marker Frequency

Press `[Marker Freq]` softkey, 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. If out of the range, the waveform generator will automatically set the marker frequency as the maximum or minimum allowed in the sweep range.

3.11.5 Sweep Time

Press `[Sweep Time]` softkey 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.

3.11.6 Hold Time

Press **[Hold Time]** softkey and use the knob or numeric keypad to enter the desired hold time. The hold time specifies the number of seconds to remain at the stop frequency.

3.11.7 Return Time

Press **[Return Time]** softkey and use the knob or numeric keypad to enter the desired return time. The return time specifies the number of seconds to return from the stop frequency to the start frequency. No matter sweep mode is Linear or log,

3.11.8 Interval Time

Press **[Interval Time]** softkey and select Interval parameter. Then use the knob or numeric keypad to enter the desired interval time. The interval time specifies the time from one sweep to next sweep. No matter sweep mode is Linear or log,

3.11.9 Trigger Source

Press **[Trig Imm/Ext]** softkey. When Immediate 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]** softkey. When External selected, generator takes external source, the detail description refer to chapter 3.14.

3.12 Frequency List Sweep

Press **[Sweep]** key to enter into sweep mode. the working mode displays as sweep, the sweep sketch and menu will be both displayed.

3.12.1 Set Sweep Signal

First set the shape, amplitude and offset for sweep signal. The waveform generator can produce a frequency list sweep for most waveforms mentioned above, but some waveforms are not available.

In frequency sweep mode, the change of frequency only by linearly and logarithm, and each point stand period during sweeping never change. So in some occasion, a frequency list with arbitrary regularity or without any regularity need to be output, and dwell time on each frequency point can be set, then list sweep will be used. In the frequency list mode, the function generator “steps” through the frequencies contained in a list, dwelling on each frequency for a specified period.

3.12.2 Sweep Mode

Press \llbracket Sweep Mode \rrbracket and select List to display the list sweep menu.

3.12.3 Frequency List

Generator has default frequency list, which ranges from 1kHz to 128kHz. User can create its own frequency list, the maximum length of which is 128 frequency value.

- (1) Press \llbracket List Number \rrbracket softkey and set the desired list number.
- (2) Press \llbracket List Freq \rrbracket will be automatically selected and set the frequency value according to selected list number.
- (3) Press \llbracket Next \rrbracket softkey can add 1 on list number and set the following frequency value.
Using this method to create or modify a frequency list.
- (4) When complete the new list, you can save the current list by state storage method, the the data of which won't be lost even power-off and also could be recalled in need. The detail method is referred to chapter 3.20.

3.12.4 Start Number and Stop Number

In the frequency list sweep mode, the waveform generator moves from the start number, output each frequency value contained in a list one by one, until to the stop number.

Press \llbracket Start Number \rrbracket softkey to set start number. The start number should be less than stop number, if not, the generator will set start number less 1 than stop number.

Press **[[Stop Number]]** softkey to set stop number. The stop number should be larger than start number, if not, the generator will set stop number more 1 than start number.

3.12.5 Dwell Time

Press **[[Dwell Time]]** softkey. Then use the knob or numeric keypad to enter the desired dwell time. The dwell time specifies the number of seconds to remain at each frequency point.

3.12.6 Hold Time

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

3.12.7 Trigger Source

Press **[[Trig Imm/Ext]]** softkey. When Immediate 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]]** softkey. When External selected, generator takes external source, the detail description refer to chapter 3.14.

3.13 Burst Output

Press **【Burst】** key to enter into the sweep mode. The burst waveform sketch and burst menu will be both displayed.

3.13.1 Set Burst Signal

First set the shape of burst signal. Normally sine is selected for burst signal, the other built-in waveform are also could be selected except of some waveforms. Press **[[Burst Signal]]** softkey to set frequency, amplitude and offset of burst signal.

3.13.2 Burst Mode

You can use burst in two modes by pressing \llbracket Mode Trig/Gat \rrbracket softkey to select.

- (1) If 'Triggered' is selected, the waveform generator outputs a waveform with a specified number of cycles (burst count) each time a trigger is received. After the specified number of cycles have been output, the waveform generator stops and waits for the next trigger.
- (2) If Gated is selected, only external source was available for trigger, the detail description refer to chapter 3.14.

3.13.3 Burst Period

Press \llbracket Burst Period \rrbracket softkey to set the burst period. The burst period defines time from the start of one burst to the start of the next burst. The burst period must be long enough to accommodate the setting counts, see below formula,

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

If the burst period is too short, the waveform generator will automatically adjust it to be allowed minimum value. Once the frequency of burst signal changes and leads to the burst period can't hold the burst count, the generator will automatically adjust it to be allowed minimum value.

3.13.4 Burst Count

To set the burst count, press \llbracket N Cycles \rrbracket softkey The burst count defines the number of cycles to be output per burst. The burst count must be short enough to be held in burst period. See below formula to clarify the relationship between burst count and burst period.

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

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

3.13.5 Burst Phase

The start phase defines the start time and stop time always at the same phase of waveform for burst signal. To set the burst phase, press the [Burst Phase] softkey.

3.13.6 Trigger Source

Press [Trig Imm/Ext] softkey. When Immediate selected, the waveform generator takes internal source and output burst signal continuously. The setting of burst period is valid. When manual mode selected, the waveform generator outputs one burst signal each time you press [Manual Trig] softkey. When External selected, generator takes external source and the setting of burst period is invalid, the detail description refers to chapter 3.14.

3.14 External Trigger Source

Generator has two bidirectional trigger ports on the rear panel <Trig In/Out>. When you select external source, the trigger port is set as input from external trigger signal. When you select internal source, the trigger port is set as output from internal trigger signal.

CHA is only for channel A and CHB is for channel B.

3.14.1 Trigger Level Input

When generator is under the function of FSK, 4FSK, QFSK, PSK, 4PSK, QPSK, ASK, OSK, user can input external trigger signal, which is digital logic level.

- (1) Press [Polarity] softkey. If select “Positive”, the logic high level of trigger signal will be set as “1”, the logic low level as “0”. If select “Negative”, the logic high level of trigger signal will be set as “0” and logic low level as “1”.
- (2) If generator is under burst output function and burst mode selected as “Gated”, when trigger signal is “1”, the burst signal starts output. When trigger signal is “0”, it will wait for the last periodic waveform and stops output. There will be at least two cycles for gated output, the cycle of which should meet with the following relationship:

$$\text{Trigger Cycle} > 2/\text{Frequency of burst signal}$$

- (3) If generator under FSK, PSK, ASK, OSK function, external signal will be input from the trigger port. When trigger signal is “0”, it will output carrier frequency, carrier phase and carrier amplitude, when trigger signal is “1”, it will output hop frequency, hop phase and hop amplitude.
- (4) If generator under 4FSK, QFSK, 4PSK, QPSK, user need to input two digits of trigger signal. The trigger port of original channel is inputted by low digit and the other channel port by high digit.

When trigger signal is “00”, it outputs carrier frequency and carrier phase.

When trigger signal is “01”, it outputs hop frequency 1 and hop phase 1.

When trigger signal is “10”, it outputs hop frequency 2 and hop phase 2.

When trigger signal is “11”, it outputs hop frequency 3 and hop phase 3.

3.14.2 Trigger Edge Input

When generator under function of burst output or frequency sweep, user can input external trigger signal, which is edge hopping.

- (1). Press [Trig Edge] softkey. If select “Rise”, the valid trigger edge is the hopping of trigger signal from low to high. If select “Fall”, the valid trigger edge is the hopping of trigger signal from high to low.
- (2). For burst output mode, when “Trigger” selected, each valid trigger edge burst output the signal once, the cycle of trigger signal should meet with the following relationship:
$$\text{Trigger Cycle} > \text{Cycle number} / \text{Frequency of burst signal}$$
- (3). For frequency sweep mode, each valid trigger edge finish triggering one sweep, the cycle of trigger signal should be longer than the total sweep time, as below relationship:
$$\text{Trigger Cycle} > \text{Sweep Time} + \text{Hold Time} + \text{Return Time} + \text{Interval Time}$$
- (4). For list sweep mode, each valid trigger edge finish triggering one sweep, the cycle of trigger signal should be longer than the total sweep time, as below relationship:

Trigger Cycle > (Stop Number- Start Number) × Dwell Time + Hold Time

3.14.3 Trigger Output

For burst output, frequency sweep and list sweep mode, when internal or manual selected as trigger source, the trigger port will be set as output port to output internal trigger signal that is digital logic level, for triggering other device.

- (1). Press \llbracket Trig Out \rrbracket softkey. If select “Rise”, the trigger signal is logic high level when selecting “1” for trigger output. If select “Fall”, the trigger signal is logic low level when selecting “1” for trigger output. If select “Off”, there will be no output.
- (2). For burst output mode, the trigger port outputs “1” during the burst outputting and outputs “0” for disabling the burst output.
- (3). For frequency sweep mode, when internal source selected, the trigger port outputs “1” at start of sweeping, the pulse width of which should be half of total sweep time.
- (4). For list sweep mode, when internal source selected, the trigger port outputs “1” at start of sweeping, the pulse width of which should be equal to dwell time.
- (5). For frequency sweep or list sweep mode, when manual selected, trigger port outputs “1” at start of sweeping, the pulse width should be more than 100us.

3.15 Dual Channel Operations

You enter the dual channel configuration menu by pressing \llbracket Dual Channel \rrbracket key. The working mode will display as Dual Setting, the instruction and menu of which will be both shown. It has two working modes, parameter coupling and waveform combine. Parameter coupling contains Frequency Coupling and Amplitude Coupling.

3.15.1 Coupling Direction

The dual channels are identical and allowed to be coupled by both of each other. Press \llbracket Couple Direction \rrbracket softkey to set the coupling direction between channels.

If set A to B, A is source channel and B is object channel, vice versa. The direction is one way to allow the source channel to be coupled to object channel.

Any mode of dual channel once enabled, the indicator of which will be lighted on and tells user entering into the coupling state. And user only can operate source channel but not the object channel.

3.15.2 Frequency Coupling

With frequency coupling function, generator can make the dual channel frequency output relates and generates two multiplied frequency or differenced frequency signal.

- (1) Press the \llbracket Freq Cpl On/Off \rrbracket softkey to turn frequency coupling on, the dual channels coupled function is enabled. When you change the frequency of source channel, the frequency of object channel will change along with the source channel automatically and not allowed to be independently set again. The frequency relationship between two channels accords with the formula:

$$\text{Frequency of object channel} = \text{frequency of source channel} \times \text{frequency ratio} + \text{frequency difference}$$

- (2) Press \llbracket Cpl Para \rrbracket softkey and enter into the parameter coupling menu. Press \llbracket Freq Ratio \rrbracket and \llbracket Freq Diff \rrbracket softkey to specify the desired frequency ration and frequency difference.
- (3) Press the \llbracket Freq Cpl On/Off \rrbracket softkey to turn frequency coupling off, the dual channels coupled function is disabled and frequency can be set independently for both of channels.

3.15.3 Amplitude Coupling

Amplitude coupling, which is enabled by the \llbracket Ampl Cpl On/Off \rrbracket softkey, couples the amplitude and offset voltage between the channels. When you change the amplitude or offset of source channel, the amplitude or offset of object channel will change along with the

source channel automatically. Once select Off, the dual channels coupled function is disabled and amplitude and offset can be set independently for both of channels.

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

Amplitude of object channel = amplitude of source channel + amplitude difference

Offset of object channel = offset of source channel + offset difference

3.14.4 Waveform Combine

In waveform combine, select most waveforms mentioned above table except of some. Waveform combine is similar to Sum modulation. The difference is that Sum modulation use modulating waveform but waveform combine allows using continuous wave, modulating wave, sweeping wave and bursting wave. Therefore, more complicated wave can be generated for waveform combine.

Press \llbracket Combine On/Off \rrbracket softkey then select On to enable waveform combine feature. The waveform of source channel can be combined with the one of object channel, then output from the connector of object channel.

Enter into the parameter coupling menu and press \llbracket Combine Ampl \rrbracket softkey to set the parameter of combine amplitude. Combine amplitude represents the source channel amplitude superposed to object channel waveform, expressed by percentage of object channel amplitude setting. For 100% combine amplitude, source channel amplitude equals to the half of object channel amplitude. For 0% combine amplitude, source channel amplitude is 0, now object channel amplitude is half of setting, the relationship between dual channels are:

Combined waveform = source channel wave \times combine amplitude + object channel wave

3.15.5 Waveform Combine Example

Make use of waveform combine feature, the waveform generator can output some special waveforms. For example, couple two narrow pulse on CHB. You can operate as following steps:

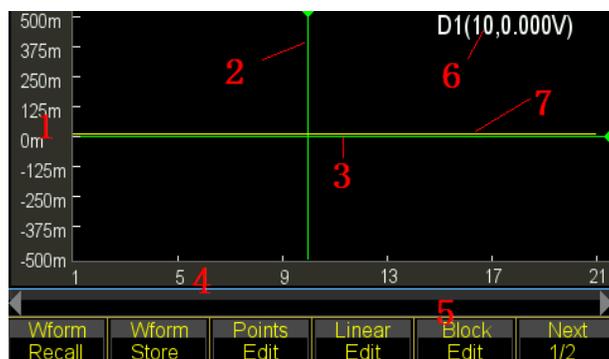
- (1) Enable CHA to be continuous, 10kHz Square with duty cycle 10%.
- (2) Enable CHA to be burst again, burst period 1ms and burst count 2.
- (3) Press **[[Dual Channel]]** key and set the amplitude combine to be 50%.
- (4) Press **[[Combine On/Off]]** softkey then select On.
- (5) Enable CHB to be continuous, 1kHz Sine.
- (6) Then a Sine superposed by two narrow pulse at each period output from CHB connector.

3.15 Arbitrary Waveform

There are two types for arbitrary waveform setting, short and long arbitrary waveform, the methods of which are same. Waveform length for short is 16384 (16k) points and allows being set independently for dual channels. Waveform length for long is 1048576 (1M) points and only applicable for channel A.

3.15.1 Enter into the Waveform Edit

Press **【Waveform】** key to display all the waveform option and select **[[Arbitrary]]** key to enter into the arbitrary waveform menu. If you want to create the waveform with length less 16K points, you can press **[[Create Normal]]** key. If you want to create the waveform with length more than 16K points, you can press **[[Create Ultra Long]]** key. Once enter into the window of waveform edit, generator pre-create one straight line with length of 20 points, voltage of each points is 0Vdc and sampling rate is 1MSa/s. The interface is as below:



- 1.Voltage Scale 2.X Cursor 3.Y Cursor(green) 4. Points
 5. Editing Parameters 6. Current Cursor 7.Current Waveform (yellow)

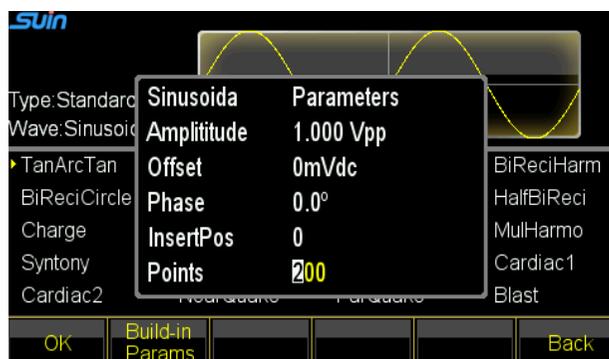
3.15.2 Insert Built-in Waveform

To create a simple waveform, like a Pulse or Ramp, you can edit by “Point Edit” and “Line Edit” methods manually. But for Sine, it is not so easy to edit manually because the each point requires extremely accurate value. So the generator prepares 150 built-in arbitrary waveform for users, the part of each waveform can be selected and inserted to current edited waveform. Then user can correct, cut and copy it to complete the desired complicated waveform, no need to edit point by point.

During the editing, user can change the parameters such as sampling rate, amplitude and waveform length to alter the characteristic of editing waveform timely.

Refer to next page and press `[[Insert Wave]]` key to enter into the waveform selection window. Select desired waveform and press `[[Enter]]` key.

For your selected waveform, press `[[Waveform]]` key to show a setting frame, which allows the user to make parameter setting for the inserted waveform. Up/Down key for select and knob for value setting, no option setting means default value.

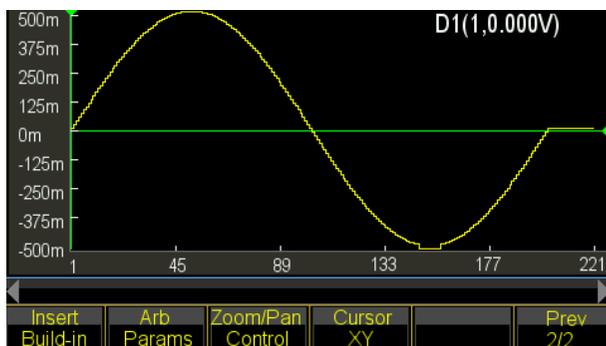


- (1) Amplitude: set the Vpp for inserted waveform
- (2) Offset: set the DC offset voltage for inserted waveform
- (3) Phase: set the start phase for inserted waveform, refer to the phase of which.
- (4) Insert position: set the position (X-axis value) where the editing waveform you want to be inserted.
- (5) Total points: set the total points for inserted waveform. Generator abstract points from inserted waveform at interval, which is also the waveform length of inserted waveform.

When parameter setting finished, press \llbracket Return \rrbracket key to back editing window and you will see the selected waveform locate at your desired position.

The example shows how to insert a sine wave with 200 points.

- (1) press \llbracket Insert Wave \rrbracket key to enter into the waveform select interface. Then press \llbracket Normal Wave \rrbracket key and select Sine.
- (2) Press \llbracket Enter \rrbracket to confirm the operation and then \llbracket Waveform \rrbracket key to display parameter setting frame. Set amplitude to be 1.0Vpp, offset 0Vdc, phase 0° , insert position 0, total points 200, as below picture:
- (3) Keep press \llbracket Return \rrbracket until back to edit waveform window and you will see the inserted Sine as you set.



3.15.3 Select Cursor

User can make more fast and accurate position for one point by using of Cursor.

Cursor setting has four types. Press \llbracket Cursor All \rrbracket and select “Cursor Off” to disable the cursor. Select “Cursor X” to display one vertical cursor. Select “Cursor Y” to display one horizontal cursor. Select “Cursor All” to display both of vertical and horizontal lines.

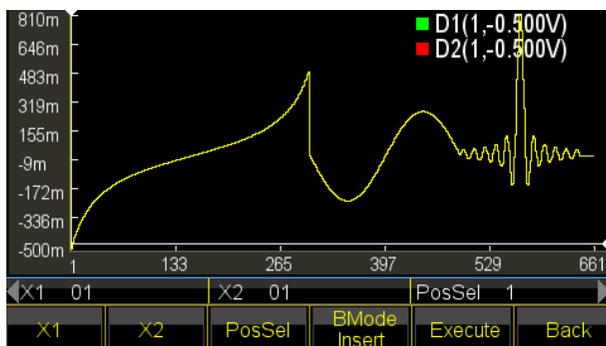
Only selecting X or Y axis, the cursor is valid. User will found cursor will be mainly operated in following editing work.

3.15.4 Point Edit

Point edit can set voltage to one point on waveform, also can insert or delete one point at specified location on waveform, which is applicable for locally modification to existing waveform or create a simple waveform with less points.

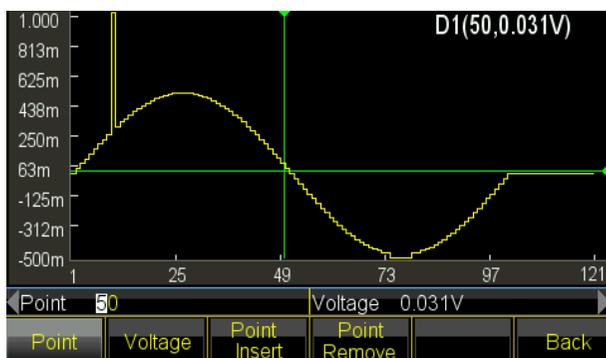
The example shows how to locally modify, insert and delete the points to one sine with 100 points:

- (1) Insert a sine with 100 points wave as the method introduced in chapter 3.15.2.
- (2) Press \llbracket Point Edit \rrbracket key to enter into the editing window.



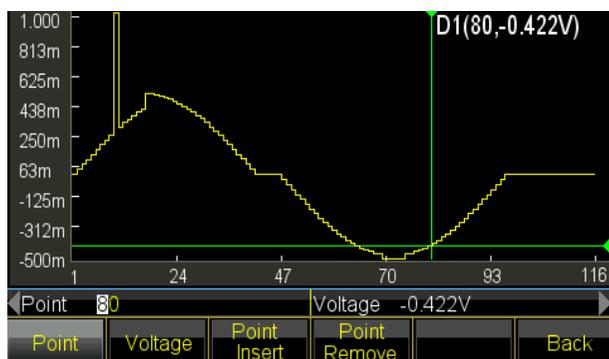
- (3) Press \llbracket Select Point \rrbracket key and set the X-axis to be 10.
- (4) Press \llbracket Point Voltage \rrbracket key and set the Y-axis to be 1.0V.

Once X and Y cursor are both on, user can press \llbracket Select Point \rrbracket and turn the knob to see the two cursors crossing moving along with the trace of sine, also the X and Y axis value of each point. When cursor moves to where X-axis is 0, Y-axis is 1.000V, that is also the setting of step 4 and 5 above.



In picture, the value of X and Y axis are auto adjusted by varying of setting range. The feature is applicable for other editing modes.

- (5) Move the X-axis to 50 and repeat pressing \llbracket Point Edit \rrbracket 5 times, you will observe that 5 points with same voltage are added to where 50 points locates and total points are plus 5:
- (6) Move the Y-axis to 26 and repeat pressing \llbracket Point Delete \rrbracket 10 times, you will observe that 10 points are deleted at where 26 points locate and total point decreased 10.

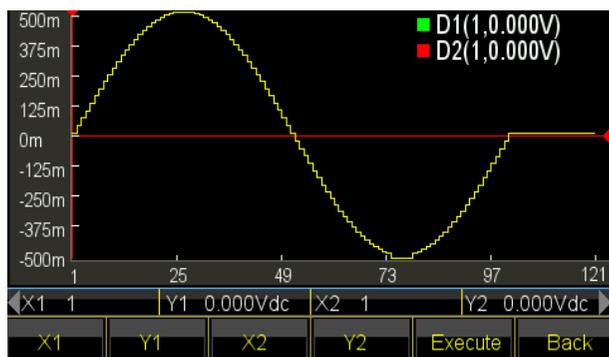


3.15.4 Line Edit

For Line Edit, user only need to set two points and generator will follow the linear regulation and auto set all the points between the two points, then connect which by a line. So compared to Point Edit, Line Edit could be quicker at creating the waveform by setting lots of points one time, applicable for linear modification to existing waveform or create a line waveform.

The example shows how to do linear modification to a sine wave with 100 points.

- (1) Insert a sine wave with 100 points as the method introduced in chapter 3.15.2.
- (2) Press \llbracket Line Edit \rrbracket key to enter into the editing window. X1 and Y1 indicate the start coordinate of a line in green. X2 and Y2 indicate the stop coordinate of a line in red.



- (3) Press \llbracket X1 \rrbracket key and set the X1 to be 10. Press \llbracket Y1 \rrbracket key and set Y1 to be 1Vdc, the green crossing is the start point of the line.

- (4) Press $\llbracket X2 \rrbracket$ key and set the X2 to be 10. Press $\llbracket Y2 \rrbracket$ key and set Y2 to be 0mVdc, the red crossing is the stop point of the line.
- (5) Press $\llbracket Execute \rrbracket$ key and generator will link up the start and stop point and send the new waveform to output.

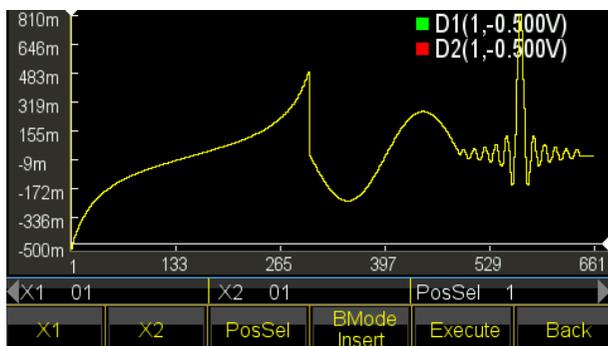


3.15.6 Block Edit

By Block Editing, user can insert, copy or delete the block wave to existing waveform and create a very complicated arbitrary waveform.

The example shows how to do the Block Edit to a arbitrary wave consist

- (1) Insert below three different waveforms as the method introduced in chapter 3.15.2.
 - Sinc Wave, amplitude 1.000Vpp, Offset 310mVdc, phase 0.0°, total points 150.
 - Sine Wave, amplitude 500mVpp, Offset 0mVdc, phase 180°, total points 200.
 - Tangent Wave, amplitude 1.000Vpp, Offset 0mVdc, phase 0.0°, total points 300.
- (2) Press $\llbracket Block Edit \rrbracket$ key to enter into the editing window. Then select option $\llbracket Block Insert \rrbracket$ or $\llbracket Block Copy \rrbracket$ or $\llbracket Block Delete \rrbracket$ to enter into the editing window.

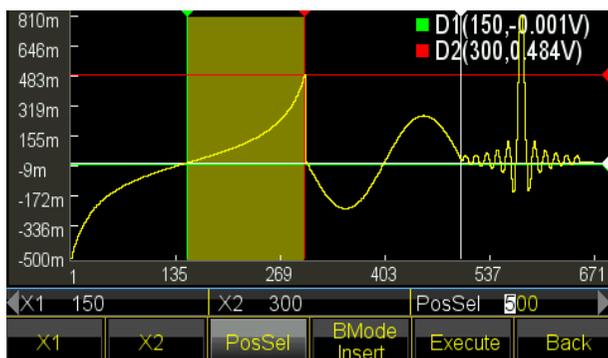


- (3) Block insert: Press \llbracket BMode \rrbracket and select “Insert” mode.

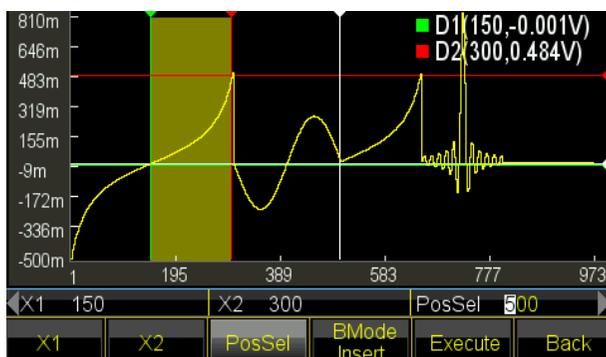
Press \llbracket X1 \rrbracket key to set start coordinate to be 150, that the green cursor cross will be the start point.

Press \llbracket X2 \rrbracket key to set stop coordinate to be 300, that the red cursor cross will be the stop point. The selected block wave is the last half part of Tangent.

Press \llbracket PosSel \rrbracket key to set insert position to be 500, that the white cursor cross is the position ready for insert, where behind the Sine.



Press \llbracket Execute \rrbracket key to insert the block wave to specified position and move the part of original wave behind the point to right and keep the shape.



- (4) Block Copy: Press \llbracket BMode \rrbracket and select “Copy” mode.

Always use the current selected wave.

Press \llbracket PosSel \rrbracket key to set copy position to be 650, that the white cursor cross is the position ready for insert, where is front the Sinc.

Press \llbracket Execute \rrbracket key to copy the block wave to specified position and cover the part of Sinc wave behind the point.



- (5) Operation Sequence: The sequence for inserting and copying is always from X1 to X2.

If coordinate X2 larger than X1, the block insert or copy direction will be from left to right. If coordinate X2 less than X1, the block insert or copy direction will be from right to left, which means the block wave is reverse image inserted.

Now change the X1 and X2 to each other, to make X2 less than X1.

Press \llbracket X1 \rrbracket key to set start coordinate to be 300, that the green cursor cross will be the start point.

Press $\llbracket X2 \rrbracket$ key to set stop coordinate to be 150, that the red cursor cross will be the stop point. The selected block wave is the last half part of Tangent.

Press $\llbracket Execute \rrbracket$ key, you will see that the selected block wave to be copied as reversed image to specified position.



- (6) Block Remove: Press $\llbracket BMode \rrbracket$ and select “Remove” mode.

Always use the current selected wave. There is no $\llbracket PosSel \rrbracket$ option.

press $\llbracket Execute \rrbracket$ key to make the selected wave to be removed, moving the part of Since wave behind the point to left and keep the shape unchanged. For this operation, X1 and X2 value has no influence.

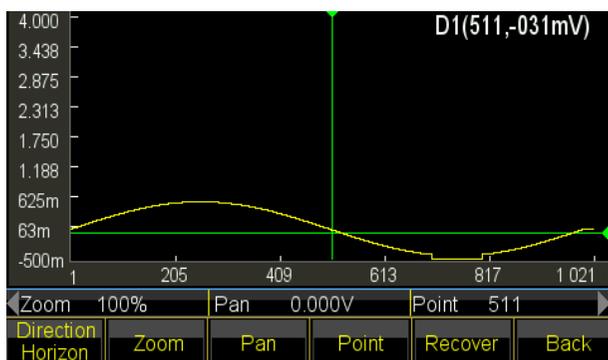


3.15.7 Horizontal Zoom and Shift

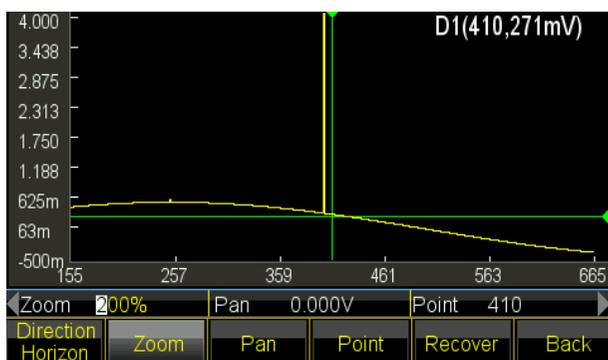
For some complicated waveform, it is difficult to observe the detail section in the limited window display. User can operate zoom or shift function to set the desired pantographratio to watch details of waveform.

The example shows how to zoom or shift a Sine wave with 1000 points:

- (1) Insert a sine wave with 1000 points as the method introduced in chapter 3.15.2.
- (2) Select the point that X coordinate is 400 and set its Y coordinate to be 4.000V with Point Edit function. Then select another point that X coordinate X is 250 and change its Y coordinate to be 550mVdc. Both of changed points can't be observed because of the low resolution of window.
- (3) Horizontal Zoom: exit the Point Edit function and press **[[Zoom/Shift]]** key to enter into the zoom/shift window:



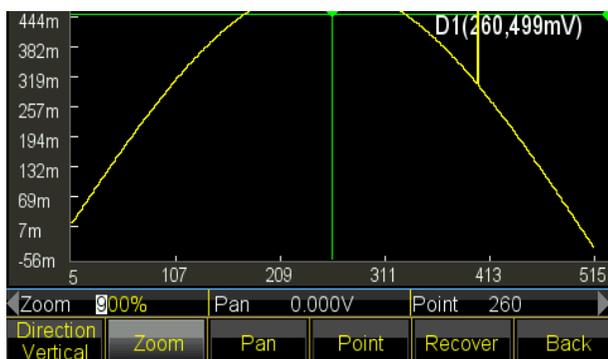
Press **[[Direction]]** key and select Horizon. Press **[[Point]]** key and set the horizontal coordinate to be 410. Generator will horizontally zoom as the center of point. Press **[[Zoom]]** and set the zoom ratio to be 200%. The waveform point (400, 4.000V) is displayed. Continue to increase the zoom ratio to 500%, you will see the points clearer:



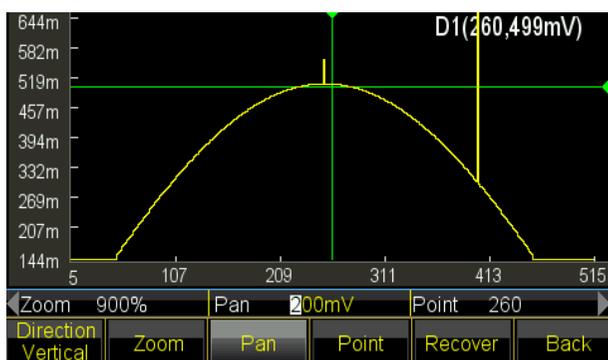
- (4) Vertical Zoom: Press \llbracket Point \rrbracket key and set the horizontal coordinate to be 260. Generator will vertically zoom as the center of point. Press \llbracket Zoom \rrbracket and set the zoom ratio to be 500%. The waveform point (250, 550mV) is displayed.



Continue to increase the zoom ratio to 900%, the point is overflow the window and can't be seen:



Press \llbracket Pan \rrbracket option and set Pan to be 200mVdc, the whole waveform move to down and you will observe the point (250, 550mV) again.



(5) Press [Recover] to back for the initial parameters and display the original waveform.

3.15.8 Store Waveforms

Generator allows user to save the current editing waveform to user-defined waveform, which is convenient for user to recall and use the editing waveform even exit of the editing function. It supplies 7 user-defined waveforms (User_arb (*), *=1, 2, 3...). The following steps show how to save the current editing waveform to user defined waveform.

- (1) Press [Advance] key to enter into setting menu.
- (2) Press [User] key and select waveform from 7 user defined waveforms. If selected waveform is existing, it will be substituted by new one.
- (3) Press [Return] and back to advance setting, Press [Return] key again to other function window.
- (4) Use the stored user defined waveform. User defined waveform can be selected from built-in waveforms, please refer to **Insert Built-in Waveform**.

3.15.9 Recall and Save Arbitrary Waveform

- (1) Recall the saved waveform: press [Stored Wave] key to enter into the file manager and select the file with "*.arb" extension. Then recall it as the method introduction in chapter 3.15.8,
- (2) Recall the arbitrary waveform: new created arbitrary waveform can be saved in non-volatile memory. Press [Store] key to enter into the file manager and save it, which will be saved as the extension "*.arb", the method introduced in chapter 3.16.8.

Note: during the editing, any other function key pressing will exit the editing function and the editing data will be lost, generator returns to the state before editing. Pay attention to save the arbitrary waveform data with the reference to Store Waveform.

3.15.10 Arbitrary Operation

User can change the sampling rate, waveform length, amplitude and offset of arbitrary during the creating of which.

Set sampling rate: press \llbracket Sample Rate \rrbracket key and set it by numeric key or knob within the range from 1uSa/s to 125MSa/s. frequency is decided both by sampling rate and arbitrary points, three parameters of which should follow the relationship:

$$\text{Output Frequency} = \text{Sampling Rate} * \text{Waveform Length}$$

Set waveform length: waveform length defines the actual sweep points, different from the point in editing. Press \llbracket Waveform Length \rrbracket and set it by numeric keys or knob within the range from 1 to limited points. If the output waveform differ from the displayed waveform after the editing operation including point insert, block copy, block cut, user need to modify the parameters to output desired point.

Set Amplitude and Offset: the setting of amplitude and offset is same as the normal operation to general waveforms.

3.15.11 Harmonic Waveform

As Fourier Transform theory tells, any periodic function can be decomposed to several Sine function with different frequencies, amplitudes and phases. On the other hand, we also can synthesize several Sine wave with different frequencies, amplitudes and phases to a periodic arbitrary waveform. By this method, user can well analog the distorted waveform in real life and supply the ideal signal source to testing device.

Our generator can make use of 2 to 50 harmonics to synthesize the arbitrary waveform, each of them can be set independently the harmonic times, phase and amplitude. Press **【Waveform】** key and then \llbracket Arb \rrbracket key, at last \llbracket Harmonic \rrbracket key to enter into the synthesis window.

- (1) Harmonic Times: it defines as the multiple of harmonic frequency to fundamental frequency, so the parameter should be the positive integer within 50. When harmonic time set as 1, harmonic frequency is fundamental frequency. It can be set as practical need, several times or even no fundamental and no order for times.

- (2) Harmonic Phase: it defines the phase difference between the start points of harmonic and fundamental wave with reference to a period 360° of fundamental.
- (3) Harmonic Amplitude: it defines the percentage that harmonic amplitude occupied in the full amplitude range of synthesizer. In limited condition, at a certain point, each harmonic amplitude adds as full range, so the sum of amplitude should be less than 100%. But practice is different, for same point, different harmonic amplitudes are possible offset by each other. So the sum of harmonic amplitude maybe larger than 100%. Once the final synthesized waveform get out of the full amplitude, it will produce the limited amplitude, User should make decision as practical need and less the amplitude of fundamental or some harmonics; If amplitude set as 0, the harmonic will be canceled.

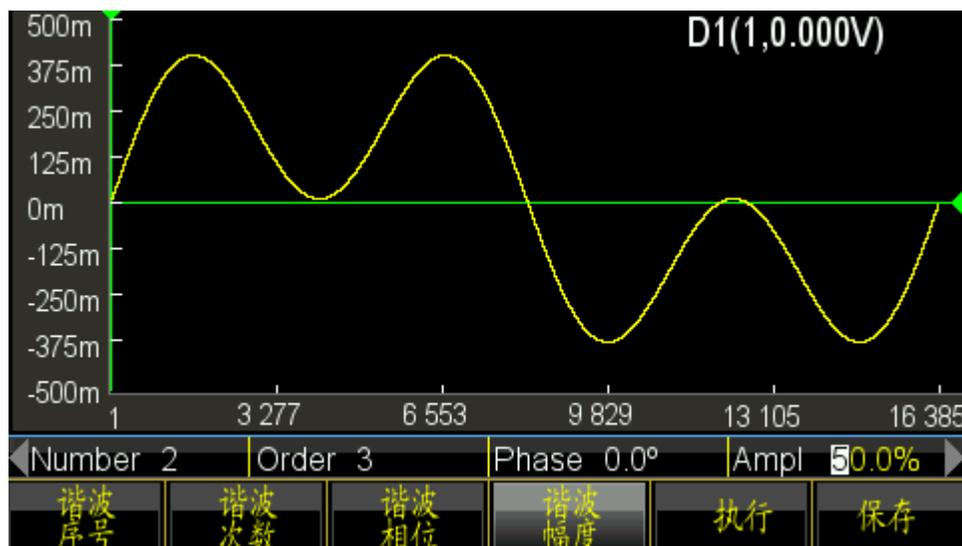
Press \llbracket Harmonic Order \rrbracket key to set the three parameters. When complete the setting, press \llbracket Execute \rrbracket key to synthesize the arbitrary waveform on basis of harmonics and show it on the window. The more times harmonics you set, the longer time for synthesis procedure needs.

When power off, the harmonic synthesis data will be lost. So press \llbracket Save \rrbracket key to store this harmonic wave to the "User_harmo" memory in \llbracket Special Wave \rrbracket of \llbracket Built-in Wave \rrbracket , which allows to be recalled.

The example shows how to synthesize a arbitrary waveform by fundamental and its 3 harmonics.

- (1) Press \llbracket Harmonic Order \rrbracket key and set it to be 1.
- (2) Press \llbracket Harmonic Time \rrbracket key and set it to be 1.
- (3) Default setting for \llbracket Harmonic Phase \rrbracket is 0, no need change.
- (4) Press \llbracket Harmonic Amplitude \rrbracket key and set it to be 50.00%.
- (5) Press \llbracket Harmonic Order \rrbracket key and set it to be 2.

- (6) Press [Harmonic Time] key and set it to be 3.
- (7) Default setting for [Harmonic Phase] is 0, no need change.
- (8) Press [Harmonic Amplitude] key and set it to be 50.00%.
- (9) Press [Execute] key. The synthesized waveform will be shown after a while.



3.16 System Configuration

Press [Utility] key to set the items like Language, Sync Output, Interface, Power Off State, Display/Beep, System Resume, Storage, Recall, Calibration and System Update.

3.16.1 Language

Press [Language] softkey to choose Chinese language or English language. The selection is available for operate menu and prompt information.

3.16.2 Sync Output

Press [SYNC] softkey to enable of disable the sync output.

3.16.3 Interface

Press [Interface] to enter into the setting menu, which have [Network] and [Return] two options. Press [Network] key and set the DHCP, IP address, Subnet Mask, Default Gateway and Return.

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 **[Subnet Mask]** key to set subnet mask by numeric keys.

Press **[Default Gateway]** key to set Default Gateway by numeric keys.

Press **[Return]** key to go back to last level menu, and press **[Confirm]** to enable the setting.

3.16.4 Power-on State

Press **[Power on State]** softkey and select “Last” option, generator will automatically recall the last setting that before power off when next power on. For specified conditions, user can set the power-on state as Last to reduce the repeated operation every time they turn on the generator. Once select “Default”, the generator will recall the default state at power-on.

3.16.5 Display/Beep

Press **[Display/Sound]** softkey to enter into the setting menu.

Press **[Screensaver]** key to set the screensaver on or off. If set on, the generator will enter into the screen protection at 2 minutes.

Press **[Brightness]** key to set the backlight of screen.

Press **[Key Beep]** key to enable or disable the beep for key pressing. Even if set the beep off, once the setting out of range, generator also gives a warning with long blew. The key pressing beep is only a short prompt tone.

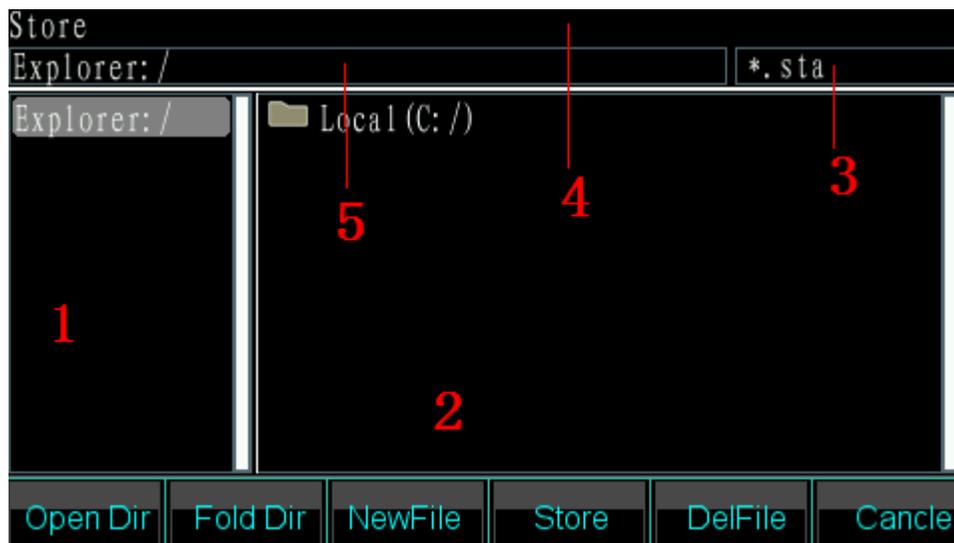
Press **[Display]** key to select display channel. If select single channel display, the graph displaying area will show current output sketch. If select dual channel, the graph area will be off and show the dual channel parameters. User also can set the independent channel parameter, just press the **[CHA/CHB]** to switch the channel.

3.16.6 System Reset

Press **[System Reset]** , generator will return to the system default setting.

3.16.7 Store

Press [Store] key to enter into the file manager.



File Manager:

- (1) Current Directory Area: to display current opened directory, that is the upper directory of sub-directory display area.
- (2) Sub-directory Area: to display the sub-directory of current directory and the file comply with the type.
- (3) Type of operated file: to indicate the required file type to accomplish the operation (*.sta, *.arb, *.exe).
- (4) Current operation: to indicate the use of current opened file manager such as State Operation (State Store and Recall, *.sta), Arbitrary Operation (Arbitrary Store and Recall, *.arb), Program Update (*.exe).
- (5) Current File Path: to indicate current operation directory of selected file.

Operation:

Select between directory and sub-directory by left/right key.

- (1) Open directory: 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]]** to show the next directories and files whose type meets with the operation requirement.
- (2) Fold directory: press left key to move the cursor to parent directory area, then select **[[Fold]]** option to fold current directory.
- (3) File name typing: if user want to create a new file that accords with the operation type, press **[[File Name]]** to enter desired numbers and letters. **[[Capital/Lower]]** key to switch between the capital letter and lowercase typing, arrow keys or knob to select letters and finally **[[Select]]** to confirm the typing letters. If make wrong type, user can press **[[Delete]]** to delete the wrong letter. When finish file name, press **[[Finish]]** to save the file. Generator will add the right suffix behind the file name. Press **[[Cancel]]** to exit the typing.
- (4) Press **[[Store]]** key to save the selected file.
- (5) Press **[[Delete]]** key to delete stored file.

3.16.8 Recall

Press **[[Recall]]** softkey to recall the file introduced in chapter 3.16.7.

3.16.9 System Update

Use this function to update the application firmware, which should be operated through USB interface. Before update, please format the U-disk first to ensure that there is no other file in.

The following step will show you how to update:

- (1) At power on, place the U-disk on USB device port, generator will identify it automatically and prompt a “Di” sound once it successfully connected.
- (2) Press **[[Utility]]** softkey to enter into the utility interface. Press **[[System Update]]** key and input the password 0.-123456 to enter into the file manager.

- (3) Select Removable Disk A in manager and .exe file. The further operation refers to chapter 3.16.8. Then select **[[System Update]]** to pop up the confirm window. If you select confirm, the generator will start updating and then restart with new firmware. If you select cancel, the generator will exit and operate with original firmware.
- (4) Note: make sure that the updating always at power on, once cut off the power, the generator will fail to update and restart, which need to return to factory for repair.

3.17 Frequency Counter

Press **【Counter】** key to enter into counter menu.

Connect the external measured signal to 'Counter' connector on rear panel, then to measure the frequency, period, pulse width and duty cycle of measured signal.

3.17.1 Continuous Signal

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

Press **[[Freq]]** softkey then select 'Frequency' to measure frequency of measured signal.

Press **[[Period]]** softkey then select 'Period' to measure period of measured signal.

Press **[[Width]]** softkey then select 'Width' to measure pulse width of measured signal.

Press **[[Duty Cyc]]** softkey then select 'Duty Cyc' to measure duty cycle of measured signal.

3.17.2 Non-continuous Signal

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

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

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

3.17.3 Gate Time

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

3.17.4 Trigger Level

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

3.17.5 Sensitivity

Press **[[Sensitiv]]** softkey then select 'Sensitive' to configure the desired sensitivity value. The bigger the value is, the higher the sensitivity is. The influence for sensitivity adjustment is small if the amplitude of tested signal is higher. But if the amplitude of measured signal is lower and noise contained in signal, you need adjust the sensitivity to get a better result. Generally speaking, improve sensitivity if test value of frequency is less than standard frequency of measured signal, or lower sensitivity if test value of frequency is greater than standard frequency of measured signal.

3.17.6 Coupling Mode

Press **[[Coupled]]** softkey to choose between AC or DC. If frequency of measured signal is higher with DC offset, select AC mode and set the trigger level to be 0. If frequency of

measured signal is lower than 1Hz or amplitude lower than 100mVpp, select DC mode and adjust trigger level properly to get a better result.

3.17.7 Low-pass Filter

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

3.18 Input/Output Port

The output port is not allowed using as input s port, or the waveform generator will be damaged. Clock Input port is isolated with case and other ports, also other ports such as Output port, Sync Output Port, Modulate Input are isolated with case.

3.18.1 CHA output port

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

3.18.2 CHB output port

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

3.18.3 Synchronous output port

Locate at front panel. Press **[Utility]**key then to **[Sync On/Off]**softkey to enable or disable the sync output. The indicator at top of port lights on if user enables the sync port. The indicator light off if user disables the sync port.

The synchronous output signal is a pulse signal with TTL compatible. The characteristic will be different under working mode changing, introduce as below,

- (1) If select CHA under continuous mode, frequency of sync signal is same as signal from CHA port, but phase lag to CHA's. The phase difference can be set on phase setting of CHA.
CHB under continuous mode is same as CHA.
- (2) Under FM, AM, PM, PWM and Sum mode, the duty cycle of sync signal is 50%, the frequency of sync signal is same as frequency of modulating waveform and the phase of sync signal are relative with phase of modulating waveform.
- (3) Under FSK, QFSK, 4FSK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier frequency and high level when outputting hop frequency.
- (4) Under PSK, QPSK, 4PSK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier phase and high level when outputting hop phase.
- (5) Under ASK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier amplitude, and high level when outputting hop amplitude.
- (6) Under OSK mode, the duty cycle of sync signal is 50%, frequency of sync signal equals to hop rate. The sync signal is low level when outputting carrier amplitude, and high level when outputting hop amplitude.
- (7) Under frequency sweep mode, the period of sync signal equals to total time of sweep process. The rise edge corresponding to start frequency point and falling edge corresponding to marker frequency point.

- (8) Under list sweep mode, the duty cycle of sync signal is 50%, period of sync signal equals to total sweep time and rise edge of sync signal corresponding to start number.
- (9) Under burst mode, period of sync signal equals to burst period, the rise edge corresponding to start point of burst signal and fall edge corresponding to stop point of burst signal. Sync signal is high level if enable burst signal but low level if disable burst signal.
- (10) Under FSK, QFSK, 4FSK, PSK, QPSK, 4PSK, ASK, OSK, frequency sweep, list sweep and burst output mode, the frequency of sync signal will determined by trigger signal if external or manual trigger is selected.

3.18.4 Clock Output Port '10MHz Out'

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

3.18.5 Clock Input Port '10MHz In'

Locate at rear panel and can be inputted external clock signal to make the generator synchronized with other device, also can take the higher accuracy frequency standard as the clock.

3.18.6 Counter Input Port 'Counter'

Locate at rear panel and can be inputted test signal.

3.18.7 Modulation In/Trigger In/Out Port 'Trig In/OUT Mod In'

Locate at rear panel and both of input/output port, can work at input state and output state. When outputs internal trigger signal, input function is disabled. Input external modulating signal under FM, AM, PM, PWM and Sum mode. Input external trigger signal under FSK, PSK, ASK, OSK modulating modes, frequency sweep, list sweep and burst modes. Also can output internal trigger signal under frequency sweep, list sweep, burst output mode.

3.19 Communication Port

3.19.1 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.

3.19.2 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.

3.19.3 LAN Port

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

3.20 Calibration

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

Professional staffs are required for calibration work and calibration used instruments must comply with the accuracy requirements. When calibrating, the instrument needs to be warmed up more than 30 minutes and the environments should be meet the specification required.

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

3.20.1 Enable Calibration

Press **【Utility】** key then to **〔Calibrate〕** softkey.

Press **〔Password〕** key then enter calibration code. Press **〔Finish〕** to enter into calibration window. User can make calibration to frequency, offset, amplitude, flatness, offset level and

trigger level of counter, the relationship among offset, amplitude and flatness separately by knob, numeric keys and Last Page/Next Page.

3.20.2 Channel Selection

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

3.20.3 Frequency Calibration

After channel selected, press \llbracket Freq Cal \rrbracket softkey to enter into frequency calibration window. Then press \llbracket Cal Value \rrbracket key and set it by knob or numeric keys, to make the frequency as close to 1MHz as possible. Finally press \llbracket Finish \rrbracket key to exit the calibration.

3.20.4 Offset Calibration

Press \llbracket Offs Cal \rrbracket softkey to enter into offset calibration window. Connect generator with digital multimeter, adjust the calibration value to make the signal offset as the target value according to calibration instruction. Press \llbracket Next \rrbracket key or input calibration value to enter into the next point calibration. Go on the next standard points calibration like this, finally press \llbracket Finish \rrbracket key to exit the calibration.

3.20.5 Amplitude Calibration

Press \llbracket Ampl Cal \rrbracket softkey to enter into amplitude calibration window. Then adjust the calibration value to make the signal output amplitude as the target value according to calibration instruction. Press \llbracket Next \rrbracket key or input calibration value to enter into the next point calibration. Go on the next standard points calibration like this, finally press \llbracket Finish \rrbracket key to exit the calibration.

3.20.6 Flatness Calibration

The amplitude of output signal will decrease as the frequency increasing. Therefore, you need to calibrate for different frequency points. Amplitude flatness uses the relative

comparison method and makes the amplitude with 1MHz frequency as comparison standard. The calibration includes 3 parts, nominal amplitude of which is 4dBm, 17.96 dBm and 11.93dBm. The step is 5MHz for output signal frequency.

Press **[Flat Cal]** softkey to enter into flatness calibration window.

- (1) Calibration sequence display as 0#. Now the generator output 1MHz frequency, 4dBm amplitude reference signal. Measure the actual output amplitude by spectrum analyzer, the result of which is taken as the first reference value. Press **[Next]** key and sequence still shows 0#. Adjust calibration value to make the output amplitude equals to the reference value. Go on the operation like this until the first section flatness calibration finishes. (0# ~ 31#).
- (2) The second and third section of calibration is same as the first section.

3.20.7 Counter Offset Calibration

Press **[Count Cal]** softkey to enter into counter offset calibration window. Test the TP49 point on mainboard by using of DC multimeter. Then adjust the calibration value to make the voltage on 0# of point TP49 as 0.5Vdc. Finally press **[Finish]**key to exit the calibration. (Please note that this calibration needs to open the case, if counter works normal, you don't have to calibrate it).

3.20.8 Trigger Level Calibration

Press **[Trig Level Cal]** softkey to enter into trigger level calibration window. Test the TP55 point on mainboard by using of DC multimeter. Then adjust the calibration value to make the TP55 voltage on 0# as 0Vdc and on 1# as 0.5Vdc. Finally press **[Finish]** key to exit the calibration. (Please note that this calibration needs to open the case, if counter works normal, you don't have to calibrate it).

3.20.9 Store Calibration Value

User must store the calibration value after finishing the calibration, for it would be lost once power-off. Press [Cal Store] key to save the data to non-volatile memory. Generator exit the calibration after storage.

3.20.10 Recall Calibration Value

Press [Cal Recall] softkey then screen prompts inquiry "Back to factory calibration setting?". Press [Default] to select default calibration data. Press [Finish] to enable the recalling. Press [Cancel] to exit the recalling.

When power on, the waveform generator will recall automatically the value from [User Value] memory and applied to it.

3.20.11 Exit Calibration

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

3.21 System Reset

Press [Utility] key then to [Reset] softkey to recall the default setting value.

3.22 Default Setting

3.22.1 Continuous Output

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	Normal	Output Port	Off
External Load	High Z		

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

Frequency Difference	600Hz	Sum Frequency	100Hz
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AM Depth	100%	Modulating Frequency	100Hz
Phase Difference	90°	Modulating Waveform	Sine
Pulse Width Difference	50%	Modulating Source	Internal
Sum Amplitude	20%		

3.22.3 Modulating Output (FSK, QFSK, 4FSK, PSK, QPSK, 4PSK, ASK and OSK)

Hop Frequency (FSK)	200Hz	Hop Phase (PSK)	180°
Hop Frequency (QFSK, 4FSK)	Hop Freq 1: 200Hz Hop Freq 2: 5.0Hz Hop Freq 3: 400Hz	Hop Phase (QPSK, 4PSK)	Hop Phase 1:180° Hop Phase 2:45° Hop Phase 3:90°
Hop Time	1.0ms	Hop Amplitude	0.5Vpp
Hop Rate (FSK, QFSK, 4FSK)	100Hz	Hop Rate (PSK, QPSK, 4PSK)	500Hz
Hop Rate (ASK, OSK)	100Hz	Modulating Source	Internal

3.22.4 Frequency Sweep

Start Frequency	100Hz	Sweep Time	3s
Stop Frequency	1kHz	Hold Time	0s
Marker Frequency	550Hz	Return Time	0s
Sweep Mode	Linear	Interval Time	1ms
Trigger Source	Immediate		

3.22.5 List Sweep

Start Number	1#	Hold Time	0ms
Stop Number	21#	Trigger Source	Immediate
Stop Time	1s		

3.22.6 Burst Output

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

3.22.7 Dual Channel Operation

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

3.25.8 System Configuration

Beeper	On	Power-on State	Default
Display Mode	Single CH	Screen saver	Off
Error Queue	Clear	Calibration State	Closed
Brightness	50%	DHCP	Off

3.23 Power Amplifier (Option)

If user selects power amplifier, a power amplifier board will be supplied in the package, 'Amplifier In' in rear panel is input connector of power amplifier and 'Amplifier Out' is output connector of power amplifier.

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

3.23.1 Input Waveform

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

3.23.2 Input voltage

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

3.23.3 Frequency range

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

3.26.4 Output power

The expression of power for the power amplifier is

$$P = V^2 / R$$

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

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

3.23.5 Output protection

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

Chapter 5 Specifications

5.1 Continuous Output (CHA&CHB)

5.1.1 Waveform

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

Built-in Waveforms: 137 waveforms including PRBS (Pseudorandom Binary Sequence), Exponential Fall, Exponential Rise, Logarithm, Sinc, Gaussian, Cardiac, Tangent, Semi-Circle, Quake, etc.

User-defined Arbitrary: 7

User-defined Harmonic: 1 (Max. 50 times, amplitude and phase adjustable)

Sampling Rate: 500MSa/s

Vertical Resolution: 14bits

5.1.2 Sine

Harmonic distortion (0dBm): $\leq -60\text{dBc}$ Frequency < 10MHz
 $\leq -55\text{dBc}$ Frequency < 80MHz
 $\leq -50\text{dBc}$ Frequency < 100MHz
 $\leq -45\text{dBc}$ Frequency $\geq 100\text{MHz}$

Total Distortion (20Hz to 20kHz, 20Vpp): $\leq 0.1\%$

5.1.3 Square, Pulse and Ramp

Duty Cycle of Square/Pulse: 0.1% to 99.9%

(minimum Pos width and Neg width of Square is 10ns)

Overshoot of Square/Pulse (Typical Value): $\leq 5\%$

Edge time of Square (1Vpp): $\leq 8\text{ns}$

Edge time of Pulse (1Vpp): 4ns to 100us

Pulse Width: 10ns to 1000s

Symmetry of Ramp: 0.0% to 100.0%

5.1.4 Arbitrary Waveform

Waveform Length:	6 to 1M points
Sample Rate:	1uSa/s to 125MSa/s, 1uSa/s Resolution
Amplitude Resolution:	14bits

5.1.5 Frequency

Frequency Range:

Sine:	1μHz to 160MHz (see note)
Square and Pulse:	1μHz to 50MHz (see note)
Ramp:	1μHz to 5MHz
Other waveforms:	1μHz to 30MHz

Frequency Resolution: 1μHz

Frequency Accuracy: $\pm(2\text{ppm}+1\mu\text{Hz})$

5.1.6 Amplitude (offset 0Vdc)

Amplitude Range:

2mVpp to 20Vpp (open circuit), 1mVpp to 10Vpp (50Ω)	Frequency≤40MHz
2mVpp to 10Vpp (open circuit), 1mVpp to 5Vpp (50Ω)	Frequency≤80MHz
2mVpp to 5Vpp (open circuit), 1mVpp to 2.5Vpp (50Ω)	Frequency≤120MHz
2mVpp to 4Vpp (open circuit), 1mVpp to 2Vpp (50Ω)	Frequency>120MHz

Amplitude Resolution:

2mVpp (Amplitude≥2Vpp, open circuit), 1mVpp (Amplitude≥1Vpp, 50Ω)

0.2mVpp (Amplitude<2Vpp, open circuit), 0.1mVpp (Amplitude<1Vpp, 50Ω)

Amplitude Accuracy (1kHz Sine, 0V offset, auto range):

$$\pm(\text{setting value} \times 1\% + 2\text{mVpp})$$

Amplitude Flatness (compared to 1MHz Sine):

$$\pm 0.1\text{dBm} \quad \text{frequency} < 10\text{MHz}$$

$\pm 0.2\text{dBm}$ frequency $< 80\text{MHz}$

$\pm 0.3\text{dBm}$ frequency $\geq 120\text{MHz}$

Amplitude Unit (Sine): V_{pp} , V_{rms} and dBm

5.1.7 Offset

Offset Range: $\pm 5\text{Vpk ac} + \text{dc}$ (50Ω)

$\pm 10\text{Vpk ac} + \text{dc}$ (open-circuit)

Offset Resolution: 1mVdc (offset $\geq 0.5\text{Vdc}$, 50Ω)

0.1mVdc (offset $< 0.5\text{Vdc}$, 50Ω)

2mVdc (offset $\geq 1\text{Vdc}$, open circuit)

0.2mVdc (offset $< 1\text{Vdc}$, open circuit)

Offset Accuracy: $\pm(\text{setting value} \times 1\% + 2\text{mVdc} + \text{amplitude} \times 0.5\%)$

5.1.8 Polarity and Phase

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

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

5.1.19 Output Port

Output Impedance: 50Ω (typical)

Protection: overload automatically disables main output

Connector: connect with the housings of Sync Output, Modulate In, Counter In, Clock Out, but isolated with case, limited voltage for connector housing is 42Vpk .

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 (FM, AM, PM, PWM)

	1mHz to 1MHz (Sum)
Frequency Difference:	0 μ Hz to half of Max. Frequency
AM Modulating Depth:	0% to 120%
Phase Deviation:	0° to 360°
Pulse Width Deviation:	0% to 99%
Sum amplitude:	0% to 100%
Modulating Source:	Internal and External

5.2.2 FSK, 4FSK, QFSK, PSK, 4PSK, QPSK, ASK and OSK

Carrier Waveforms:	Sine, Square, Ramp and so on
FSK Frequency:	1 μ Hz to Max. Frequency
Hop Phase:	0° to 360°
Hop Amplitude:	2mVpp to amplitude of carrier
Hop Time:	4ns to 400s
Hop Rate:	1mHz to 1MHz
Modulating Source:	Internal/External

5.3 Sweep Characteristics

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

5.3.2 Sweep Mode: linear, logarithmic, list sweep of whole range

5.3.3 Sweep Time:

Linear and Logarithmic Sweep:

Sweep Time:	1ms to 500s
Hold Time:	0s to 500s
Return Time:	0s to 500s
Interval Time:	0s to 500s

List Sweep:

Dwell Time:	1ms to 500s
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Hold Time: 0s to 500s

5.3.4 Frequency List Length: 128

5.3.5 Trigger Source: internal, external and manual

5.4 Burst Output

5.4.1 Burst Waveform: Sine, Square, Ramp and etc.

5.4.2 Burst Mode: Triggered, Gated

5.4.3 Burst Period: 1 μ s to 500s

5.4.4 Burst Count: 1 to 100000000 cycles

5.4.5 Gated Output: More than two complete cycles

5.4.6 Start/Stop Phase: 0° to 360°

5.4.7 Trigger Source: internal, external or manual

5.5 Dual Channels Characteristics

5.5.1 Frequency Coupling: frequency ratio, frequency difference

5.5.2 Amplitude & Offset Coupling: amplitude difference, offset difference

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

5.6 SYNC Output

5.6.1 Waveform Characteristics: TTL compatible, edge time \leq 10ns

5.6.2 Frequency and Pulse Width: changes as working mode

5.6.3 Output Impedance: 50 Ω typical value

5.6.4 Connector Grounded: connect with the housings grounded and isolated with case, limited voltage for connector housing is ± 42 Vpk.

5.7 Modulation In and Trigger In/Out

5.7.1 Modulation Input:Input Voltage: $\pm 2.5V_{pp}$ (full scale)Input Impedance: $10k\Omega$ **5.7.2 Trigger Input:**

Input Level: TTL Compatible

Input Impedance: $1k\Omega$ **5.7.3 Trigger Output:**

Output Level: TTL Compatible

Input Impedance: $1k\Omega$ **5.7.4 Connector:** isolated with case, limited voltage for connector housing is $\pm 42V_{pk}$ **5.8 Frequency Counter****5.8.1 Frequency Range:** 10MHz to 350MHz Resolution: 7 digits/s**5.8.2 Measurement of Period and Pulse-width:** 100ns to 20s**5.8.3 Duty Cycle Measurement:** 1% to 99%**5.8.4 Count Measurement:** 1 to 9999999999**5.8.5 Sensitivity:**

20mVrms to 5Vrms	10MHz to 150MHz
40mVrms to 5Vrms	150MHz to 250MHz
100mVrms to 5Vrms	250MHz to 300MHz
200mVrms to 5Vrms	300MHz to 350MHz

5.8.6 Gate Time: 1ms to 100s**5.8.7 Trigger Level:** -2.5V to +2.5V**5.8.8 Couple Mode:** AC, DC**5.8.9 Low-pass Filter:** enable or disable**5.8.9 Connector:** isolated with case, limited voltage for connector housing is $\pm 42V_{pk}$

5.9 Communication Port

5.9.1 Interface type: USB Device, USB Host, LAN

5.9.2 Connector: connected with case grounded

5.10 Clock

5.10.1 External Clock Input

Clock Frequency: 10 MHz \pm 50Hz

Clock Amplitude: 100m V_{pp} to 5 V_{pp}

Input Impedance: 300 Ω , AC coupling

Connector: isolated with case and other connectors

5.10.2 Internal Clock Output

Clock Frequency: 10 MHz

Clock Amplitude: >1 V_{pp}

Output Impedance: 50 Ω , AC coupling

Connector: isolated with case, limited voltage for connector housing is \pm 42V_{pk}

5.11 General Characteristics

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

5.11.2 Environment Condition: Temperature: 0 to 40°C Humidity: <80%

5.11.3 Display: 4.3" colorful TFT-LCD, 480 \times 272 pixel

5.11.4 Dimensions & Weight: 367 \times 256 \times 106 mm, Approx.3.7 kg

5.12 Power Amplifier (Option)

5.12.1 Input signal:

Voltage: 0Vrms to 5Vrms

Frequency: 1Hz to 200kHz

5.12.2 Voltage Amplifier: double

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

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

Note 1: The test of the specifications should be operated under temperature of 18°C to 28°C, warm up time >30 minutes

Note 2: TFG3916A Sinewave frequency range: 1μHz~160MHz

Square and Pulse frequency range: 1μHz~50MHz

TFG3912A Sinewave frequency range of: 1μHz~120MHz

Square and Pulse frequency range: 1μHz~40MHz

TFG3908A Sinewave frequency range of: 1μHz~120MHz

Square and Pulse frequency range: 1μHz~43MHz