

GF-856

SINGLE-CHANNEL ARBITRARY WAVEFORM GENERATOR


















Version	Date
1.0	September 2016

SAFETY RULES

- * Use Proper Power Cord. Use only the power cord supplied with the product and certified to use in your country.
- * Product Grounded. This instrument is grounded through the power cord grounding conductor. To avoid electric shock, the grounding conductor must be grounded. The product must be grounded properly before any connection with its input or output terminal.
- * Check all Terminal Ratings. To avoid fire or shock hazard, check all ratings and markers of this product. Refer to the user's manual for more information about ratings before connecting to the instrument.
- * Do not operate without covers. Do not operate the instrument with covers or panels removed.
- * Use Proper Fuse. Use only the specified type and rating fuse for this instrument. Do not place the equipment on damp or wet surfaces.
- * Avoid exposed circuit. Do not touch exposed junctions and components when the instrument is powered.
- * Do not operate if in any doubt. If you suspect damage occurs to the instrument, have it inspected by qualified service personnel before further operations.
- * Use your instrument in a well-ventilated area. Make sure the instrument installed with proper ventilation, refer to the user manual for more details.
- * Do not operate in wet conditions.
- * Do not operate in an explosive atmosphere.
- * Keep product surfaces clean and dry.

*** Symbols related with safety:**

	DIRECT CURRENT		ON (Supply)
	ALTERNATING CURRENT		OFF (Supply)
	DIRECT AND ALTERNATING		DOUBLE INSULATION (Class II protection)
	GROUND TERMINAL		CAUTION (Risk of electric shock)
	PROTECTIVE CONDUCTOR		CAUTION REFER TO MANUAL
	FRAME TERMINAL		FUSE
	EQUIPOTENTIALITY		EQUIPMENT OR COMPONENT TO BE RECYCLED
			

Descriptive Examples of Over-Voltage Categories


Cat I Low voltage installations isolated from the mains.

Cat II Portable domestic installations.

Cat III Fixed domestic installations.

Cat IV Industrial installations.

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SINGLE-CHANNEL ARBITRARY WAVEFORM GENERATOR

GF-856

1 INTRODUCTION

1.1 Description

These products are multi-function generator which combines Arbitrary Waveform Generation and Function Generation. The product introduces Direct Digital Synthesizer (DDS) technology to provide stable, precise, pure and low distortion signal.

The user-friendly interface design and panel layout bring exceptional user experience. Provide more alternative solutions for users.

1.2 Main Features

- 4 inch high resolution (480 × 320 pixels) TFT LCD display;
- Advanced DDS technology, max. 60 MHz frequency output;
- Max. Sample rate: 125 MSa/s, Frequency resolution: 1 μ Hz;
- Vertical resolution: 14 bits, max. 8192 waveform record length;
- Abundant waveform output: 5 basic waveforms and 45 built-in arbitrary waveforms output;
- Exponential rise, Exponential fall, $\text{Sin}(x)/x$, Staircase, etc. 45 built-in waveforms and user defined arbitrary waveform;
- Abundant modulation functions along with output liner/logarithm sweep and pulse string waveform;
- Standard interface: USB (type B) connector.



2 GETTING STARTED

2.1 Front Panel

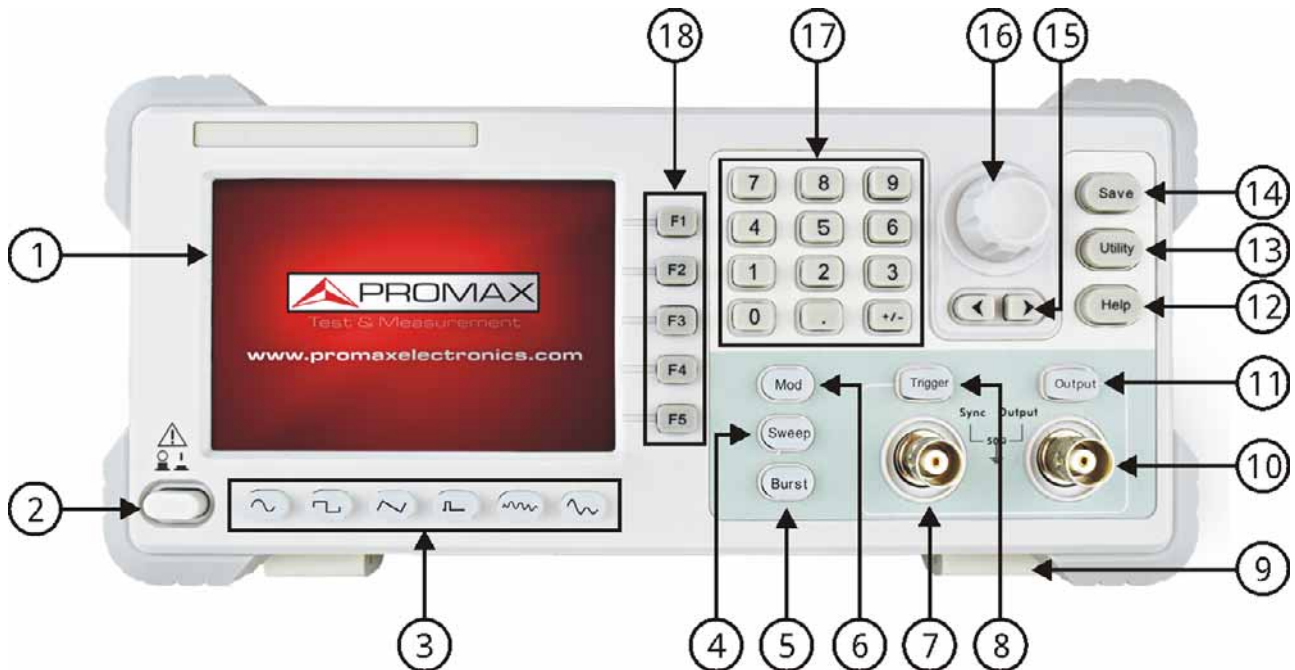










Figure 1. Front panel description.

- ① **LCD:** Display the user interface.
- ② **Power button:** Turn on/off the generator.
- ③ **Waveform selection buttons:** Include: Sine , Square , Ramp , Pulse , Noise  and Arbitrary  waveform. When a waveform is selected, the backlight of the button turns on.
- ④ **Sweep button:** Sweep Sine, Square or Ramp waveform.
- ⑤ **Burst button:** Generate burst for Sine, Square, Ramp, Pulse and Arbitrary waveform.
- ⑥ **Modulation button:** Generate the Modulated waveforms.
- ⑦ **Sync output terminal:** Output sync signal.
- ⑧ **Trigger key:** Activate or deactivate the sync signal output. The button is lit when it is in the On state.
- ⑨ **Foot stool:** Make the instrument to be tilted for ease of operation.
- ⑩ **Main output terminal:** Output main signal.



- 11 **Output key:** Activate or deactivate the output signal. The button is lit.
- 12 **Help button:** View the build-in help information.
- 13 **Utility button:** Set the auxiliary system function.
- 14 **Save button:** Manage the waveform files in the file system.
- 15 **Direction key:** Move the cursor of the focused parameter or select the file locations.
- 16 **Knob:** Change the current highlighted number, also can be used to select file location or switch the character of the soft keyboard when entering file name. In Sweep and N-Cycle Burst, if you choose Source as "Manual", every time you press this knob, the generator will be triggered once.
- 17 **Number keys:** Input parameters, include: number, point and plus/minus sign.
- 18 **Menu selection buttons:** Include 5 buttons:  - , activate the corresponding menu.



2.2 Rear Panel



Figure 2. Rear panel description.

- 1 **Ext Trig/Burst/Fsk In connector:** This signal can be used as external signal source in Sweep, Burst and FSK mode.
- 2 **Ref Clk/Counter In connector:** To accept an external clock signal, or to accept the input signal of counter.
- 3 **Ext Mod In Connector:** External modulation input, use it as external signal source.
- 4 **USB (type B) connector:** This can be used to connect a USB type B controller. Connect with an external device, such as connected to a PC and controlled via PC software.
- 5 **Power switch:** Switch between 110 V and 220 V.
- 6 **Fuse:** The rating is 250 V, F2AL.
- 7 **Power socket:** AC input connector.

2.3 Display

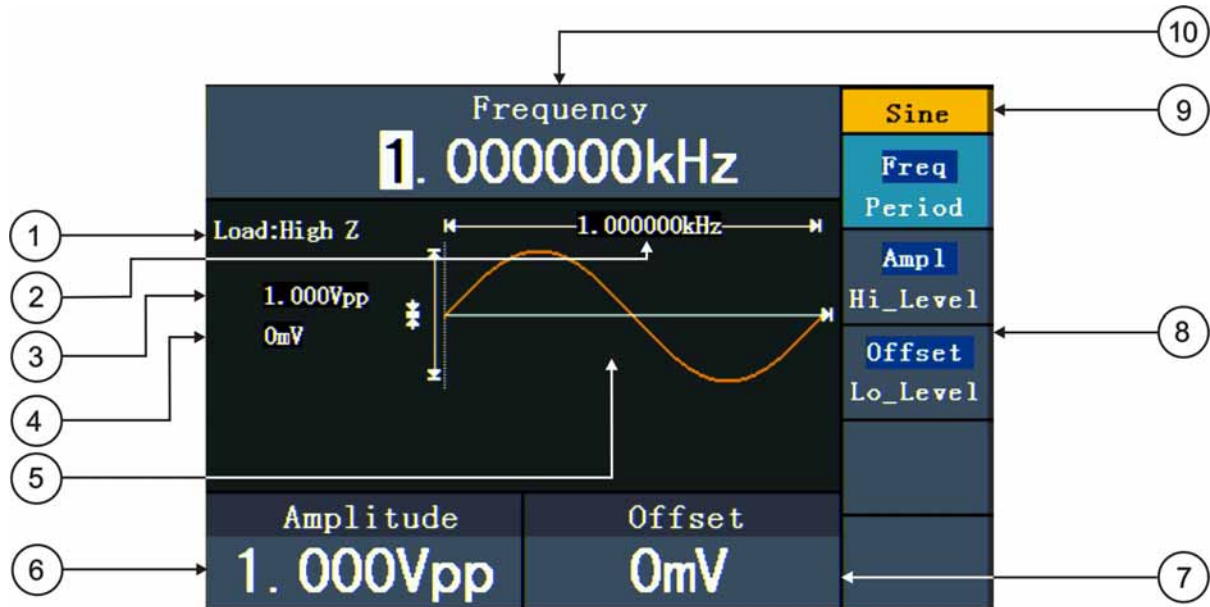


Figure 3. User Interface description.

- ① Load, High Z represents high resistance.
- ② Frequency/period, depends on the highlighted menu item on the right.
- ③ Amplitude/high level, depends on the highlighted menu item on the right.
- ④ Offset/low level, depends on the highlighted menu item on the right.
- ⑤ Display current waveform.
- ⑥ Parameter 2, display parameter and edit the focused parameter.
- ⑦ Parameter 3, display parameter and edit the focused parameter.
- ⑧ The setting menu of current signal or mode.
- ⑨ Current signal type or mode.
- ⑩ Parameter 1, display parameter and edit the focused parameter.



2.4 General Inspection

After you get a new Waveform Generator, it is recommended that you should make a check on the instrument according to the following steps:

Check whether there is any damage caused by transportation

If it is found that the packaging carton or the foamed plastic protection cushion has suffered serious damage, do not throw it away first till the complete device and its accessories succeed in the electrical and mechanical property tests.

Check the Accessories

The supplied accessories are:

- A power cord that fits the standard of the destination country
- A USB cable
- A Quick Guide
- A BNC/Q9 cable

You can check whether there is any loss of accessories with reference to this description. If it is found that there is any accessory lost or damaged, please get in touch with the distributor of PROMAX responsible for this service or the PROMAX local offices.

Check the Complete Instrument

If it is found that there is damage to the appearance of the instrument, or the instrument can not work normally, or fails in the performance test, please get in touch with the PROMAX distributor responsible for this business or the PROMAX local offices. If there is damage to the instrument caused by the transportation, please keep the package.

Foot Stool Adjustment

Unfold the foot stools on the bottom of the generator, as shown at number 10 of frontal panel figure.

2.4.1 AC Power Input Setting

AC Power Input Setting

Adopt 110 V / 220 V AC power source. Users should regulate the voltage scale of the **Power Switch** according to the standards in their own country at the rear panel.

To change the voltage scale of the instrument, do the following steps:

- 1 Turn off the power button at the front panel and remove the power cord.
- 2 Regulate the Power Switch to the desired voltage scale.



2.4.2 Power On

- 1 Connect the instrument to the AC supply using the supplied power cord.

Warning:



To avoid electric shock, the instrument must be grounded properly.

- 2 Press down the power button at the front panel, the screen shows the boot screen.



3 PANEL OPERATION

3.1 Channel Output On/Off

Press **Output** to turn on/off signal output. The button is lit when it is in the On state. You can configure the signal with the outputs off to minimize the chance of sending a problematic signal.

3.2 To set signals

The following describes how to set and output Sine (⌚), Square (⌚), Ramp (⌚), Pulse (⌚), Noise (⌚), Arbitrary (⌚) signals and DC and copy channel.

3.2.1 To Output Sine Signals

Press (⌚) button to call the user interface of Sine signal, the Sine waveform parameters can be set by operating the Sine setting menu on the right.

The parameters of Sine waveform are: **Frequency/Period, Amplitude/High Level, Offset/Low Level**. You can operate the menu by using the menu selection buttons on the right.

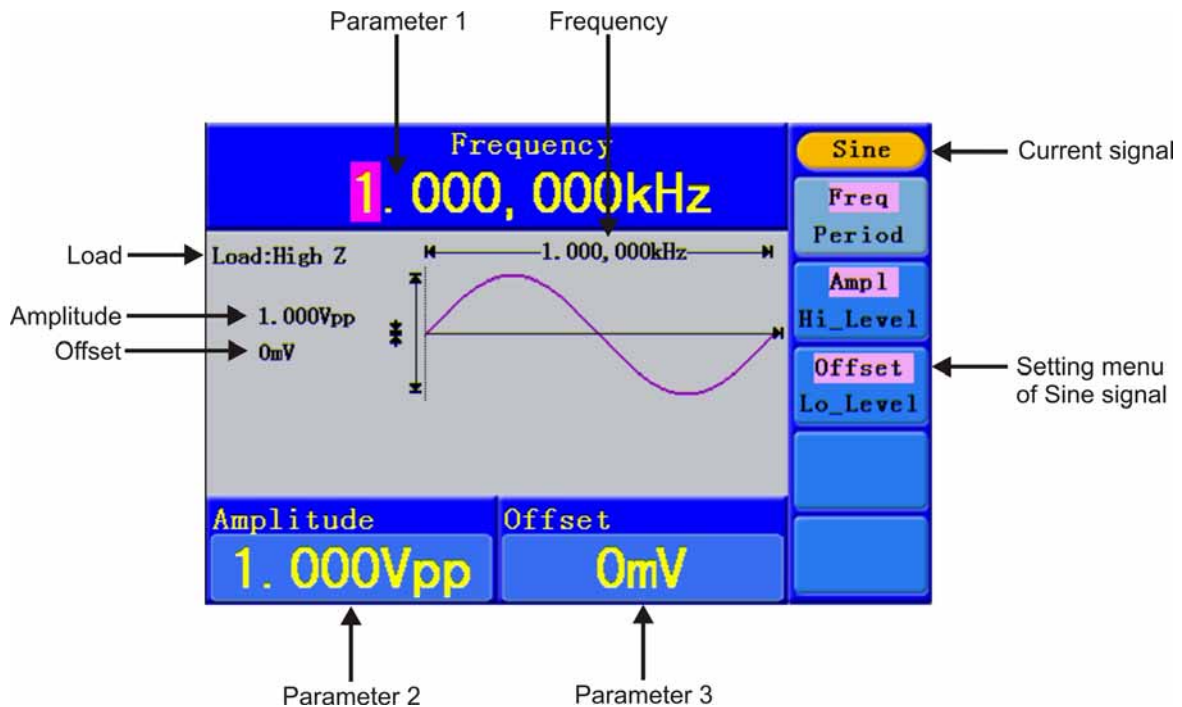


Figure 4 The User Interface of Sine Signal.



► To Set the Frequency/Period

Press **F1** button, the chosen menu item is highlighted, the focused parameter is displayed in **Parameter 1**. Press **F1** button to switch between Frequency/Period.

Two methods to change the chosen parameter:

- Turn the **knob** to change the value of cursor position. Press **◀/▶** direction key to move the cursor.
- Press a number key in the front panel, an input box will pop up; keep going to input the value. Press direction key **◀** to delete the last number. Press **F1** ~ **F3** to choose the unit, or press **F4** to go to next page and choose other units. Press **F5** to cancel the input.

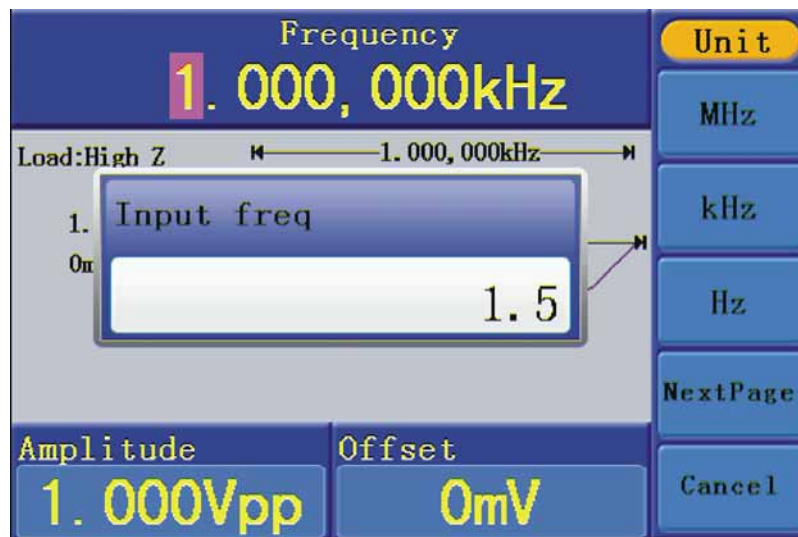


Figure 5. Set the frequency using number keys.

► To Set the Amplitude

Press **F2**, confirm whether the "**Ampl**" menu item is highlighted; if not, press **F2** to switch into "**Ampl**". In **Parameter 2**, a cursor appears under the value of amplitude. Use the knob or the number keys to set the desired value.

► To Set the Offset

Press **F3**, confirm whether the "**Offset**" menu item is highlighted; if not, press **F3** to switch into "**Offset**". In **Parameter 3**, a cursor appears under the value of offset. Use the **knob** or the number keys to set the desired value.



▶ **To Set the High Level**

Press **F2**, confirm whether the "Hi_Level" menu item is highlighted; if not, press **F2** to switch into "Hi_Level". In **Parameter 2**, a cursor appears under the value of amplitude. Use the **knob** or the number keys to set the desired value.

▶ **To Set the Low Level**

Press **F3**, confirm whether the "Lo_Level" menu item is highlighted; if not, press **F3** to switch into "Lo_Level". In **Parameter 3**, a cursor appears under the value of offset. Use the **knob** or the number keys to set the desired value.

3.2.2 To Output Square Signals

Press **F2** button to call the user interface of Square signal, the Square waveform parameters can be set by operating the Square setting menu on the right.

The parameters of Square waveform are: **Frequency/Period, Amplitude/High Level, Offset/Low Level, Duty**. You can operate the menu by using the menu selection buttons on the right.

To set the Frequency/Period, Amplitude/High Level, Offset/Low Level, please refer to "To Output Sine Signals").

Press **F5** button to select TTL Output, TTL level will be outputted. When the load is High Z, the output signal is set to 5 Vpp amplitude and 2.5 V offset. When the load is 50 Ω, the output signal is set to 2.5 Vpp amplitude and 1.25 V offset.

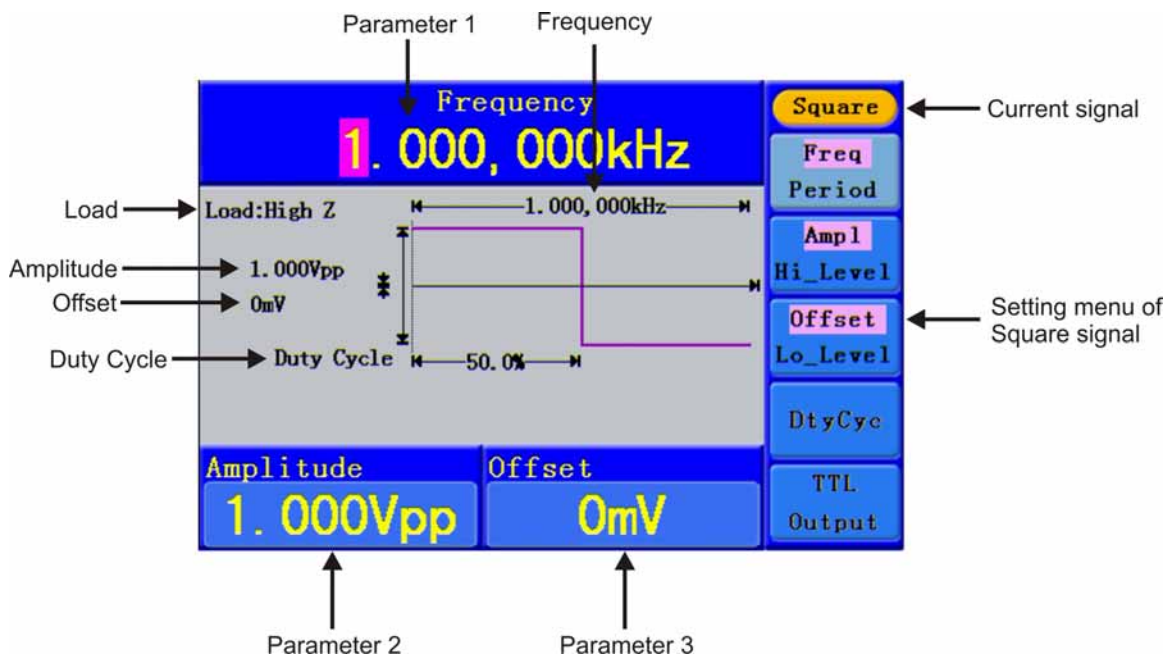


Figure 6. The User Interface of Square Signal.

**Term Explanation**

Duty Cycle: The percentage that the High Level takes up the whole Period.

▶ **To Set the Duty Cycle**

- 1 Press **F4** button, the "**Duty**" menu item is highlighted, the current value of the Duty cycle is displayed in **Parameter 1**.
- 2 Turn the **knob** to change the value directly; or press the number keys to input the desired value, press **F4** to choose "%".

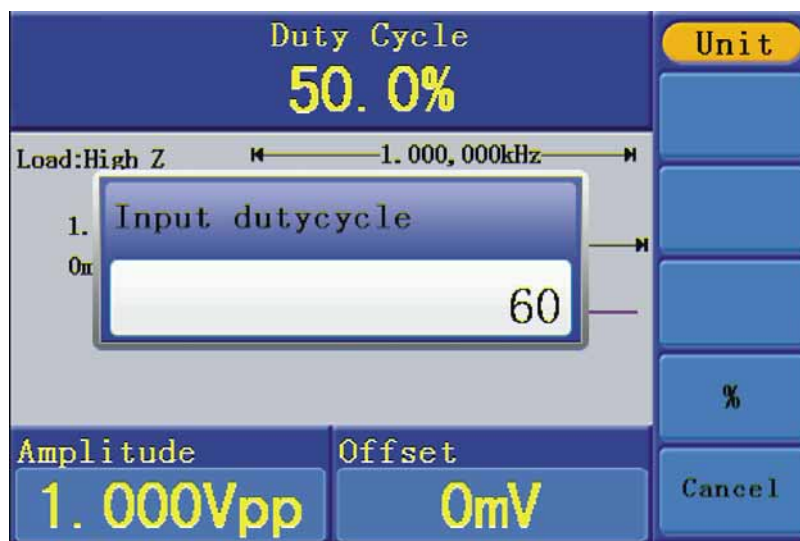


Figure 7. Set the Duty cycle of Square signal.



3.2.3 To Output Ramp Signals

Press button to call the user interface of Ramp signal, the Ramp waveform parameters can be set by operating the Ramp setting menu on the right.

The parameters of Ramp waveform are: **Frequency/Period, Amplitude/High Level, Offset/Low Level, Symmetry**. You can operate the menu by using the menu selection buttons on the right.

To set the Frequency/Period, Amplitude/High Level, Offset/Low Level, please refer to "To Output Sine Signals".

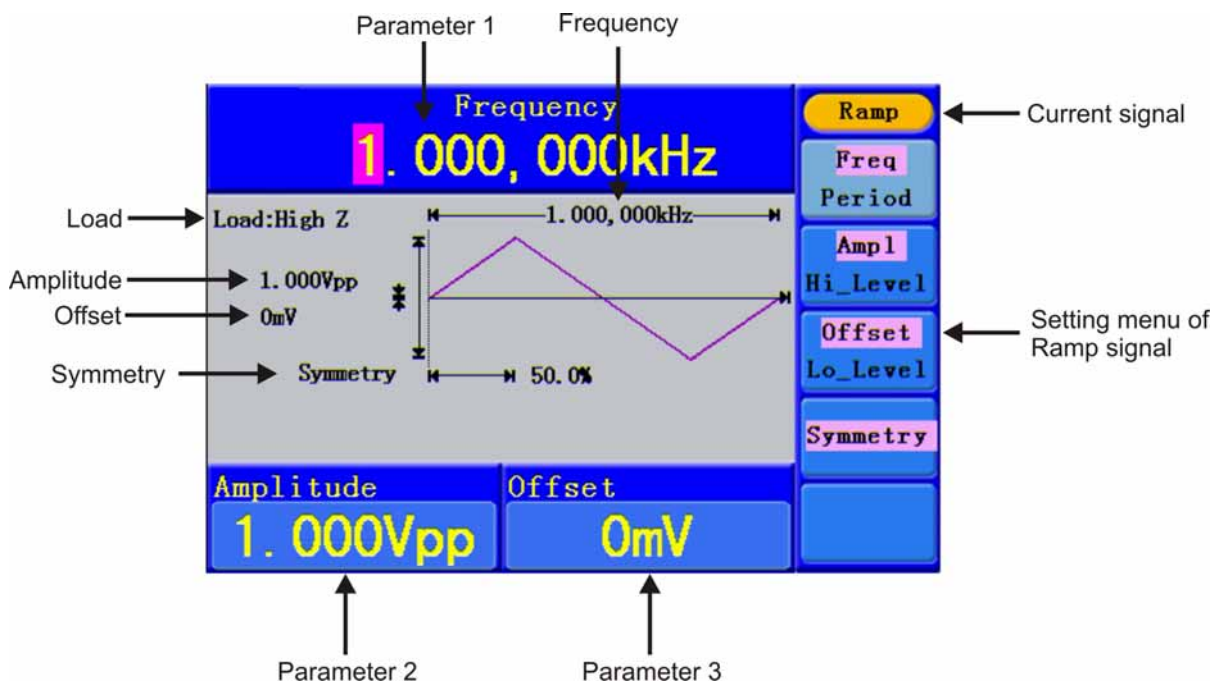


Figure 8. The User Interface of Ramp signal.

**Term Explanation**

Symmetry: The percentage that the Rising Period takes up the whole Period.

▶ To Set the Symmetry

- 1 Press **F4** button, the "**Symmetry**" menu item is highlighted, the current value of the symmetry is displayed in **Parameter 1**.
- 2 Turn the **knob** to change the value directly; or press the number keys to input the desired value, press **F4** to choose "%".

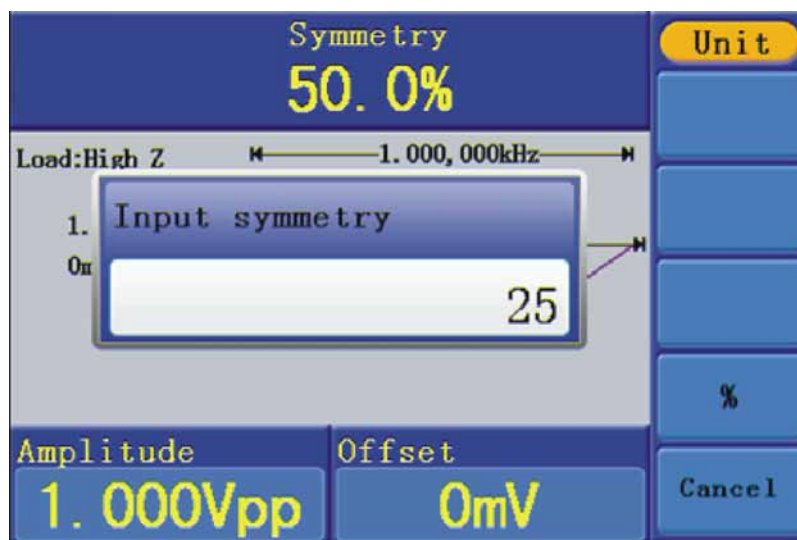



Figure 9. Set the symmetry of Ramp signal



3.2.4 To Output Pulse Signals

Press  button to call the user interface of Pulse signal, the Pulse waveform parameters can be set by operating the Pulse setting menu on the right.

The parameters of Pulse waveform are: **Frequency/Period, Amplitude/High Level, Offset/Low Level, Pulse Width/Duty**. You can operate the menu by using the menu selection buttons on the right.

To set the **Frequency/Period, Amplitude/High Level, Offset/Low Level**, please refer to "To Output Sine Signals".

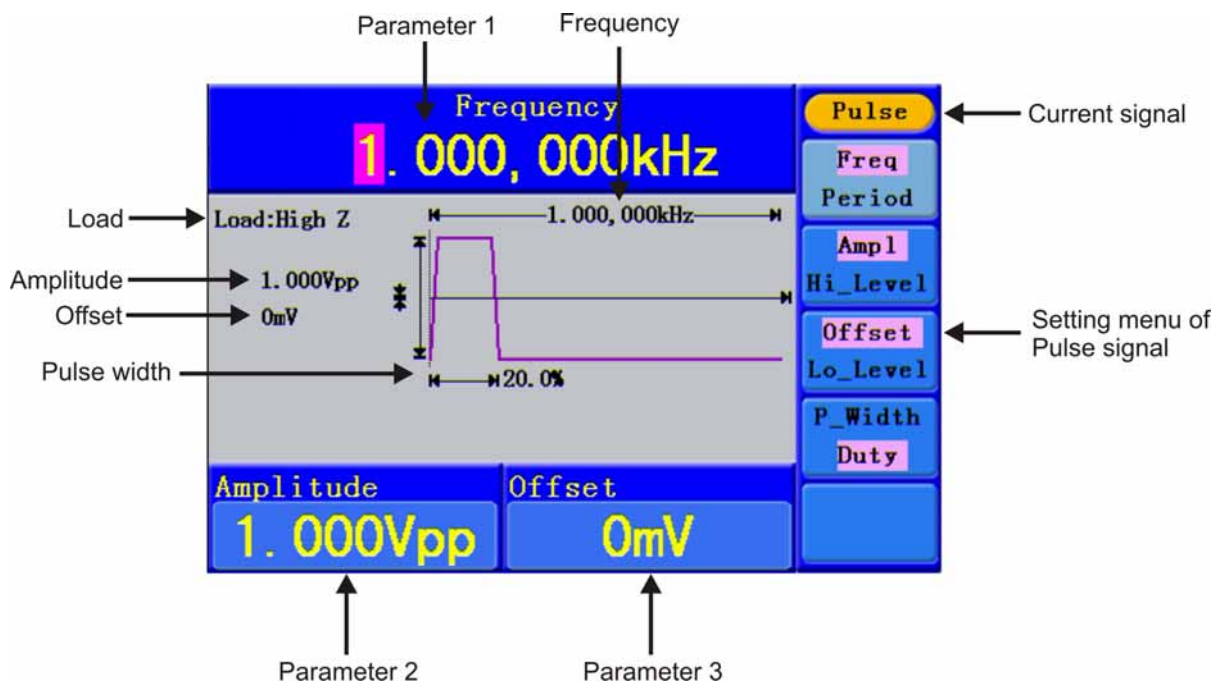


Figure 10. The User Interface of Pulse Signal.

Term Explanation

Pulse Width: There are two kinds of Pulse Width—positive and negative. Positive Pulse Width is the time span between thresholds of 50% of the rising edge amplitude to the next 50% of the falling edge amplitude. Negative Pulse Width is the time span between thresholds of 50% of the falling edge amplitude to the next 50% of the rising edge amplitude. Pulse Width is determined by Period and Duty Cycle; the formula is: Pulse Width = Period * Duty Cycle.



► **To Set the Pulse Width / Duty Cycle**

- 1 Press **F4** button, the chosen menu item is highlighted, the focused parameter is displayed in **Parameter 1**. Press **F4** to switch between Pulse Width/Duty.
- 2 Turn the **knob** to change the value directly; or press the number keys to input the desired value and choose the unit.

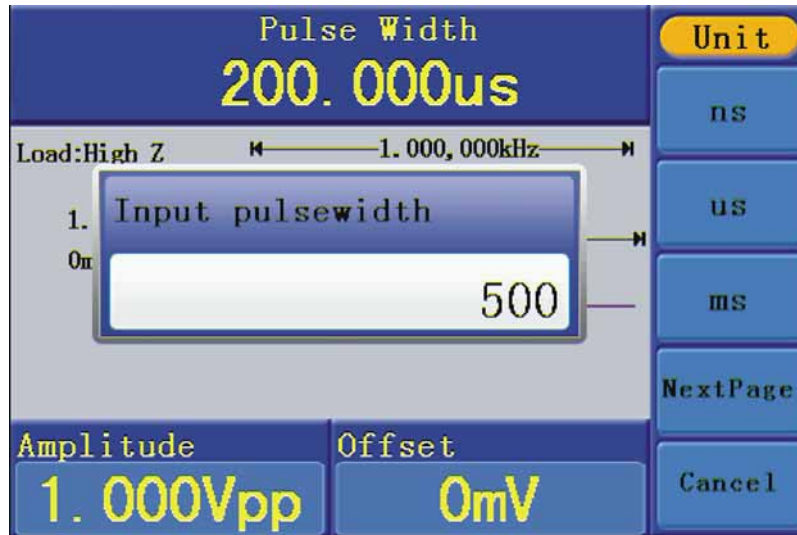



Figure 11. Set the Pulse Width of Pulse signal.



3.2.5 To Output Noise Signals

The noise signal which the generator output is white noise. Press  button to call the user interface of Noise signal, the Noise waveform parameters can be set by operating the Noise setting menu on the right.

The parameters of Noise waveform are: **Amplitude/High Level, Offset/Low Level**. You can operate the menu by using the menu selection buttons on the right.

To set the Amplitude/High Level, Offset/Low Level, please refer to "To Output Sine Signals".

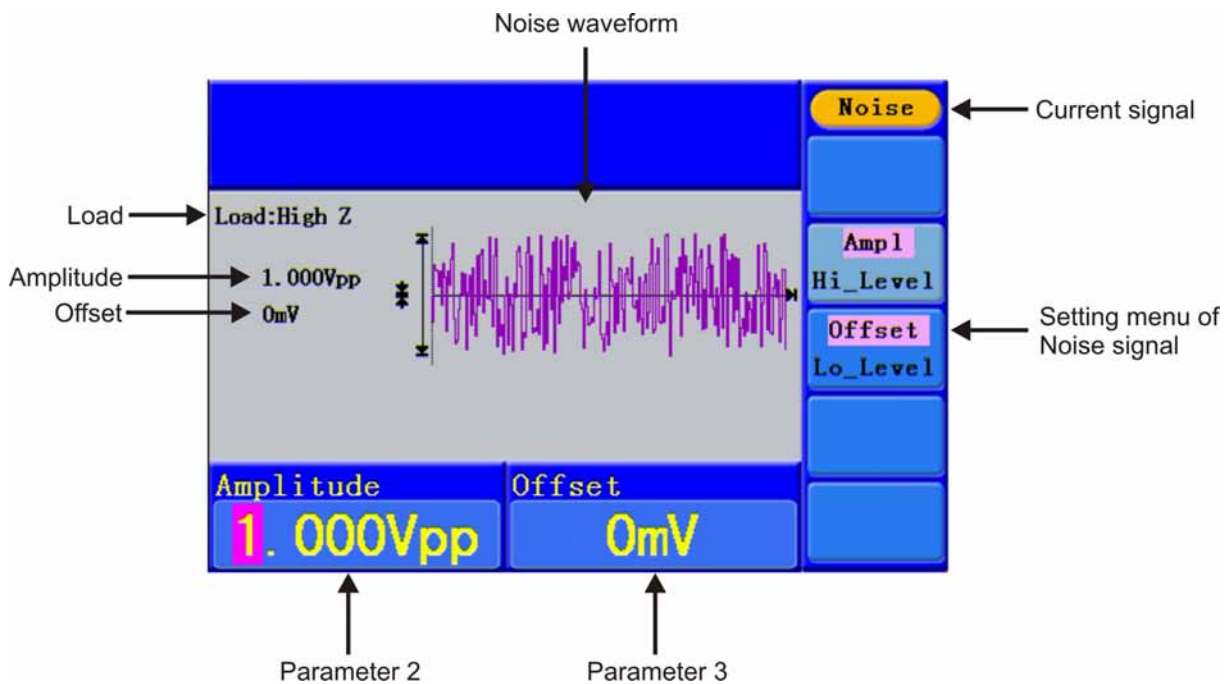



Figure 12. The User Interface of Noise Signal.

3.2.6 To Output Arbitrary Signals

Press  button to call the user interface of Arbitrary signal, the Arbitrary waveform parameters can be set by operating the Arbitrary setting menu on the right.

The menu items of Arbitrary waveform are: **Frequency/Period, Amplitude/High Level, Offset/Low Level, Built-in Waveform, Editable Waveform**. You can operate the menu by using the menu selection buttons on the right.

To set the Frequency/Period, Amplitude/High Level, Offset/Low Level, please refer to "To Output Sine Signals".



The Arbitrary signal consists of two types: the system built-in waveform and the user-definable waveform.

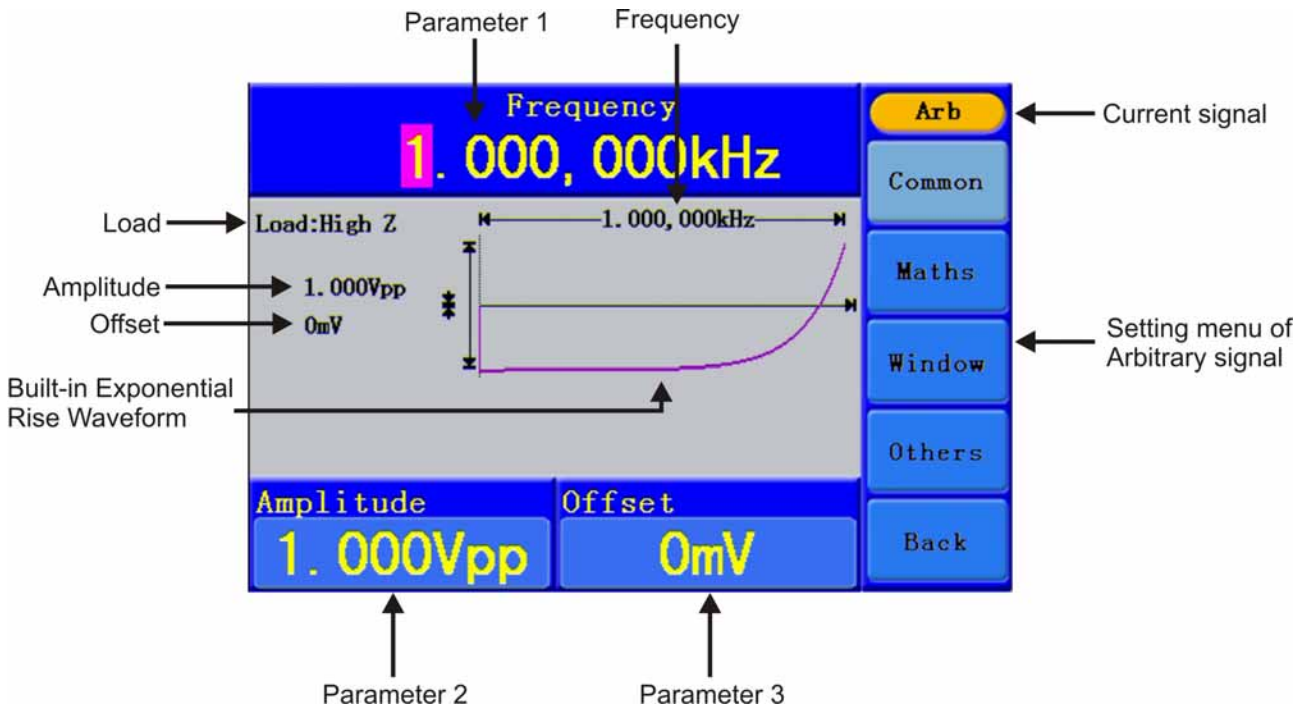


Figure 13. The User Interface of Arbitrary Signal.

▶ **To select the built-in waveform:**

There are 45 built-in Arbitrary waveforms.
Steps for selecting the built-in waveform:

- 1 Press button, then press **F4** to enter the **Built-in Wform** menu.
- 2 Press **F1** ~ **F4** to select Common, Maths, Window or Others. E.g. select Maths to enter the following interface.

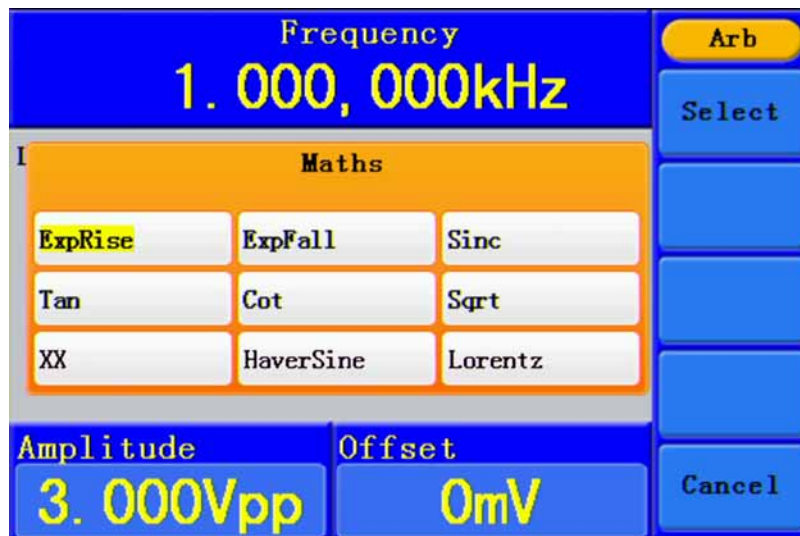


Figure 14.



- 3 Turn the knob or press  direction key to choose the desired waveform.

Built-in Waveform Table

Name	Explanation
Common	
StairD	Stair-down waveform
StairU	Stair-up waveform
StairUD	Stair-up and stair-down waveform
Trapezia	Trapezoid waveform
RoundHalf	RoundHalf wave
AbsSine	Absolute value of a Sine
AbsSineHalf	Absolute value of half a Sine
SineTra	Sine transverse cut
SineVer	Sine vertical cut
NegRamp	Negative ramp
AttALT	Gain oscillation curve
AmpALT	Attenuation oscillation curve
CPulse	Coded pulse
PPulse	Positive pulse
NPulse	Negative pulse
Maths	
ExpRise	Exponential rise function
ExpFall	Exponential fall function
Sinc	Sinc function
Tan	Tangent
Cot	Cotangent
Sqrt	Square root
XX	Square function
HaverSine	HaverSine function
Lorentz	Lorentz function
In	Natural logarithm function
Cubic	Cubic function
Cauchy	Cauchy distribution
Besselj	BesselI function



Bessely	BesselII function
Erf	Error function
Airy	Airy function
Windows	
Rectangle	Rectangle window
Gauss	Gauss distribution
Hamming	Hamming window
Hann	Hanning window
Bartlett	Bartlett window
Blackman	Blackman window
Laylight	Laylight window
Triang	Triangle window (Fejer window)
Others	
DC	DC signal
Heart	Heart signal
Round	Round signal
LFMPulse	Linear FM pulse
Rhombus	Rhombus signal
Cardiac	Cardiac signal

▶ **The User-Definable Waveform**


Press  button and press  to select "**Editable Wform**".

Menu item	Instruction
Create Wform	Create a new waveform.
Select Wform	Select the waveform stored in internal storage (FLASH) or U disk (USBDEVICE).
Edit Wform	Edit the stored waveform.






▶ **How to Create a New Waveform**

1 Enter the operation menu:



Press  → **Editable Wform** → **Select Wform**.

2 **Set the number of waveform points:** Press  to select "**Wform Points**", turn the **knob** or press the number keys to input the desired value and choose the unit. **X1**, **XK**, **XM** respectively represent 1, 1000, 1,000,000. The waveform points range is 2 ~ 1,000,000.





- 3 **Set the interpolation:** Press  to switch between **On/Off**. If you choose **On**, the points will be connected with beelines; otherwise, the voltages between two consecutive points will not change, and the waveform looks like a step-up one.
- 4 **Edit the waveform points:** Press  to enter the operation menu.
 - Press  to choose "**Points**", input the number of the point to be edited.
 - Press  to choose "**Voltage**", input the voltage for the current point.
 - Repeat the step above, set all the points to your needs.
 - Press  to choose "**Store**", enter the file system. "FLASH" is the internal storage. Choose **Next level**, enter the desired storage path, choose **Save**, an input keyboard pops up, input the file name, and then choose **DONE**.


How to Select a Stored Waveform

- 1 **Enter the operation menu:**
Press  → **Editable Wform** → **Select Wform**.
- 2 Enter the storage path of the desired waveform file. Turn the knob or press  direction key to select the desired waveform file.
- 3 Choose **Recall output**.

How to edit a Stored Waveform


- 1 **Enter the operation menu:**
Press  → **Editable Wform** → **Edit Wform**.
- 2 Enter the storage path of the desired waveform file. Turn the **knob** or press  direction key to select the desired waveform file.
- 3 Choose **Recall suppress**.

How to Delete a Stored Waveform

- 1 Press **Save** function button to enter the file system.
- 2 Enter the storage path of the desired waveform file. Turn the **knob** or press  direction key to select the desired waveform file.
- 3 Choose **Delete**.



3.2.7 To Output DC

- 1 Press  button, then press **F4** to enter the **Built-in Wform** menu.
- 2 Press **F4** to select **Others**. Select DC. Press **F1** to output DC.
- 3 Press **F3** confirm whether the "**Offset**" menu item is highlighted; if not, press **F3** to switch into "**Offset**". A cursor appears under the value of offset. Use the **knob** or the number keys to set the desired value and choose the unit.

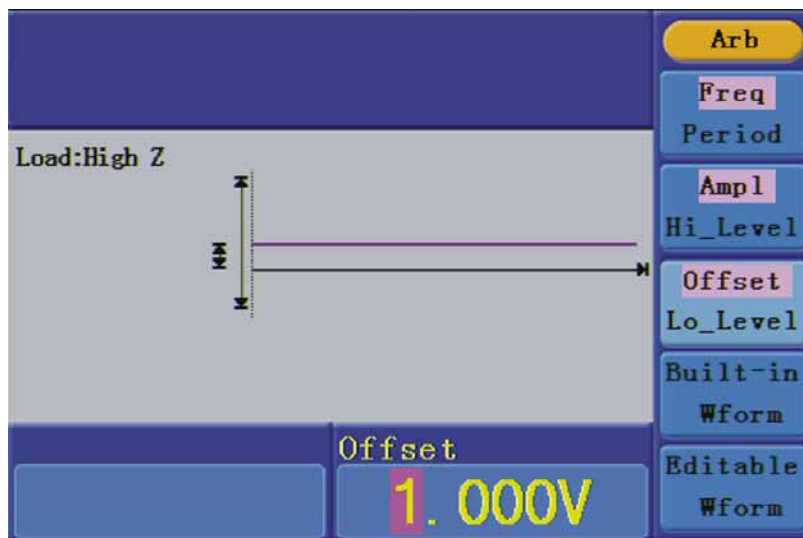


Figure 15. The DC Setting Interface.



3.3 To Generate the Modulated Waveform

Press the Mod button, to generate modulated waveform. The waveform generator can modulate waveform using AM, FM, PM, FSK. To turn off the modulation, press the Mod button.

3.3.1 AM (Amplitude Modulation)

The modulated waveform consists of two parts: the Carrier Waveform and the Modulating Waveform. The Carrier Waveform can only be Sine. In AM, the amplitude of the Carrier Waveform varies with the instantaneous voltage of the modulating waveform. The user interface of the AM is shown as below.

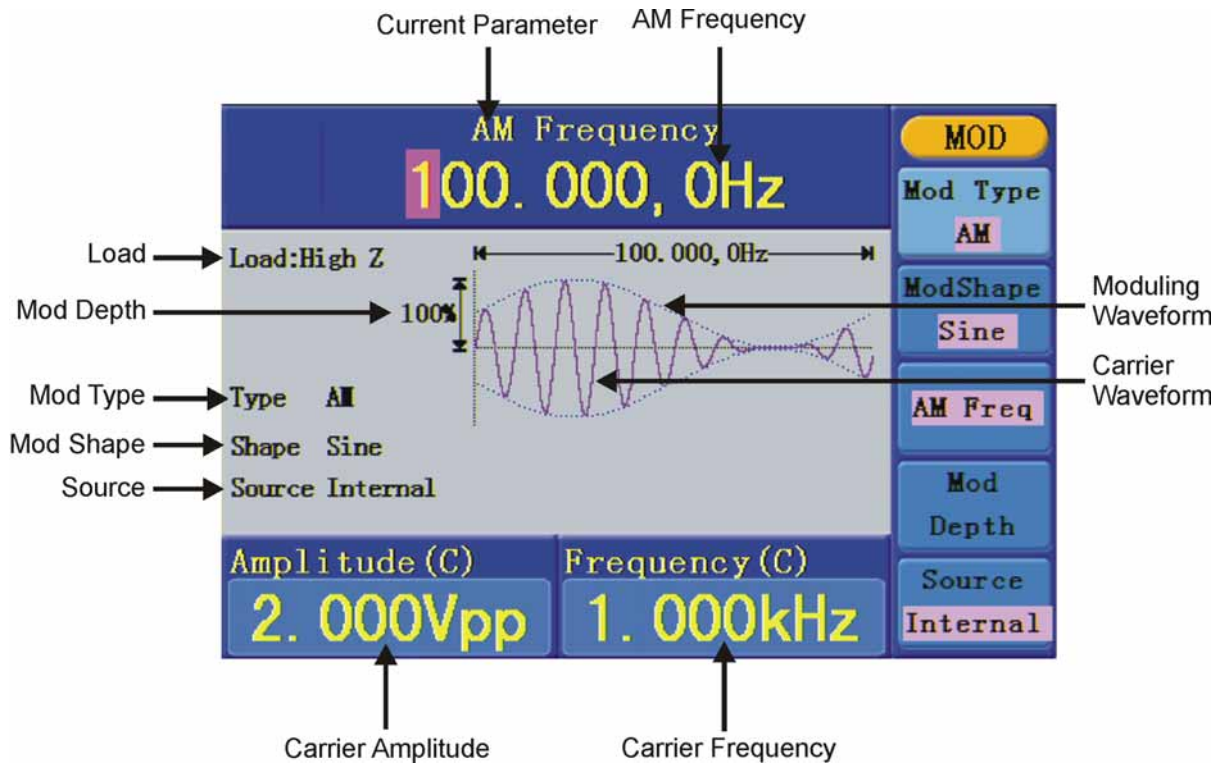




Figure 16: The User Interface of AM



▶ **How to set the parameters of AM**

- 1 Press **Mod** function button.
- 2 Press **F1** to switch Mod Type to AM. If the Carrier Waveform is not Sine, the system will switch it to Sine automatically.
- 3 Press button  to display the waveform and parameters of the Carrier Waveform. You can change the parameters, please refer to To Output Sine Signals. Press button  again to return to the Modulation mode interface.
- 4 Press **F5** to select the source. If the source is External, use the Ext Mod In connector in the rear panel to input the external signal, the setting of AM is finished. If you choose Internal, continue to the steps below.
- 5 Press **F2** to choose Mod Shape, you can choose Sine, Square or Ramp.
- 6 Press **F3** to set AM Frequency. The range is 2 mHz - 20 kHz (Internal source only).
- 7 Press **F4** to set Mod Depth. The range is 0% - 100%.

Term Explanation

AM Frequency:

The frequency of modulating waveform.

Mod Depth: The Amplitude Range of modulating waveform. In the 0% Modulation, the output amplitude is the half of the set one. In the 100% Modulation, the output amplitude is the same with the set one. For an external source, the depth of AM is controlled by the voltage level of the signal connected to the Ext Mod In connector in the rear panel. +5 V corresponds to the currently set depth 100%.

3.3.2 **FM (Frequency Modulation)**

The modulated waveform consists of two parts: the Carrier Waveform and the Modulating Waveform. The Carrier Waveform can only be Sine. In FM, the frequency of the Carrier Waveform varies with the instantaneous voltage of the modulating waveform. The user interface of the FM is shown as below.

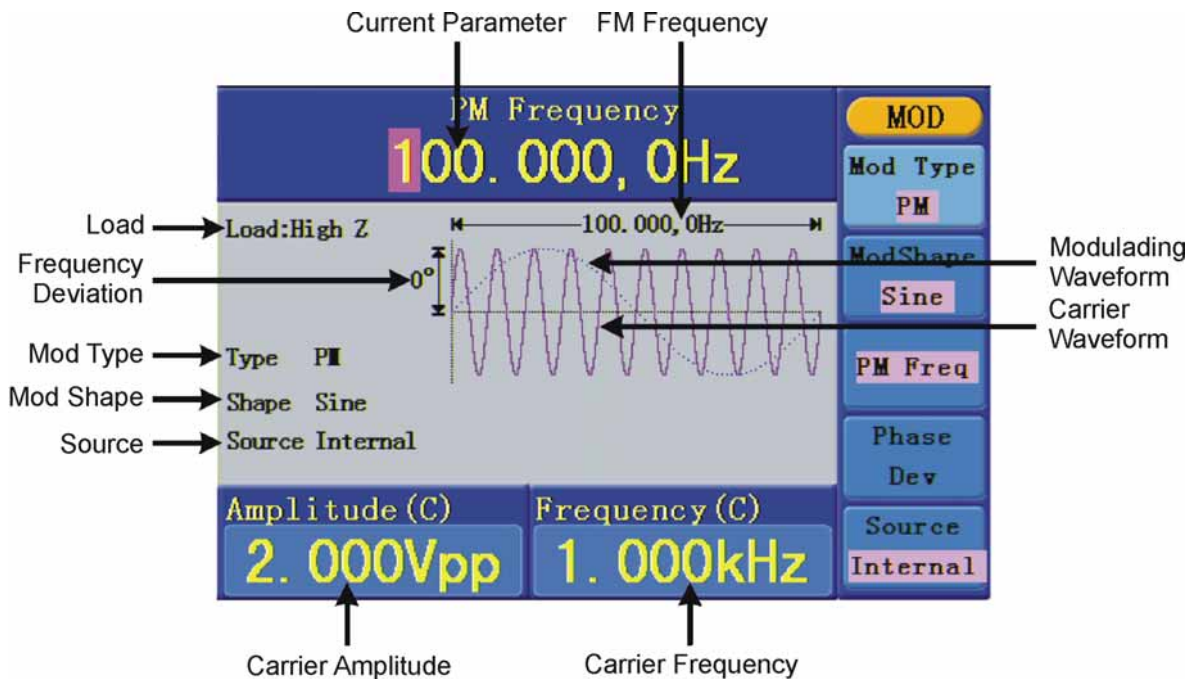


Figure 17: The User Interface of FM

► **How to set the parameters of FM**

- 1 Press **Mod** function button, then press **F1** to select **Mod**.
- 2 Press **F1** to switch **Mod Type** to **FM**. If the Carrier Waveform is not Sine, the system will switch it to Sine automatically.
- 3 Press **~** button to display the waveform and parameters of the Carrier Waveform. You can change the parameters, please refer to *To Output Sine Signals*. Press **~** button again to return to the Modulation mode interface.
- 4 Press **F5** to select the source. If the source is **External**, use the **Ext Mod In** connector in the rear panel to input the external signal, then skip ahead to step (6). If you choose **Internal**, continue to the steps below.
- 5 Press **F2** to choose **Mod Shape**, you can choose Sine, Square or Ramp.
- 6 Press **F3** to set **Mod Frequency**. The range is 2 mHz - 20 kHz (Internal source only).
- 7 Press **F4** to set **FM Deviation**. The Deviation should be less than the Carrier Waveform Frequency.



NOTE: The Sum of the Deviation and the Carrier Frequency should be equal to or less than maximum frequency of the selected function plus 1 kHz.

For an External Source, the Deviation is controlled by the voltage Level of the signal connected to the **Ext Mod In** connector in the rear panel. +5 V corresponds to the selected Deviation and -5 V to the negative selected Deviation.

3.3.3 PM (Phase Modulation)

The modulated waveform consists of two parts: the Carrier Waveform and the Modulating Waveform. The Carrier Waveform can only be Sine. In PM, the phase of the Carrier Waveform varies with the instantaneous voltage level of the modulating waveform. The user interface of the PM is shown as below.

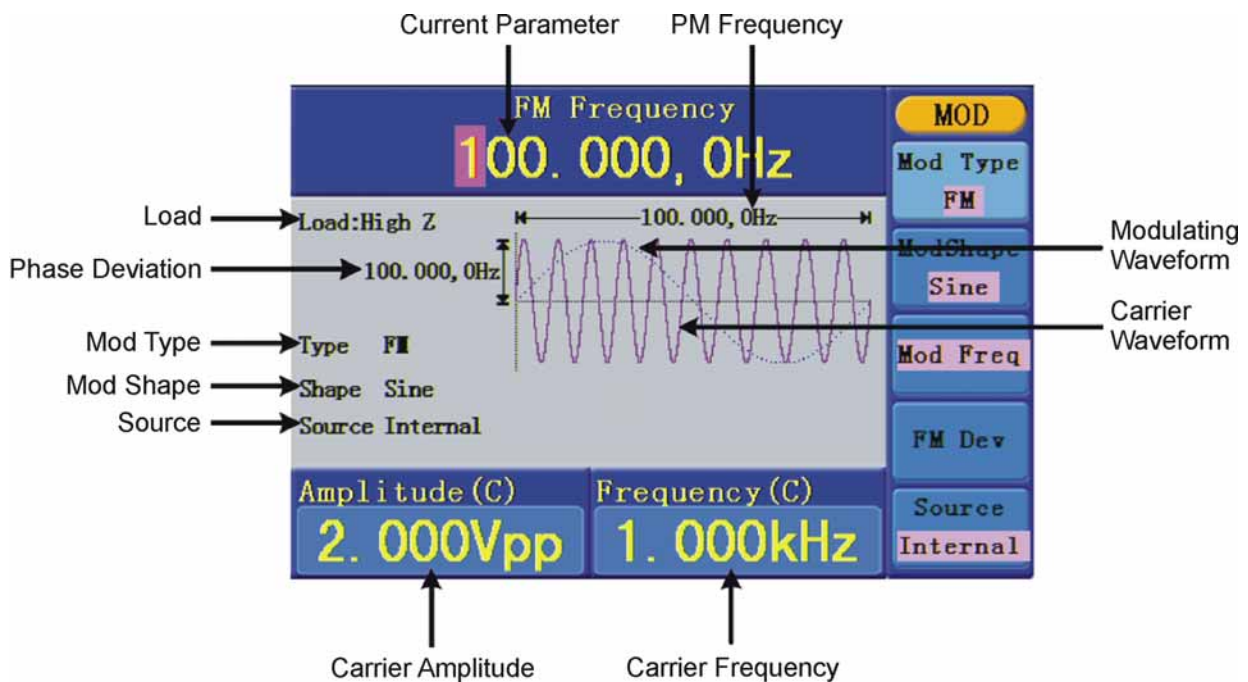




Figure 18: The User Interface of PM

► How to set the parameters of PM

- 1 Press **Mod** function button.
- 2 Press **F1** to switch **Mod Type** to **PM**. If the Carrier Waveform is not Sine, the system will switch it to Sine automatically.



- 3 Press  button to display the waveform and parameters of the Carrier Waveform. You can change the parameters, please refer to *To Output Sine Signals*. Press  button again to return to the Modulation mode interface.
- 4 Press **F5** to select the source. If the source is **External**, use the Ext Mod In connector in the rear panel to input the external signal, then skip ahead to step (6). If you choose **Internal**, continue to the steps below.
- 5 Press **F2** to choose **Mod Shape**, you can choose Sine, Square or Ramp.
- 6 Press **F3** to set **PM Frequency**. The range is 2 mHz - 20 kHz (Internal source only).
- 7 Press **F4** to set **Phase Deviation**. The Phase Deviation between the Modulating Waveform and the Carrier Waveform ranging from 0° to 180°.

3.3.4 FSK (Frequency Shift Keying)

The FSK Modulation is a modulation method, the output frequency of which switches between two the pre-set frequencies (Carrier Waveform Frequency and the Hop Frequency). The Frequency of the Output Frequency switch between the carrier waveform frequency and the Hop frequency is called the **FSK rate**. The frequency by which the output frequency switch from each other is determined by the Internal Frequency generator or the Signal Voltage Level offered by the **Ext Trig/Burst/Fsk In** connector in the rear panel. The Carrier Waveform can only be Sine. The user interface of the FSK is shown as below.

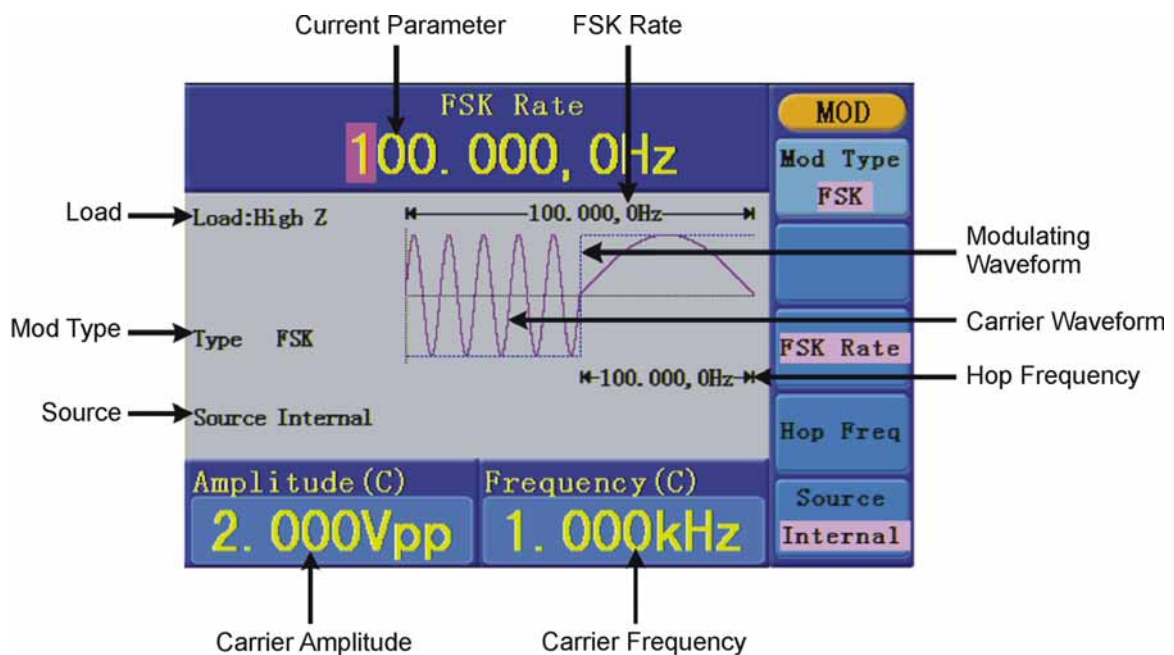




Figure 19: The User Interface of FSK



▶ **How to set the parameters of FSK**

- 1 Press **Mod**, a continuación pulse la tecla **F1** para seleccionar **Mod**.
- 2 Press **F1** to switch **Mod Type** to **FSK**. If the Carrier Waveform is not Sine, the system will switch it to Sine automatically.
- 3 Press  button to display the waveform and parameters of the Carrier Waveform. You can change the parameters, please refer to *To Output Sine Signals*. Press  button again to return to the Modulation mode interface.
- 4 Press **F5** to select the source. If the source is **External**, use the **Ext Trig/Burst/Fsk In** connector in the rear panel to input the external signal, then skip ahead to step (5). If you choose **Internal**, continue to the steps below.
- 5 Press **F3** to set **FSK Rate**. The range is 2 mHz - 100 kHz (Internal source only).
- 6 Press **F4** to set **Hop Frequency**. The range is 2 mHz - 25 kHz.

Term Explanation
FSK Rate: The frequency at which the output frequency shifts between the carrier frequency and the Hop frequency (Internal Modulation only).



3.4 To Generate Sweep

In the frequency sweep mode, the generator "steps" from the start frequency to the stop frequency at the sweep rate you specify. Sweep can be generated by Sine, Square or Ramp Waveforms.

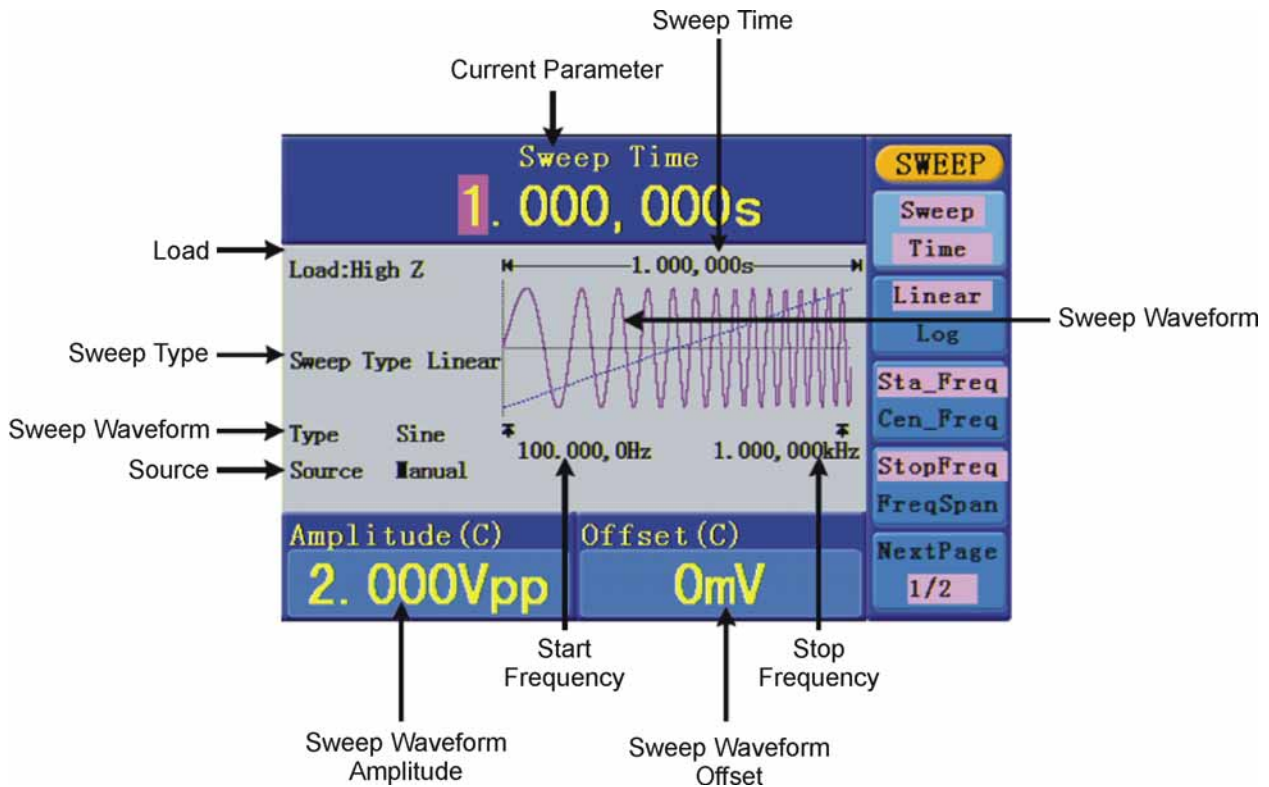







Figure 20: The User Interface of Sweep Mode

► **How to set the parameters of Sweep**

- 1 When the output signal is Sine, Square or Ramp waveform, press the **Sweep** button to enter the Sweep mode.
- 2 Press ,  or  button to choose the waveforms. Take Sine for instance, press  to display the waveform and parameters. You can change the parameters, please refer to *To set signals*. Press  button again to return to the Sweep mode interface.
- 3 Press **F1** to set **Sweep Time**, the Time Span of the Sweep for which the Frequency changes from the Start Frequency to Stop Frequency.
- 4 Press **F2** to select the Sweep Type. **Linear** means setting the Sweep with linear spacing; **Log** means setting the Sweep with logarithmic spacing.
- 5 Use **Start Freq** and **Stop Freq** or **Center Freq** and **Freq Span** to set the range of the frequency. Press **F3** to select **Sta_Freq** or **Cen_Freq**, and set the desired value.



- 6 Press **F4** to select **StopFreq** or **FreqSpan**, and set the desired value.
- 7 Press **F5** to select **NextPage**, press it again to enter the next page.
- 8 Press **F1** to select the source. **Internal** means using the internal source. **External** means using the **Ext Trig/Burst/Fsk In** connector in the rear panel to input the external signal. **Manual** means choosing manual trigger; in Sweep interface, press the **knob** on the front panel to trigger a Sweep.

3.5 To Generate Burst

Press the **Burst** button to generate versatile waveforms in burst. Burst can last for certain times of waveform cycle (N-Cycle Burst), or to be controlled by external gated signals (Gated Burst). Burst can apply to Sine, Square, Ramp, Pulse and Arbitrary waveforms (Noise can not be used).

Term Explanation

Burst:

Output Waveforms with set cycle times. Generally it is called BURST function within every Signal Generator.

N-Cycle Burst:

N-Cycle has specific number of waveform cycles, and every burst is activated by a trigger event.

Gated Burst:

Gated burst use external source to control burst as when to be activated.



► **Set the N-Cycle Burst**

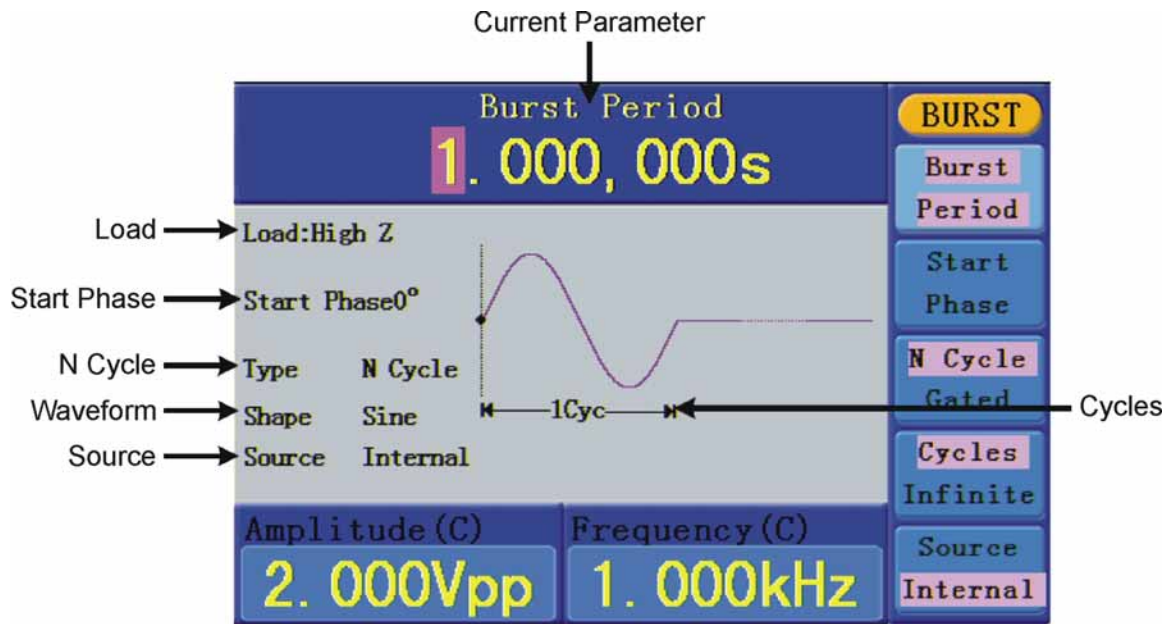









Figure 21: The User Interface of N-Cycle Burst

- 1 When the output signal is Sine, Square, Ramp, Pulse or Arbitrary waveform press the **Burst** button.
- 2 Press , , ,  or  button to choose the waveform. Take Sine for instance, press  to display the waveform and parameters. You can change the parameters, please refer to *To set signals* on page 12. Press  button again to return to the Burst mode interface.
- 3 Press **F3** to switch to **N Cycle**.
- 4 Press **F1** to select **Burst Period**, set it to the desired value.
- 5 Press **F2** to select **Start Phase** (if current waveform is Pulse, skip this step), define the Start and the Stop Point in a waveform. The phase varies from -360° to $+360^\circ$. For an Arbitrary Waveform, 0° is the first waveform point.
- 6 Press **F4** to select **Cycles** or **Infinite**. Set the number of Waveform Cycle in an N-Cycle (from 1 to 50,000). If you choose **Infinite**, then a continuous waveform will be generated which will not stop until a trigger event happens (the **knob** on the front panel is pressed).



NOTE: If needed, Burst Period will increase to cater to the specific number of cycles.
For an infinite-cycle Burst, External or Manual Trigger is needed to activate burst.

- 7 Press **F5** to select the source. **Internal** means using the internal source. **External** means using the **Ext Trig/Burst/Fsk In** connector in the rear panel to input the external signal. **Manual** means choosing manual trigger; in N-Cycle Burst interface, press the **knob** on the front panel to output a burst signal.

► **Set the Gated Burst**

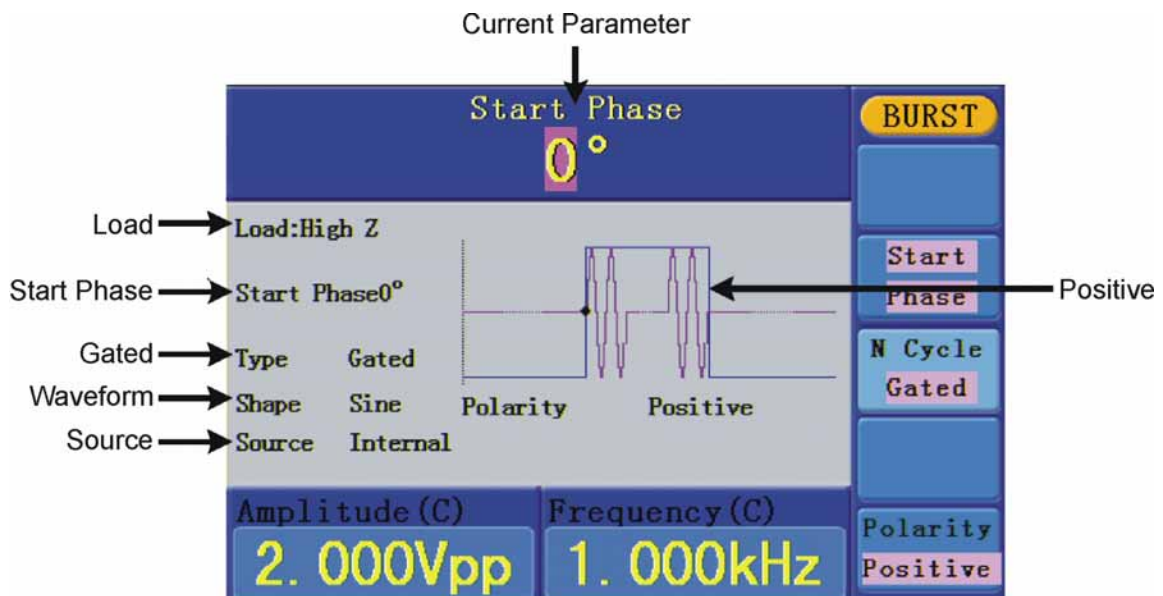









Figure 22: The User Interface of Gated Burst

- 1 When the output signal is Sine, Square, Ramp, Pulse or Arbitrary waveform, press the **Burst** button.
- 2 Press , , ,  or  button to choose the waveforms. Take Sine for instance, press  to display the waveform and parameters. You can change the parameters, please refer to *To set signals* on page 12. Press  button again to return to the Burst mode interface.
- 3 Press **F3** to switch to **Gated**.



- 4 Press **F2** to select **Start Phase**, define the Start and the Stop Point in a waveform. The phase varies from -360° to $+360^{\circ}$. For an Arbitrary Waveform, 0° is the first waveform point.
- 5 Press **F5** to switch between **Positive/Negative**. Set the Polarity for the Gated Signal.

3.6 To Manage File

Press **Save** function button to enter the file system. You can view the waveform files, create a new folder, and perform the file operations such as delete, rename, copy and paste.

▶ To Edit the File Name

In file system, the user can edit the name of a file or a folder. When the system needs the user to input a name, an input keyboard will appear.



Figure 23. Edit the File Name.

- 1 Turn the knob or press **←/→** direction key to move the cursor left and right in the keyboard. Press **F3** to switch between capital and small of the characters.
- 2 Press **F1** to enter the current character. Press **F2** to delete the last character.
- 3 Press **F4** to finish editing and save the file. Press **F5** to cancel the save operation.

NOTE: The length of file name is up to 15 characters.



3.7 To Set the Utility Function

Press **Utility** function key to enter the Utility Menu. You can set the parameters of the Generator such as: Display Parameter, Counter Parameter, Output Parameter and System Setting. Press **Utility** again to exit the Utility Menu.

3.7.1 To Set Display Parameter

▶ To Set the Bright




- 1 Press **Utility** and choose Disp Setup, press **F1** to select Bright.
- 2 Turn the knob to change the value, press **◀/▶** direction key to move the cursor mleft and right; or press the number keys to input the desired value in percent, press **F4** to select the unit. The bright range is 0% - 100%.

▶ To Set the Separator

The user can set the separator of the displayed parameter.

- 1 Press **Utility** and choose Disp Setup, press **F2** to select Sep.
- 2 Press **F2** to switch between Comma, Space, Off.

Take the Frequency parameter for instance:

Comma	
Space	
Off	

▶ To Set the Screen Saver

The screen saver will run automatically if no operation is taken for any key within the set time. Press any button to resume.

- 1 Press **Utility** and choose Disp Setup, press **F3** to select Scrn Svr.
- 2 Press **F3** to switch between On/Off.



- 3 If On is selected, you can set the screen saver time. Turn the knob to change the value, press \leftarrow/\rightarrow direction key to move the cursor left and right; or press the number keys to input the desired time in minutes, press $F4$ to select the unit. The screen saver time range is 1 - 999 minutes.

3.7.2 To Set the Counter

The counter can measure the signal with frequency form 100 MHz to 200 MHz.

The operation steps:

- 1 Press **Utility** and choose Counter.
- 2 Connect the signal to the connector [Ref Clk/Counter In] on the rear panel.
- 3 Press $F3$ to choose Set, enter measurement setting menu.
 - To set the coupling mode: Press $F1$ to switch Coupling as AC/DC.
 - To set the sensitivity: Press $F2$ to switch Sens as Low/Middle/High. For low amplitude signal, the "Middle" or "High" sensitivity should be used. For low frequency signal with high amplitude and slower rising edge, low sensitivity is a better choice.
 - To set the high frequency restrain on/off: Press $F3$ to switch HFR as ON/OFF. High frequency restrain is used for filtering the high frequency signal in measuring the low frequency signal, and improve the measure accuracy.
 - To measure low frequency signal lower than 1 kHz, you should put on the high frequency restrain to filter the high frequency noise disturb.
 - To measure high frequency signal higher than 1 kHz, you should put off the high frequency restrain.
 - To set the trig level: Press $F4$ to choose TrigLev. Turn the knob to change the value, press \leftarrow/\rightarrow direction key to move the cursor left and right; or press the number keys to input the desired value and choose the unit. The range of trig levle is -2.5 V - 2.5 V.
 - Press $F5$ to choose Back to previous menu, view the result.
After all the set was done, the counter will measure the signal according to the current set. If the reading is unsteady, please repeat the above step until it is steady.
- 4 Press $F1$ to switch to view the measure result of frequency or period. Press $F2$ to switch to view the measure result of positive width or duty.



3.7.3 To Set Output Parameter

▶ To Set the Output Load

For the **Main output terminal** on the Front panel, the Generator has a built-in 50 Ω series impedance. If the actual load does not match the set one, the displayed amplitude and offset are incorrect. This function is used to match the displayed voltage with the expected one.

Steps for setting the Load of each channel:

- 1 Press Utility and choose Output Setup. Press **F1** to select HighZ, or * Ω ("*" represents a value).
- 2 To change the load value, after selecting * Ω , turn the knob to change the value, press **◀/▶** direction key to move the cursor left and right; or press the number keys to input the desired value. Press **F3** or **F4** to select the unit. The load range is 1 Ω - 10 k Ω .

NOTE: For **Output** terminal on the Front panel, the waveform generator has a fixed 50 Ω Series Impedance. No matter what Value the set parameter is, if the real load is different from the set one, the displayed voltage will not equal the real voltage.



3.7.4 To Set the System

▶ Language Setting

Press **Utility** and choose System, press **F1** to switch display languages.

▶ Power On Setting

- 1 Press **Utility** and choose System, press **F2** to select Power On.
- 2 Press **F2** to switch between Default/Last. Default means that all the settings return to default when powered. Last means that all the settings return to the last one when powered.

▶ To Return to Default Setting

Press **Utility** and choose System, press **F3** to select Set to Default, press **F1** to confirm. All the settings will be set to default. The default settings of the system are as follows:



Output	Default
Function	Sine Wave
Frequency	1 kHz
Amplitude/Offset	1 Vp-p / 0 Vdc

Waveforms	Default
Frequency	1 kHz
Amplitude	1 Vp-p
Offset	0 Vdc
Duty Cycle of Square	50%
Symmetry of Ramp	50%
Pulse Width of Pulse	200 us
Duty Cycle of Pulse	20%

Modulation	Default
Carrier	1 kHz Sine Wave
Modulating	100 Hz Sine Wave
AM Depth	100%
FM Deviation	100 Hz
PM Phase Deviation	0°
FSK Hop Frequency	100 Hz
FSK Frequency	100 Hz
Source	Internal

Sweep	Default
Start/Stop Frequency	100 Hz/1 kHz
Time	1 sec
Mode	Linear

Burst	Default
Frequency	1 kHz
Count	1 Cycle
Period	1 sec
Phase	0°



Others	Default
Brightness	95%
Separator	Comma
Screen Saver time	100 minutes
Load	High Z
Phase Deviation	0°
Clock Source	Internal
Channel Output Control	Off

▶ **To Set the Beep**

- 1 Press **Utility** and choose System, enter the second page of the menu.
- 2 Press **F1** to select Beep.
- 3 Press **F1** to switch between On/Off. On is to activate the sound when the system informs you. Off is to deactivate it.

▶ **View System Information**

- 1 Press **Utility** and choose System, enter the second page of the menu.
- 2 Press **F2** to select Sys info. You can view the Version and Serial number.

▶ **To Set the Clock Source**

The waveform generator provides an internal clock source and also accepts external clock source input from the [Ref Clk/Counter In] connector at the rear panel.

NOTE: The amplitude of the [Ref Clk/Counter In] input signal must be over 1 V.

- 1 Press **Utility** and choose System, enter the second page of the menu.
- 2 Press **F3** to select CLK Sou.
- 3 Press **F3** to switch between Internal/External.



3.8 To Set the Sync Output

The Generator provides Sync output through the **Sync output terminal** on the Front Panel. All standard output functions (except DC and Noise) have a corresponding Sync Signal.

Press **Trigger** button to activate or deactivate the Sync Signal on the **Sync output terminal** on the front panel. When it is deactivated, the output Voltage of the **Sync output terminal** is Level Low.

NOTE: When the amplitude is relatively low, disabling Sync Signal can reduce the distortion in output.





▶ **The Instructions of the Sync Signal in certain situations:**

- In the Inverse Mode, the Waveform that corresponds to the Sync Signal does not Inverse.
- For Sine, Square, Ramp and Pulse Signal, the Sync Signal is a Square Signal with 50% Duty Cycle. When the output is positive, The Sync Signal is TTL Level High compared to 0 V Voltage or DC Offset; when the output is negative, The Sync Signal is TTL Level Low compared to 0 V Voltage or DC Offset.
- For Arbitrary Waveform, the Sync Signal is a Square Waveform with 50% Duty Cycle. At the time when the first output waveform point is generated, the Sync Signal Voltage is TTL Level High.
- For Internal Modulating AM, FM, and PM, the Sync Signal reference is the Modulated Signal (not the Carrier Signal). The Sync Signal is a Square Waveform with 50% Duty Cycle. In the first half modulation period, the Sync Signal is TTL Level High. For External Modulation, the Sync Signal reference is the Carrier Signal (not the Modulated Signal). The Sync Signal is also a Square Waveform with 50% Duty Cycle.
- For FSK, the Sync Signal Reference is the Hop Frequency, and the Sync Signal is a Square Waveform with 50% Duty Cycle. For the Hop Frequency, at the hopping point, the Sync Signal is TTL Level High.
- For a Sweep which disables the Mark function, the Sync Signal is a Square Waveform with 50% Duty Cycle. When the Sweep starts, the Sync Signal is TTL Level High and turns Low at the Center of the Sweep. The Sync Frequency equals the specific Sweep time. For a Sweep that enables the Mark Function, the Sync Signal is TTL Level High at the beginning of the Sweep and turns Low at the Mark Frequency.
- For the Burst, when the burst starts, the Sync Signal is Level High. At the specific point when the Cycle Number ends, the Sync Signal turns Level Low (If the Waveform has a relative starting phase, it may be not zero intersections). For an infinite burst, the Sync Signal is the same with the Sync Signal of the continuous Signal.



- For the External Gated Burst, the Sync Signal follows the External Gated Signal. But, please note that this signal will not turn Level Low until the end of the last period (If the Waveform has a relative starting phase, it may be not zero intersections).

3.9 **To Use Built-in Help**

- 1 Press Help function button, the catalog will display in the screen.
- 2 Press  or  to choose help topic, or just turn the knob to choose.
- 3 Press  to view the details about the topic; press  to go back to the catalog.
- 4 Press Help again to exit the help, or just do other operations.




4 COMMUNICATION WITH PC

The Waveform Generator supports communications with a PC through USB port. You can use the ultrawave communication software to set the parameters, control the output of the Waveform Generator.

The Waveform Generator supports communications with a PC by SCPI commands through USB port.

Here is how to connect with PC. Install the software available on the web (www.promaxelectronics.com).

- 1 Connection:** Use a USB data cable to connect the **USB (type B) connector** on the rear panel of the Waveform Generator to the USB port of a PC.
- 2 Install the driver:** When the Waveform Generator is turned on, a dialog will appear on the PC screen and guide you to install the USB driver. The driver is in the "USBDRV" folder under the directory where the ultrawave communication software is installed, such as "C:\Program Files\PROMAX\ultrawave\USBDRV".
- 3 Port setting of the software:** Run the ultrawave software; click "Communications" in the menu bar, choose "Ports-Settings", in the setting dialog, choose "Connect using" as "USB". After connect successfully, the connection information in the bottom right corner of the software will turn green.

To learn about how to operate the software, press  in the software to open the help document.



5 SCPI

The waveform generator supports SCPI, and the users can operate and control the device by USB port.



6 TROUBLESHOOTING

1. The instrument is powered on but no Display.

- a. Check if the power is connected properly.
- b. Check if the Power Switch is in the proper voltage scale.
- c. Check if the fuse which is below the AC Power socket is used appropriately and in good condition (the cover can be pried open with a straight screwdriver).
- d. Restart the instrument after the steps above.
- e. If the problem still exists, please contact PROMAX for our service.

2. The measured value of output signal amplitude disaccords to the displayed value:

Check if the actual load matches the set one. Please refer to "To Set the Output Load".

If you encounter other problems, try to reset the settings (refer to "*To Return to Default Setting*") or restart the instrument. If it still can not work properly, please contact PROMAX for our service.



7 INSTRUCTIONS FOR RETURNING BY MAIL

Instruments returned for repair or calibration, either within or out of the warranty period, should be sent with the following information: Name of the Company, name of the contact person, address, telephone number, receipt (in the case of coverage under warranty) and a description of the problem or the service required.



8 GENERAL CARE AND CLEANING

8.1 General Care

Do not store or leave the instrument where the liquid crystal display will be exposed to direct sunlight for long periods of time.

Caution:



To avoid any damage to the instrument, do not exposed it to any sprays, liquids, or solvents.

8.2 Cleaning

Inspect the instrument as often as operating conditions require. To clean the instrument exterior, perform the following steps:

- 1 Wipe the dust from the instrument surface with a soft cloth. Do not make any scuffing on the transparent LCD protection screen when clean the LCD screen.
- 2 Disconnect power before cleaning your instrument. Clean the instrument with a wet soft cloth not dripping water. It is recommended to scrub with soft detergent or fresh water. To avoid damage to the instrument, do not use any corrosive chemical cleaning agent.

Warning:



Before power on again for operation, it is required to confirm that the instrument has already been dried completely, avoiding any electrical short circuit or bodily injury resulting from the moisture.



9 TECHNICAL SPECIFICATIONS

All these specifications apply to the Waveform Generator unless otherwise explanation. To reach these specifications, the instrument must have been operating continuously for more than 30 minutes within the specified operating temperature.

All the specifications are guaranteed unless those marked with "typical".

Specifications		
Frequency output	25 MHz	
Simple rate	125 MS/s	
Vertical resolution	14 bits	
Waveform (output)	Standard	Sine, Square, Ramp, Pulse and Noise
	Arbitrary	Exponential Rise, Exponential Fall, Sin(x)/x, Step Wave and others, total 48 built-in waveforms and user-defined arbitrary waveform

Frequency characteristic Max sampling rate 125 MSa/s; Frequency resolution is 1 µHz	
Sine	1 µHz — 5 MHz
Square	1 µHz — 5 MHz
Ramp	1 µHz — 1 MHz
Pulse	1 µHz — 5 MHz
White Noise	5 MHz (-3 dB) (typical)
Arbitrary waveform	1 µHz — 5 MHz

Amplitude Characteristic		
Output Amplitude	High Z	1 mVPP - 25 VPP
	50 Ω	1 mVPP - 12.5 VPP
Amplitude Accuracy	1 mVPP or 14 bits	
DC Offset Range (AC+DC)	±6.25 V (50 Ω) ±12.5 V (High Z)	
DC Offset Accuracy	1 mV	
Output Impedance	50 Ω (typical)	



Waveform Characteristic	
Sine	
Flatness (when the Amplitude is 1.0 Vp-p (+4 dBm), relative to 1 kHz)	1 μ Hz to 5 MHz 0.2 dB
Harmonic Distortion (when the Amplitude is 1.0 Vp-p)	<-40 dBc
Total Harmonic Distortion (when the Amplitude is 1 Vp-p)	10 Hz to 20 kHz <0.2 %
Phase Noise	-110 dBc/Hz at 1 MHz frequency, 10 kHz offset, 1 Vp-p, typical
Residue Clock Noise	-57 dBm (typical)
Square	
Rise/Fall Time	<25 ns (10% - 90%) (typical, 1 kHz, 1 Vp-p)
Jitter (rms)	< 1 ns
Non-symmetry (below 50% Duty Cycle)	1% of period+ 5 ns
Overshoot	< 5%
Duty Cycle	50% fixed
Ramp	
Linearity	< 0.1% of peak output (typical, 1 kHz, 1 Vp-p, Symmetry 50%)
Symmetry	0% to 100%
Pulse	
Pulse Width	100 ns to 1000 ks
Accuracy	10 ns
Rising/Falling Edge Time	< 25 ns
Overshoot	< 5%
Jitter	< 1 ns
Arbitrary	
Waveform Length	2 - 8k points
Sample Rate	125 MSa/s
Amplitude Accuracy	14 bits
Minimum Rise/Fall Time	35 ns (typical)
Jitter (RMS)	6 ns + 30 ppm



Modulated Waveform	
AM	
Carrier Waveforms	Sine
Source	Internal/ External
Internal Modulating Waveforms	Sine, Square, Ramp, White Noise, Arbitrary
Internal AM Frequency	2 mHz - 20 kHz
Depth	0.0% - 100.0%
FM	
Carrier Waveforms	Sine
Source	Internal/ External
Internal Modulating Waveforms	Sine, Square, Ramp, White Noise, Arbitrary
Internal Modulating Frequency	2 mHz - 20 kHz
Frequency Deviation	2 mHz - 1 kHz
PM	
Carrier Waveforms	Sine
Source	Internal/ External
Internal Modulating Waveforms	Sine, Square, Ramp, White Noise, Arbitrary
Internal PM Frequency	2 mHz - 20 kHz
Phase Deviation	0° - 180°
FSK	
Carrier Waveforms	Sine
Source	Internal/ External
Internal Modulating Waveforms	50% duty cycle square
FSK Rate	2 mHz - 100 kHz
Sweep	
Type	Linear, Logarithmic
Carrier Waveforms	Sine, Square, Ramp
Direction	Up / Down
Sweep Time	1 ms to 500 s \pm 0.1%
Source	Source, External or Manual
Burst	
Waveforms	Sine, Square, Ramp, Pulse, Arbitrary
Types	Count (1 to 50,000 periods), infinite, gated
Start Phase	-360° - +360°
Internal Period	(10 ms - 500 s) \pm 1%
Gated Source	External Trigger
Trigger Sources	Source, External or Manual



Counter Specification		
Function	Frequency, period, positive Pulse width, Duty cycle	
Frequency Range	Single channel: 100 mHz - 200 MHz	
Frequency Resolution	6 digits	
Voltage Range and Sensitivity (non-modulation signal)		
DC coupled	DC offset range	±1.5 VDC
	100 mHz - 100 MHz	250 mVp-p - 5 Vp-p (AC+DC)
	100 MHz - 200 MHz	450 mVp-p - 3 Vp-p (AC+DC)
AC coupled	1 Hz - 100 MHz	250 mVp-p - 5 Vp-p
	100 MHz - 200 MHz	450 mVp-p - 4 Vp-p
Pulse width and Duty cycle Measure	1 Hz - 10 MHz (100 m Vp-p - 10 Vp-p)	
Input adjust	Input impedance	1 MΩ
	Coupling mode	AC, DC
	High frequency restrain	High frequency noise restrain (HFR) On or Off
	Sensitivity	Low, Middle, High
Trigger level range	±2 V	



Input/Output		
Rear Panel		
Interfaces	USB (type B) connector	
External Modulation Input		
Input Frequency Range	DC-20 kHz	
Input Voltage Range	± 1 Vpk	
Input Impedance	10 kΩ (typical)	
External Trigger Input		
Level	TTL-compatible	
Slope	Rising or falling (selectable)	
Pulse Width	>100 ns	
External Reference Clock Input		
Impedance	1 kΩ, AC coupled	
Requested Input voltage swing	100 mVp-p to 5 Vp-p	
Locking range	10 MHz ± 35 kHz	
Counter Input (it shares the same port as External Reference Clock Input)		
DC coupled	DC offset range	±1.5 VDC
	100 mHz - 100 MHz	250 mVp-p - 5 Vp-p (AC+DC)
	100 MHz - 200 MHz	450 mVp-p - 3 Vp-p (AC+DC)
AC coupled	1 Hz - 100 MHz	250 mVp-p - 5 Vp-p
	100 MHz - 200 MHz	450 mVp-p - 4 Vp-p

Display

Display Type	4 inch colored LCD (Liquid Crystal Display)
Display Resolution	480 (Horizontal) × 320 (Vertical) Pixels
Display Colors	65536 colors, 16 bits, TFT screen

Power

Supply	220 - 240 VAC, 100 - 120 VAC, 50/60 Hz, CAT
Consumption	Less than 18 W
Fuse	250 V, F2AL



Environment

Temperature	Working temperature: 0 C° - 40 C° Storage temperature: 20 C° - 60 C°
Relative Humidity	≤ 90%
Height	Operating: 3,000 m Non-operating: 15,000 m
Cooling Method	Natural cooling

Mechanical Specifications

Dimension	235 mm × 110 mm × 295 mm (W*H*D)
Weight	3 kg

Interval Period of Adjustment:

One year is recommended for the calibration interval period.