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USG3000V/USG5000V Series RF Vector Signal Generators

User Manual

This document applies to the following models:

USG5000V series

USG3000V series

V1.0

November , 2025

Foreword

Thank you for choosing this UNI-T instrument. For safe and proper use this instrument, please read this manual carefully, especially the safety instructions session.

After reading this manual, it is recommended to keep the manual in a convenient location, preferably near the device, for future reference.

Chapter 1 Instructions Manual

This manual is to introduce the safety requirements, installment and the operation of USG3000V&5000V series RF Vector Signal Generators.

1.1 Inspecting Packaging and List

Upon receiving the instrument, please check the packaging and list as follows.

1. Check whether the shipping box and cushioning materials show any signs of compression or damage from external impact. Also, inspect the instrument's exterior for visible damage. If you have any concerns about the product or require assistance, please contact your distributor or local service office.
2. Carefully remove the instrument from the package and compare the items received against the packing list.

1.2 Safety Instructions

This chapter contains information and warnings that must be observed. Ensure that the instrument is operated under the safe conditions. In addition to the safety precautions indicated in this chapter, you must also follow accepted safety procedures.

Safety Precautions	
Warning	**Please follow these guidelines to avoid possible electric shock and risk to personal safety.**
	Users must follow the following conventional safety precautions in operation, service, and maintenance of this device. UNI-T will not be liable for any personal safety and property loss caused by the user's failure following the safety precautions. This device is designed for professional users and responsible organizations for measurement purposes. Do not use this device in any manner not specified by the manufacturer. This device is intended for indoor use only, unless otherwise stated in the product manual.
Safety Statements	
Warning	**"Warning"** indicates the presence of a hazard. It warns users to pay attention to a certain operation process, operation method or similar. Personal injury or death may occur if the rules in the "Warning" statement are not properly executed or observed. Do not proceed to

	the next step until you fully understand and meet the conditions stated in the "Warning" statement.
Caution	**"Caution"** indicates the presence of a hazard. It warns users to pay attention to a certain operation process, operation method or similar. Product damage or loss of important data may occur if the rules in the "Caution" statement are not properly executed or observed. Do not proceed to the next step until you fully understand and meet the conditions stated in the "Caution" statement.
Note	**"Note"** indicates important information. It reminds users to pay attention to procedures, methods, and conditions, etc. The contents of "Note" should be highlighted if necessary.

Safety Signs

	Danger	It indicates danger of electric shock, which may cause personal injury or death.
	Warning	It indicates that there are factors you should be cautious of to prevent personal injury or product damage.
	Caution	It indicates danger, which may cause damage to this device or other equipment if you fail to follow a certain procedure or condition. If the "Caution" sign is present, all conditions must be met before you proceed to operation.
	Note	It indicates potential problems, which may cause failure of this device if you fail to follow a certain procedure or condition. If the "Note" sign is present, all conditions must be met before this device will function properly.
	AC	Alternating current of device. Please check the region's voltage range.
	DC	Direct current device. Please check the region's voltage range.
	Grounding	Frame and chassis grounding terminal
	Grounding	Protective grounding terminal
	Grounding	Measurement grounding terminal
	OFF	Main power off
	ON	Main power on
	Power	Standby power supply: When the power switch is turned off, this device is not completely disconnected from the AC power supply.
CAT I	Secondary electrical circuit connected to wall sockets through	

		transformers or similar equipment, such as electronic instruments and electronic equipment; electronic equipment with protective measures, and any high-voltage and low-voltage circuits, such as the copier in the office.
CAT II		Primary electrical circuit of the electrical equipment connected to the indoor socket via the power cord, such as mobile tools, home appliances, etc. Household appliances, portable tools (e.g., electric drill), household sockets, sockets more than 10 meters away from CAT III circuit or sockets more than 20 meters away from CAT IV circuit.
CAT III		Primary circuit of large equipment directly connected to the distribution board and circuit between the distribution board and the socket (three-phase distributor circuit includes a single commercial lighting circuit). Fixed equipment, such as multi-phase motor and multi-phase fuse box; lighting equipment and lines inside large buildings; machine tools and power distribution boards at industrial sites (workshops).
CAT IV		Three-phase public power unit and outdoor power supply line equipment. Equipment designed to “initial connection,” such as power distribution system of power station, power instrument, front-end overload protection, and any outdoor transmission line.
CE	**Certification**	CE indicates a registered trademark of the EU.
UKCA	**Certification**	UKCA indicates a registered trademark of United Kingdom.
Intertek	**Certification**	Conforms to UL STD 61010-1 and 61010-2-030. Certified to CSA STD C22.2 No.61010-1 and 61010-2-030.
	Waste	Do not place equipment and accessories in the trash. Items must be properly disposed of in accordance with local regulations.
40	**EEUP**	This environment-friendly use period (EFUP) mark indicates that dangerous or toxic substances will not leak or cause damage within this indicated time period. The environmentally friendly use period of this product is 40 years, during which it can be used safely. Upon expiration of this period, it should enter the recycling system.
Safety Requirements		
Warning		
Preparation before use		Please connect this device to the AC power supply with the power cable provided. The AC input voltage of the line reaches the rated value of this device. See the product manual for specific rated value. The line voltage switch of this device matches the line voltage. The line voltage of the line fuse of this device is correct.

	This device is not intended for measuring the main circuit.
Check all terminal rated values	Please check all rated values and marking instructions on the product to avoid fire and the impact of excessive current. Please consult the product manual for detailed rated values before connection.
Use the power cord properly	You can only use the special power cord for the instrument approved by the local and state standards. Please check whether the insulation layer of the cord is damaged, or the cord is exposed, and test whether the cord is conductive. If the cord is damaged, please replace it before using the instrument.
Instrument Grounding	To avoid electric shock, the grounding conductor must be connected to the ground. This product is grounded through the grounding conductor of the power supply. Please be sure to ground this product before it is powered on.
AC power supply	Please use the AC power supply specified for this device. Please use the power cord approved by your country and confirm that the insulation layer is not damaged.
Electrostatic prevention	This device may be damaged by static electricity, so it should be tested in the anti-static area if possible. Before the power cable is connected to this device, the internal and external conductors should be grounded briefly to release static electricity. The protection grade of this device is 4 kV for contact discharge and 8 kV for air discharge.
Measurement accessories	Measurement accessories are of lower class, which are not applicable to main power supply measurement, CAT II, CAT III, or CAT IV circuit measurement. Probe subassemblies and accessories within the range of IEC 61010-031 and current sensors within the range of IEC 61010-2-032 can meet its requirements.
Use the input / output port of this device properly	Please use the input / output ports provided by this device in a proper manner. Do not load any input signal at the output port of this device. Do not load any signal that does not reach the rated value at the input port of this device. The probe or other connection accessories should be effectively grounded to avoid product damage or abnormal function. Please refer to the product manual for the rated value of the input / output port of this device.
Power fuse	Please use a power fuse of exact specification. If the fuse needs to be replaced, it must be replaced with another one that meets the specified specifications by the maintenance personnel authorized by UNI-T.
Disassembly and cleaning	There are no components available for operators inside. Do not remove the protective cover. Qualified personnel must conduct maintenance.

Service environment	This device should be used indoors in a clean and dry environment with ambient temperature from 10 °C to +40 °C. Do not use this device in explosive, dusty, or humid air.
Do not operate in humid environment	Do not use this device in a humid environment to avoid the risk of internal short circuit or electric shock.
Do not operate in flammable and explosive environment	Do not use this device in a flammable and explosive environment to avoid product damage or personal injury.
Caution	
Abnormality	If this device may be faulty, please contact the authorized maintenance personnel of UNI-T for testing. Any maintenance, adjustment or parts replacement must be done by the relevant personnel of UNI-T.
Cooling	Do not block the ventilation holes at the side and back of this device. Do not allow any external objects to enter this device via ventilation holes. Please ensure adequate ventilation and leave a gap of at least 15 cm (about 5.91 in) on both sides, front and back of this device.
Safe transportation	Please transport this device safely to prevent it from sliding, which may damage the buttons, knobs, or interfaces on the instrument panel.
Proper ventilation	Poor ventilation will cause the device temperature to rise, thus causing damage to this device. Please keep proper ventilation during use, and regularly check the vents and fans.
Keep clean and dry	Please take actions to avoid dust or moisture in the air affecting the performance of this device. Please keep the product surface clean and dry.
Note	
Calibration	The recommended calibration period is one year. Calibration should only be conducted by qualified personnel.

1.3 Environmental Requirements

This instrument is designed for use under the following conditions.

- Indoor use only
- Pollution degree 2
- Overvoltage Category II: Connect this product only to a power supply that complies with Overvoltage Category II. This typically applies to equipment connected to the mains via power cords and plugs.

- Operating altitude: up to 2000 meters (about 1.24 mi); non-operating altitude: up to 15,000 meters (about 9.32 mi)
- Unless otherwise specified, the operating temperature range is +10 °C to +40 °C; storage temperature range is −20 °C to +60 °C.
- Operating relative humidity: ≤90% RH at temperatures up to +35 °C; non-operating relative humidity: ≤60% RH at +35 °C to +40 °C

Ventilation openings are on the instrument's rear and side panels. Ensure that airflow through these vents remains unobstructed. To prevent excessive dust accumulation, clean the instrument housing regularly. The housing is not waterproof, always disconnect the power supply before cleaning. Use a dry cloth or a soft cloth slightly moistened with water.

1.4 Connecting Power Supply

The AC power supply specifications are shown in the following table.

Voltage Range	Frequency
100 V-240 V AC (Fluctuations ±10%)	50/60 Hz
100-120 V AC (Fluctuations ±10%)	400 Hz

Notes:

- The maximum power consumption of the instrument does not exceed 75 W.
- Use only the supplied power cord to connect to the power inlet.

Connecting the Power Cable

This instrument is a Class I safety product. The supplied power cables have reliable performance in terms of case grounding. This instrument is equipped with a three-prong power cable that meets international safety standards. It provides good case grounding performance for the specifications of your country or region.

To install the AC power cable:

- Ensure the power cable is in good condition.
- Leave enough space to connect to the power cord.
- Plug the attached three-prong power cable into a well-grounded power socket.

1.5 Electrostatic Discharge Protection

Electrostatic discharge (ESD) can cause permanent damage to components. Such damage may not be immediately visible and can occur during transportation, storage, or operation.

To minimize the risk of ESD damage:

- Perform testing in an ESD-protected area whenever possible.
- Before connecting the power cord to the instrument, briefly ground both the inner and outer conductors to discharge any static electricity.
- Ensure all instruments are properly grounded to prevent the buildup of static charges.

1.6 Preparation Work

1. Connect the power cord. Insert the plug into a properly grounded AC outlet, then adjust the alignment jig as required.
2. Press the software switch on the front panel to turn on the instrument.

1.7 Activation and Upgrade

Activating Optional Features

To activate an optional feature, the user needs to install its corresponding license file. The user contacts UNI-T office to purchase the license.

Follow these steps to activate your purchased option:

1. Copy the license file to the root directory of a USB flash drive.
2. Insert the USB flash drive into the front-panel USB port of the instrument.
   a. On the front panel, press Utility →System Information to open the System Information window.
   b. Click Add License under the Optional Features Information table to open the Add License dialog box.
   c. Locate the license file on the USB flash drive, select it, and check the corresponding box.
   d. Once the process is complete, the status of the corresponding optional feature in the Optional Features Information table will be updated to show the activated features.

Firmware Upgrade

After downloading the firmware upgrade package from the official UNI-T website, follow these steps to perform the upgrade:

1. Extract the upgrade package to the root directory of a USB flash drive. The package should contain four files: fpga_bin.md5, fpga_bin.upg, usg_xxxx.md5, and usg_xxxx.upg, as shown in the figure below.

Figure 1-1 Upgrade Package

2. Insert the USB flash drive into the front-panel USB port.
   a. Press the File System button at the bottom left of the screen, then navigate to File System →U Drive →Upgrade Package → and select the fpga_bin.upg file.
   b. Click Load on the right-hand menu and confirm the upgrade.
   c. The instrument will restart automatically after the first package is installed.
3. After the restart, repeat the same steps to load the second file.
   a. Press the File System button at the bottom left of the screen, then navigate to File System →U Drive →Upgrade Package → and select the usg_xxxx.upg file.
   b. Once the installation is complete, the instrument will restart again.
   c. The upgrade process is now finished.

Note

- Use a USB drive formatted in FAT32.
- Do not power off or remove the USB flash drive during the upgrade process.
- Avoid performing other operations during the upgrade to prevent failure, which may cause the device to malfunction.

1.8 Remote Control

USG3000V&5000V series RF Vector Signal Generator supports communication with a computer via USB, LAN, and GPIB interfaces. Users can send SCPI (Standard Commands for Programmable Instruments) commands over USB or LAN, using programming languages or NI-VISA, to remotely control the instrument as well as other SCPI-compliant instruments.

For detailed information about installation, remote control modes, and programming, please refer to the *USG Series RF Vector Signal Generator Programming Manual* on the official website: http://www.uni-trend.com.

1.9 Help Information

USG3000V&5000V series has a built-in help system for each function key and menu control key. From the main interface, press the Help icon to open the help system and navigate to the relevant page for detailed information.

Chapter 2 USG3000V&5000V Series Overview

USG5000V Series adopts Direct Digital Synthesis (DDS) technology, enabling the generation of high-precision, stable waveforms across a frequency range of 9 kHz to 22 GHz. It supports analog demodulation functions such as AM, FM, ΦM, and I/Q modulation, and is also equipped with pulse modulation, pulse train generation, and a power meter function. With its user-friendly operation, superior technical specifications, and intuitive graphical display, the USG5000V Series serves as a versatile tool for learning, testing, and improving work efficiency.

The basic operating principles are consistent across both the USG3000V and USG5000V Series; however, differences exist in hardware configurations and system parameters. This manual introduces the user interface and provides descriptions of the various keys for the USG5000V Series. For specific models, the parameter configurations and ranges of each menu key may vary. Please refer to the respective data sheets for detailed specifications.

2.1 Output Features

Channel	RF	LF
Amplitude Range	-135 dBm to 25 dBm	1 mVpp to 2 Vpp (50 Ω)
Waveform	Sine wave	Sine wave, square wave, pulse wave, triangular wave, arbitrary wave, DC, noise
Modulation	AM, FM, ΦM, Pulse, IQ	AM, FM, ΦM, Pulse, ASK, FSK, PSK, QAM
Sweep Modw	Step sweep, list sweep, step amplitude sweep, list amplitude sweep	Logarithmic sweep, linear sweep, step sweep

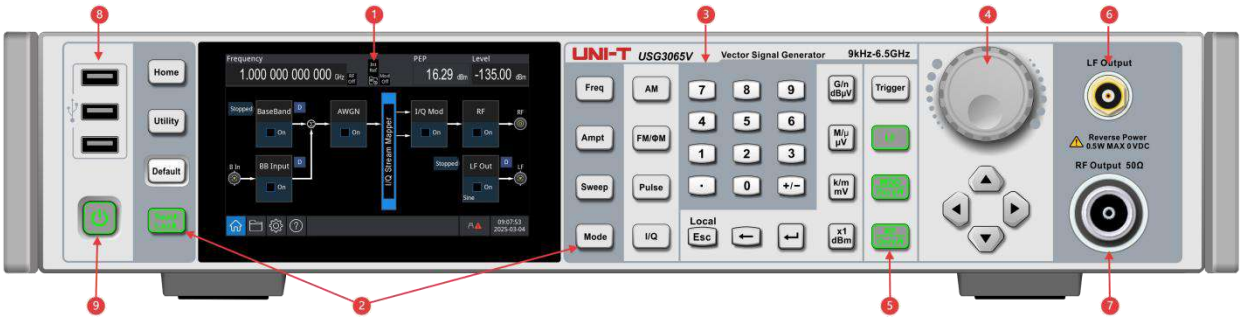
2.2 Panel and Button

2.2.1 Front Panel

The product has a front panel of simple, intuitive, and easy to use, as shown in the following figure.

USG5000V Front Panel

USG3000V Front Panel



1. Display Screen

   The 5-inch capacitive touch screen clearly distinguishes function menus, control statuses, and other important information using distinct color tones. Parameter adjustments and output controls are accessible through the touch screen, and the user-friendly system interface enhances human-computer interaction, improving work efficiency.

2. Function Key

   The function buttons are Home, Utility, Mode, Sweep, AM, FM/ΦM, Pulse, and IQ. Pressing the Home button returns to the home page; the Mode button enables RF modulation; the Sweep button enables RF sweep; the AM button configures the AM setting for RF; the FM/ΦM button configures the FM/ΦM setting for RF; the Pulse button configures the pulse setting for RF; the IQ button configures the IQ setting for RF; and the Utility button is used to set the auxiliary functions.

3. Numeric keypad

   The numeric keypad includes digit keys 0–9, a decimal point ()., a sign key (+/–), and unit keys for parameter input. The left arrow key functions as a backspace to delete the previous digit in the current entry.

4. Multifunction Rotary Knob / Arrow Keys

   The multifunction rotary knob is used to change values (rotate clockwise to increase the number) or function as an arrow key. Press the knob to select a function or confirm a setting. When using the multifunction rotary knob and arrow key to set parameters, they can be used

to switch between digit positions, clear the previous digit, or move the cursor left or right.

5. RF/LF/MOD Output Button

   Press the RF button to enable or disable the RF signal output. Press the LF button to enable or disable the LF signal output. Press the MOD button to turn each modulation mode on or off. The key backlight illuminates when the function is enabled and turns off when it is disabled.

6. LF Output Interface

   This interface is equipped with a backlight indicator. When the backlight is illuminated, the port is outputting a signal; when it is off, there is no signal output.

7. RF Output Interface

   This interface is equipped with a backlight indicator. When the backlight is illuminated, the port is outputting a signal; when it is off, there is no signal output.

8. USB Port

   This port is used to connect to an external USB storage device. It allows the instrument to read or import arbitrary waveform data files stored on the USB flash drive. It can also be used to upgrade the instrument system, ensuring that the firmware and arbitrary waveform generator software are kept up to date.

9. Power Supply Switch

   Press the power switch to turn on the instrument; press it again to turn it off.

Note

The LF output interface is equipped with an overvoltage protection function. This protection is triggered when any of the following conditions are met:

- The instrument output amplitude is ≤ 4 Vpp, while the input voltage exceeds ±3 V, and the frequency is below 10 kHz.
- When overvoltage protection is triggered, the channel output will be automatically disabled.

2.2.2 Rear Panel

The rear panels of USG3000V and USG5000V are shown in the figure below.

USG5000V Rear Panel

USG3000V Rear Panel

1. GPIB Port

   Connects the signal generator to a PC, allowing instrument control via PC software.

2. USB Port

   Connects the signal generator to a PC, allowing instrument control via PC software.

3. Local Area Network (LAN)

   Connects the instrument to a LAN for remote control.

4. Q OUT_N

   When the I/Q modulation source is internal, enabling I/Q Output allows the analog quadrature (Q) component of the I/Q modulation to be output from the built-in baseband generator.

5. Q OUT_P

   Operates with Q OUT_N to provide a balanced baseband signal output.

6. I OUT_N

   When the I/Q modulation source is internal, enabling I/Q Output allows the analog in-phase (I) component of the I/Q modulation to be output from the built-in baseband generator.

7. I OUT_P

   Operates with I OUT_N to provide a balanced baseband signal output.

8. I IN

   Used to input an externally modulated I-channel baseband signal when the I/Q modulation source is external.

9. Q IN

   Used to input an externally modulated Q-channel baseband signal when the I/Q modulation source is external.

10. PATTERN

    Pattern trigger input.

11. EVENT

    Outputs an auxiliary pulse signal when the played Arb (arbitrary waveform) contains a marker. The output pulse level corresponds to the marker polarity:

- Positive polarity: the marker point in the waveform is at a high level (approximately 3.3 V)
- Negative polarity: the marker point in the waveform is at a low level (approximately 0 V)

12. BB TRIG

    Baseband trigger input.

13. External Analog Modulation Input

    During RF amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM), when the modulation source is set to External or Internal + External, the modulation signal is applied through the external analog modulation input port. The corresponding modulation depth, frequency offset, phase offset, or duty cycle deviation is controlled by a 4 Vpp high-impedance input signal.

14. Valid Output

    This active output provides a pulse signal. When parameters such as frequency or amplitude are being adjusted, the Valid output remains at a high level. After the parameter settings are completed, the Valid output switches to a low level.

15. TRIG In/Out

    For LF Sweep: When trigger output is enabled, a TTL-compatible square-wave trigger signal is output through this connector. During RF pulse modulation, this connector can also output a synchronization signal.

    For External Triggering: When the trigger mode of the RF Sweep or LF Sweep is set to External, this connector accepts a TTL pulse of the specified polarity as the trigger input signal.

16. Pulse Signal Output

    During pulse modulation, this port outputs the internally generated “Pulse In” signal.

17. Pulse Signal Input

    This port accepts external pulse signals when the pulse type is set to External Trigger, External Trigger Pulse Pair, Gate, or External Pulse.

18. External 10MHz Input Port

    Establish synchronization between multiple generators or with an external 10 MHz clock signal. If the instrument detects an external 10 MHz clock signal at the 10MHz IN connector (input requirements: frequency of 10MHz, amplitude ≥ 0 dBm/50 Ω), it will automatically switch to this signal as the external clock source, indicated by the first icon Ext Ref in the status bar. In Auto mode, when the external clock source is lost, exceeds limits, or disconnected, the instrument clock source will automatically switch to the internal clock, and the icon Ext Ref will update to Int Ref.

19. Internal 10MHz Output Port

    Establish synchronization between multiple signal generators or the output of a 10 MHz

reference clock signal to an external source.

20. Ground Terminal

The ground terminal provides an electrical connection point for attaching an antistatic wrist strap to reduce electrostatic discharge (ESD) when handling or connecting the DUT.

21. Main Power Supply Switch

When the power switch is set to “I”, the instrument is powered on. When the power switch is set to “O,” the instrument is powered off (the power switch on the front panel does not function).

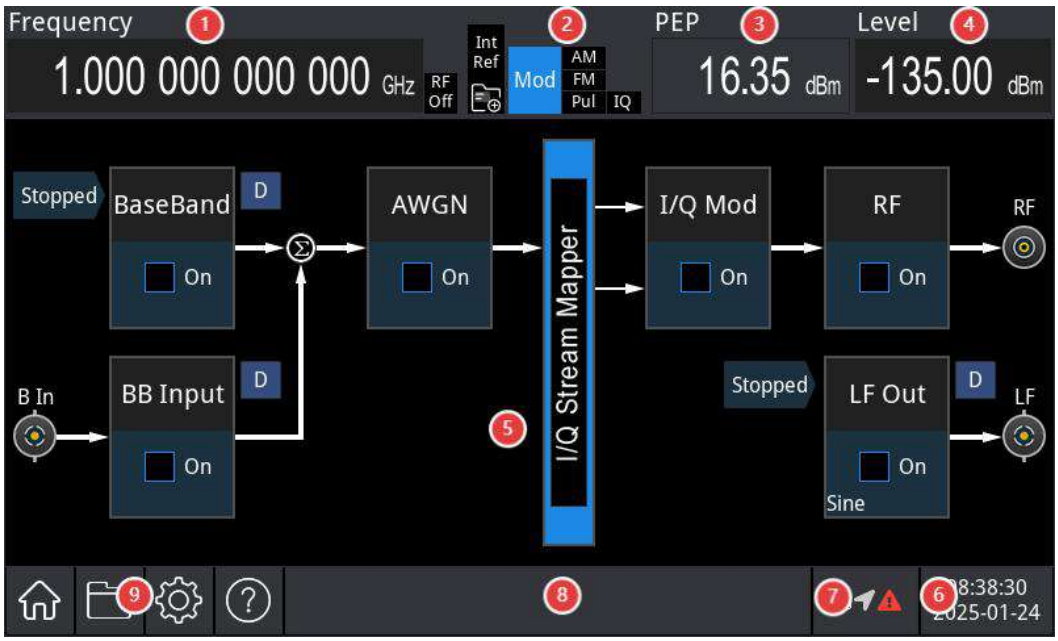
22. AC Power Input Port

For the AC power specifications, refer to the *Connecting Power Supply* section.

23. Safety Lock

The safety lock (sold separately) is used to secure the instrument in a fixed position.

2.2.3 Function Interface



1. RF Frequency (Display Frequency): Configures the RF frequency. This differs from the frequency output setting in the frequency menu, RF Frequency (Display Frequency) = Frequency Output + Frequency Offset.

2. Status Bar

RF: Displays RF output state. Gray indicates that the output is disabled, while blue indicates that the output is enabled.

ExtRef/IntRef: ExtRef indicates that the signal generator is using the external 10MHz reference input. IntRef indicates that the signal generator is using the internal 10MHz reference.

AM/FM/Pul/IQ: Indicates the currently active modulation type. Gray indicates that the current

modulation is disabled, while blue indicates that the current modulation is enabled.

3. PEP (Peak Envelope Power): Envelope power is defined as the average power measured over a time interval that is long compared to the highest modulation frequency period, yet short compared to the carrier period.

   The maximum value of this envelope power is called the Peak Envelope Power (PEP). PEP is an important parameter for characterizing the output power of amplitude-modulated or other varying-envelope signals.

4. RF (Display Amplitude): Configures the RF amplitude. This differs from the amplitude output setting in the frequency menu, RF Amplitude (Display Amplitude) = Amplitude Output + Amplitude Offset.

5. Parameter Setting Area

   Modulation Source: Configures the internal modulation source for RF. This includes enabling or disabling the internal source, and setting parameters such as modulation waveform, frequency, amplitude, and phase.

   Modulation Input: Configures the external modulation source for RF. This includes enabling or disabling the external input and setting the input load for the external modulation source.

   Analog Modulation: Configures RF modulation parameters. This includes enabling or disabling modulation, and setting the modulation type, amplitude modulation (AM), frequency modulation (FM), phase modulation (ΦM), or pulse modulation (PM).

   Baseband: Configures baseband parameters, including settings for Custom, ARB (Arbitrary Waveform), Multi-tone, and IoT modes.

   Baseband Input: Configures the baseband input switch.

   Noise Superposition: Configures parameters related to superimposed noise, including noise bandwidth, system bandwidth, minimum noise-to-system bandwidth ratio, and other associated parameters.

   I/Q Modulation: Configures the I/Q modulation switch and related parameters, including I/Q source, I/Q adjustment, and I/Q output settings.

   RF (Radio Frequency): Configures RF carrier signal parameters, including enabling or disabling the RF output, and setting frequency, amplitude, sweep, power meter, and other related parameters.

   Function Generation: Configures LF (Low Frequency) signal parameters, including enabling or disabling the LF output, and setting fundamental waveform, sweep, and modulation parameters.

6. Date and time: Displays day and time.

7. Connection type: Displays the connection device state, such as mouse, USB flash drive, and

screen lock.

8. System log dialog box: Click on the blank area on the right side of the file storage section to access the system log, view local runtime logs, alarms, notifications, and other information.
9. Function setting: Screenshot, file system, setup system, and help system.

   Hom page : Click on this key to return to the home page, double-click on this key to take a screenshot and save it to the instrument.

   File system : In the file system, users can save, copy, move, delete, load, and rename files, including sweep list files, pulse string files, screenshots, state files, arbitrary files, and other files.

   System information : View basic and optional information about the instrument.

   Help system : Open the help navigation.

2.2.4 Touch Operation

RF Vector Signal Generator features a 5-inch capacitive touchscreen that supports multiple gesture operations:

- Tap a parameter or menu on the screen to edit the selected parameter.
- Swipe left or right to switch between menus.
- Swipe up or down to scroll through the menu items.

Note: The menu can be scrolled only when a scroll bar is displayed on the right side of the screen. If no scroll bar appears, the current page contains all available items.

Chapter 3 Quick Start Guide

3.1 Output RF Signal

3.1.1 Output Frequency Setting

By default, the RF output is configured as a continuous wave with a frequency of 1 GHz and an amplitude of –135 dBm.

To change the frequency to 2.5 GHz, follow these steps:

1. Press the Freq key.
2. Use the numeric keypad to enter 2.5.
3. Select GHz as the unit for the frequency parameter.

3.1.2 Frequency Offset Setting

Default RF waveform configuration: The frequency offset is set to 0 Hz.

To change the frequency offset to 100 kHz, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Freq Offset key.
3. Use the numeric keypad to enter 100 and select kHz as the unit.
4. Press the Freq Offset key again to enable the setting.

Note: The multifunction knob and arrow keys can also be used together to set this parameter.

3.1.3 Frequency Reference Setting

Default RF waveform configuration: The frequency reference is set to 0 Hz.

To change the frequency reference to 200 MHz, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Freq Ref key.
3. Use the numeric keypad to enter 200 and select MHz as the unit.
4. Press the Freq Ref key again to enable the setting.

3.1.4 Phase Offset Setting

Default RF waveform configuration: The phase offset is set to 0°.

To change the phase offset to 90°, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Phase Offset key.
3. Use the numeric keypad to enter 90 and select deg as the unit.

3.1.5 Phase Reference Setting

Default RF waveform configuration: The phase reference is set to 0°.

To change the phase reference to 180°, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Phase Ref key.
3. Use the numeric keypad to enter 180 and select deg as the unit.
4. Press the Phase Ref key again to enable the setting.

3.1.6 Internal TB Calibration Setting

Default RF waveform configuration: The internal TB calibration is set to 0 ppb.

To change the internal TB calibration to 30 ppb, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Inner TB key.
3. Use the numeric keypad to enter 30 and select ppb as the unit.

3.1.7 Reference Source Setting

Default RF waveform configuration: The reference source is set to Auto.

To change the reference source to internal, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→ Ref Oscillator →Internal key.

3.1.8 Output Amplitude Setting

Default RF waveform configuration: The amplitude is set to -135 dBm.

To change the amplitude to 0 dBm, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Ampt→Ampt key.
3. Use the numeric keypad to enter 0 and select dBm as the unit.

3.1.9 Amplitude Offset Setting

Default RF waveform configuration: The amplitude offset is set to 0 dB.

To change the amplitude offset to 10 dB, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Freq→Ampt Offset key.
3. Use the numeric keypad to enter 10 and select dB as the unit.
4. Press the Ampt Offset key again to enable the setting.

3.1.10 Amplitude Reference Setting

Default RF waveform configuration: The amplitude reference is set to 0 dB.

To set the amplitude reference, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Ampt→Ampt Ref key. The amplitude reference will automatically update to the current amplitude value.

3.1.11 User-defined Maximum Power Setting

Default RF waveform configuration: The user-defined maximum power is set to 25 dBm.

To set the user-defined maximum power to 20 dBm, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Ampt→User Power Max key.
3. Use the numeric keypad to enter 20 and select dBm as the unit.
4. Press the User Power Max key again to enable the setting.

3.1.12 Attenuation Setting

Default RF waveform configuration: The attenuation is set to 0 dB.

To change the attenuation to 10 dB, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Ampt→Set Atten key.
3. Use the numeric keypad to enter 10 and select dB as the unit.

3.1.13 ALC Setting

Default RF waveform configuration: The ALC (Automatic Level Control) is enabled.

To change the ALC state to Auto, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the RF →Ampt→ ALC State.
3. In the drop-down menu, select Auto to complete the setting.

3.2 Output LF Signal

3.2.1 Output Frequency Setting

Default LF waveform configuration: The LF signal waveform is configured with a frequency of 500 kHz and an amplitude of 2 Vpp (high impedance).

To change the frequency to 2.5 MHz, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Freq key.
3. Use the numeric keypad to enter 2.5 and select MHz as the unit.

3.2.2 Output Amplitude Setting

Default LF waveform configuration: The LF signal waveform is a sine wave (high impedance) with an amplitude of 2 Vpp.

To change the amplitude to 300 mVpp, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Ampt key.
3. Use the numeric keypad to enter 300 and select mVpp as the unit.

3.2.3 DC Offset Voltage Setting

Default LF waveform configuration: The LF signal waveform is a sine wave (high impedance) with DC offset voltage.

To change the DC offset voltage to -150 mV, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→DC Offset key.
3. Use the numeric keypad to enter –150 and select mVpp as the unit.

Note: The multifunction knob and arrow keys can also be used together to set this parameter.

3.2.4 Phase Setting

Default LF waveform configuration: The phase is set to 0°.

To change the phase to 90°, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Phase key.
3. Use the numeric keypad to enter 90 and select deg as the unit.

3.2.5 Duty Ratio for Square Wave Setting

Default LF signal square wave configuration: Frequency 500 kHz with a 50% duty cycle.

To change the duty ratio to 25%, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Type key.
3. In the drop-down menu, select the square wave, then use the numeric keypad to enter 25, and select % as the unit.

3.2.6 Symmetry for Triangular Wave Setting

Default LF signal ramp wave configuration: Frequency 500 kHz with a 50% duty cycle.

To change the symmetry to 75%, follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Type key.
3. In the drop-down menu, select the triangular wave, then use the numeric keypad to enter 75, and select % as the unit.

3.2.7 Arbitrary Wave Setting

Default LF signal arbitrary wave configuration: Frequency 500 kHz, with the arbitrary waveform file set to "ACosH.bsv."

To set the arbitrary waveform file to "ACosH.bsv," follow these steps:

1. On the screen, press the Home key in the analog stream mapper.
2. Press the Function Gen →LF Carrier→Type key.
3. In the drop-down menu, select the arbitrary wave.
4. Press the Arb Wave File key.
5. In the file window, double-click the folder "Common," and select the file "ACosH.bsv" to import the arbitrary waveform.

3.3 Auxiliary Function

The auxiliary function (Utility) can access the system information and set the system, network, and default setting. The specific functions are described below.

3.3.1 System Information

Press the Utility →System Info or RF Info key to open the system menu and view basic and optional information.

1. Basic information: Product name, manufacturer, model, serial number, software version, intermediate frequency hardware version, RF hardware version, intermediate frequency logic version, and RF logic version.
2. Optional information: Optional version and optional status.
3. RF information: Each board name, version, and serial number.

3.3.2 System Setting

Press the Utility →Setting key to open the setting menu to configure the basic and network settings.

1. Basic Setting

Language: Simplified Chinese, English, and German

Time format: 12-hour and 24-hour

Date/Time: Tap the area to open the settings box. Slide the number up or down to adjust the value, then tap "√" to confirm and close the settings box when finished.

Picture format: Set the format for saved screenshots to either BMP or PNG.

User state: The system configuration can be exported.

Backlight: Slide the scroll bar to adjust the screen backlight.

Screenshot inverse: Enable to save screenshots with inverse colors.

2. Network Setting

Adapter: LAN (Local Area Network) switch. Tap the checkbox "□" to enable this function, indicating that LAN is active.

DHCP: Tap the checkbox "□" to enable DHCP (Dynamic host configuration protocol). If the checkbox "□"is not checked, manual settings are applied.

IPV4 address: The format of the IP address is nnn.nnn.nnn.nnn. The range of the first nnn is from 1 to 223. The range of the other three nnn is from 0 to 255. It is recommended to consult your network administrator for an available IP address.

Subnet mask: The format of the subnet mask is nnn.nnn.nnn.nnn. The range of nnn is from 0 to 255. It is recommended to consult your network administrator for a subnet mask address.

Gateway address: The format of the gateway address is nnn.nnn.nnn.nnn. The range of the first nnn is from 1 to 255. The range of the other three nnn is from 0 to 255. It is recommended to consult your network administrator for an available gateway address.

MAC address: The physical address used to identify the location of the network device, also known as the hardware address. It is 48 bits (6 bytes) in length, composed of hexadecimal numbers, and divided into two parts: the first 24 bits and the last 24 bits. The format is xx-xx-xx-xx-xx-xx. The first 24 bits are called the Organizationally Unique Identifier (OUI), while the last 24 bits are allocated by the manufacturer and called the Extended Identifier.

3. Interface Setting

The web address follows the format http://IP, where IP refers to the IPv4 address configured in the network settings, for example, http://192.168.20.117.

Web login password: The login password is set together with the username used for browser access. After successfully logging in, the user can perform instrument control, execute SCPI commands, and configure network settings directly through the browser.

Once the web login username and password have been configured, the user can use a web browser on a PC or mobile device to remotely control the instrument. This remote-control

feature simulates the touchscreen and mouse operation of the physical device, allowing the instrument to function identically to local operation.

1) LAN Access

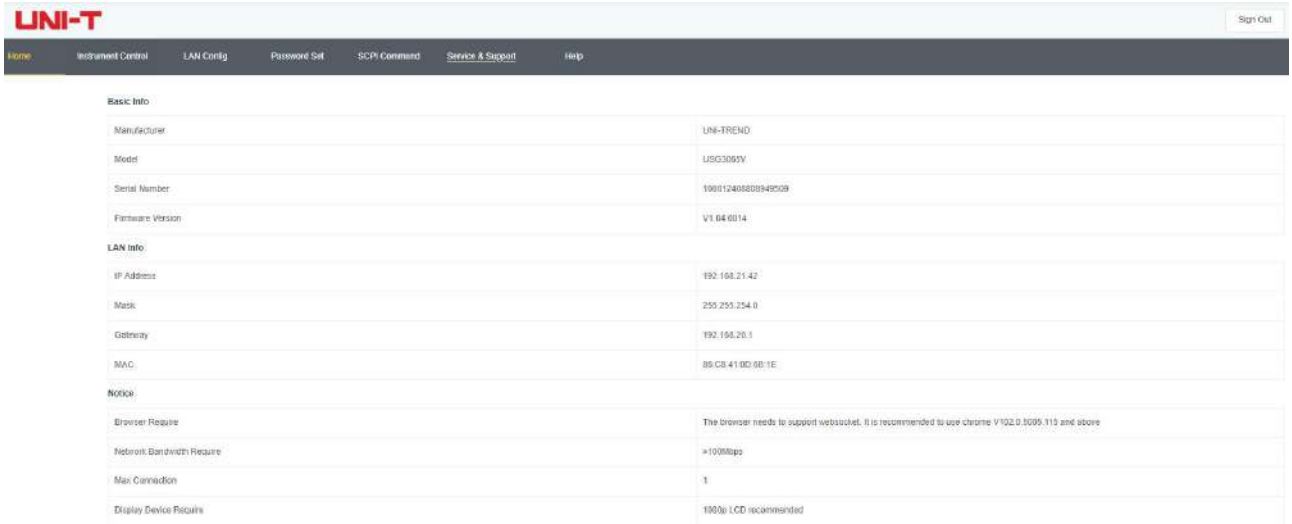
The computer and the signal generators are required to be in the same LAN and can ping each other. View the signal generator's local IP via the Utility menu and then access the signal generators by accessing the http://ip: port in a browser.

Example:

Computer IP: 192.168.21.131

Signal generator IP: 192.168.20.117

Use 192.168.20.117 to access the signal generator in the computer browser, view the basic information, and perform operations such as instrument control, network settings, password settings, and SCPI command control, as shown in the following figure.

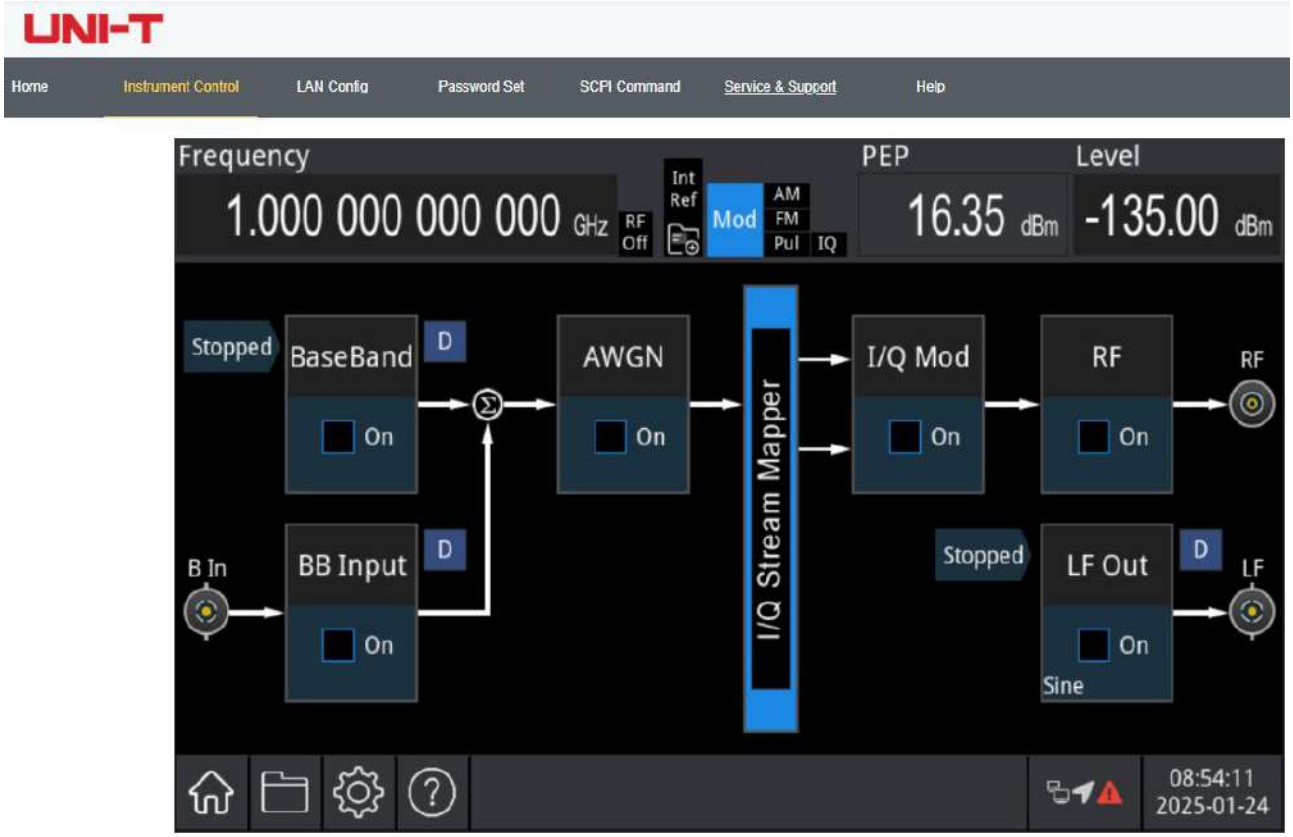


Web Basic Information

When accessing instrument control, network settings, password settings, or SCPI command control, login authentication is required.

For the username and password, refer to Web Login Username and Web Login Password in the interface setting.

After successful login, the user can view and control the signal generator, as shown in the figure below.



Web Instrument Control

Operations that can be performed on the touch screen of a physical instrument, such as selecting a menu panel, clicking function keys, entering numbers and characters, dragging a mark, etc., can also be operated on this web page, and the screen can also be printed.

2) External Access

a. Connect the signal generator to a network cable and ensure the network has Internet access.

b. Enable the frp proxy service on the server.

c. Configure the frp proxy IP address and port number on the signal generator.

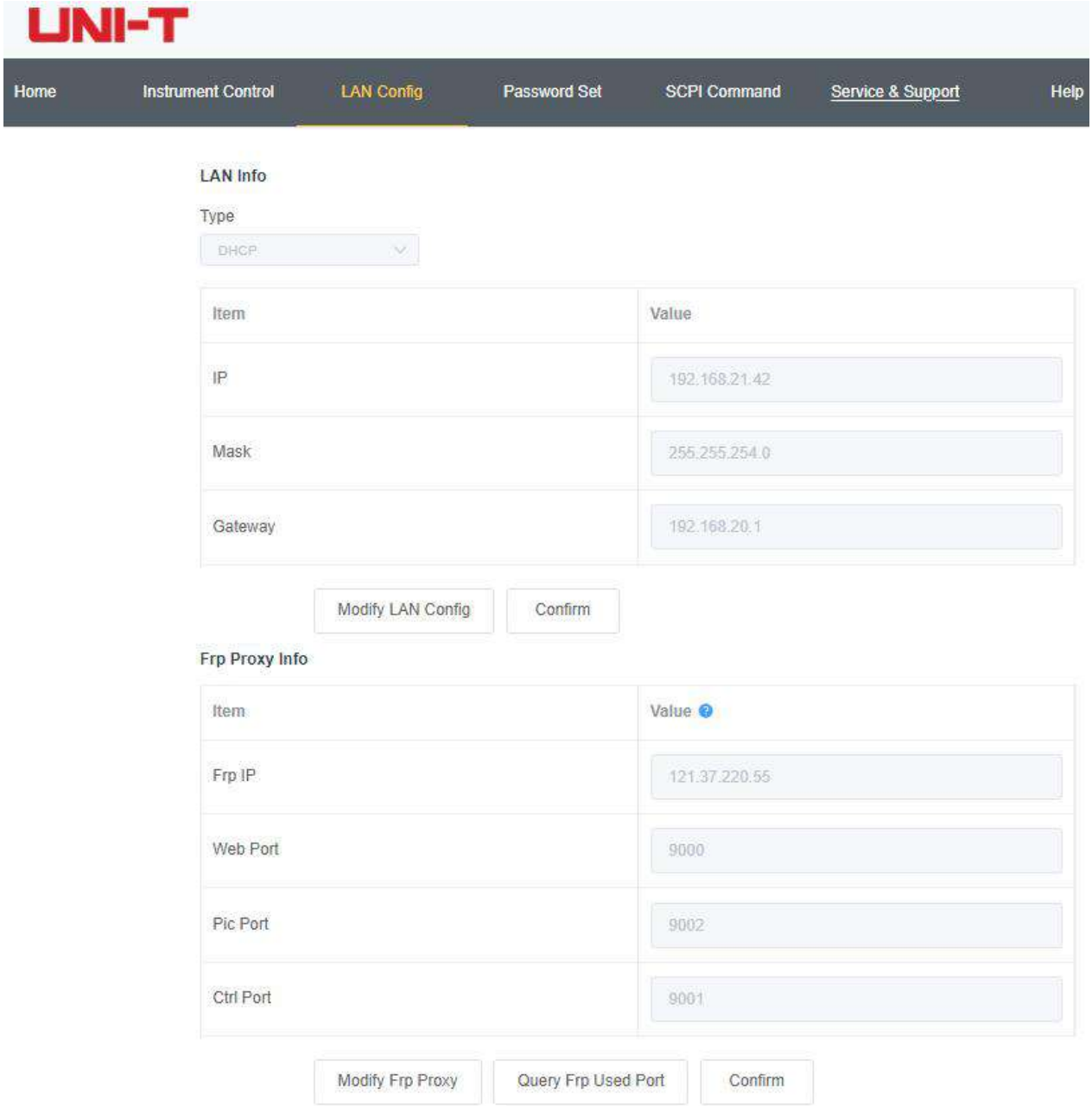
d. In the browser, enter the proxy address in the format http://IP:web_port to access the signal generator. The access interface is identical to that of the intranet connection.

Note: The instrument uses the frp intranet penetration mode to enable external network access. The frp version is 0.34.0.

The instrument includes the frp-0.34.0 client, which must be used in conjunction with an FRP server. The server must have the FRP service enabled, and the client connects to the server through port 7000. Therefore, the server configuration must include the parameter bind_port = 7000.

3) Network Setting

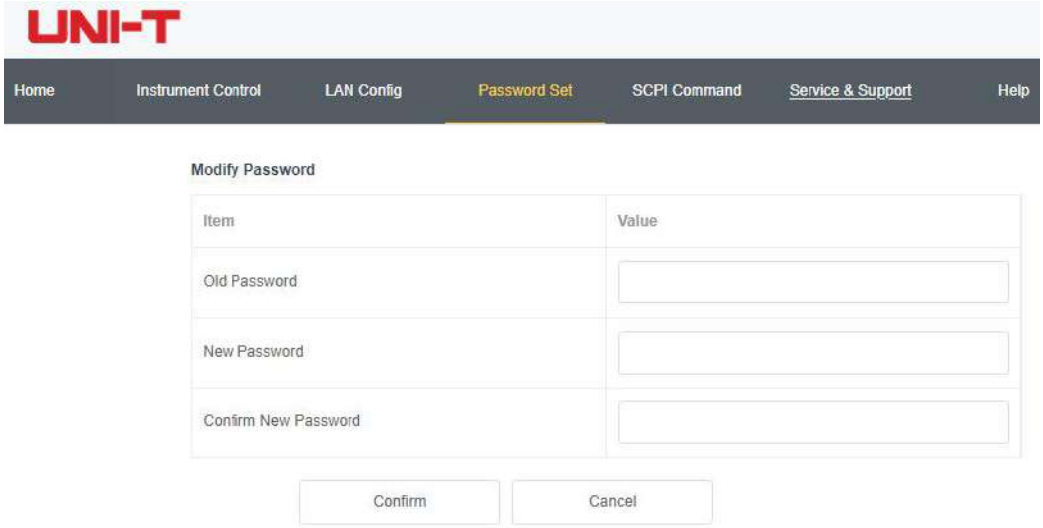
Set and modify the network information of the signal generator and the frp agent, as shown in the following figure.



Web Network Settings

4) Password Setting

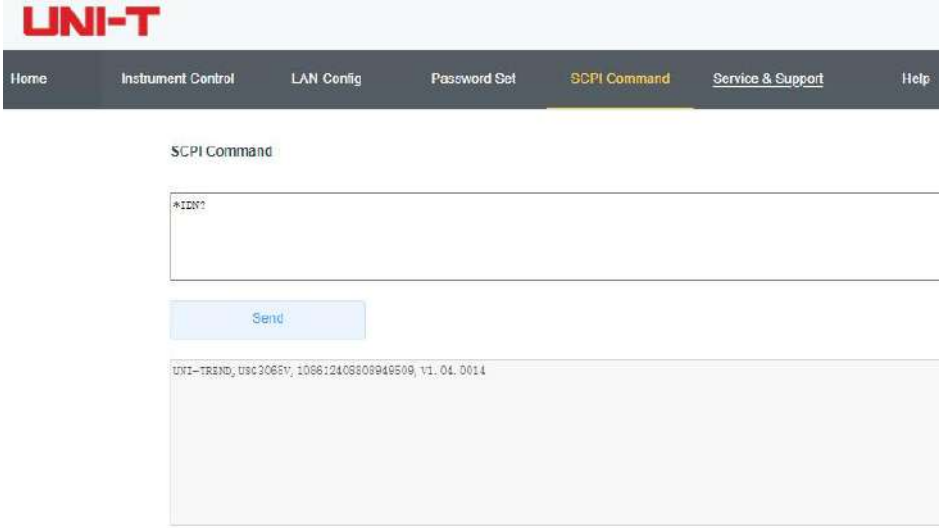
Set and modify the web login password of the signal generator, as shown in the following figure. The original password can be viewed under the Physical Instrument ->System->Setting-> Interface Setting.



Web Password Settings

5) SCPI Command

Execute the SCPI command, as shown in the following figure. Enter the command in the SCPI command to edit box, click the "Send Command" key, and print the execution result to the report column below.



SCPI Command Control

3.3.3 Restore Default

Press the Utility → Defaults key to open the default setting menu.

1. Restore: Reset the signal generator system settings to the default state.
2. Data: Delete all saved data on the signal generator.
3. All: Restore all settings to the default state and delete user data.

3.3.4 GPIB Setting

Press the Utility →GPIB Bus key to open the GPIB setting menu to set the GPIB address.

Chapter 4 Advance Application

Both Low Frequency (LF) and Radio Frequency (RF) outputs support modulated waveforms. The LF and RF signals are transmitted through independent channels and operate separately.

This chapter covers the following modulation functions:

- RF Modulation: AM (Amplitude Modulation), FM (Frequency Modulation), ΦM (Phase Modulation), Pulse Modulation, Custom Modulation, ARB (Arbitrary Waveform) Modulation, Multi-tone Modulation, and IoT Modulation.
- LF Modulation: AM (Amplitude Modulation), FM (Frequency Modulation), ΦM (Phase Modulation), Pulse Modulation, ASK (Amplitude Shift Keying), FSK (Frequency Shift Keying), PSK (Phase Shift Keying), and QAM (Quadrature Amplitude Modulation).

In addition, this chapter includes RF Sweep Waveforms, LF Sweep Waveforms, and Power Meter functions.

Press the MOD On/Off key to enter RF modulation mode; the backlight of the MOD On/Off key will illuminate. Press the key again to exit RF modulation mode; the backlight will turn off.

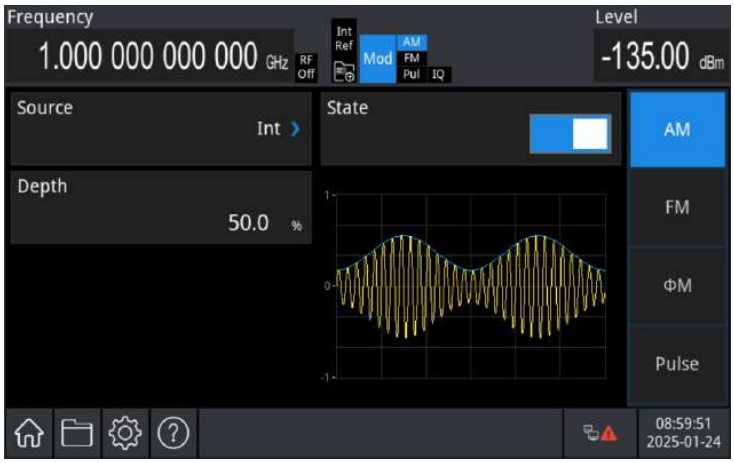
4.1 Modulation Wave Output

4.1.1 RF Amplitude Modulation (AM)

In AM mode, the modulated wave consists of the carrier wave and the modulation wave. The amplitude of the carrier wave changes with the amplitude of the modulation wave.

Amplitude Modulation (AM)

Press the AM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →AM →State key to enable AM mode. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave Frequency

Each carrier wave has a different frequency, with a default frequency of 1 GHz. The frequencies of each carrier wave are shown in the following table.

Frequency							
USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
9 kHz	4.5 GHz	9 kHz	6.5 GHz	9kHz	14 GHz	9 kHz	22 GHz

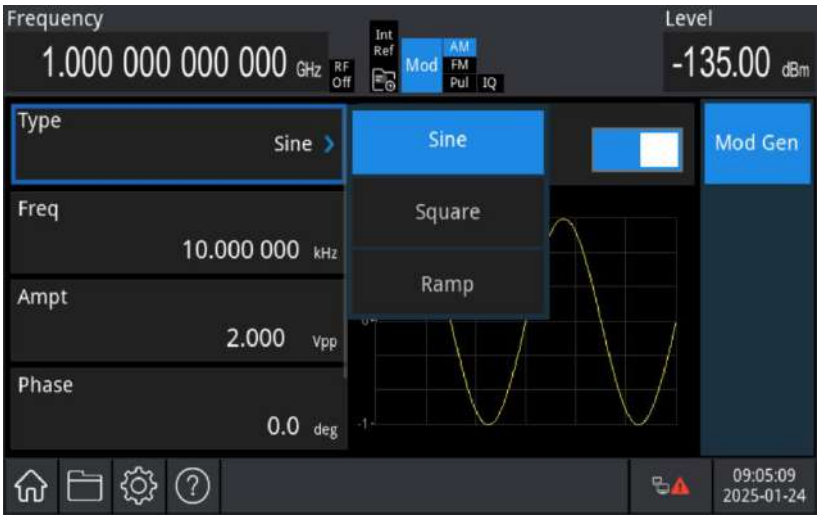
Press the Freq key to set the carrier wave frequency and use the numeric keypad to enter the number and select the unit to complete this setting.

Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, and triangular waveforms, with sine wave selected by default.

After AM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation wave can be adjusted by pressing the Home → Source key, using the multi-function rotary knob in modulation source interface or pressing the Type key to adjust the modulation wave.

- Square wave: Duty ration is 50%.
- Triangular wave: Symmetry is 50%.



Modulation Frequency Setting

Set the modulation waveform frequency within the range of 1 MHz to 100 kHz (default: 10 kHz). After AM mode is enabled, the default modulation frequency of 10 kHz will be displayed.

The user can adjust the modulation frequency either by rotating the multi-function knob in the modulation source interface, or by pressing the Freq key, entering a numeric value using the

numeric keypad, and selecting the desired unit to complete the setting.

Modulation Depth Setting

The modulation depth indicates the change in amplitude, expressed as a percentage. The AM modulation depth can be set between 0% and 99%, with a default of 50%.

- When the modulation depth is set to 0%, a constant amplitude (equal to the configured carrier amplitude) is output.
- When the modulation depth is set to 99%, the output amplitude varies according to the modulated waveform.

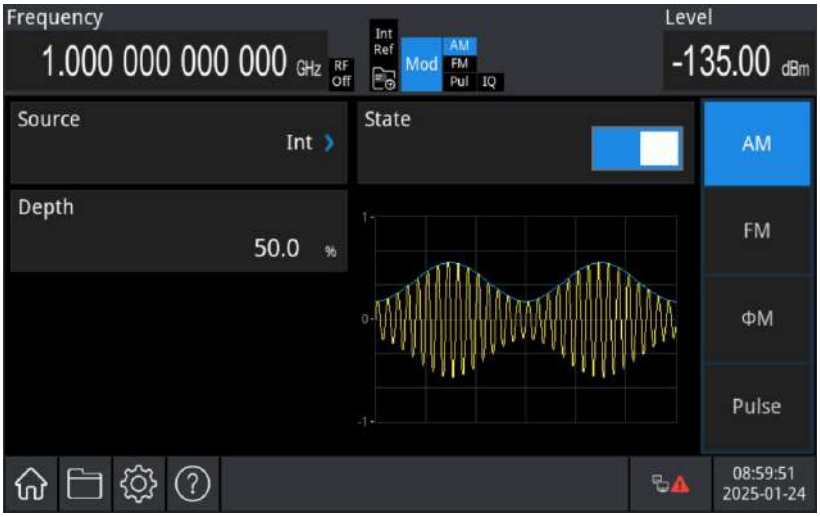
The modulation depth can be adjusted by using the multi-function rotary knob in analog modulation source interface or pressing the Depth key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to Amplitude Modulation (AM) mode. Next, configure a 20 kHz sine wave as the internal modulating signal, with a carrier frequency of 2 GHz and an amplitude of -20 dBm. Finally, set the modulation depth to 80%. The procedure is as follows.

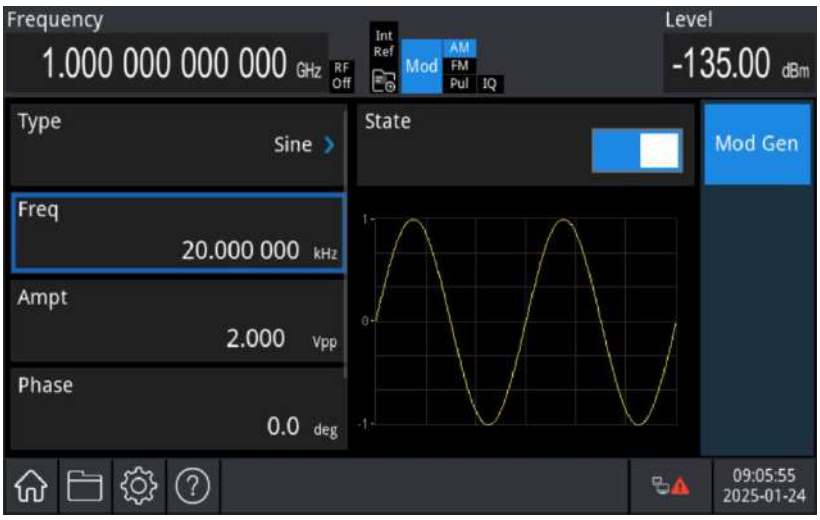
1) Enable (AM) Mode

   Press the AM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →AM →State key to enable AM mode.



2) Set Modulation Signal

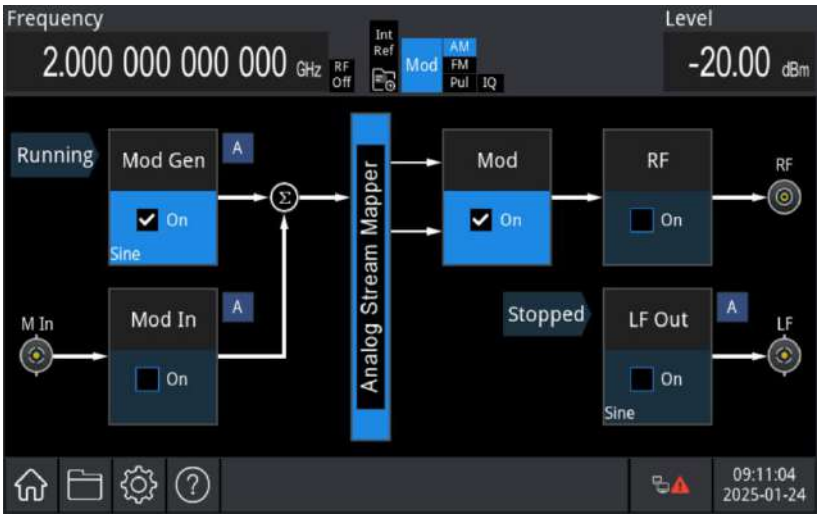
   Press the Home key in the analog stream mapper on the screen, check the analog source ON, press the Source →Freq key, then use the numeric keypad to enter 20 and select the unit kHz for this parameter.



3) Set Carrier Signal

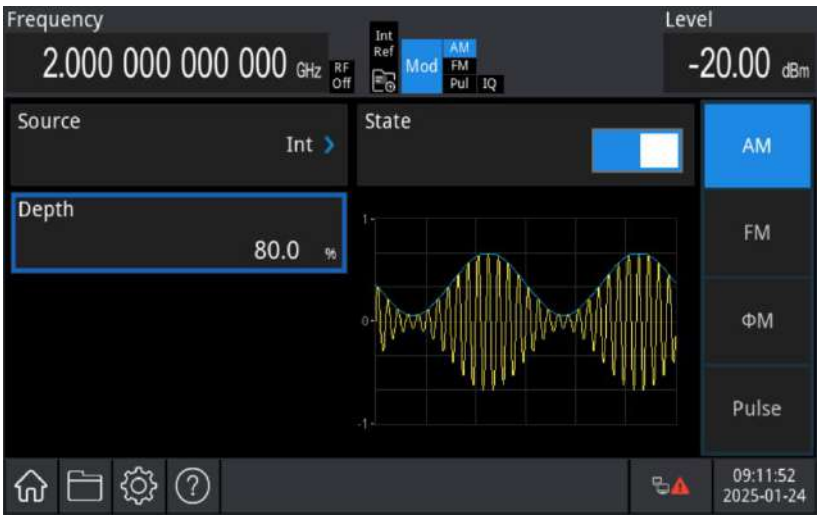
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -20 and select the unit dBm for this parameter, as shown in the following figure.



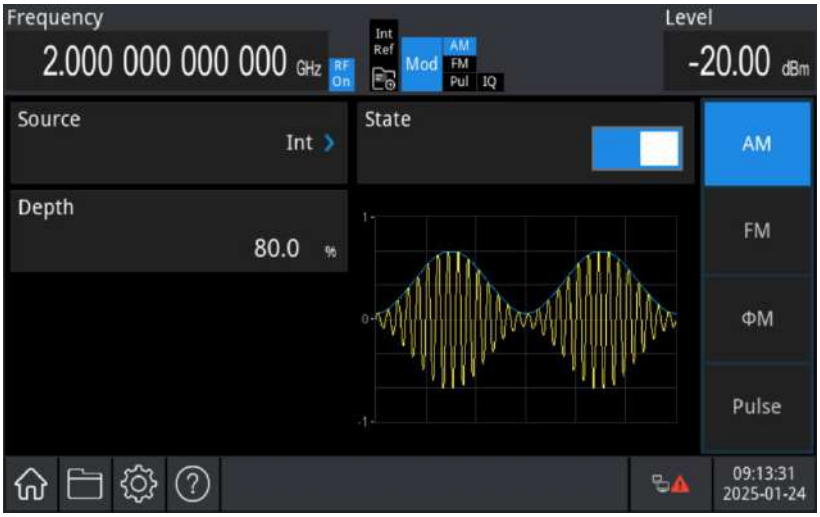
4) Set Modulation Depth

After setting the carrier parameters, press the Home key in the analog stream mapper on the screen, press the Analog Modulation key to open AM setting menu, press the Depth key, then use the numeric keypad to enter 80 and select the unit % for this parameter.

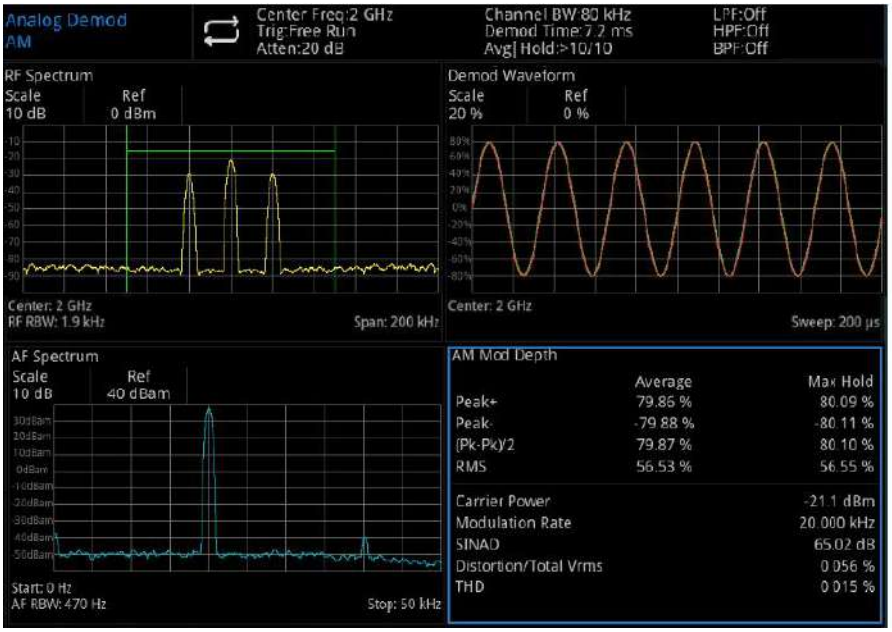


5) Enable Channel Output

Press the RF On/off key on the front panel. If the key is illuminated, the channel output is enabled.



View the AM modulation waveform on a spectrum analyzer, as shown in the following figure.

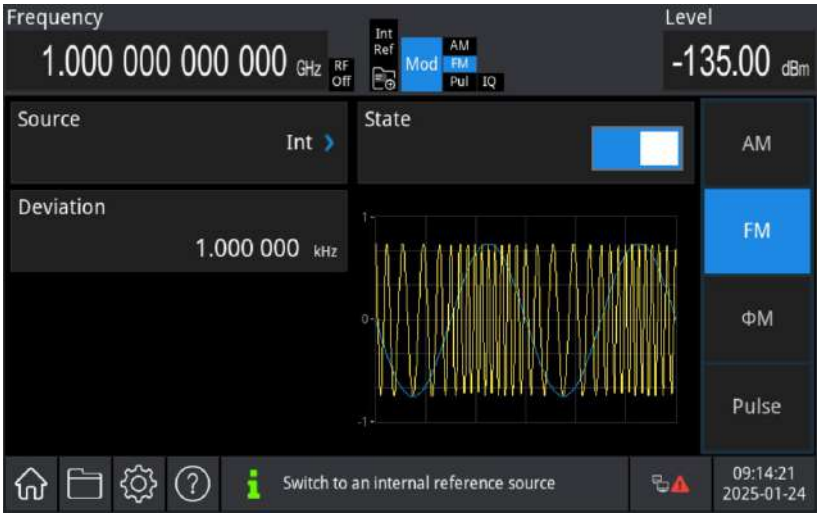


4.1.2 RF Frequency Modulation (FM)

In FM mode, the modulated wave consists of the carrier wave and the modulation wave. The frequency of the carrier wave changes with the amplitude of the modulation wave.

Frequency Modulation (FM)

Press the FM/ΦM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →FM →State key to enable FM mode. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave Frequency

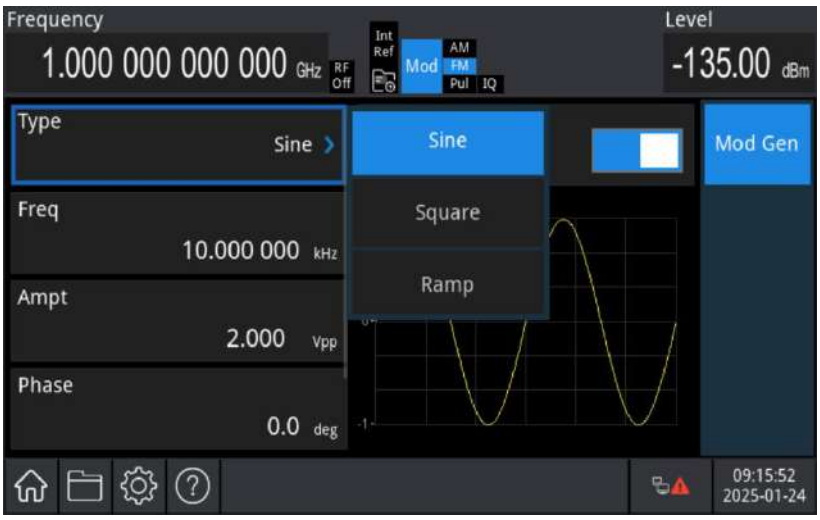
Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, and triangular waveforms, with sine wave selected by default.

After FM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation wave can be adjusted by pressing the Home → Source key, using the multi-function rotary knob in modulation source interface or pressing the Type key to adjust the modulation wave.

- Square wave: Duty ration is 50%
- Triangular wave: Symmetry is 50%



Modulation Frequency Setting

Set the modulation waveform frequency within the range of 1 MHz to 100 kHz (default: 10 kHz). After FM mode is enabled, the default modulation frequency of 10 kHz will be displayed.

The user can adjust the modulation frequency either by rotating the multi-function knob in the modulation source interface, or by pressing the Freq key, entering a numeric value using the numeric keypad, and selecting the desired unit to complete the setting.

Frequency Offset Setting

Frequency offset indicates the deviation of the frequency-modulated wave relative to the carrier wave frequency. The FM frequency offset range can be set from a minimum of DC up to half of the current maximum carrier frequency. The default frequency offset is 1 kHz.

The frequency offset can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Freq Offset key and using the numeric keypad to enter the number and select the unit to complete this setting.

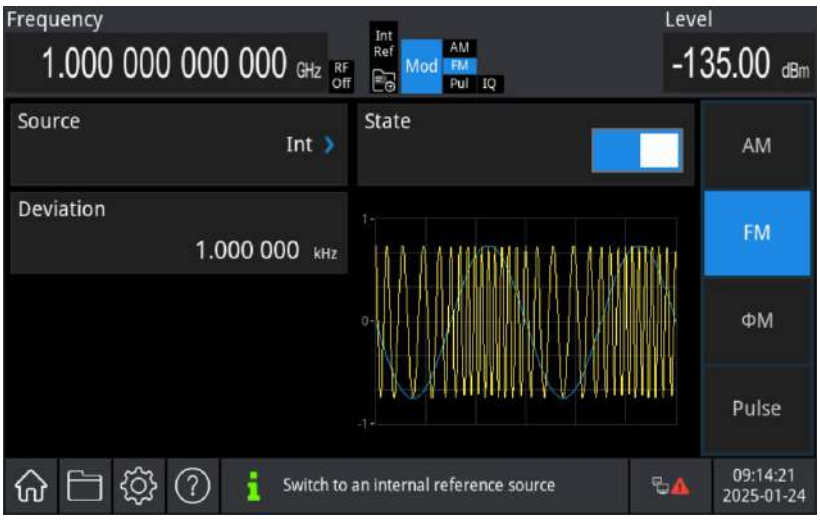
- The frequency offset range is specified in the maximum frequency offset section of the data manual for each model.

Comprehensive Example

First, set the instrument to Frequency Modulation (FM) mode. Next, configure a 20 kHz sine wave as the internal modulating signal, with a carrier frequency of 2 GHz and an amplitude of -20 dBm. Finally, set the frequency offset to 200 kHz. The procedure is as follows.

1) Enable FM Mode

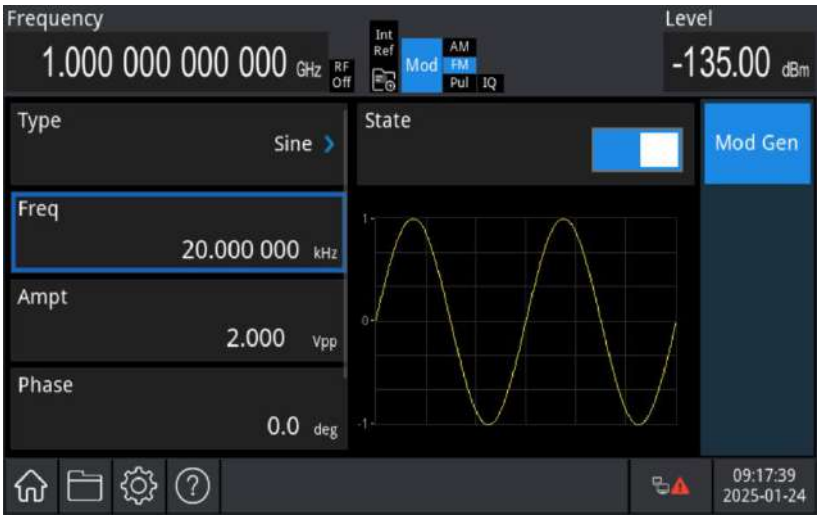
   Press the FM/ΦM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →FM →State key to enable FM mode.



2) Set Modulation Signal and Wave

Press the Home key in the analog stream mapper on the screen, check the analog source ON, press the Source →Freq key, then use the numeric keypad to enter 20 and select the unit kHz for this parameter.

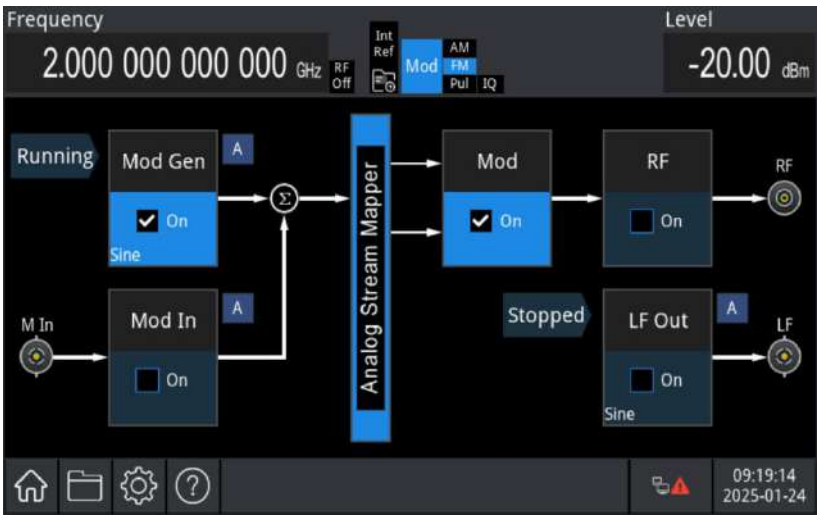
Press the Type key in the modulation source interface, then select the sine wave from the drop-down menu.



3) Set Carrier Signal

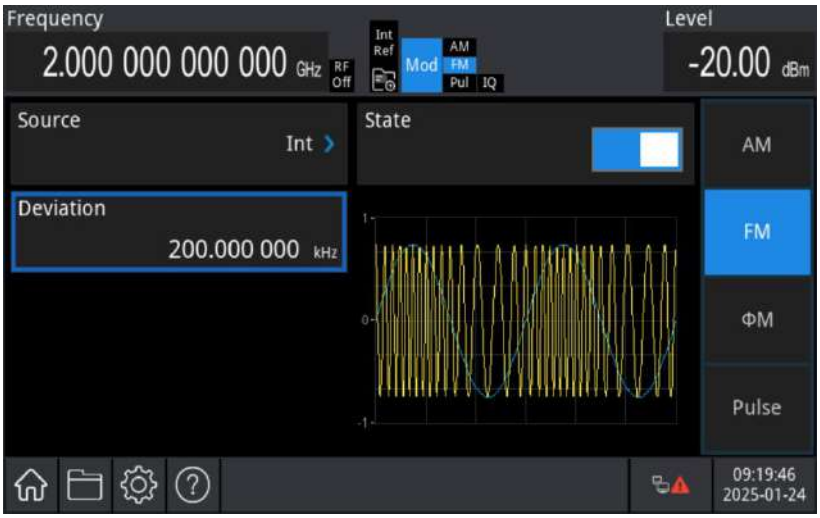
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -20 and select the unit dBm for this parameter, as shown in the following figure.



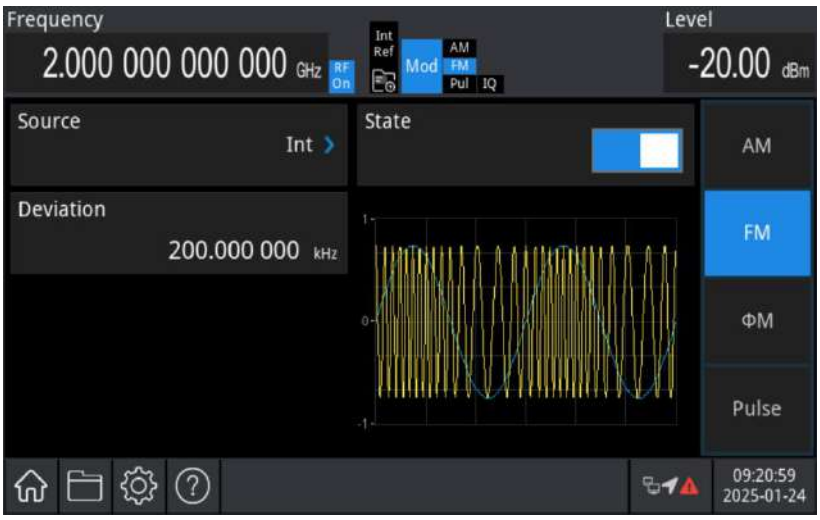
4) Set Frequency Offset

After setting the carrier parameters, press the Home key in the analog stream mapper on the screen, press the Analog Modulation key to open FM setting menu, press the Freq Offset key, then use the numeric keypad to enter 200 and select the unit kHz for this parameter.

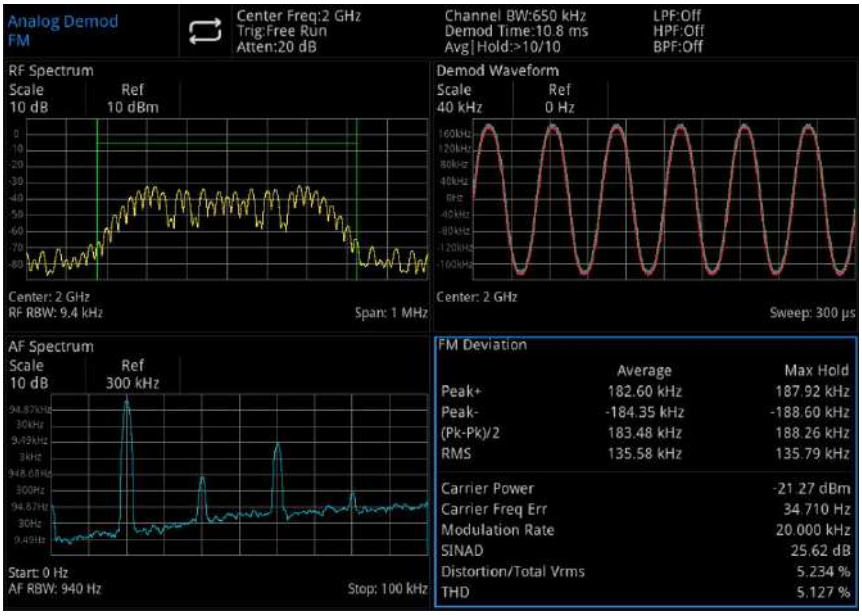


5) Enable Channel Output

Press the RF On/off key on the front panel. If the key is illuminated, the channel output is enabled.



View the FM modulation waveform on a spectrum analyzer, as shown in the following figure.



4.1.3 RF Phase Modulation (ΦM)

In ΦM mode, the modulated wave consists of the carrier wave and the modulation wave. The phase of the carrier wave changes with the amplitude of the modulation wave.

ΦM Modulation

Press the FM/ΦM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →ΦM →State key to enable ΦM mode. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.

Carrier Wave Frequency

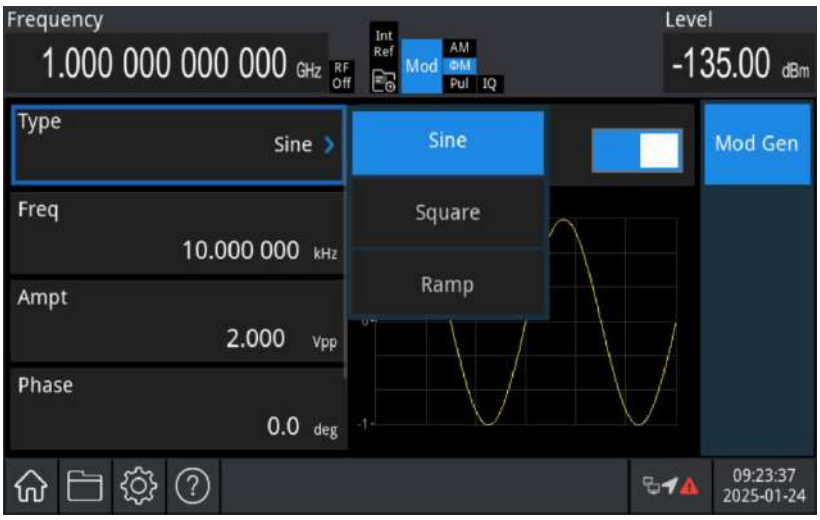
Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, and triangular waveforms, with sine wave selected by default.

After ΦM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation wave can be adjusted by pressing the Home → Source key, using the multi-function rotary knob in modulation source interface or pressing the Type key to adjust the modulation wave.

- Square wave: Duty ration is 50%.
- Triangular wave: Symmetry is 50%.



Modulation Frequency Setting

Set the modulation waveform frequency within the range of 1 MHz to 50 kHz (default: 10 kHz).

After ΦM mode is enabled, the default modulation frequency of 10 kHz will be displayed.

The user can adjust the modulation frequency either by rotating the multi-function knob in the

modulation source interface, or by pressing the Freq key, entering a numeric value using the numeric keypad, and selecting the desired unit to complete the setting.

Phase Offset Setting

Phase Offset indicates the deviation of the phase-modulated (ΦM) waveform relative to the carrier phase. The ΦM phase offset can be set within the range of 0° to 360°, with a default value of 0°. The phase offset can be adjusted either by rotating the multi-function knob in the analog modulation source interface, or by pressing the Phase Offset key and using the numeric keypad to enter the number and select the unit to complete this setting.

- The range of phase offset is specified in the maximum phase offset section of the data manual for each model.

Comprehensive Example

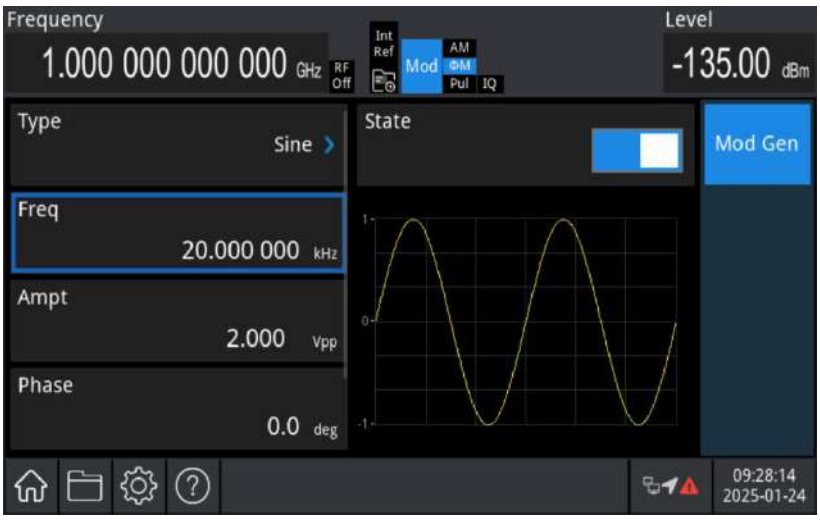
First, set the instrument to phase modulation (ΦM) mode. Next, configure a 20 kHz sine wave as the internal modulating signal, with a carrier frequency of 3 GHz and an amplitude of -10 dBm. Finally, set the phase offset to 60°. The procedure is as follows.

1) Enable ΦM Mode

   Press the FM/ΦM → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →ΦM →State key to enable ΦM mode.

2) Set Modulation Signal

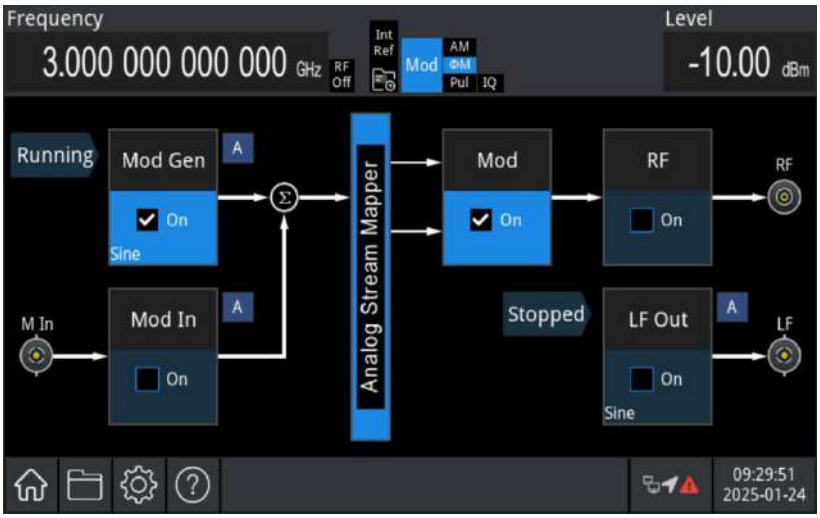
   Press the Home key in the analog stream mapper on the screen, check the analog source ON, press the Source →Freq key, then use the numeric keypad to enter 20 and select the unit kHz for this parameter.



3) Set Carrier Signal

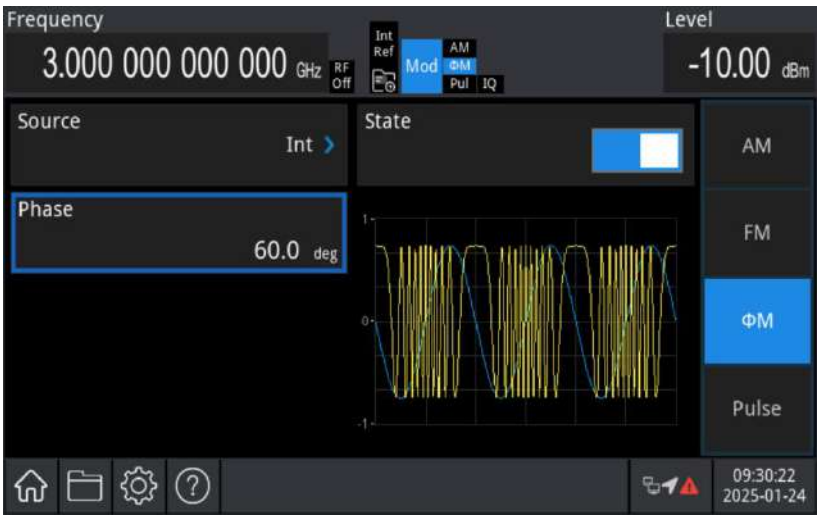
Press the Freq key to set the frequency, then use the numeric keypad to enter 3 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -10 and select the unit dBm for this parameter, as shown in the following figure.



4) Set Phase Offset

After setting the carrier parameters, press the Home key in the analog stream mapper on the screen, press the Analog Modulation key to open ΦM setting menu, press the Phase Offset key, then use the numeric keypad to enter 60 and select the unit deg for this parameter.

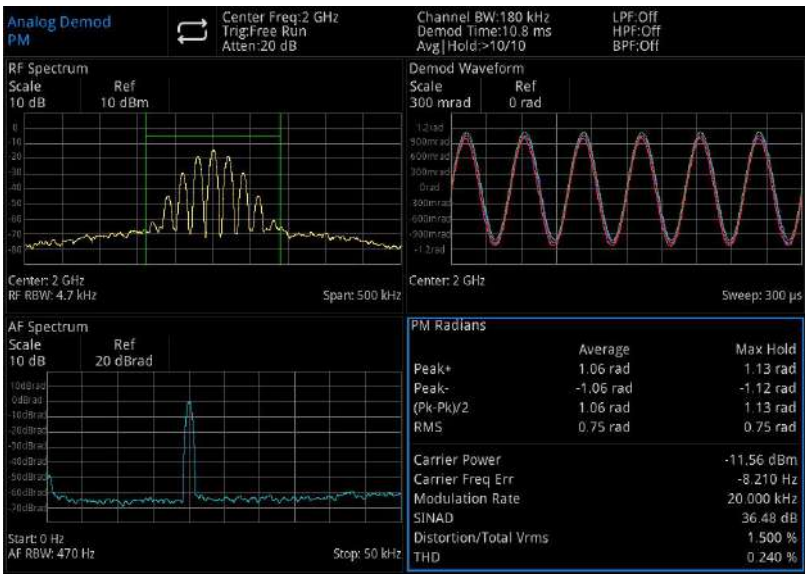


5) Enable Channel Output

Press the RF On/off key on the front panel. If the key is illuminated, the channel output is enabled.

Press the Home key in the analog stream mapper on the screen, check the ON option, the RF On/Off key will illuminate, and the channel output is enabled.

View the ΦM modulation waveform on a spectrum analyzer, as shown in the following figure.



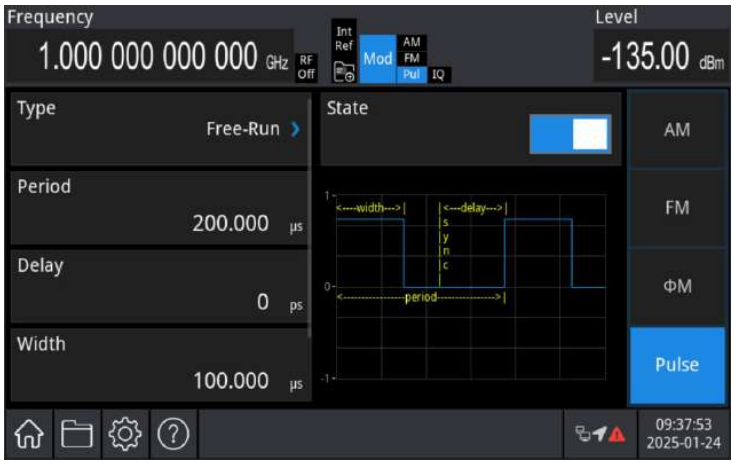
4.1.4 RF Pulse Modulation (PM)

Pulse modulation uses pulse signals as modulating signals to modulate RF carrier signals. USG5000V supports pulse modulation outputs controlled by internal and external triggers and offers a wide range of pulse modulation types, including free-running, square wave, external trigger, modulated pulse pairs, external trigger pulse pairs, gate pulse, external pulses, and pulse strings.

Pulse Modulation (PM)

1) Enable PM Mode

   Press the Pulse → Home key in the analog stream mapper on the screen, check the analog modulation ON, and press the Analog Modulation →Pulse →State key to enable PM mode. After the PM function is enabled, the instrument will output the pulse modulation signal according to the current settings.



2) Wave Frequency

   The wave frequency specifies the signal frequency used during pulse modulation.

Note

The wave frequency is different from the PM period. The PM period indicates the interval between the specified pulse modulations. The default frequency is 1 GHz. The frequencies of each model are shown in the following table.

Frequency							
USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
9 kHz	4.5 GHz	9 kHz	6.5 GHz	9 kHz	14 GHz	9 kHz	22 GHz

Press the Freq key to set up the carrier wave frequency and use the numeric keypad to enter the number and select the unit to complete this setting.

PM Type

USG5000V can output various types of pulse modulation, including free-running, square wave, external trigger, adjustable pulse pair, external trigger pulse pair, gate pulse, external pulse, and pulse train. The default type is free-running.

1) Free-running

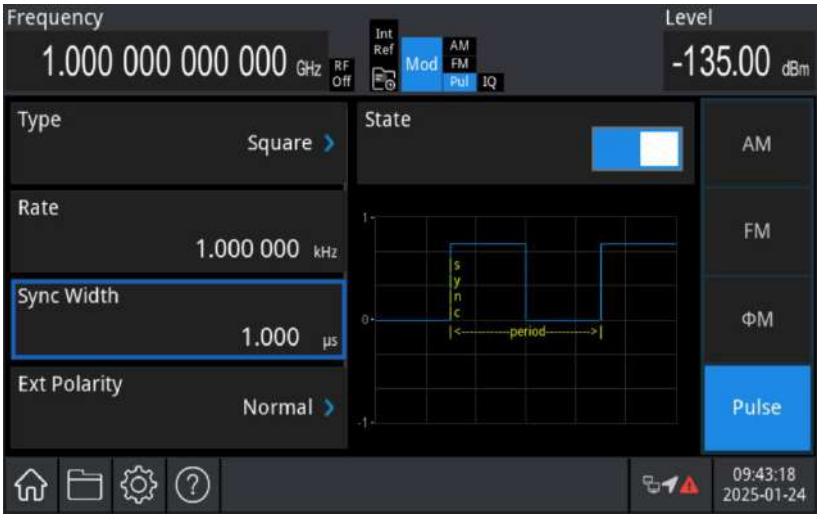
Press the Pulse Type key in the pulse interface to select the free-running. The free-running refers to an internal free-running pulse train. In this mode, the instrument's internal pulse generator serves as the pulse modulation source and does not require an external pulse signal. Meanwhile, the internal automatic pulse trigger mode will be active and will not synchronize with other trigger signals.

The pulse modulation type can be changed in the pulse interface, as shown in the following figure. Alternatively, use the multi-function rotary knob and arrow keys or press the Type key to select the free-running.

2) Square Wave

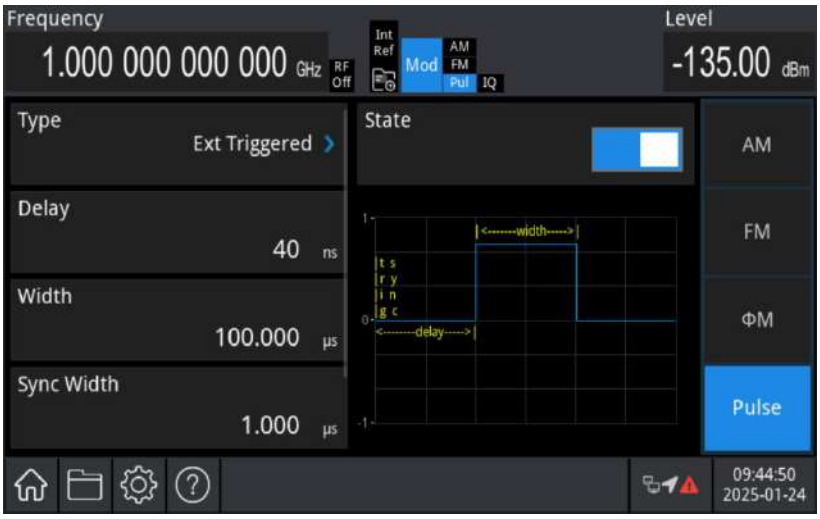
Press the Pulse Type key in the pulse interface to select square wave, where the internal

free-running pulse train duty ratio is 50%.



3) External Trigger

Press the Pulse Type key in the pulse interface to select the external trigger, which activates the external trigger mode, i.e., an internal pulse train. In this mode, the leading edge of the external pulse input signal is used to delay the pulse output from the internal pulse signal generator. The pulse modulation type can be changed in the pulse interface, as shown in the following figure. Alternatively, use the multi-function rotary knob and arrow keys or press the Type key to select the external trigger.



4) Adjustable Pulse Pair

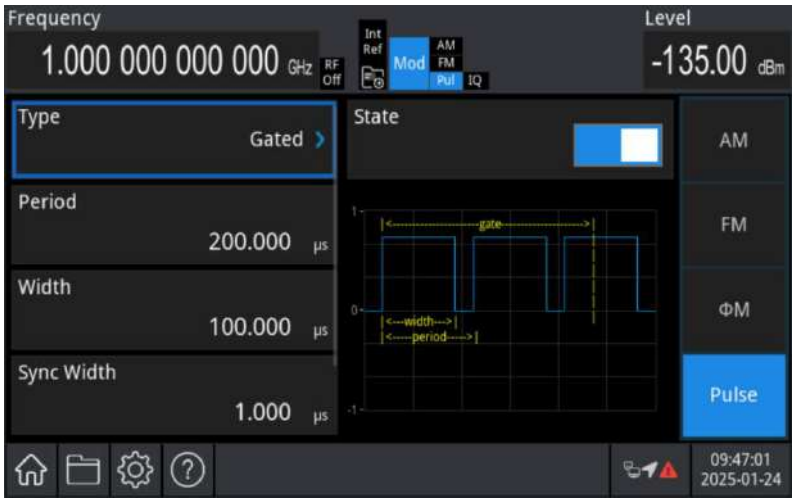
Press the Pulse Type key in the pulse interface to select the adjustable pulse pair, which activates adjustable pulse pair mode, i.e., each trigger event generates two internal pulse trains. In this mode, the first pulse is relative to the rising edge of trigger signal; the second pulse is relative to the rising edge of the first pulse signal.

5) External Trigger Pulse Pair

Press the Pulse Type key in the pulse interface to select the external trigger adjustable pulse pair, which activates the external trigger adjustable pulse pair mode, i.e., each trigger event generates two internal pulse trains. In this mode, the first pulse follows the trigger signal; the second pulse is user-defined.

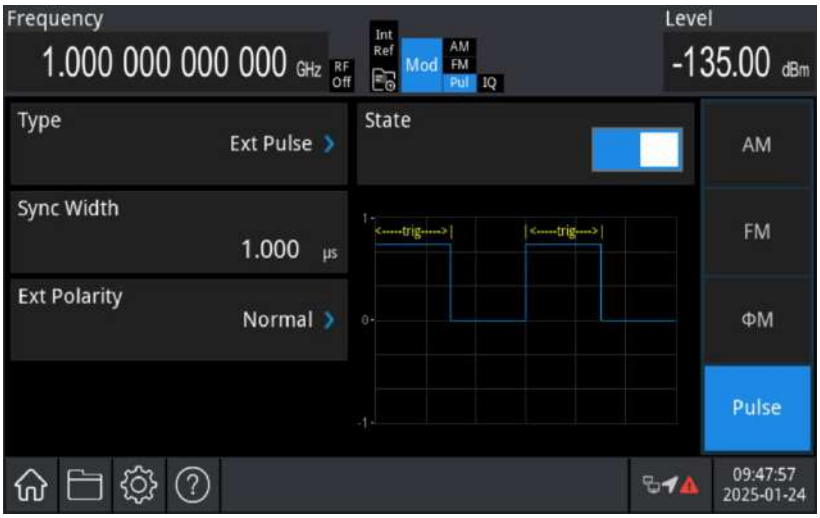
6) Gate

Press the Pulse Type key in the pulse interface to select the gating mode, which activates the gate mode, i.e., internal gate pulse train. In this mode, the internal pulse generator performs a logical AND operation with the external input pulse signal.



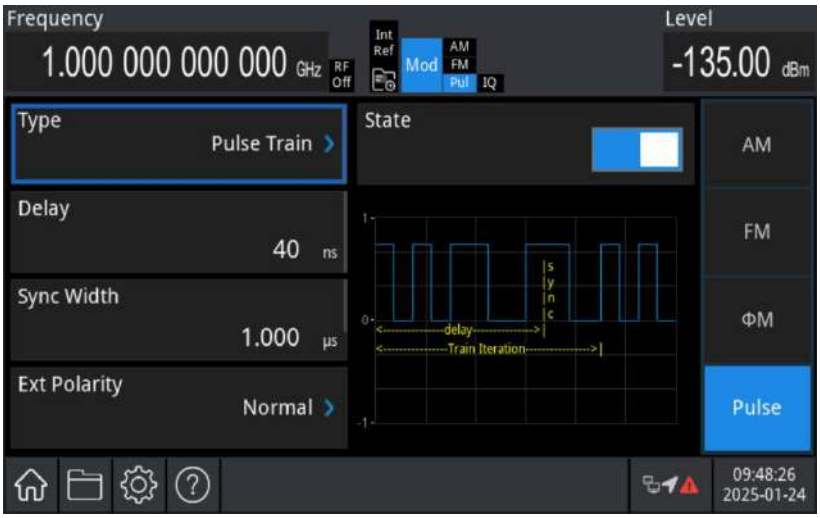
7) External Pulse

Press the Pulse Type key in the pulse interface to select the external pulse, which activates the external pulse mode, i.e., the external pulse signal from the pulse connector on the rear panel.



8) Pulse Train

Press the Pulse Type key in the pulse interface to select the pulse train, which activates the pulse train mode, i.e., an internal pulse train. In this mode, the pulse period can be manually edited.



Sync Pulse Width

The sync pulse width is used to set the pulse width of synchronization signal for pulse modulation output. This value cannot exceed the pulse width.

The pulse width can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Sync Width key, and use the numeric keypad to enter the number and select the unit to complete this setting.

External Polarity

The external polarity is used to set how the signal generator responds to the external pulse signal.

Press the Ext Polarity key in the pulse modulation interface to select either normal or inverse.

Rate

When the pulse type is set to square wave, the rate can be adjusted to define the frequency of the square wave.

The rate can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Rate key, and use the numeric keypad to enter the number and select the unit to complete this setting.

Period

When the pulse type is set to free running or gating, the pulse period parameter becomes available, representing the period of the pulse signal generated internally by the signal generator. If the set period is shorter than the current pulse width, the pulse width will be automatically adjusted to match the current pulse period.

The period can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Period key, and use the numeric keypad to enter the number and select the unit to complete this setting.

Delay

When the pulse type is set to free-running, external trigger, adjustable pulse pair, external trigger pulse pair, or pulse train, the pulse delay parameter becomes available. It defines the pulse delay for pulse modulation.

The maximum value that can be set depends on the current period and pulse width, and it cannot exceed the difference between the period and the pulse width.

The delay can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Delay key, and use the numeric keypad to enter the number and select the unit to complete this setting.

Pulse Width

When the pulse type is set to free-running, external trigger, adjustable pulse pair, external trigger pulse pair, or gating, the pulse width parameter becomes available. It defines the pulse width of the pulse signal generated internally by the signal generator.

If the set pulse width is greater than the current pulse period, the pulse width will be automatically adjusted to less than or equal to the current pulse period.

The pulse width can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Pulse key, and use the numeric keypad to enter the number and

select the unit to complete this setting.

Delay 2

When the pulse type is set to an adjustable pulse pair, the delay 2 parameter becomes available. It defines the pulse delay of the second pulse in pulse modulation.

The delay 2 can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Delay 2 key, and use the numeric keypad to enter the number and select the unit to complete this setting.

Pulse Width 2

When the pulse type is set to an adjustable pulse pair, the pulse width 2 parameter becomes available. It defines the pulse width of the second pulse in pulse modulation.

The pulse width 2 can be adjusted by using the multi-function rotary knob in the pulse modulation interface. Alternatively, press the Pulse 2 key, and use the numeric keypad to enter the number and select the unit to complete this setting.

Trigger Mode

When the pulse type is set to pulse train, the trigger mode parameter becomes available. The trigger mode can be adjusted by pressing the Trigger Mode in a pulse modulation interface. Three options are available: free running, external trigger, and gate.

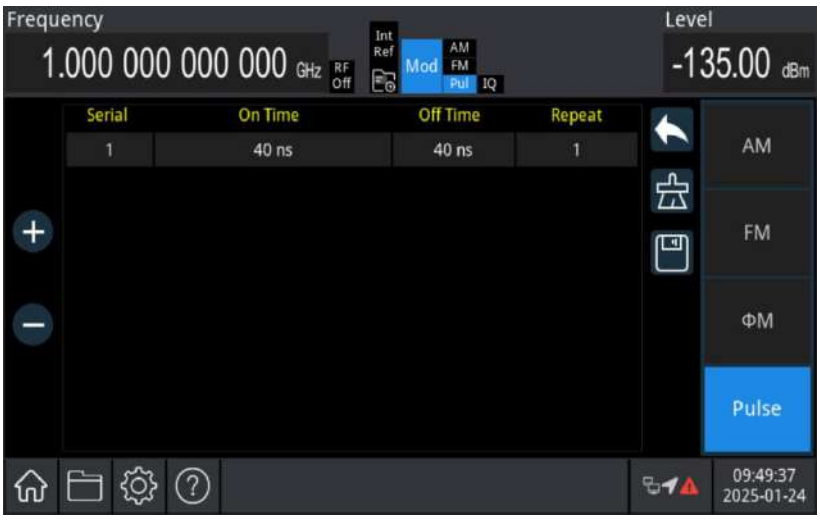
Free-running: Continuously emits a pulse sequence, ignoring all triggers.

External trigger: The external trigger (level trigger) is provided to the PULSE IN connector on the rear panel. Each time a TTL pulse signal of the specified polarity is received, the signal generator initiates a pulse modulation.

Gate: The pulse sequence operates in gate mode. An external trigger (level trigger) is applied to the PULSE IN connector on the rear panel. Each time a TTL pulse of the specified polarity is received, the signal generator initiates pulse modulation during its active level. Once initiated, the emission will always be completed, even if the gate trigger becomes inactive.

Edit Pulse Train

When the pulse type is set to pulse train, press the Edit Pulse Train key in pulse modulation to open the pulse train editing window, as shown in the following figure.



As shown in the figure above, the list displays various pulse information for the pulse train. Additionally, operations such as adding, deleting, and exporting pulses can be performed.

Serial number: Represents the row of each pulse sequence cycle. When the cycle (element) is repeated, the number of rows is skipped in the repeated pulse cycle numbers. For example, in the pulse sequence shown above, the pulse period with 3 μs high-level time and 2 μs low-level time is repeated twice. However, this pulse period is only displayed in the second row (i.e., not in the third row).

High-level time: Represents the on-time of each pulse period in the pulse sequence.

Low-level time: Represents the off time of each pulse period in the pulse sequence.

Number of repetitions: Represents the number of repetitions of each pulse period in the pulse sequence.

After clicking (Add a row of data), the user can click on High-level time, Low-level time, and Number of repetitions to edit the data.

Click to delete the row of data with the currently selected serial number.

Click to delete all pulse train data.

Click to export the pulse train data.

Click return to the previous level.

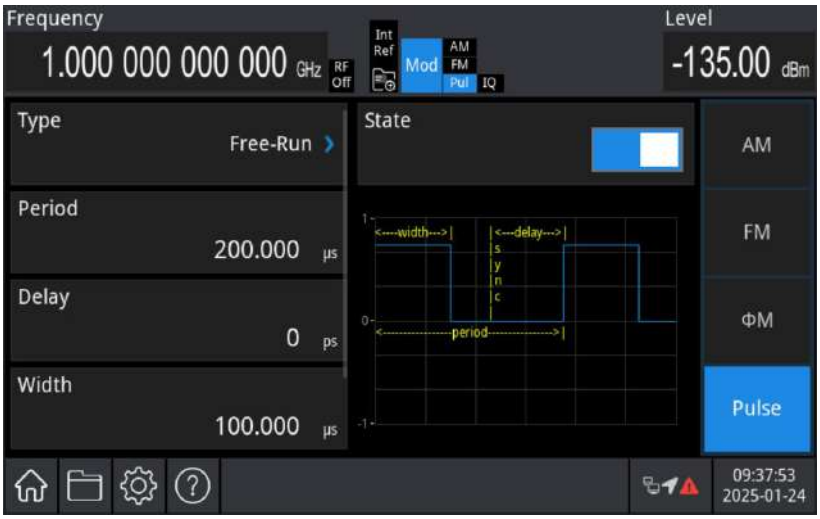
Comprehensive Example

First, set the instrument to Pulse Modulation (PM) mode. Then, configure the carrier wave with a frequency of 100 kHz and an amplitude of 0 dBm. The modulation signal is a 24 μs pulse with a 100 μs period. The procedure is as follows.

1) Enable PM Mode

Press the Pulse→Home key in the analog stream mapper on the screen, check the analog

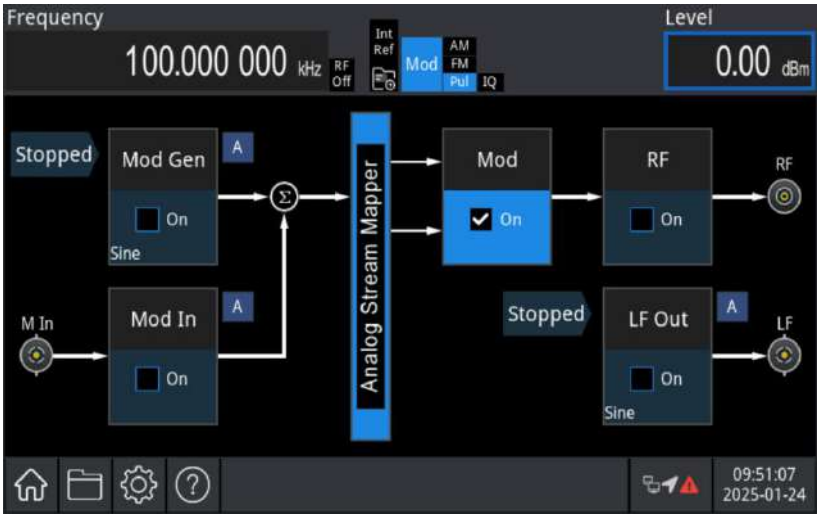
modulation ON, and press the Analog Modulation →PM →State key to enable PM mode.



2) Set Carrier Wave and Amplitude

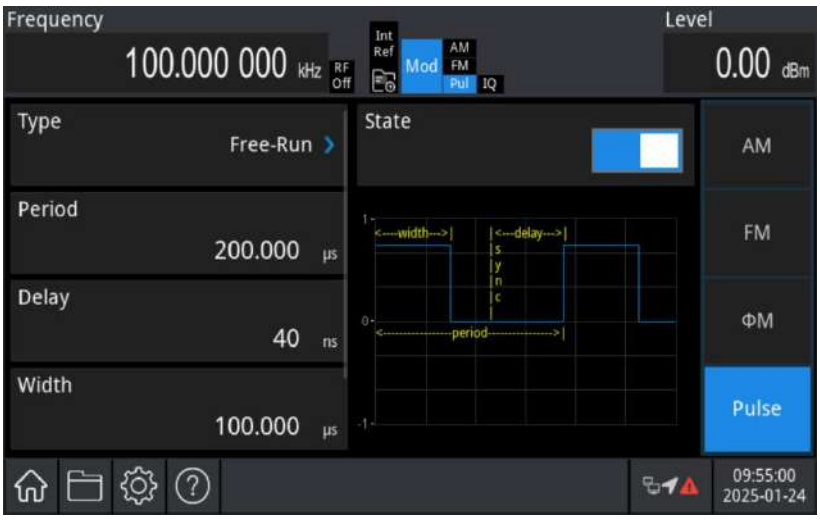
Press the Freq key to set the frequency, then use the numeric keypad to enter 100 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 0 and select the unit dBm for this parameter, as shown in the following figure.

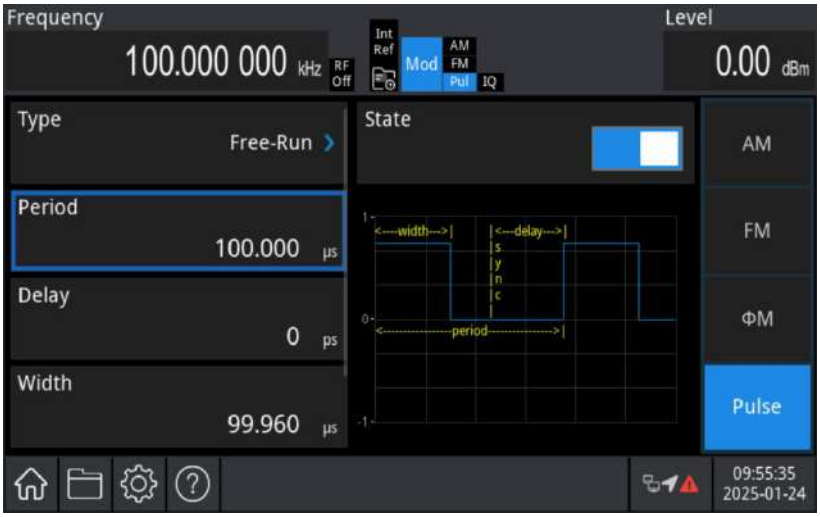


3) Set PM Period

Press the Home→ Analog Modulation →PM key to return to the following interface.

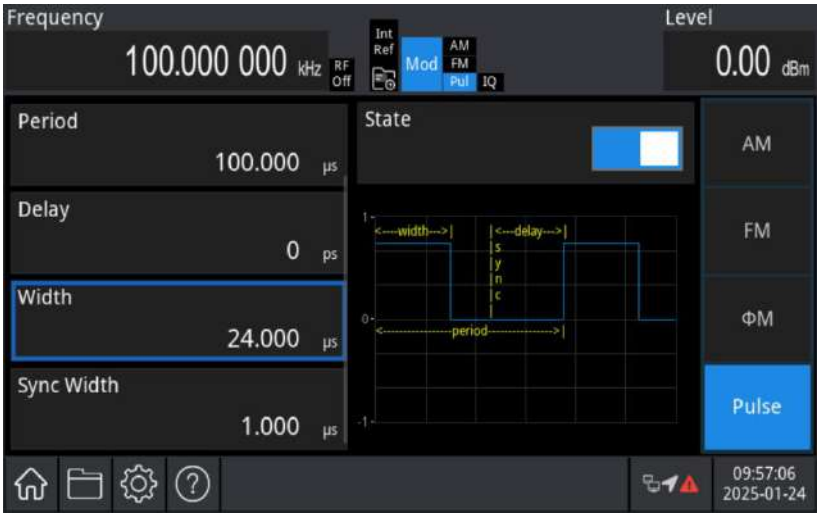


Press the Period key, use the numeric keypad to enter 100 and select the unit µs for this parameter, as shown in the following figure.



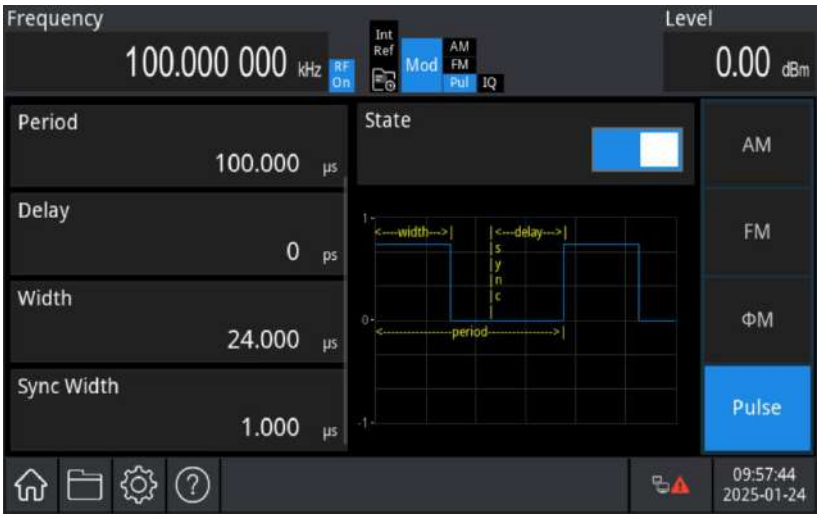
4) Set Pulse Width

In the pulse modulation interface, press the Pulse key, use the numeric keypad to enter 24 and select the unit µs for this parameter, as shown in the following figure.

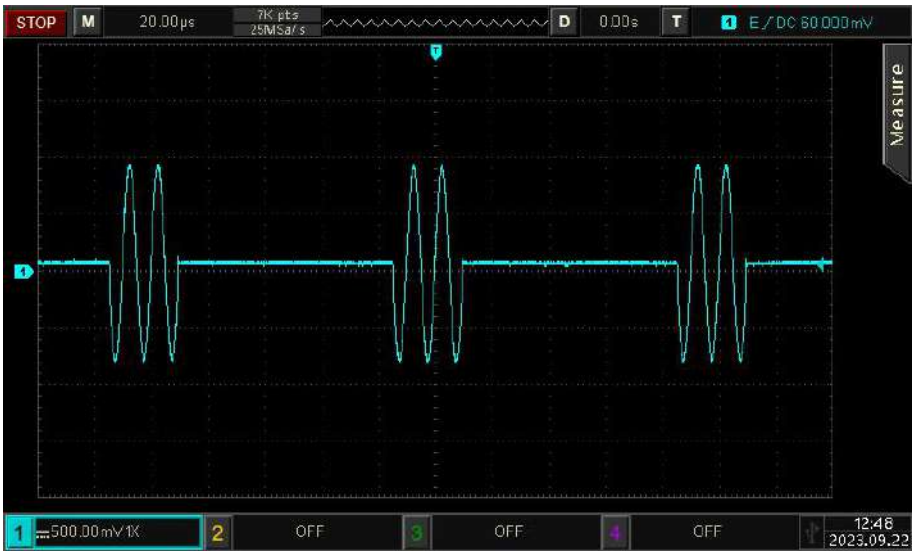


5) Enable Channel Output

Press the RF On/off key on the front panel. If the key is illuminated, the channel output is enabled.



View the PM modulation waveform on an oscilloscope, as shown in the following figure.

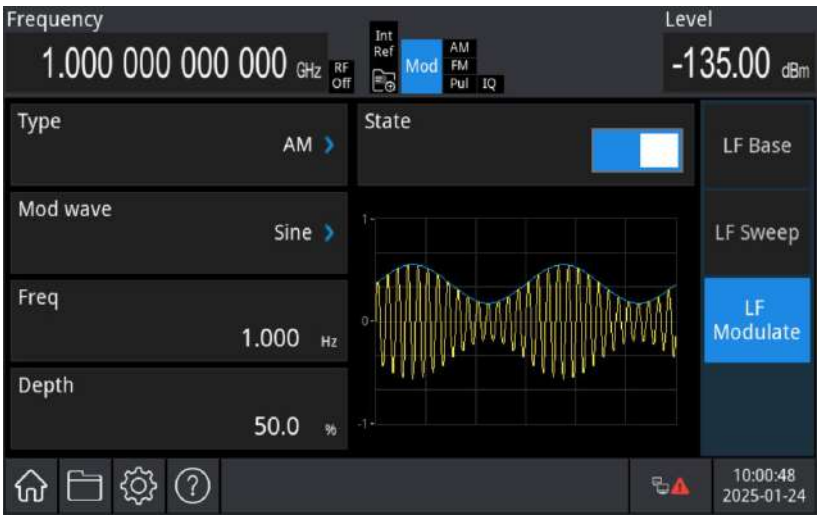


4.1.5 LF Amplitude Modulation (AM)

In AM mode, the modulated wave consists of the carrier wave and the modulation wave. The amplitude of the carrier wave changes with the amplitude of the modulation wave.

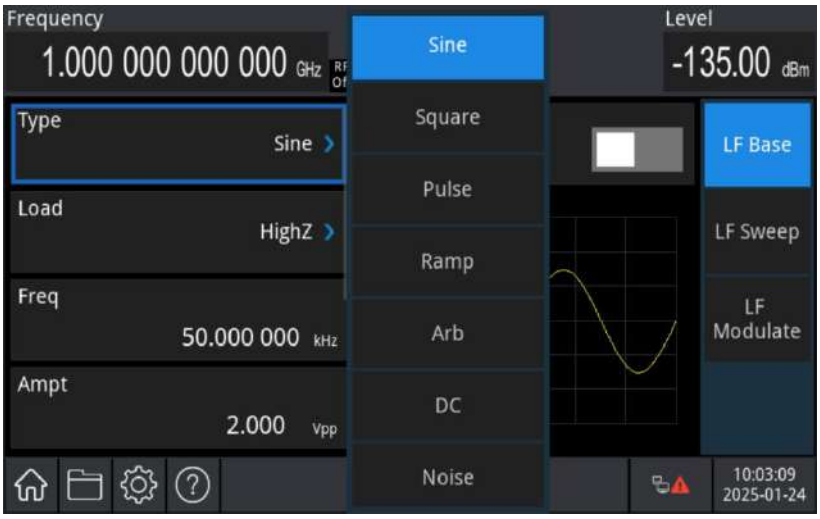
Amplitude Modulation (AM)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the AM mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the AM is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Each carrier wave has a different frequency, with the default frequency set to 500 kHz. The frequencies of the carrier waves are listed in the table below.

Carrier Wave	Frequency							
	USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Sine Wave	1 MHz	50 MHz	1 MHz	50 MHz	1 MHz	50 MHz	1 MHz	50 MHz
Square Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz
Pulse Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz
Triangular	1 MHz	3 MHz	1 MHz	3 MHz	1 MHz	3 MHz	1 MHz	3 MHz

Wave								
Arbitrary Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz

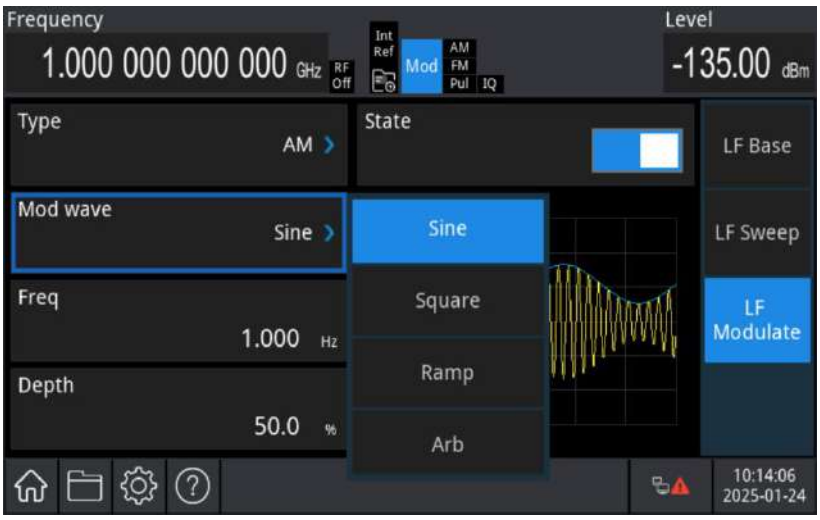
Rotate the multi-function rotary knob or press the Freq key to set up the carrier wave frequency and use the numeric keypad to enter the number and select the unit to complete this setting.

Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, triangular waveforms, and arbitrary waveforms, with sine wave selected by default.

After AM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation waveform can be adjusted either by rotating the multi-function knob or by pressing the Modulation Wave key.

- Square wave: Duty ration is 50%
- Triangular wave: Symmetry is 50%
- Arbitrary wave: When an arbitrary waveform is selected as the modulation waveform, the RF analog signal generator automatically limits the waveform's length to 4 kpts through automatic sampling.



Modulation Frequency

Set the frequency for the modulation wave within a range of 2 MHz to 5 MHz (default: 1 Hz). After AM mode is enabled, the default modulation wave frequency of 1 Hz will be displayed. The modulation frequency can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

Modulation Depth

The modulation depth indicates the change in amplitude, expressed as a percentage. The AM modulation depth can be set between 0% and 120%, with a default of 50%.

- When the modulation depth is 0%, the output is a constant amplitude at half the carrier wave amplitude.
- When the modulation depth is 100%, the output amplitude varies with the modulation waveform.
- When the modulation depth is 100%, the output amplitude will not exceed 10 Vpp (with a 50 Ω load).

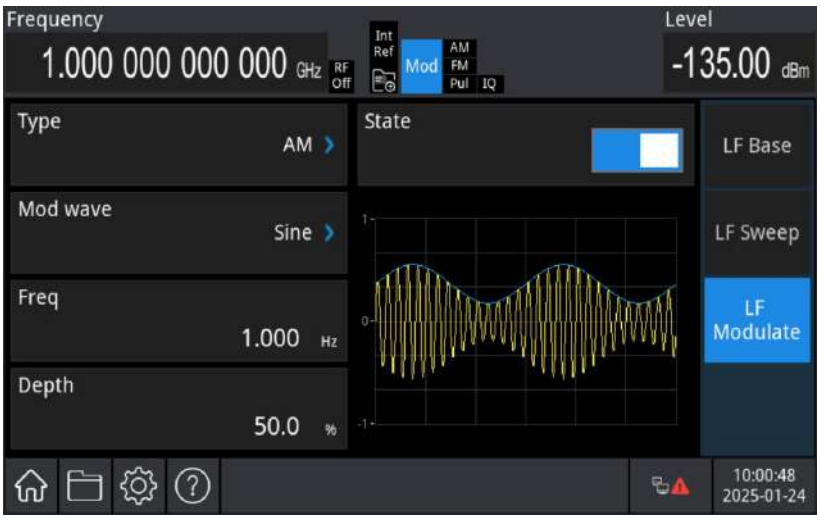
The modulation depth can be adjusted by using the multi-function rotary knob in analog modulation source interface or pressing the Depth key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to Amplitude Modulation (AM) mode. Then, configure a 200 Hz sine wave as the internal modulating signal, and set a 10 kHz square wave with an amplitude of 200 mVpp and a 45% duty cycle as the carrier signal. Finally, set the modulation depth to 80%. The procedure is as follows.

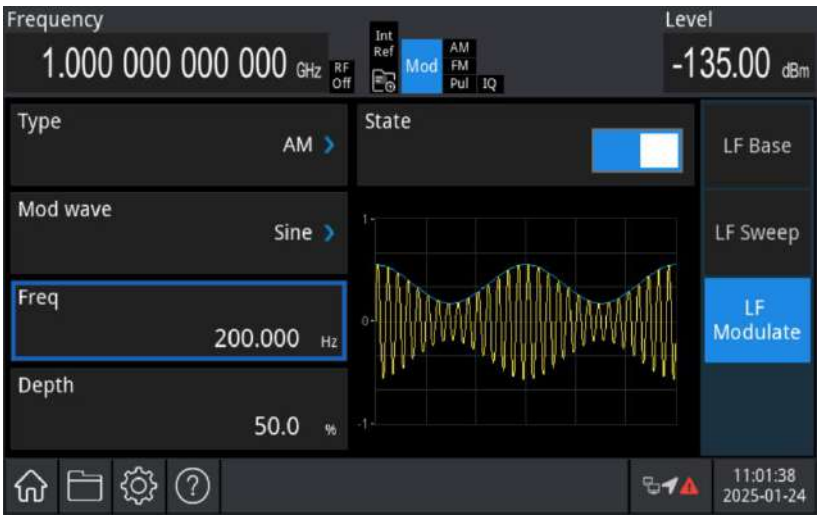
1) Enable AM Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the AM from the drop-down menu to enable AM mode.



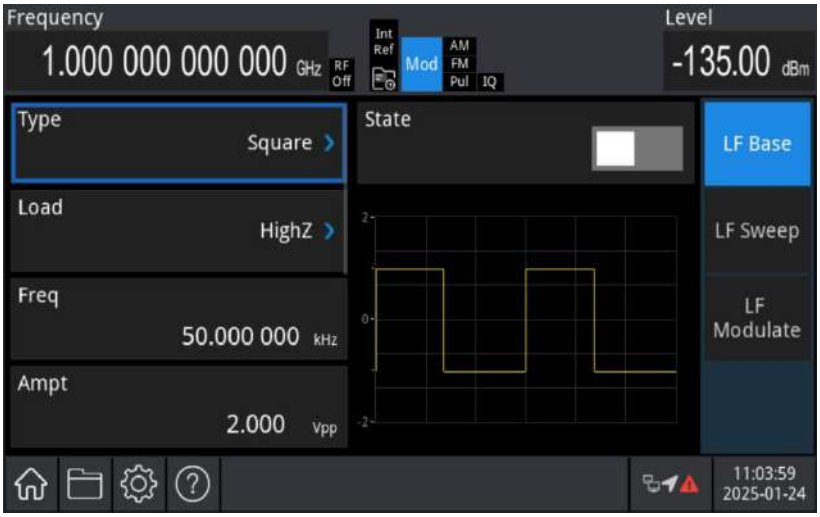
2) Set Modulation Signal

   After setting step 1, press the Freq key, use the numeric keypad to enter 200, and select the unit Hz for this parameter.



3) Set Carrier Signal

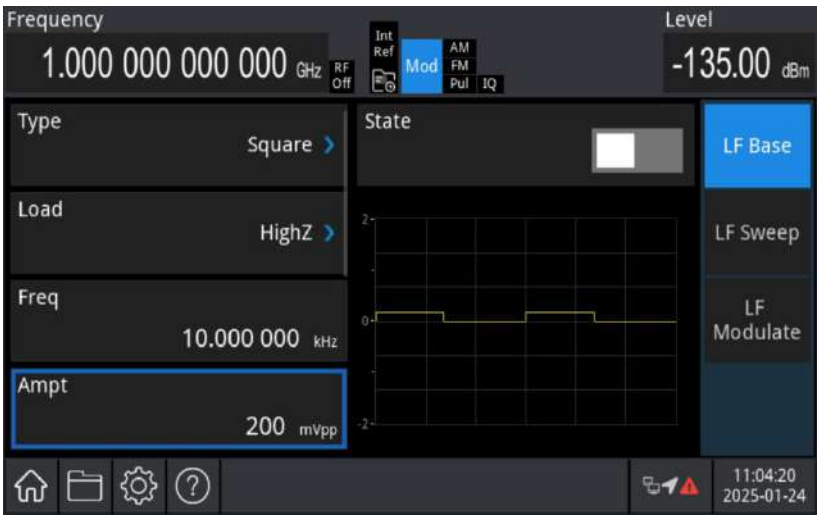
Press the LF Carrier →Type key to open the LF carrier list, select the square wave as the carrier wave (default: sine wave).



Press the Freq key to set the frequency, then use the numeric keypad to enter 10 and select the unit kHz for this parameter.

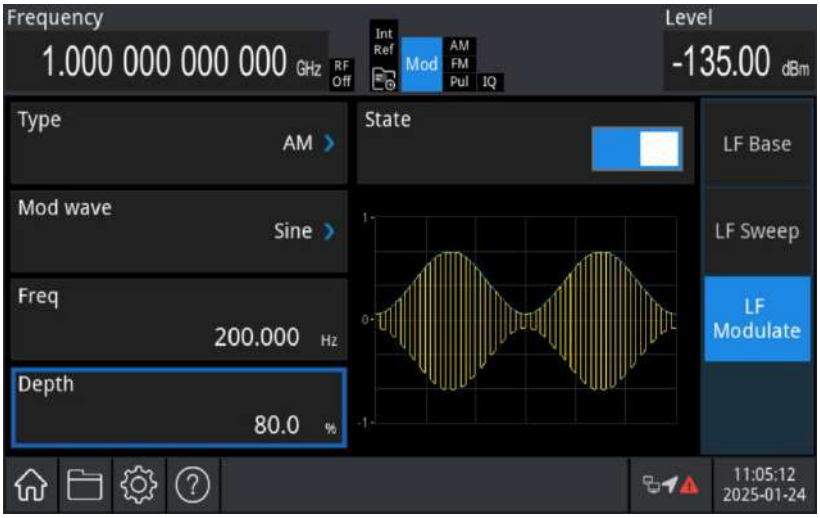
Press the Ampt to set the amplitude, then use the numeric keypad to enter 200 and select the unit mVpp for this parameter.

Press the Duty key to set the frequency, then use the numeric keypad to enter 45 and select the unit % for this parameter, as shown in the following figure.



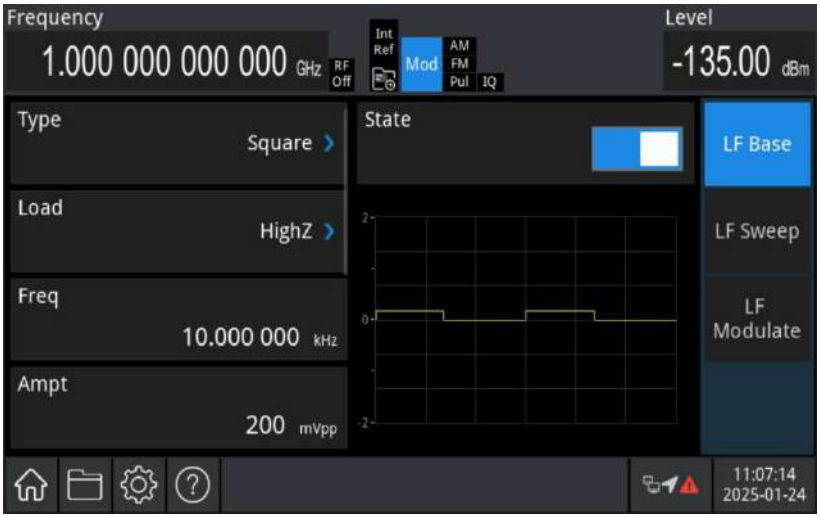
4) Set Modulation Depth

After setting the carrier parameters, press the Modulation key to enter the amplitude setting, press the Depth key, then use the numeric keypad to enter 80 and select the unit % for this parameter.

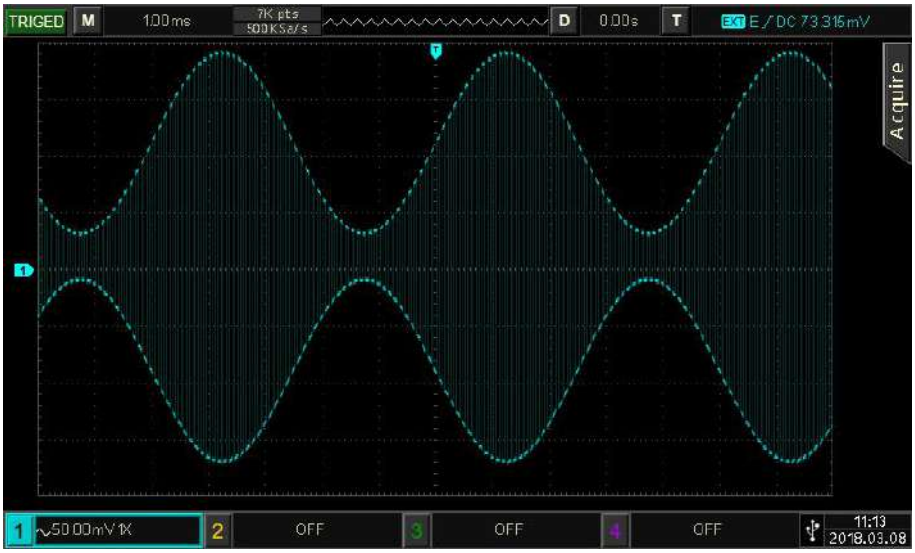


5) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the AM modulation waveform on an oscilloscope, as shown in the following figure.

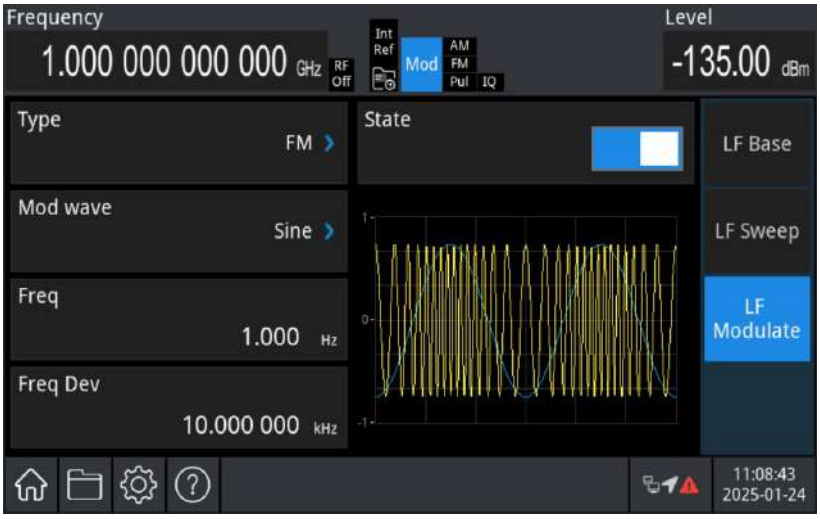


4.1.6 LF Frequence Modulation (FM)

In FM mode, the modulated wave consists of the carrier wave and the modulation wave. The frequency of the carrier wave changes with the amplitude of the modulation wave.

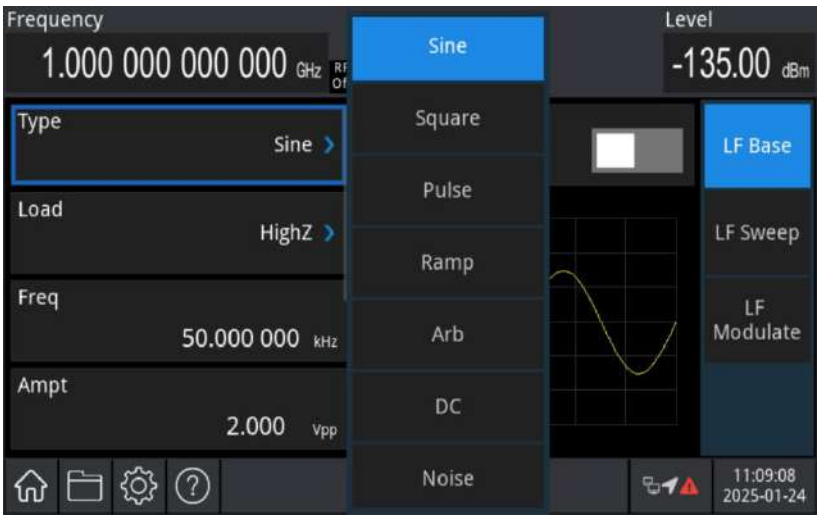
Frequence Modulation (FM)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the FM mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the FM is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

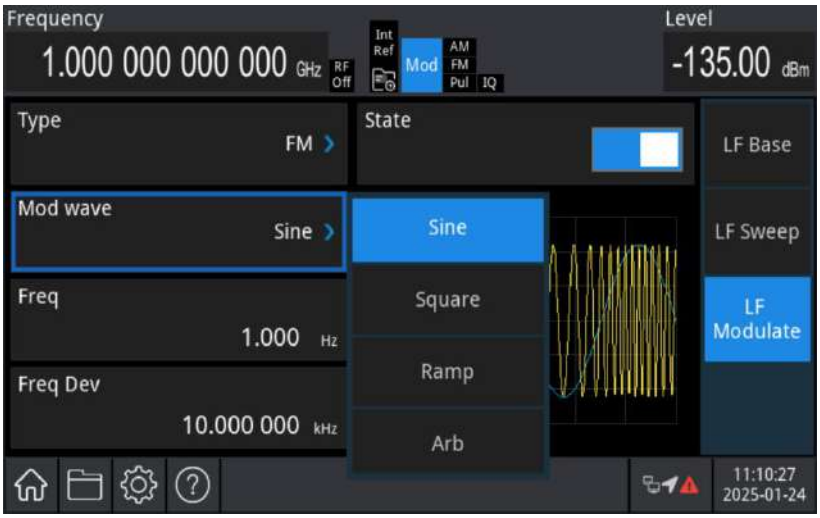
Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, triangular waveforms, and arbitrary waveforms, with sine wave selected by default.

After FM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation waveform can be adjusted either by rotating the multi-function knob or by pressing the Modulation Wave key.

- Square wave: Duty ration is 50%
- Triangular wave: Symmetry is 50%
- Arbitrary wave: When an arbitrary waveform is selected as the modulation waveform, the RF analog signal generator automatically limits the waveform's length to 4 kpts through automatic sampling.



Modulation Frequency

Set the frequency for the modulation wave within a range of 2 MHz to 5 MHz (default: 1 Hz). After FM mode is enabled, the default modulation wave frequency of 1 Hz will be displayed. The modulation frequency can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

Frequency Offset Setting

Frequency offset indicates the deviation of the frequency-modulated wave relative to the carrier wave frequency. The FM frequency offset range can be set from a minimum of DC up to half of the current maximum carrier frequency. The default frequency offset is 10 kHz.

The frequency offset can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Freq Offset key and using the numeric keypad to enter the number and select the unit to complete this setting.

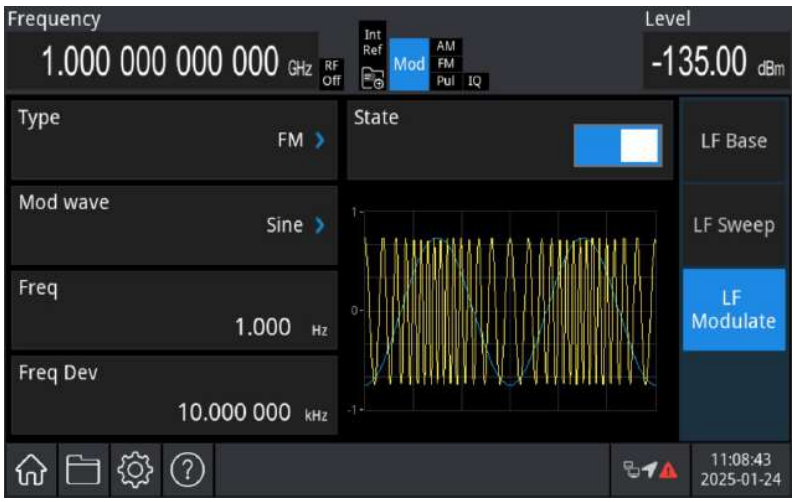
- Frequency offset ≤ Carrier wave frequency: If the frequency offset exceeds the carrier frequency, the instrument will automatically limit the offset to the maximum allowed by the current carrier frequency.
- The sum of the frequency offset and the carrier wave frequency ≤ Maximum allowed by the current carrier frequency: If the frequency offset value is invalid, the instrument will automatically limit the offset to the maximum allowed by the current carrier frequency.
- When the carrier is a pulse wave, the difference between the carrier frequency and the frequency of deviation must be greater than the modulation frequency. If the frequency offset exceeds the allowable range, the instrument automatically limits it to the maximum permissible value for the current carrier frequency.

Comprehensive Example

First, set the instrument to frequency modulation (FM) mode. Then, configure a 2 kHz square wave as the internal modulating signal, and set a 10 kHz sine wave with an amplitude of 100 mVpp as the carrier signal. Finally, set the frequency offset to 5 kHz. The procedure is as follows.

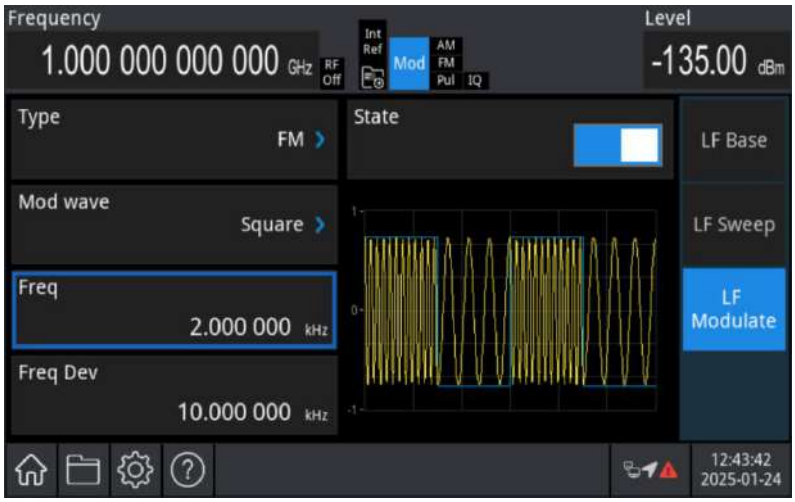
1) Enable FM Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the FM from the drop-down menu to enable FM mode.



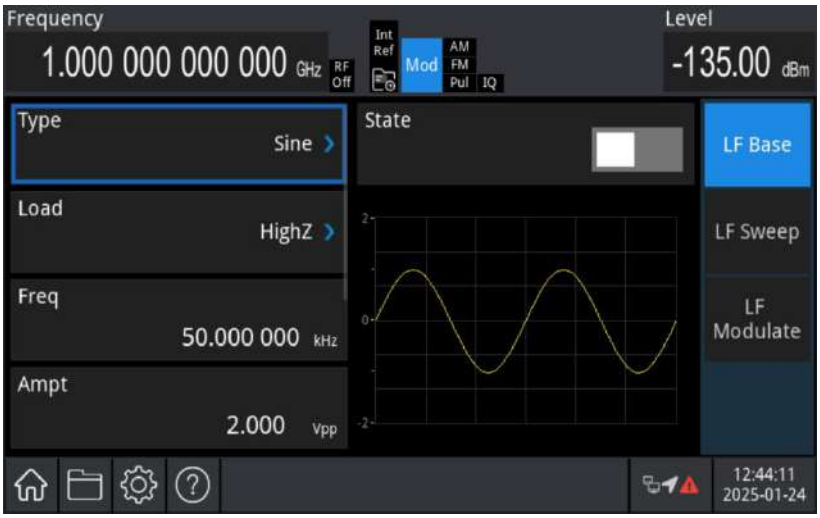
2) Set Modulation Signal and Wave

After setting step 1, press the Modulation Wave key to select the square wave as the modulation wave. Then, press the Freq key, and use the numeric keypad to enter 2, and select the unit kHz for this parameter.



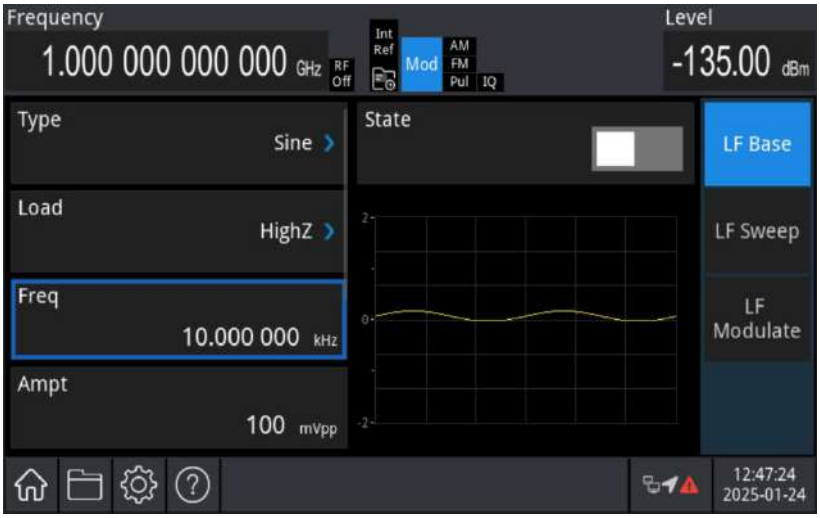
3) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



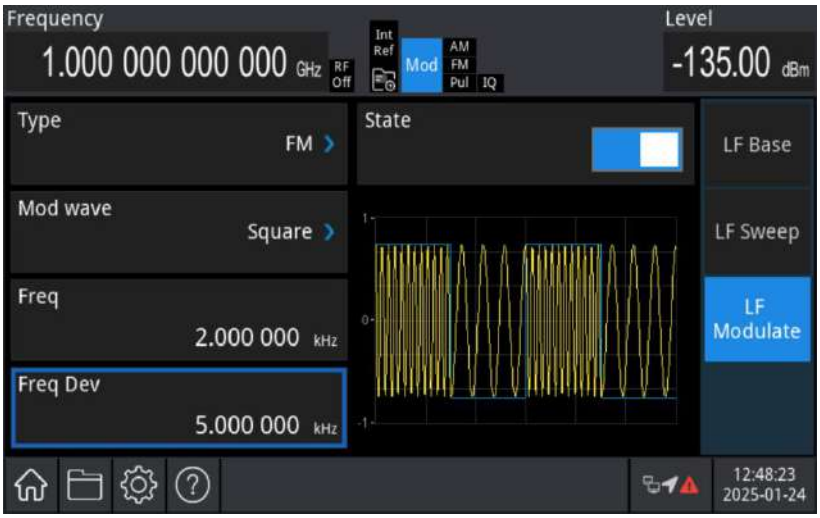
Press the Freq key to set the frequency, then use the numeric keypad to enter 10 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 100 and select the unit mV for this parameter.



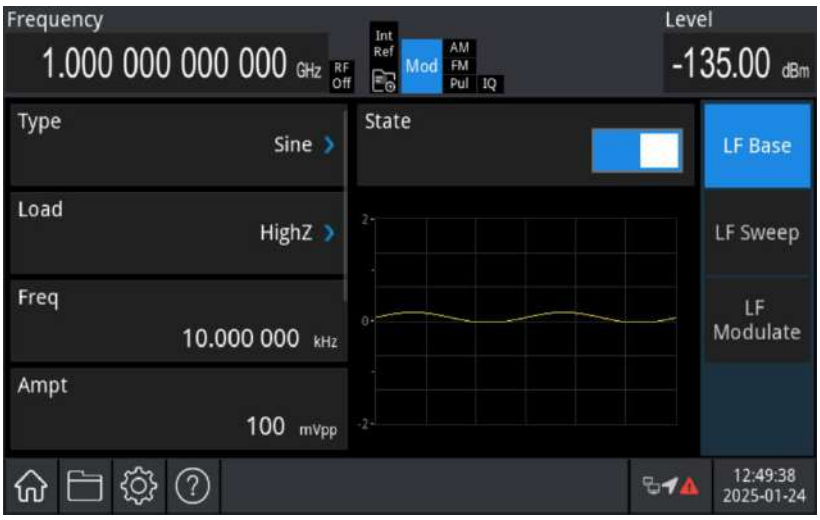
4) Set Frequency Offset

After setting the carrier parameters, press the Modulation to enter the FM setting menu, press the Freq Offset key, then use the numeric keypad to enter 5 and select the unit kHz for this parameter.

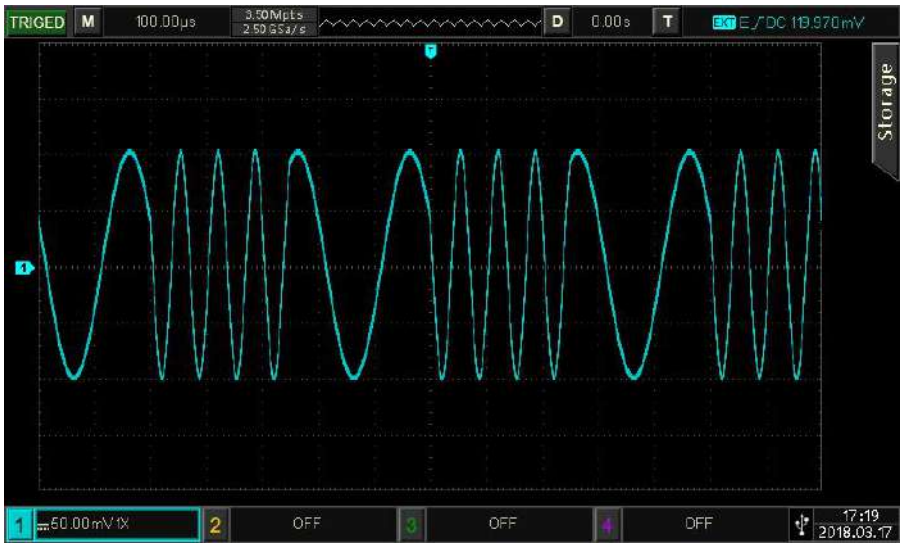


5) Enable Channel Output

Press the Home key in the analog stream mapper on the screen, check the function generator ON. If the LF key is illuminated, the channel output is enabled.



View the FM modulation waveform on a spectrum analyzer, as shown in the following figure.

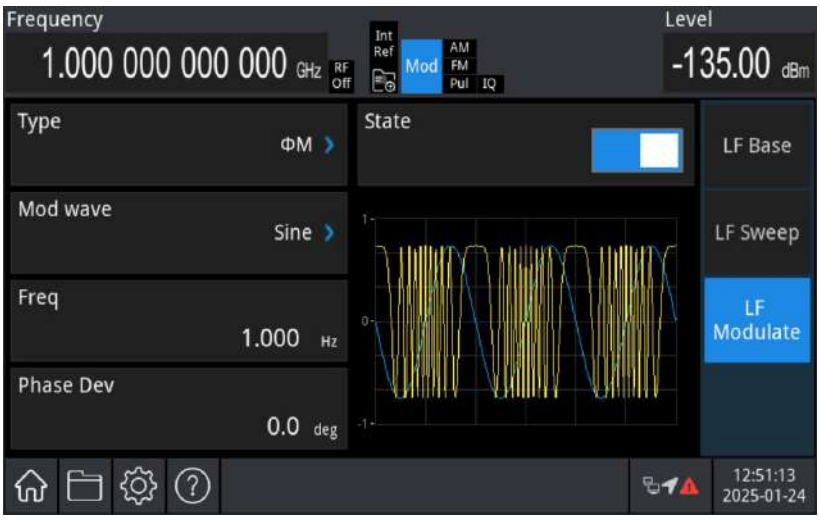


4.1.7 LF Phase Modulation (ΦM)

In ΦM mode, the modulated wave consists of the carrier wave and the modulation wave. The phase of the carrier wave changes with the amplitude of the modulation wave.

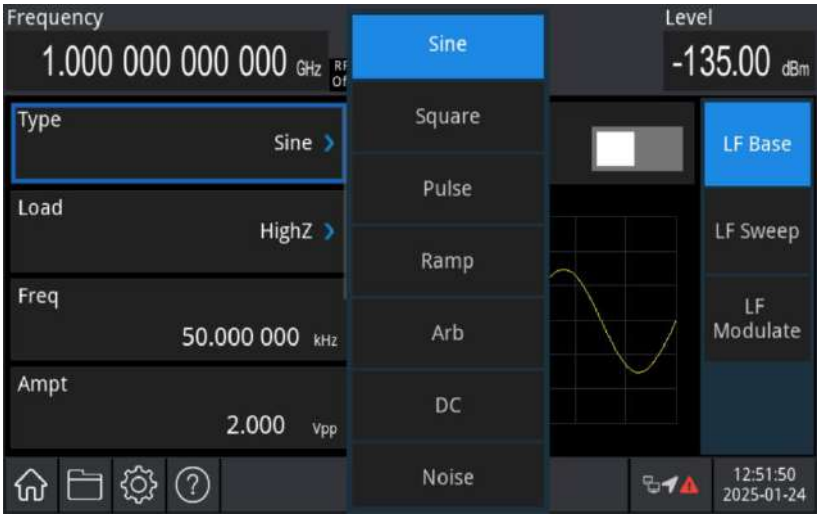
Phase Modulation (ΦM)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the ΦM mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the ΦM is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

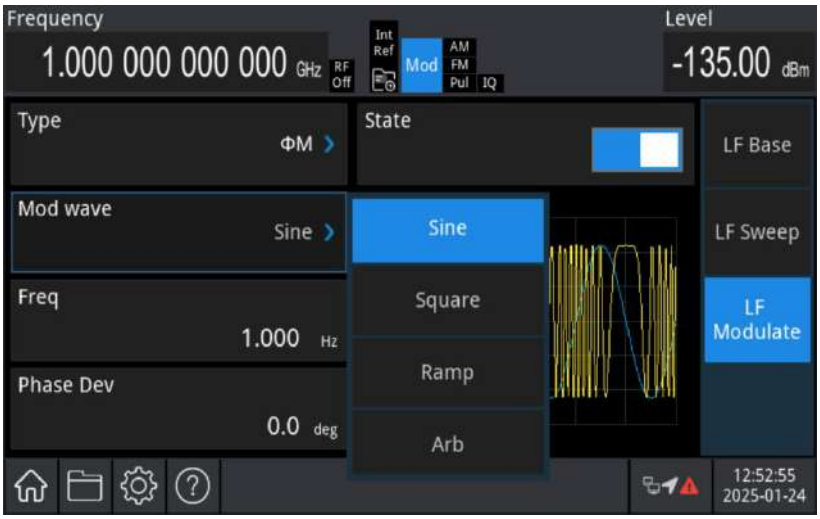
Modulation Wave Setting

This series provides three modulation source options: internal, external, and internal + external. The internal modulation source includes sine wave, square wave, triangular waveforms, and arbitrary waveforms, with sine wave selected by default.

After ΦM mode is enabled, the default modulation wave (sine wave) will be displayed. The modulation waveform can be adjusted either by rotating the multi-function knob or by pressing the Modulation Wave key.

- Square wave: Duty ration is 50%
- Triangular wave: Symmetry is 50%

- Arbitrary wave: When an arbitrary waveform is selected as the modulation waveform, the RF analog signal generator automatically limits the waveform's length to 4 kpts through automatic sampling.



Modulation Frequency

Set the frequency for the modulation wave within a range of 2 MHz to 5 MHz (default: 1 Hz). After ΦM mode is enabled, the default modulation wave frequency of 1 Hz will be displayed. The modulation frequency can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

Phase Offset Setting

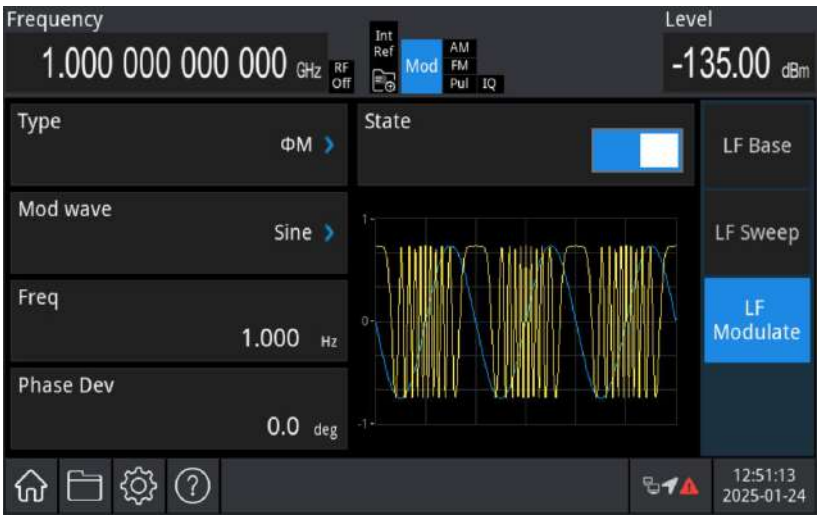
Phase offset indicates the deviation of the phase-modulated wave relative to the carrier wave phase. The ΦM phase offset range can be set from 0° to 360°. The default frequency offset is 0°.
The phase offset can be adjusted by using the multi-function rotary knob in analog modulation source interface or pressing the Phase 1 key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to phase modulation (ΦM) mode. Then, configure a 200 Hz sine wave as the internal modulating signal, with a carrier signal frequency of 900 Hz and an amplitude of 100 mVpp. Finally, set the phase offset to 200°. The procedure is as follows.

1) Enable ΦM Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the ΦM from the drop-down menu to enable ΦM mode.

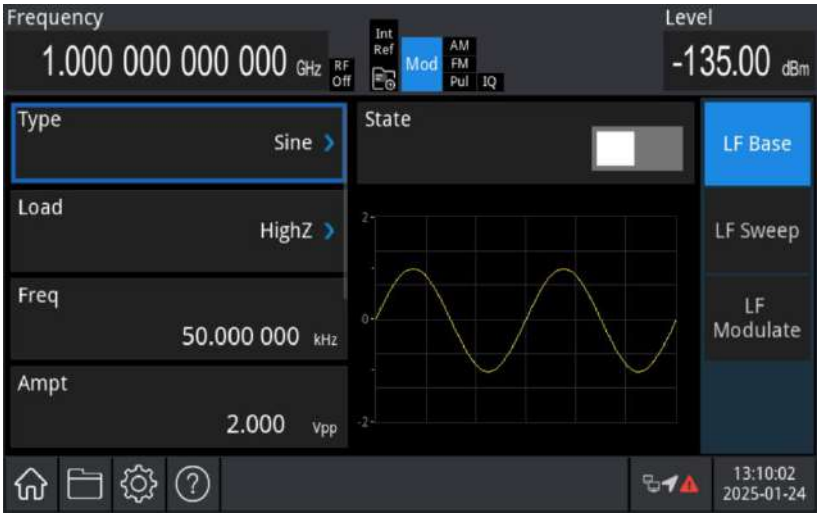


2) Set Modulation Signal

After setting step 1, press the Freq key, use the numeric keypad to enter 200, and select the unit Hz for this parameter.

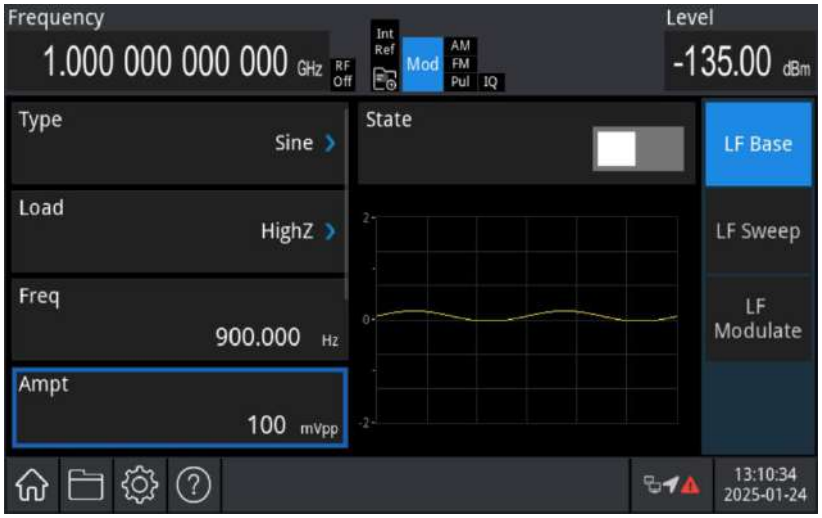
3) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



Press the Freq key to set the frequency, then use the numeric keypad to enter 900 and select the unit Hz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 100 and select the unit mVpp for this parameter, as shown in the following figure.

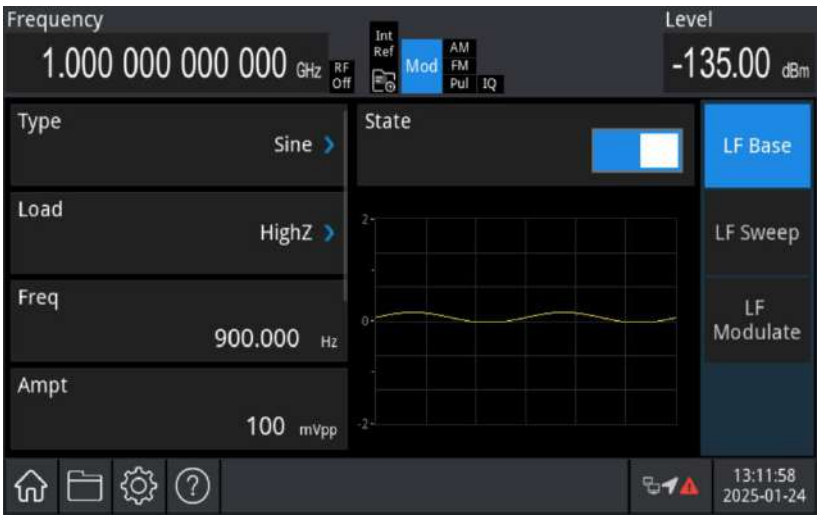


4) Set Phase Offset

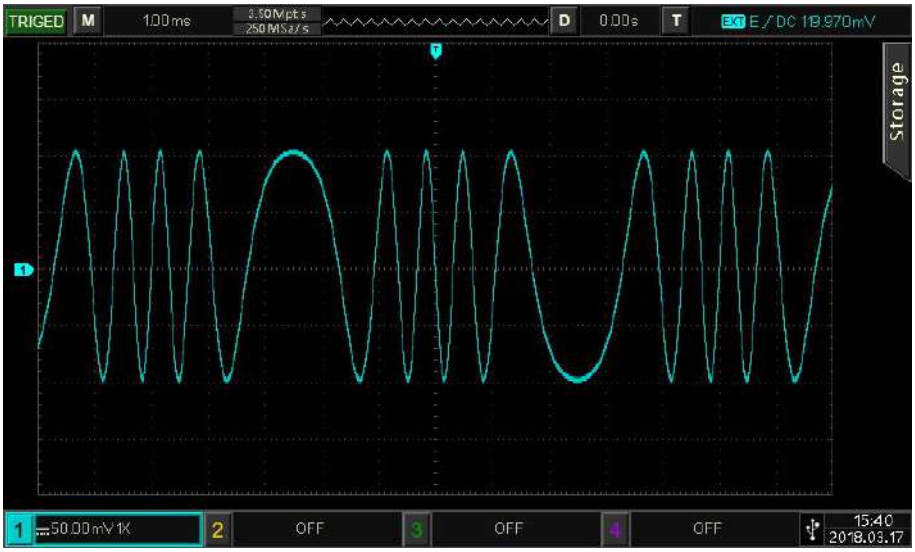
After setting the carrier parameters, press the Modulation to enter the ΦM setting menu, press the Phase 1 key, then use the numeric keypad to enter 200 and select the unit deg for this parameter.

5) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the ΦM modulation waveform on an oscilloscope, as shown in the following figure.

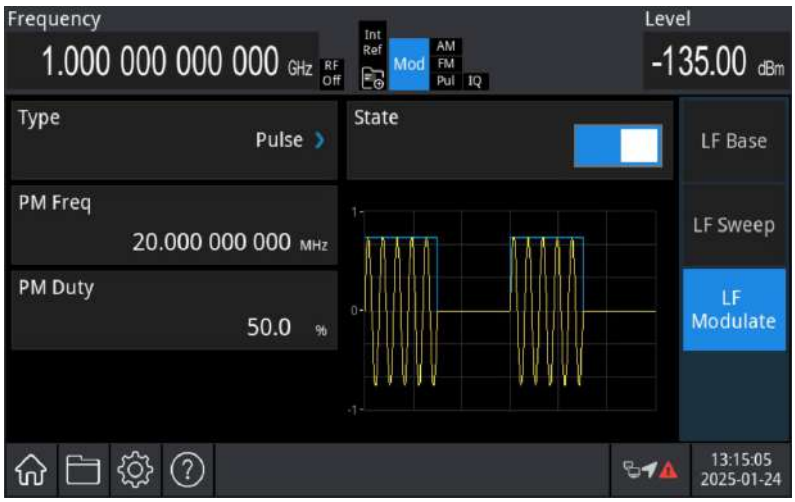


4.1.8 LF Pulse Modulation (PM)

In pulse modulation, the modulated wave consists of a carrier wave and a modulation wave. The default modulation wave is a pulse wave. The output period of the carrier wave varies according to the amplitude of the modulation wave.

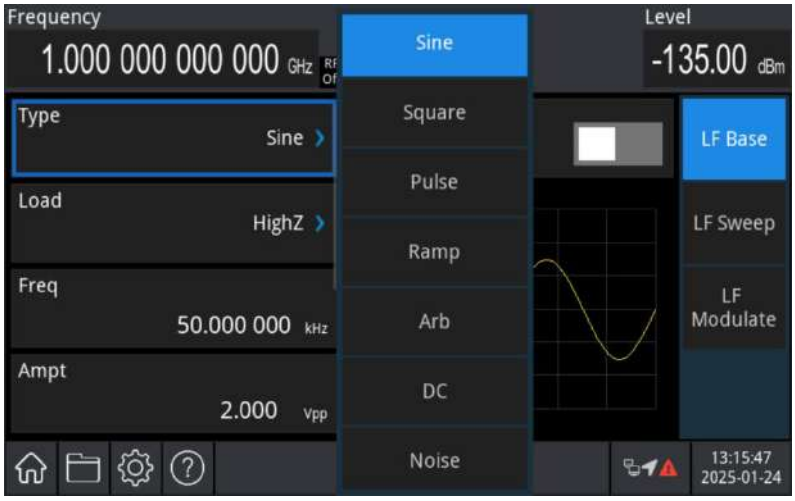
Pulse Modulation (PM)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the Pulse mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the Pulse is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

Pulse Frequency

Set the frequency for the modulation wave within a range of 1 MHz to 25 MHz (default: 20 MHz). After Pulse mode is enabled, the default modulation wave frequency of 20 MHz will be displayed. The pulse frequency can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Pulse Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

Duty Ratio

After Pulse mode is enabled, the duty ratio represents the proportion of the modulated waveform

output within one cycle of the modulation wave. The adjustable range of the phase offset for pulse modulation is from 0% to 100%, with a default value of 50%.

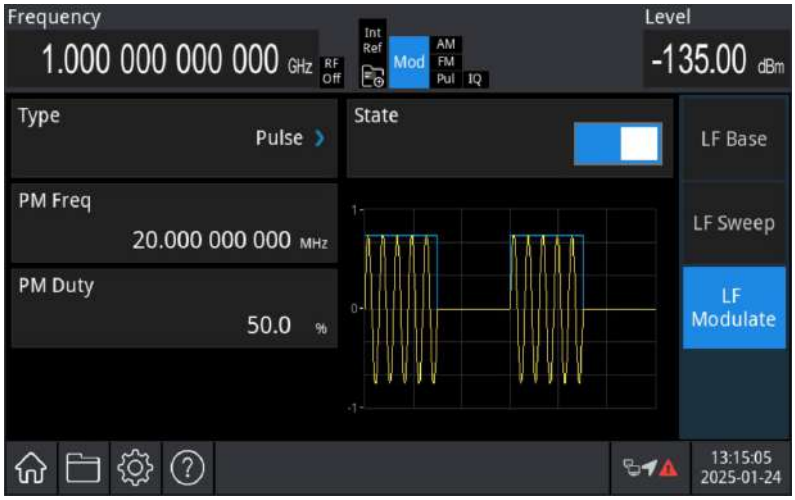
The duty ratio can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Duty key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to pulse modulation (Pulse) mode. Then, configure a 10 kHz sine wave as the modulating signal, and set a 900 kHz sine wave with an amplitude of 100 mVpp as the carrier signal. Finally, set the duty ratio to 70%. The procedure is as follows.

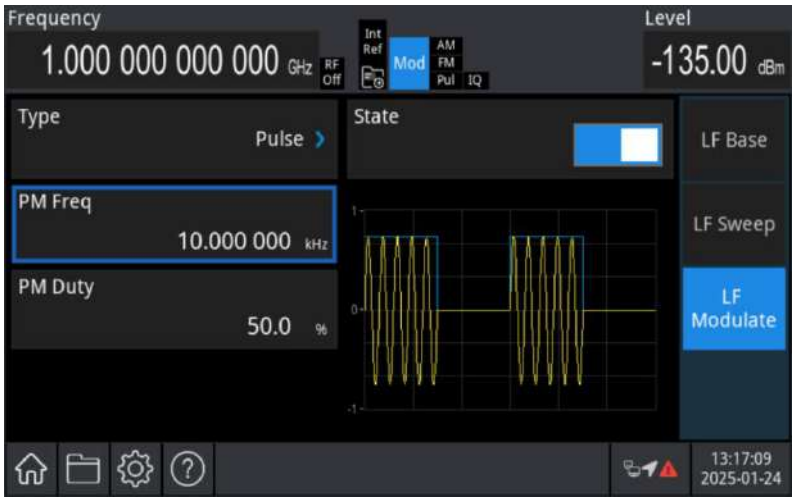
1) Enable Pulse Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the Pulse from the drop-down menu to enable pulse mode.



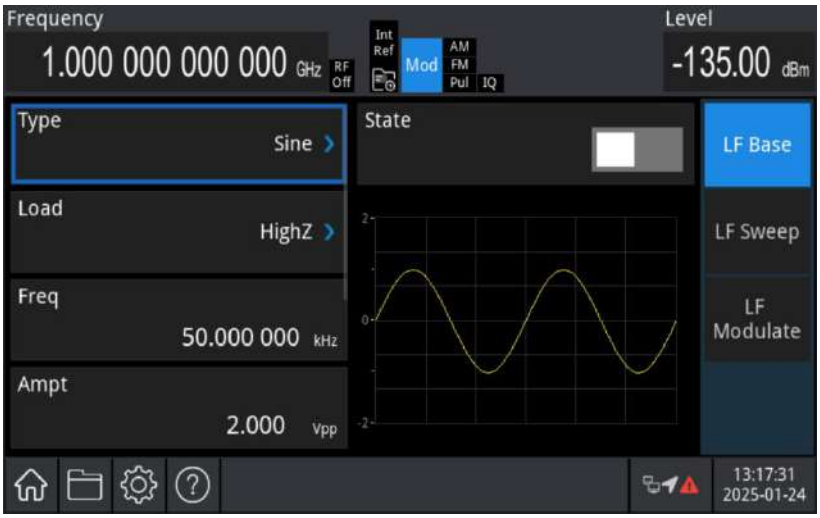
2) Set Modulation Signal

   After setting step 1, press the Pulse Freq key, use the numeric keypad to enter 10, and select the unit kHz for this parameter.



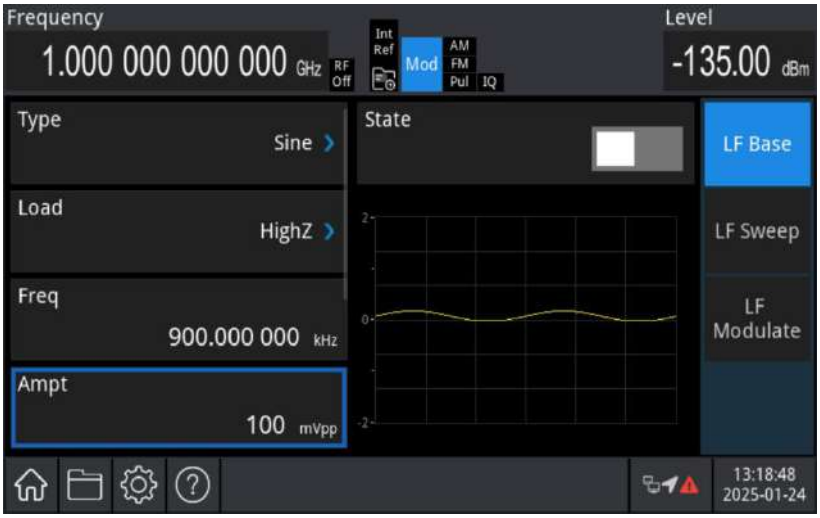
3) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



Press the Freq key to set the frequency, then use the numeric keypad to enter 900 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 100 and select the unit mVpp for this parameter, as shown in the following figure.

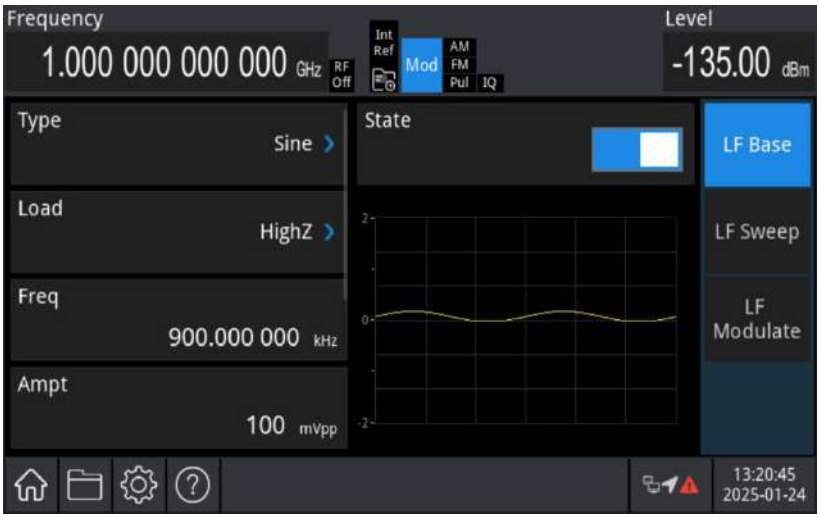


4) Set Duty Ratio

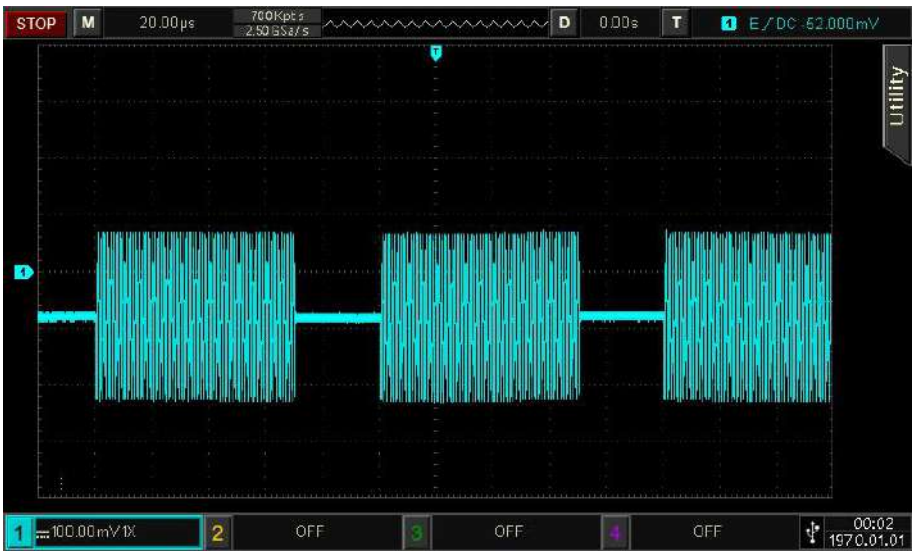
After setting the carrier parameters, press the Modulation key to enter the Pulse setting, press the DUTY key, then use the numeric keypad to enter 70 and select the unit % for this parameter.

5) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the Pulse modulation waveform on an oscilloscope, as shown in the following figure.

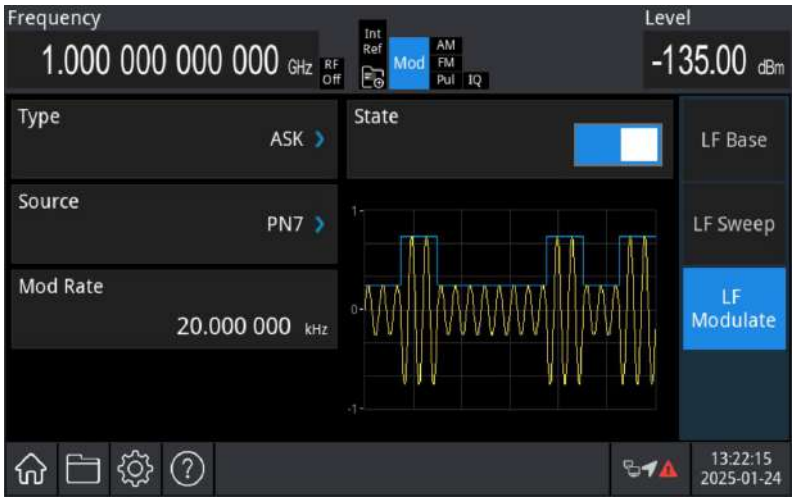


4.1.9 LF Amplitude Shift Keying (ASK)

In ASK mode, the amplitude of the carrier signal changes to represent the digital signal as “0” or “1.” The output carrier signal varies in amplitude based on the logic level of the modulation signal.

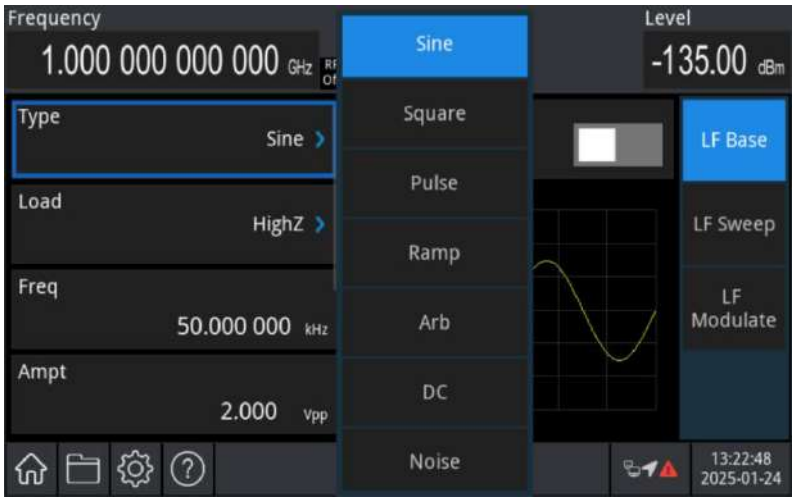
ASK Mode

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the ASK mode from the drop-down menu. The instrument will output the modulated waveform according to the current ASK rate and the carrier wave.



Carrier Wave

The ASK carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the ASK is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

ASK Rate

Set the ASK rate within a range of 2 MHz to 5 MHz (default: 20 kHz). The ASK rate can be adjusted

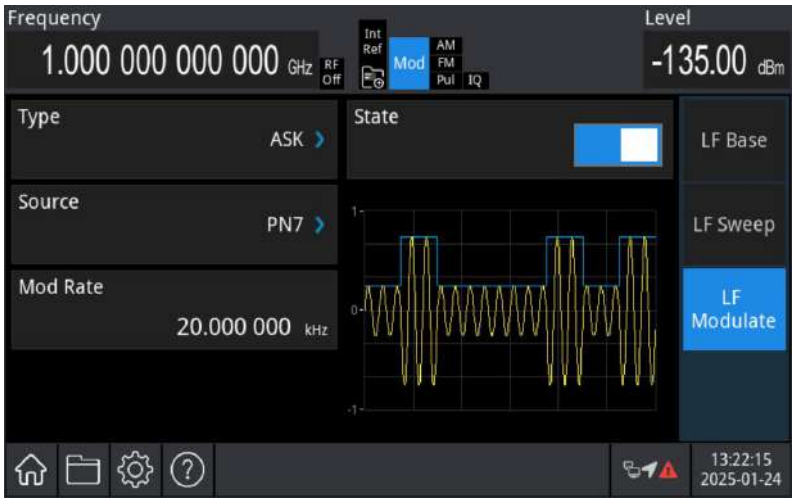
by using the multi-function rotary knob in modulation source interface or pressing the Rate key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument in ASK mode. Then, configure a 15 kHz sine wave and an amplitude of 2 Vpp as the carrier signal, and let the amplitude of the carrier frequency switch at a frequency of 300 Hz. The procedure is as follows.

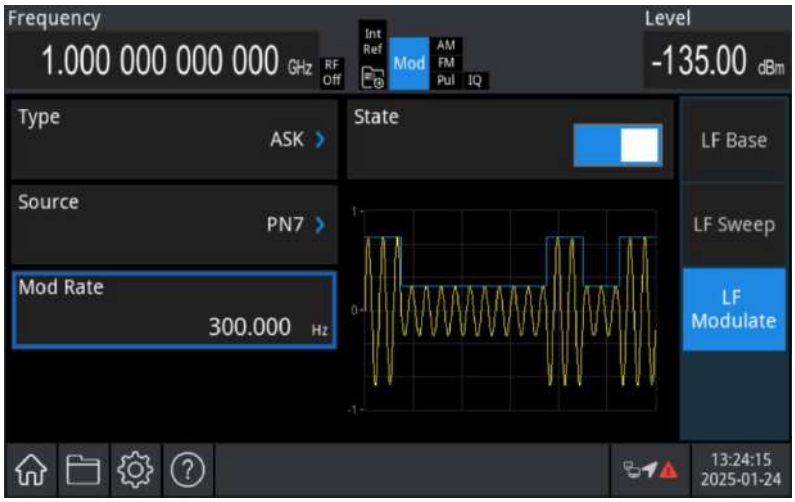
1) Enable ASK Mode

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the ASK from the drop-down menu to enable ASK mode.



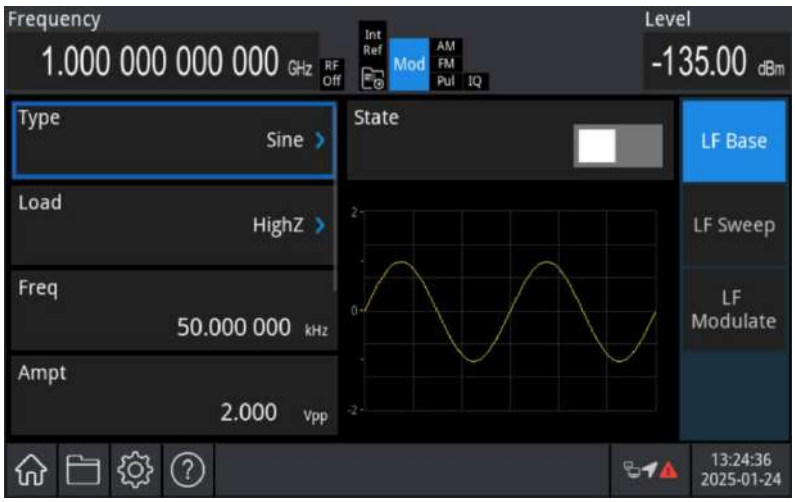
2) Set Modulation Rate

Press the Modulation Rate key, use the numeric keypad to enter 300, and select the unit Hz for this parameter.



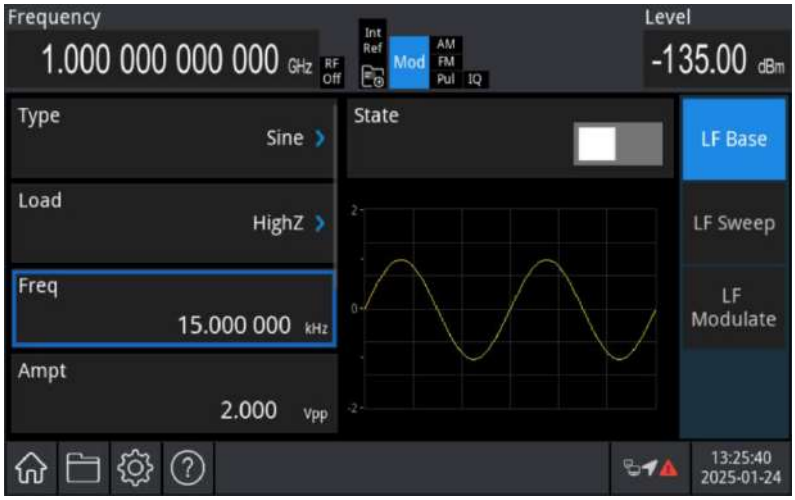
3) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



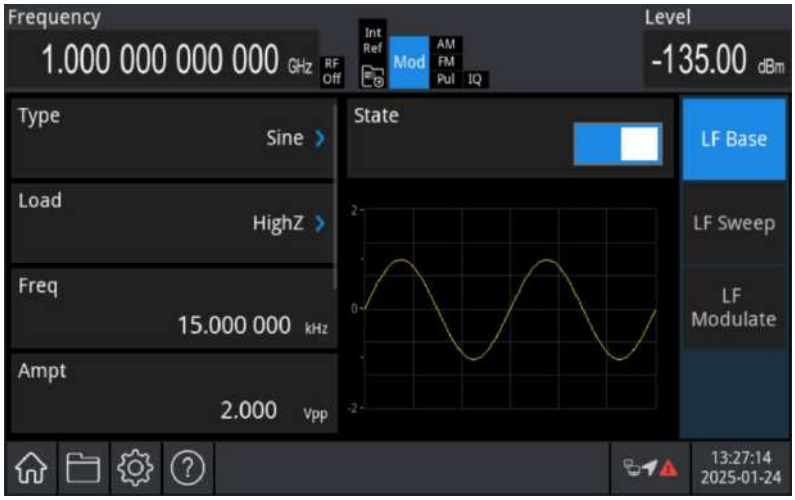
Press the Freq key to set the frequency, then use the numeric keypad to enter 15 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 12 and select the unit Vpp for this parameter.

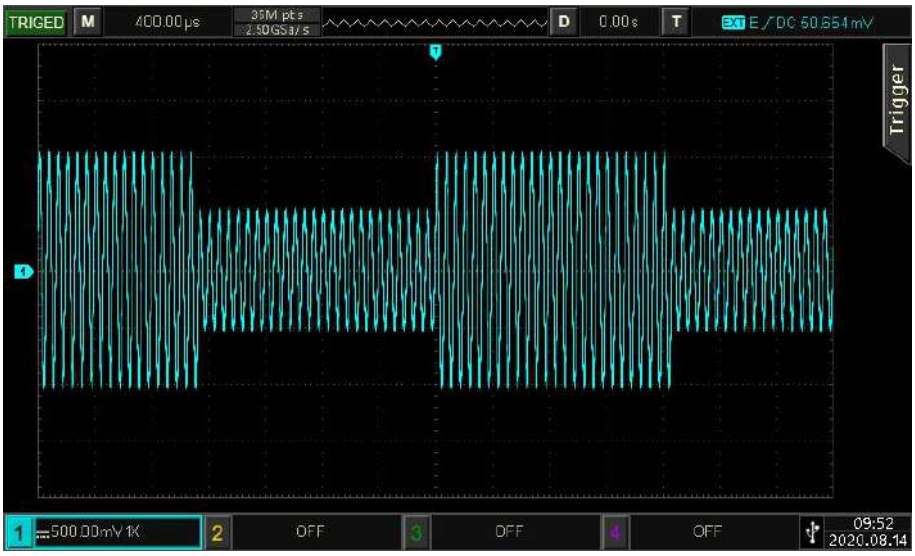


4) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the ASK modulation waveform on an oscilloscope, as shown in the following figure.

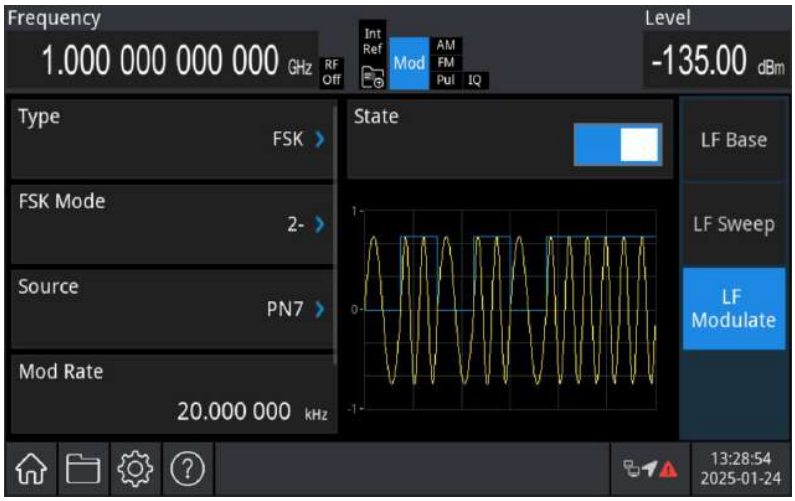


4.1.10 LF Frequency Shift Keying (FSK)

In FSK mode, the instrument switching rate between the carrier frequency and the hopping frequency can be configured.

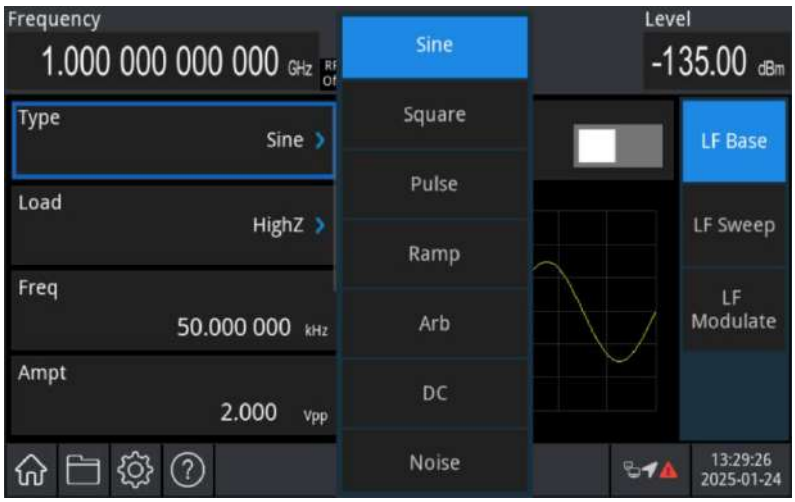
FSK Mode

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the FSK mode from the drop-down menu. The instrument will output the modulated waveform according to the current ASK rate and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the FSK is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

Hopping Frequency

After FSK mode is enabled, the default hopping frequency of 10 kHz will be displayed.

The hopping frequency can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Hopping Freq 1 key and using the numeric keypad to enter the number and select the unit to complete this setting. The hopping frequency range depends on the carrier wave; the frequency setting of the carrier wave can refer to Carrier Frequency in AM mode.

FSK Rate

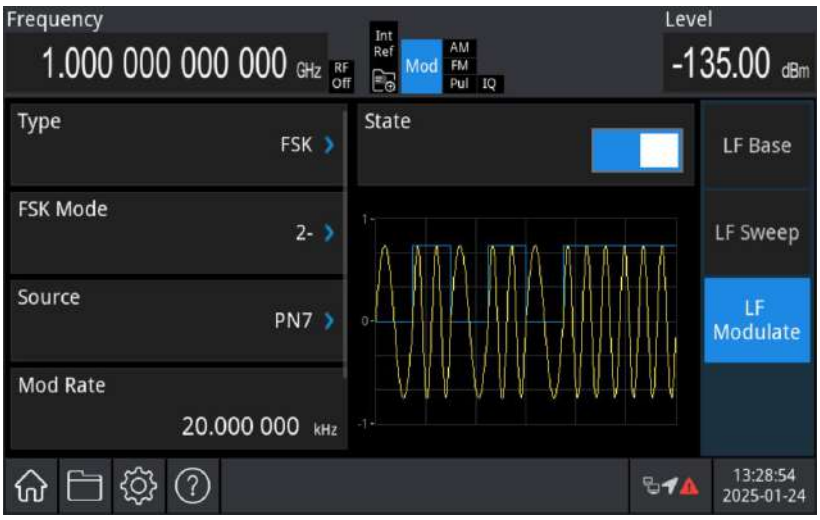
Switch between the carrier frequency and hopping frequency. After FSK mode is enabled, set the FSK within a range of 2 MHz to 5 MHz (default: 20 kHz). The FSK rate can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Modulation Rate key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to FSK mode. Then, configure a 2 kHz, 1 Vpp sine wave as the carrier signal, and set a hopping frequency to 800 Hz, let the carrier frequency and hopping frequency switch at a frequency of 200 Hz. The procedure is as follows.

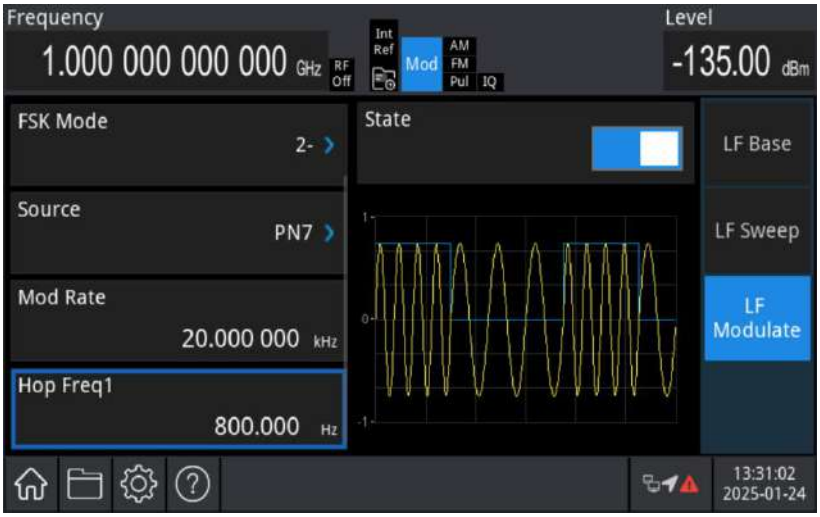
1) Enable FSK Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the FSK from the drop-down menu to enable FSK mode.



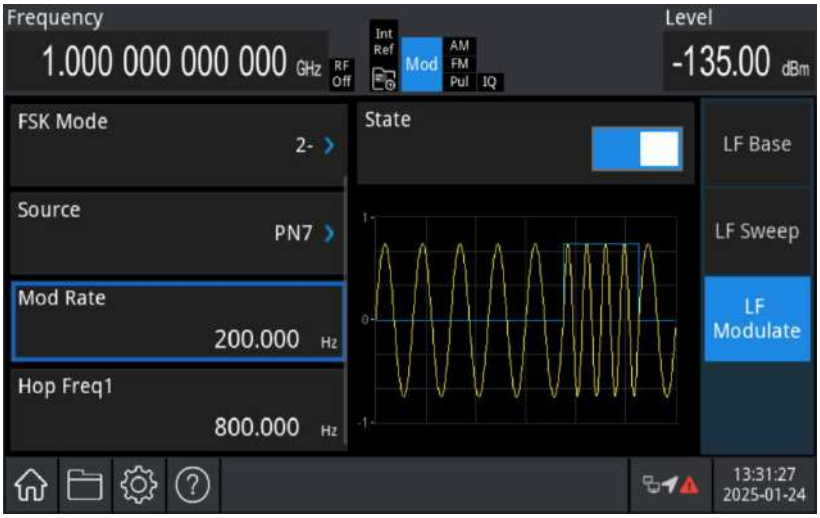
2) Set Hopping Frequency and Modulation Rate

After setting step 1, press the Hopping Freq 1 key, use the numeric keypad to enter 800, and select the unit Hz for this parameter.



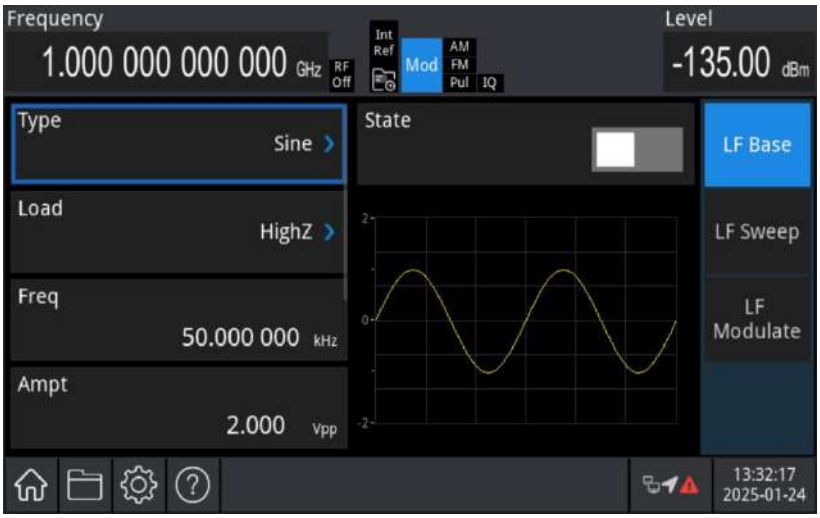
3) Set Modulation Rat

Press the Modulation Rate key, use the numeric keypad to enter 200, and select the unit Hz for this parameter.



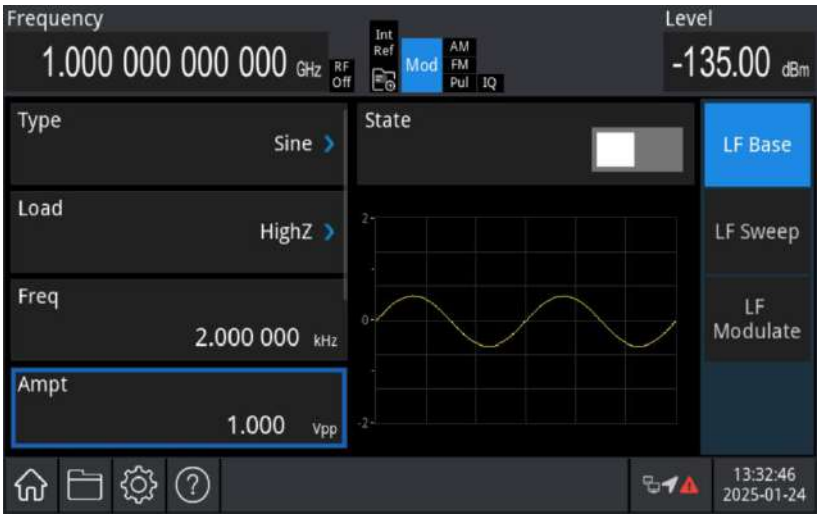
4) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



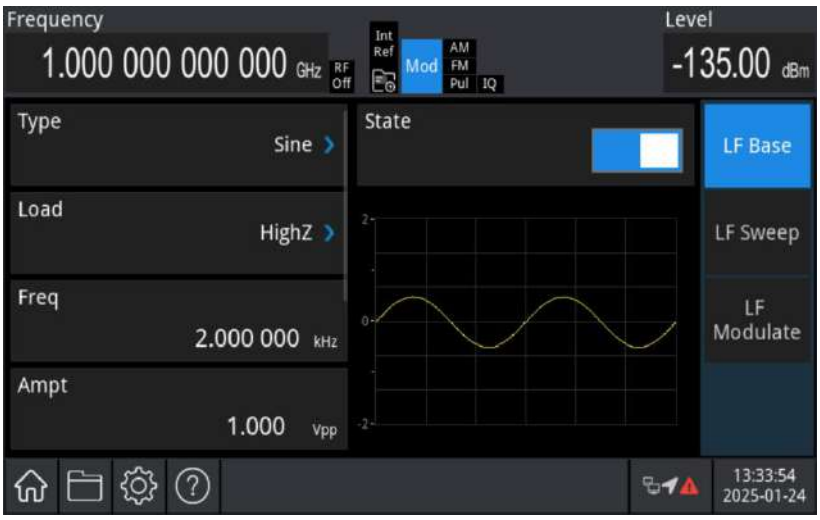
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 1 and select the unit Vpp for this parameter.

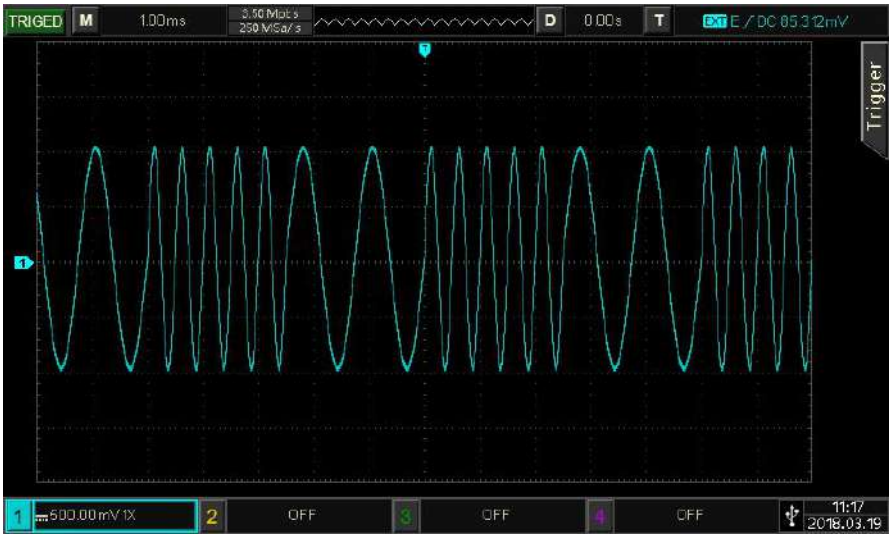


5) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the FSK modulation waveform on an oscilloscope, as shown in the following figure.

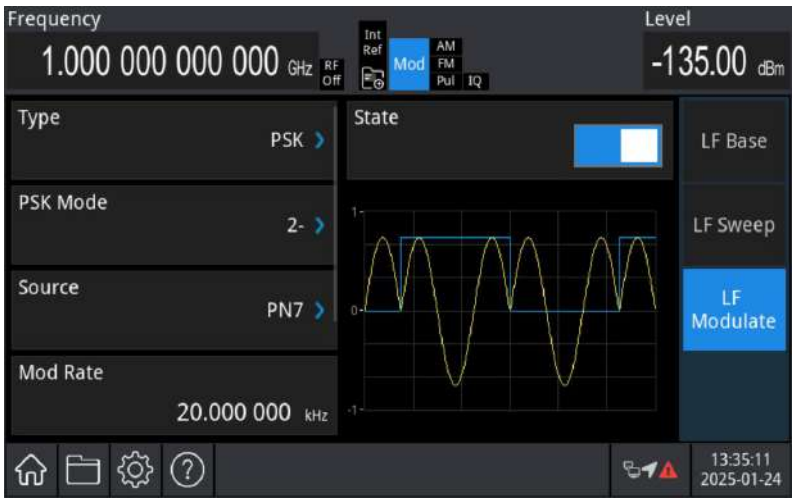


4.1.11 LF Phase Shift Keying (PSK)

In PSK mode, the radio-frequency signal generator can be configured to shift between two preset phases (carrier phase and modulation phase). The carrier signal phase or the modulation signal phase is output according to the logic level of the modulation signal.

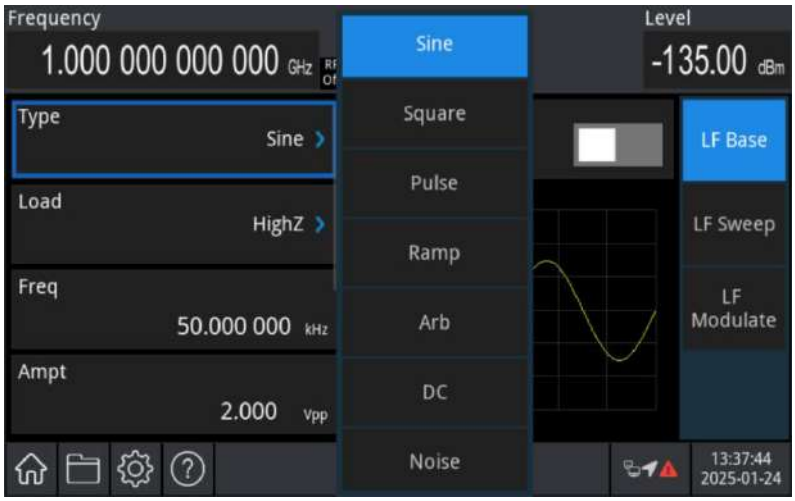
Phase Shift Keying (PSK)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the PSK mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the PM is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

PSK Rate

Set the moving frequency between the carrier phase and the modulation phase. After PSK mode is enabled, set the PSK within a range of 2 MHz to 5 MHz (default: 20 kHz). The PSK rate can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Modulation Rate key and using the numeric keypad to enter the number and select the unit to complete this setting.

Modulation Phase

The modulation phase indicates the deviation of the phase-modulated wave relative to the carrier

wave phase. The PSK modulation phase range can be set from 0° to 360°. The default frequency offset is 0° and 90°.

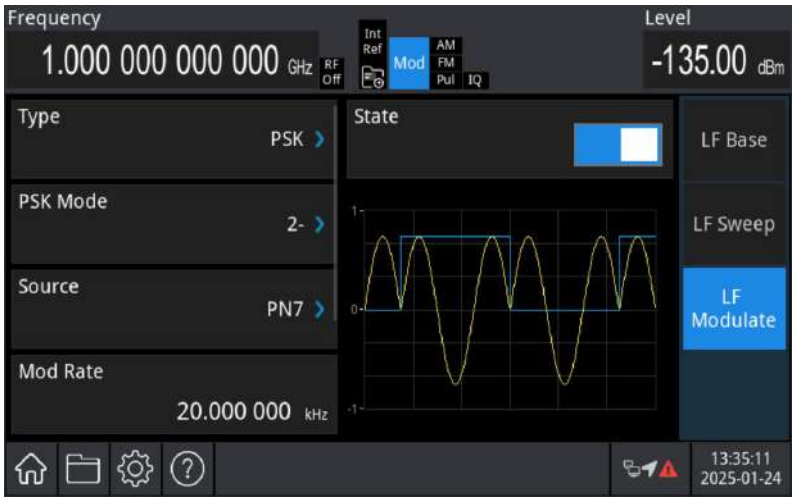
The phase offset can be adjusted by using the multi-function rotary knob in analog modulation source interface or pressing the Phase 1 and Phase 2 key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to phase shift keying (PSK)) mode. Then, configure a 2 kHz, 2 Vpp sine wave as the carrier signal. Finally, let the carrier phase and modulation phase 180° switch at a frequency of 2 kHz. The procedure is as follows.

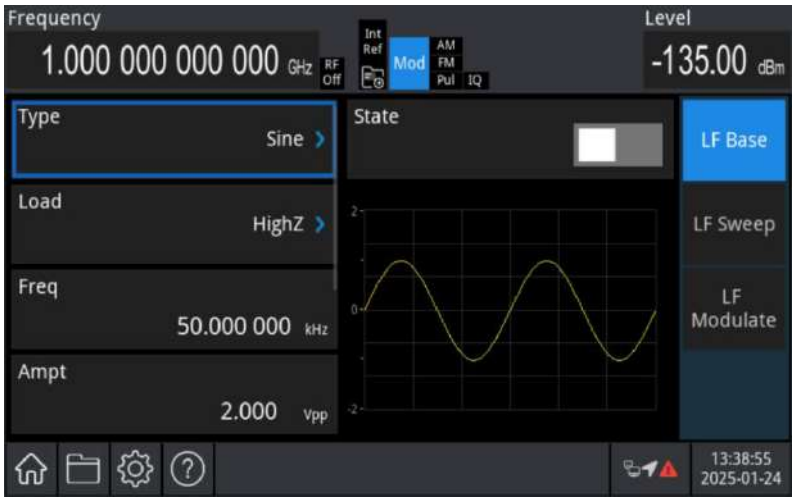
1) Enable PSK Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the PSK from the drop-down menu to enable PSK mode.



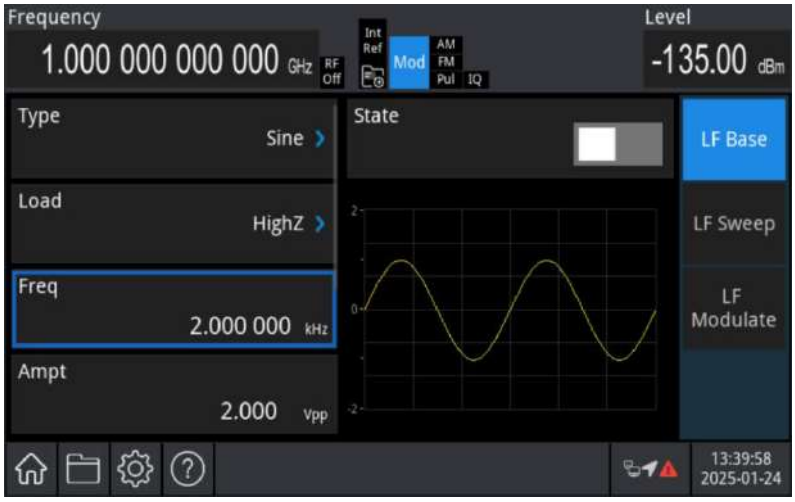
2) Set Carrier Signal

   Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



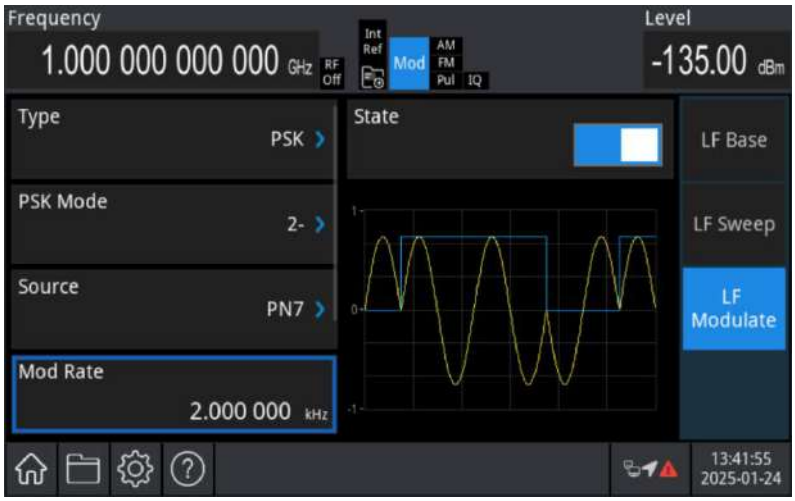
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 2 and select the unit Vpp for this parameter.



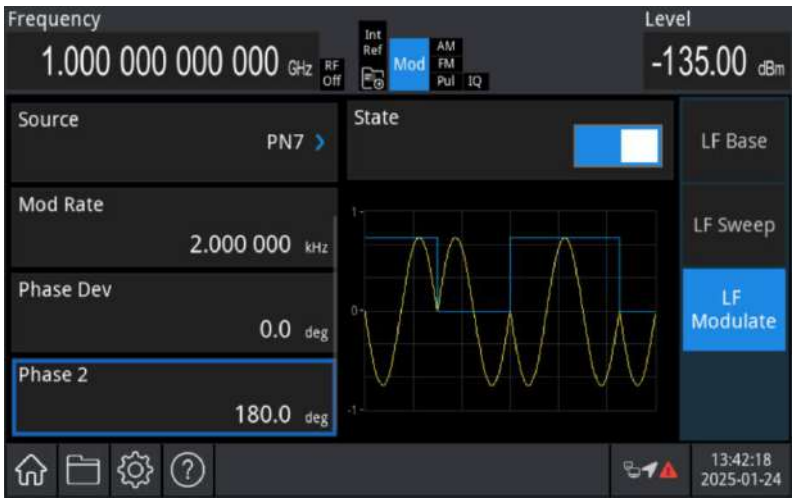
3) Set Modulation Rate

After setting the carrier parameters, press the Modulation to enter the PSK setting menu, press the Rate key, then use the numeric keypad to enter 2 and select the unit kHz for this parameter.



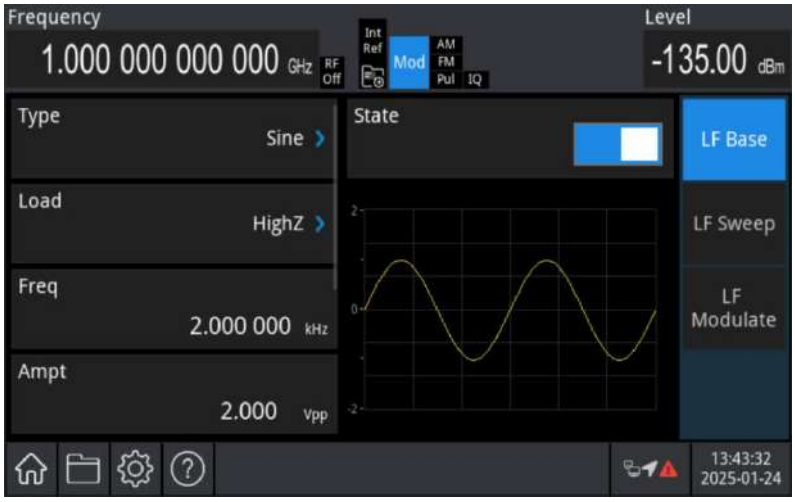
4) Set Phase

Press the Phase Offset key and Phase 2 key to adjust the phase offset to 0° and the phase 2 to 180°.

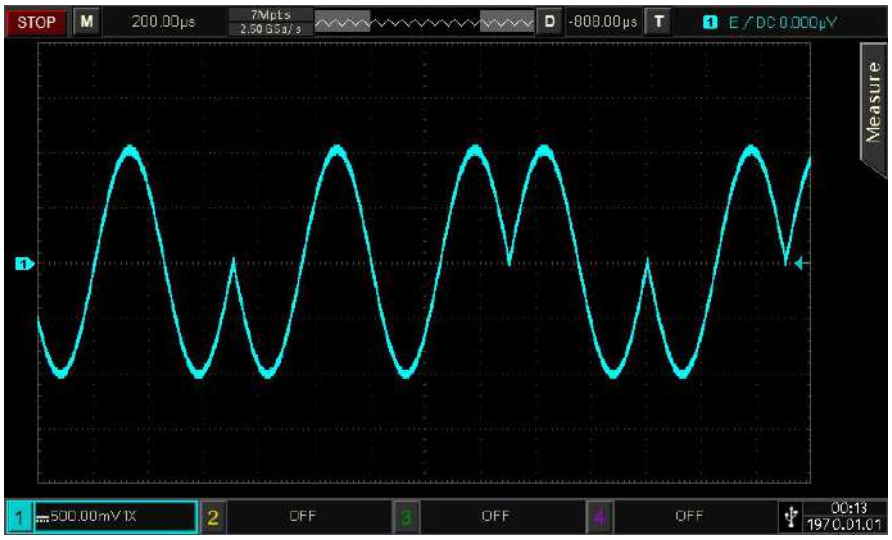


5) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



View the PSK modulation waveform on an oscilloscope, as shown in the following figure.



4.1.12 LF Quadrature Modulation (QAM)

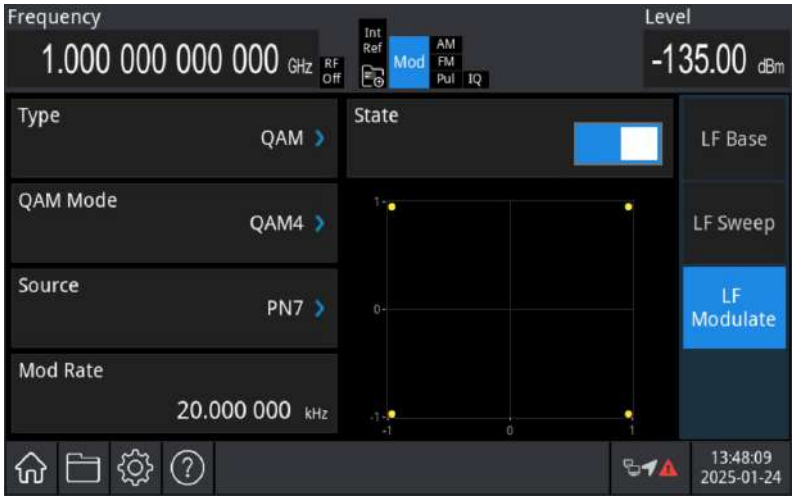
In QAM mode, set two signals with the same frequency but a 90° phase difference (typically

represented as Sin and Cos) as the carrier wave, and use a baseband signal to modulate this carrier. USG5000M RF Vector Signal Generator supports seven modulation types: QAM4, QAM8, QAM16, QAM32, QAM64, QAM128, and QAM256.

Note: For accurate demodulation, it is recommended to use the 10 MHz reference output signal of this instrument as the reference clock input for the demodulation device or input the demodulation device's reference clock as the signal clock. This clock synchronization enables precise demodulation by eliminating phase differences.

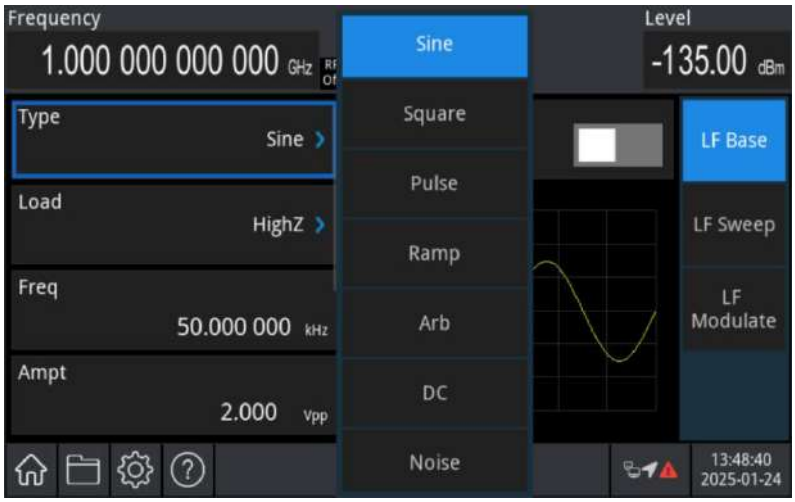
Quadrature Modulation (QAM)

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the QAM mode from the drop-down menu. The instrument will output the modulated waveform according to the current modulation wave and the carrier wave.



Carrier Wave

The carrier wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default carrier wave is a sine wave. After the QAM is enabled, press the LF Carrier →Type key in the modulation interface to open the carrier wave list.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in the Amplitude Modulation (AM) section for more details.

QAM Mode

he modulation mode, i,e the distribution of the constellation diagram, varies based on the selected modulation mode. Press the Modulation →QAM key, and select the modulation mode to QAM4, QAM8, QAM16, QAM32, QAM64, QAM128, or QAM256M from the drop-down menu.

Select Symbol

When QAM mode is enabled, the default symbol is PN7. The symbol can be adjusted by using multi-function rotary knob or pressing the softkey PNode → PN3 key to select PN3, PN5, PN7, PN9, PN11, PN13, PN15, PN17, PN19, PN21, PN23, or PN25.

Modulation Rate

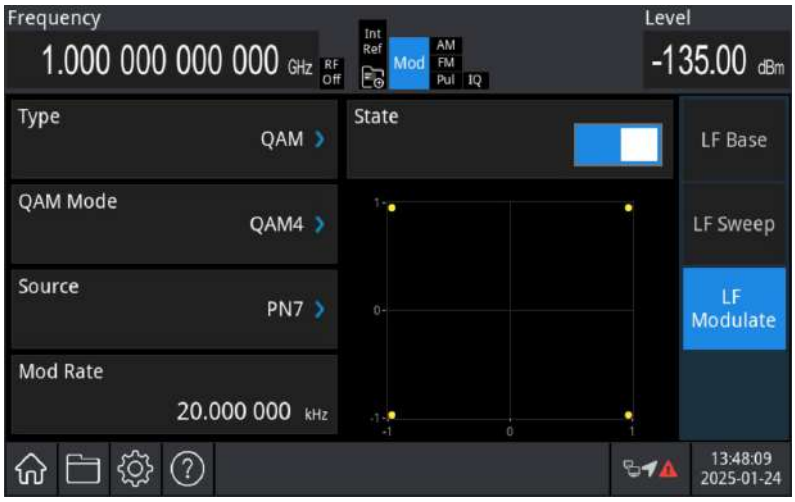
Set the moving frequency between the carrier phase and the modulation phase. After QAM mode is enabled, set the modulation rate within a range of 2 MHz to 5 MHz (default: 20 kHz). The modulation rate can be adjusted by using the multi-function rotary knob in modulation source interface or pressing the Modulation Rate key and using the numeric keypad to enter the number and select the unit to complete this setting.

Comprehensive Example

First, set the instrument to quadrature modulation (QAM) mode. Then, configure a 2 kHz, 2 Vpp sine wave as the carrier signal, and set the rate to 100 Hz, the modulation mode to QAM64, the data source to PN7. The procedure is as follows.

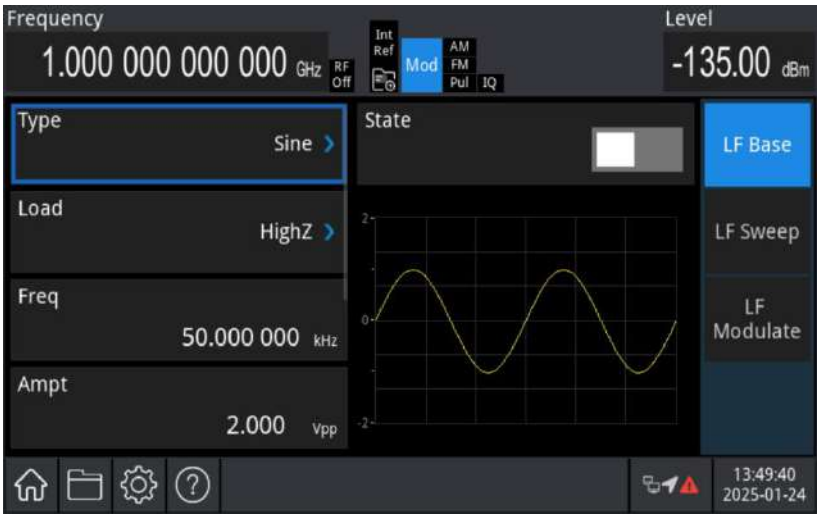
1) Enable QAM) Mode

   Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Modulation →Type key, select the QAM from the drop-down menu to enable QAM mode.



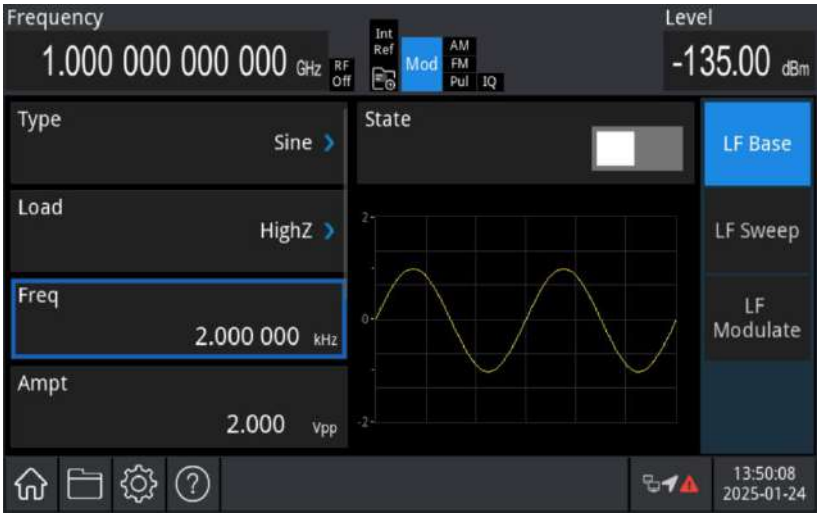
2) Set Carrier Signal

Press the LF Carrier →Type key to open the LF carrier list, select the sine wave as the carrier wave (default: sine wave).



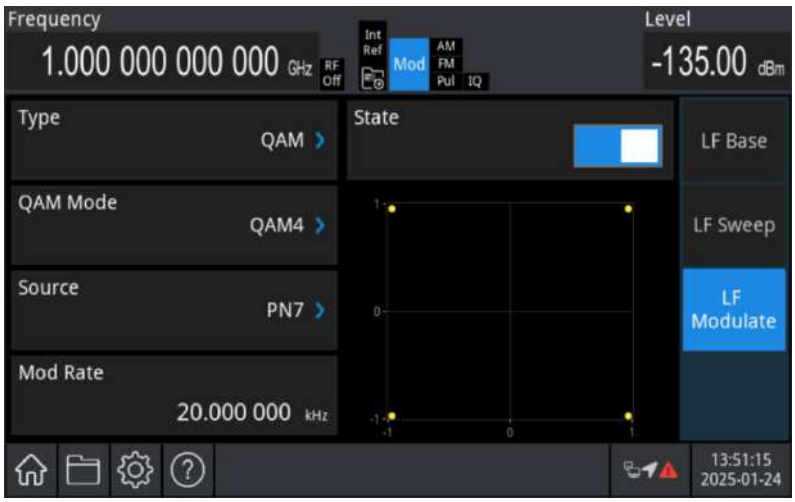
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit kHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 2 and select the unit Vpp for this parameter.



3) Set Modulation Signal

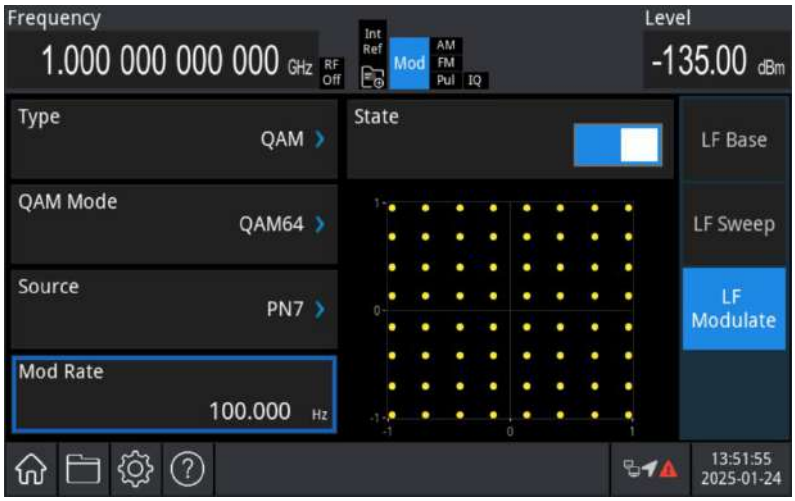
After setting the carrier parameters, press the Function Gen→Modulation key to return to the following figure to set the modulation signal.



Press the QAM key to select the mode to QAM64.

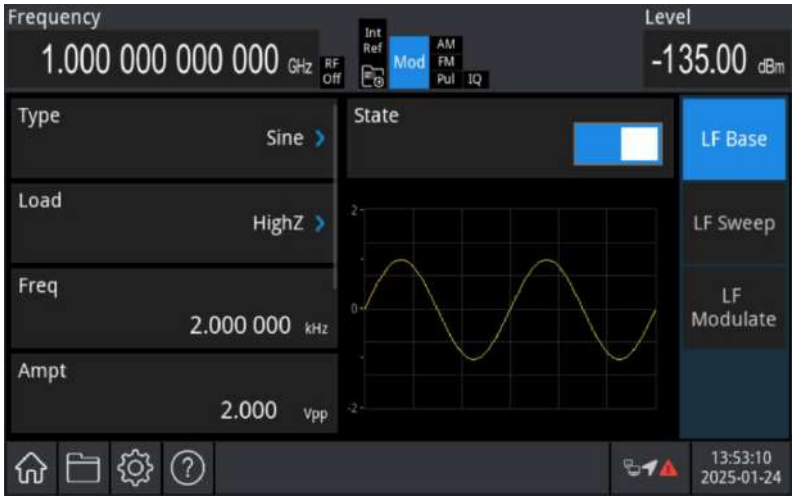
Press the Symbol key to select PN7.

Press the Modulation Rate key, then use the numeric keypad to enter 100 and select the unit Hz for this parameter. The default rate is 100 Hz.

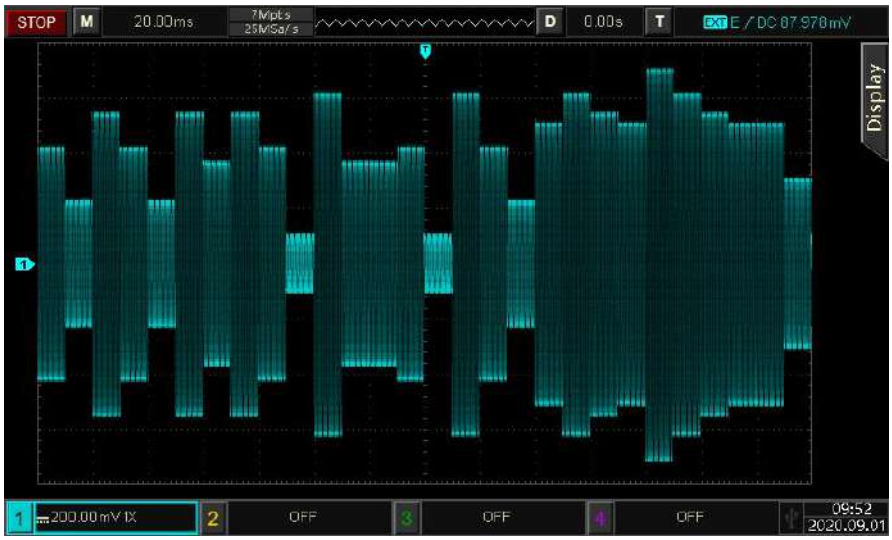


4) Enable Channel Output

Press the Home key, check the function generation ON. If LF the key is illuminated, the channel output is enabled.



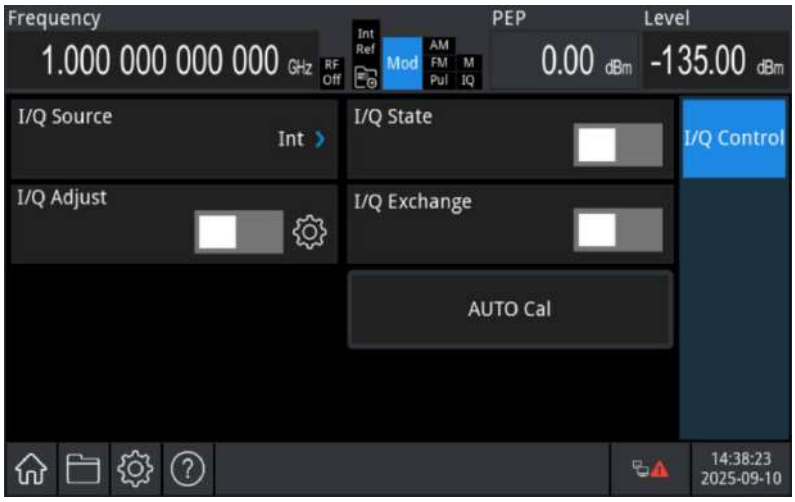
View the QAM modulation waveform on an oscilloscope, as shown in the following figure.



4.2 RF Output I/Q Modulated Waveforms

4.2.1 I/Q Setting

Configure the I/Q modulation status, select the I/Q modulation source, and set related I/Q modulation parameters.



I/Q Source

Set the I/Q source to Internal or External. Press the I/Q → Home key, then press the I/Q Modulation →I/Q Source key in the analog stream mapper. On the I/Q Source interface, use either the multi-function knob or the touchscreen to make the adjustment.

- Internal: Uses the internal signal as the modulation source.
- External: The signal generator receives external analog I and Q signals as the modulation source through the [I INPUT] and [Q INPUT] connectors on the rear panel.

Example: Using an External I/Q Modulation Source

1. Connect the external analog I and Q signals to the [I INPUT] and [Q INPUT] connectors on the

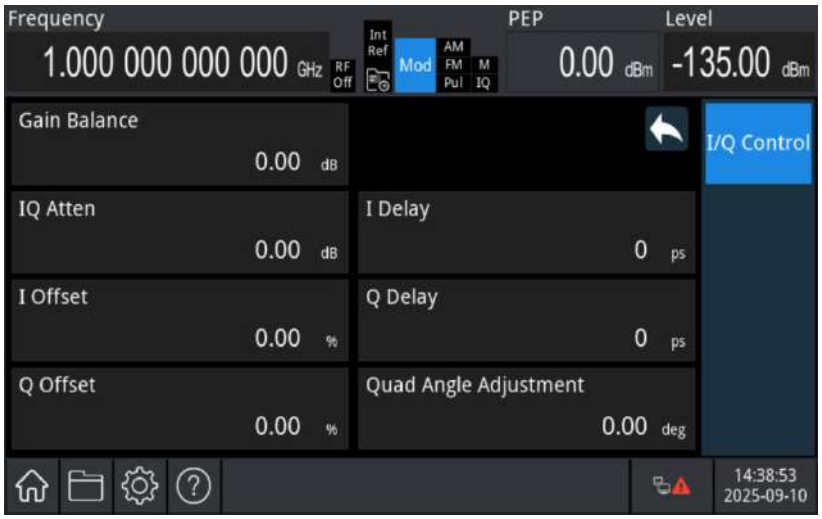
rear panel of the signal generator.

2. Press Home → I/Q Modulation → I/Q Source, and set the I/Q modulation source to External.
3. Turn on the I/Q Status switch.
4. Press the Home key, and in the analog stream mapper on the screen, check the ON option for I/Q Modulation.
5. Configure the RF carrier, then press the RF On/Off key. The illumination of the key indicates that the channel output is enabled.

The [RF OUTPUT 50 Ω] connector on the signal generator now outputs the carrier signal modulated by the external modulation source.

I/Q Adjustment

The I/Q Adjustment function is used to compensate for imperfections in the I/Q signals or to intentionally introduce controlled degradation. This adjustment affects only the front-panel RF output.



1) Gain Balance

The Gain Balance function allows adjustment of the gain ratio so that the I signal exceeds the Q signal. The adjustable range is ±4 dB, with a default value of 0 dB.

For example, entering 1 dB will make the amplitude of the I signal 1 dB higher than that of the Q signal. Gain balance can be used to correct imperfections in the I and Q signals or to introduce calibrated impairments.

To configure gain balance:

Press the Home key, then press the I/Q Modulation →I/Q Control key in the analog stream mapper. On the I/Q adjustment interface, adjust the value using the multi-function knob; alternatively, press the Gain Balance button, enter the desired value using the numeric keypad, and select the appropriate unit to complete the setting.

2) IQ Attenuation

The I/Q Attenuation function sets the attenuation level of the I and Q signals applied to the RF output channel of the signal generator.

To configure I/Q attenuation:

Press the Home key, then press the I/Q Modulation →I/Q Control key in the analog stream mapper. On the I/Q adjustment interface, adjust the value using the multi-function knob; alternatively, press the IQ Atten button, enter the desired value using the numeric keypad, and select the appropriate unit to complete the setting.

3) I Offset

The I Offset function allows the user to enter a DC offset value to be applied to the I signal before it reaches the I/Q modulator. This offset can be used to correct imperfections in the in-phase (I) signal or to introduce calibrated impairments. Adjustable range: ±50 %

Default value: 0 %

Note: For optimal performance when using this setting to minimize LO feedthrough, make the adjustment after completing all other I/Q path adjustments. Any further adjustments made afterward may increase the LO feedthrough signal.

To configure I offset:

Press the Home key, then press the I/Q Modulation →I Offset key in the analog stream mapper. On the I/Q adjustment interface, adjust the value using the multi-function knob; alternatively, press the I Offset button, enter the desired value using the numeric keypad, and select the appropriate unit to complete the setting.

4) Q Offset

The Q Offset function allows the user to enter a DC offset value to be applied to the Q signal before it reaches the I/Q modulator. This offset can be used to correct imperfections in the in-phase (I) signal or to introduce calibrated impairments. Adjustable range: ±50 %. Default value: 0 %

Note: For optimal performance when using this setting to minimize LO feedthrough, make the adjustment after completing all other I/Q path adjustments. Any further adjustments made afterward may increase the LO feedthrough signal.

To configure Q offset:

Press the Home key, then press the I/Q Modulation →I Offset key in the analog stream mapper. On the I/Q adjustment interface, adjust the value using the multi-function knob; alternatively, press the Q Offset button, enter the desired value using the numeric keypad, and select the appropriate unit to complete the setting.

5) Quadrature Phase Adjustment

The Quadrature Phase Adjustment function enables the user to fine-tune the Q signal phase angle through a user-defined input value.

When the quadrature angle is 0°, the phase difference between the I and Q signals is 90°

If a positive value is entered, the phase difference increases above 90°; if a negative value is entered, it decreases below 90°.

To configure quadrature phase adjustment:

Press the Home key, then press the I/Q Modulation →I Offset key in the analog stream mapper. On the I/Q adjustment interface, adjust the value using the multi-function knob; alternatively, press the Quad Angle Adjustment button, enter the desired value using the numeric keypad, and select the appropriate unit to complete the setting.

6) I Delay

The I Delay function adjusts the absolute phase of the I signal relative to the trigger and markers.

A positive value increases the delay, while a negative value advances the signal.

This setting affects both the baseband signal modulated onto the RF and the external output.

This function is not applicable to constant-envelope modulation and does not affect the external I input.

7) Q Delay

The Q Delay function adjusts the absolute phase of the Q signal relative to the trigger and markers.

A positive value increases the delay, while a negative value advances the signal.

This setting affects both the baseband signal modulated onto the RF and the external Q output.

This function is not applicable to constant-envelope modulation and does not affect the external Q input.

Note: Available only during waveform playback.

The I/Q Adjustment and I/Q Delay functions are intended to compensate for timing differences between the event output (marker signal) and the RF output, not to introduce impairments.

I/Q Status

The I/Q Status function toggles I/Q modulation on or off.

To configure I/Q status: Press the Home →I/Q Modulation key. On the I/Q Modulation interface, select on or off using the multi-function knob or touchscreen.

I/Q Swap

The I/Q Swap function swaps the I and Q signals, inverting the modulation sidebands (the Q component is reversed).

To configure I/Q swap: Press the Home →I/Q Modulation key. On the I/Q Modulation interface, enable or disable I/Q Swap using the multi-function knob or touchscreen.

- **Disabled:** Normal output mode. The RF modulator output is:

$$i(t)\cos(2\Pi * fc * t) + q(t)\sin(2\Pi * fc * t)$$

  where i(t) and q(t) are the I and Q signals, and fc is the carrier frequency.

- **Enabled:** The Q signal is inverted, and the RF modulator output becomes:

$$i(t)\cos(2\Pi * fc * t) - q(t)\sin(2\Pi * fc * t)$$

  At this point, the frequency spectrum is the mirror image of the normal mode.

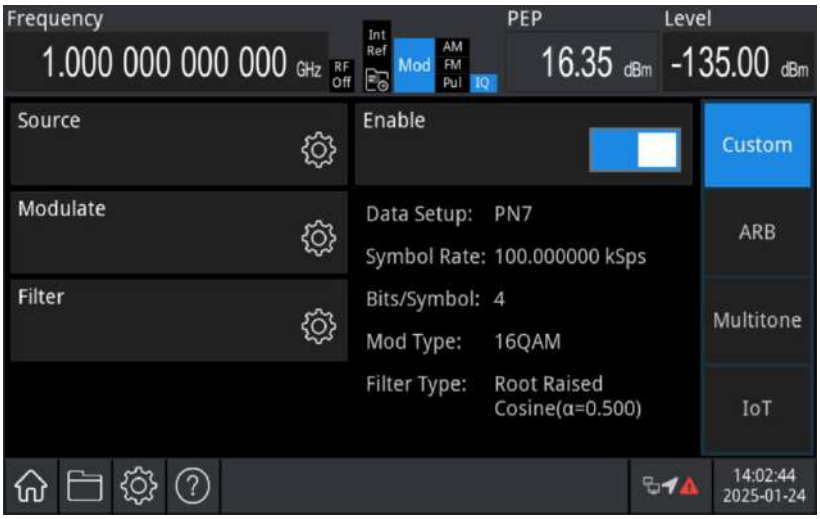
4.2.2 I/Q Custom Modulation

Custom I/Q modulation supports the following modulation types: QAM (Quadrature Amplitude Modulation), ASK (Amplitude Shift Keying), PSK (Phase Shift Keying), FSK (Frequency Shift Keying), and MSK (Minimum Shift Keying).

In addition, the instrument allows users to import custom I/Q data for modulation.

Custom Modulation

Press the I/Q → Home key, check I/Q modulation ON in the analog stream mapper on the screen, then press the Baseband →Custom →Enable key to turn on the custom modulation. The instrument will output the modulated waveform according to the current setting.



Carrier Wave Frequency

Each carrier wave has a different frequency, with a default frequency of 1 GHz. The frequencies of each carrier wave are shown in the following table.

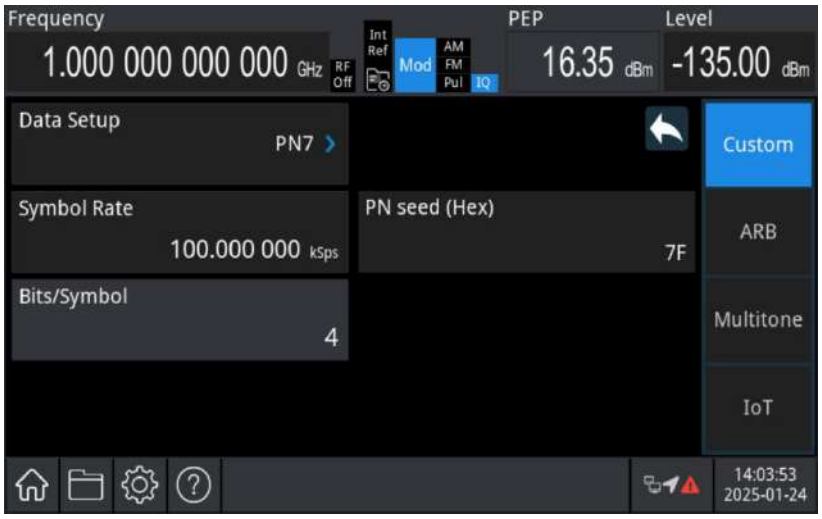
Frequency							
USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum

9 kHz	4.5 GHz	9 kHz	6 GHz	9 kHz	6 GHz	9 kHz	6 GHz

Press the Freq key to set the carrier wave frequency and use the numeric keypad to enter the number and select the unit to complete this setting.

Data Source Setting

Press the Mod key to open the modulation type menu, then press the Custom →Data Setup key in sequency to access the Custom modulation setting menu to configure the symbol data of the I/Q modulation wave, such as data source type, symbol rate, symbol length, PN seed, and bits per symbol.



1) PN Type

Select the data source code type for modulation. Available options are PN7, PN9, PN15, PN23, and Custom, with PN7 as the default selection.

After enabling the Custom function, the data source type defaults to PN7.

To change the PN type:

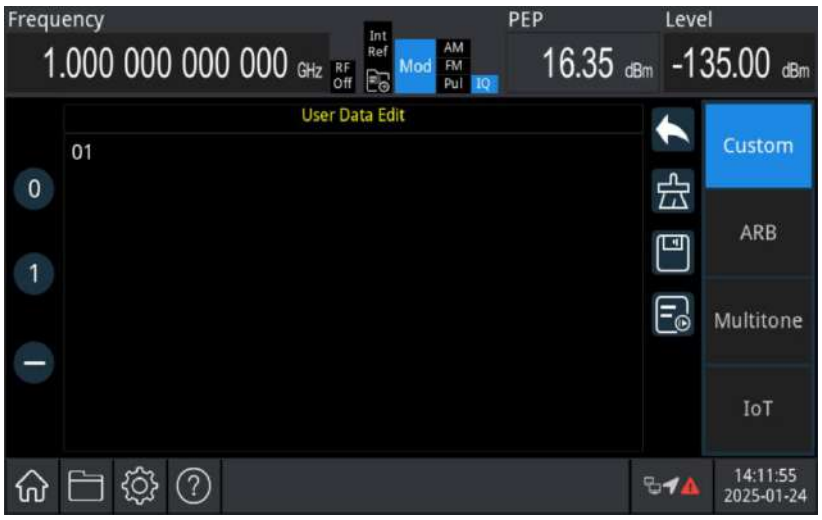
Press the Mode →Custom →Data Source →PN Type key in sequence. On the PN Type interface, use the multi-function knob or touchscreen to adjust it.

- PN7, PN9, PN15, PN23

  When one of these options is selected as the data source type, the software automatically generates the corresponding pseudo-random bit sequence.

- Custom

  When Custom is selected as the data source type, a Custom Data key will appear. Click Custom Data to open the Custom Data Editing page.



Custom Data Editing

As shown in the figure above, the Custom Data Editing page consists of three sections: the data table area, the operation buttons on the right, and the menu bar at the bottom.

Operations are as follows:

a. Click 1 to enter data “1”.

b. Click 0 to enter data “0”.

c. Click − to delete the data at the current cursor position.

d. Data Editing: After selecting the editing position, input digits “0” or “1”, or delete data using the touchscreen keypad or front-panel keyboard.

e. Click to clear all user-edited data.

f. Click to return to the upper-level menu.

g. Click to choose and load a UDATA file.

h. Click to save the currently edited user data to a UDATA file.

2) Symbol Length

When the PN Type is set to Custom, the symbol length of the I/Q modulated wave must be configured.

Adjustable range: 100 to 5120

Default value: 512

To change the symbol length:

On the data source setting menu, use the multi-function knob or press the Symbol Length key to adjust it, then use the numeric keypad to enter the desired value.

3) Symbol Rate

Set the symbol rate (symbols per second) of the I/Q modulated wave.

Adjustable range: 100 Sps to 75 MSps

Default value: 100 kSps

To change the symbol rate:

On the data source setting menu, use the multi-function knob or press the Symbol Rate key to adjust it, then use the numeric keypad to enter the desired value.

4) Bits per Symbol

Displays the number of bits contained in one modulation symbol. This parameter is read-only and cannot be configured.

5) PN Seed (Hex)

When the data source type is set to PN7, PN9, PN15, or PN23, the PN Seed value can be configured. The seed value is displayed in hexadecimal format.

Range: PN7: 0 to 7F; PN9: 1 to 1FF; PN15: 1 to 7FFF; PN23: 1 to 7FFFFF

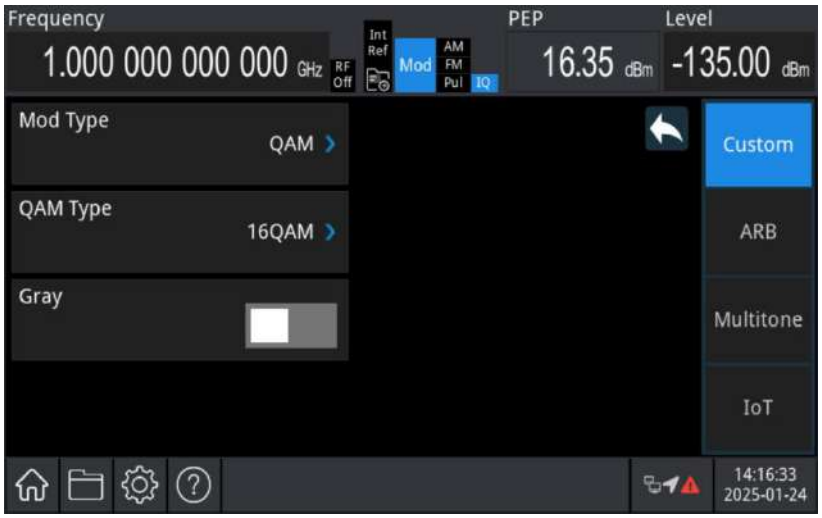
Default value: PN7: 7F; PN9: 1FF; PN15: 7FFF; PN23: 7FFFFF

To change the PN:

On the data source setting menu, use the multi-function knob or press the PN Seed (Hex) key to adjust it, then use the numeric keypad to enter the desired value.

Modulation Setting

Press the Mod key to open the modulation type menu, then press the Custom →Mode Type to access the Custom modulation setting menu to configure the custom modulation parameters, such as modulation type, custom IQ data, gray code, and FSK offset.



1) Modulation Type

The modulation type can be selected from QAM, ASK, PSK, FSK, or Custom, with QAM as the default.

To change the modulation type:

Press the Mode →Custom →Modulate Setting →Mode Type key in sequence. On the

modulation type interface, use the multi-function knob or touchscreen to adjust it.

- QAM

  Select the desired modulation type under the QAM option.

  Options: 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM

  Default: 16QAM

- ASK

  Select the desired modulation type under the ASK option.

  Options: 2ASK, 4ASK, 8ASK, 16ASK

  Default: 2ASK

- PSK

  Select the desired modulation type under the PSK option.

  Options: BPSK, QPSK, 8PSK, DBPSK, DQPSK, D8PSK, OQPSK, PI/4-DQPSK, PI/8-D8PSK

  Default: BPSK

- FSK

  Select the desired modulation type under the FSK option.

  Options: 2FSK, 4FSK, 8FSK, 16FSK, MSK

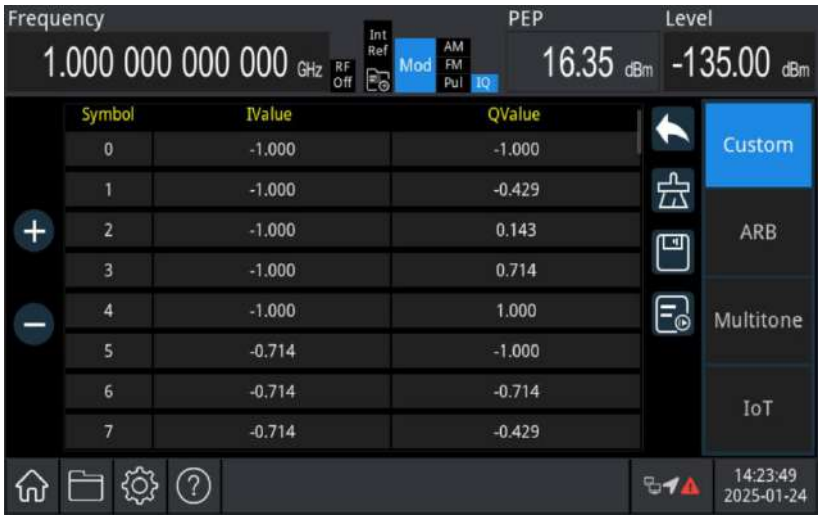
  Default: 2FSK

- Custom

  When Custom is selected, users can edit I/Q data independently. For more details, refer to *Custom I/Q Data*.

2) Custom I/Q Data

When Custom is selected as the modulation type, a Custom Table setting key appears. Click this key to open the Custom I/Q Data editing page.



Custom I/Q Data Editing

As shown in the figure above, the Custom I/Q Data editing page consists of I/Q data list (Displays Symbols, I Values, and Q Values) and bottom menu (Provides operation buttons for data management).

Operations are as follows:

a. Click to insert a new row before the currently selected row. The new row duplicates the data of the selected row.

b. Click to delete the currently selected row.

c. Click to clear all user-edited data and restore the default data (2ASK).

d. Click to apply changes to the edited data.

e. Click to return to the previous menu.

f. Click to save the current user-edited I/Q Data to a MAP file.

3) Gray Code

When the modulation type is QAM, ASK, PSK, or Custom, gray code for the I/Q data can be enabled or disabled.

Default state: Disabled

To change the gray code:

On the modulation setting interface, use the multi-function knob or press Gray key to adjust it, then use the numeric keypad to enter the desired value.

4) FSK Offset

When the modulation type is 2FSK, 4FSK, 8FSK, or 16FSK, the FSK Offset input field is displayed.

FSK offset is used to set the frequency offset for FSK modulation, with the unit in Hz.

Adjustable range: 0 to 75 MHz

Default value: 1 kHz

To change the FSK offset:

On the modulation setting interface, use the multi-function knob or press FSK Offset key to adjust it, then use the numeric keypad to enter the desired value.

Filter Setting

Press the Mod key to open the modulation type menu, then press the Custom → Filter to access the filter setting menu of Custom modulation to configure the filter parameters, such as filter type, filter length, oversampling multiple (factor) gray code, and filter Alpha.

1) Filter Type

Sets the filter type for the current modulation.

Options: Raised Cosine, Root Raised Cosine, Gaussian, Half-Sine, None

Default: Root Raised Cosine

To change the filter type:

Press the Mode →Custom →Filter Setting →Filter Type key in sequence. On the filter type interface, use the multi-function knob or touchscreen to adjust it.

Note: The Half-Sine filter is only supported in OQPSK modulation mode.

2) Filter Length

Sets the symbol length of the filter.

Range: 1 to 512

Default: 12

To change the filter length:

On the filter setting interface, use the multi-function knob or press the Filter Len to adjust it, then use the numeric keypad to enter the desired value.

3) Oversampling Multiple

Sets the oversampling multiple of the waveform. The waveform sampling rate is determined by the symbol rate multiplied by the oversampling multiple.

Range: 2 to 16

Default: 2

To change the oversampling multiple:

On the filter setting interface, use the multi-function knob or press the Oversampling Multiple to adjust it, then use the numeric keypad to enter the desired value.

Note: For OQPSK modulation, the oversampling rate must be an even number.

4) Filter Alpha

Sets the alpha factor of the filter. For the Gaussian filter, this corresponds to the BT parameter.

Range: 0.01 to 1

Default: 0.35

Gaussian Filter BT Coefficient Range: 0.1 to 1

Default BT Value: 0.5

To change the filter alpha:

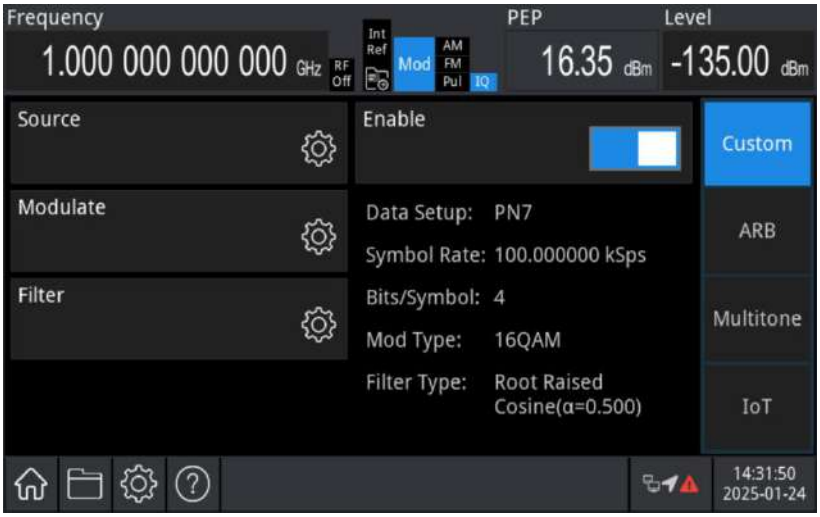
On the filter setting interface, use the multi-function knob or press the Filter Alpha to adjust it, then use the numeric keypad to enter the desired value.

Comprehensive Example

First, set the instrument to I/Q Modulation mode and select the internal modulation source. Configure Custom modulation as 16QAM with a symbol rate of 200 kHz. Next, set the carrier frequency to 2 GHz and the amplitude to -20 dBm. Finally, configure the filter type as Root Raised Cosine and set the filter Alpha to 0.2. The procedure is as follows.

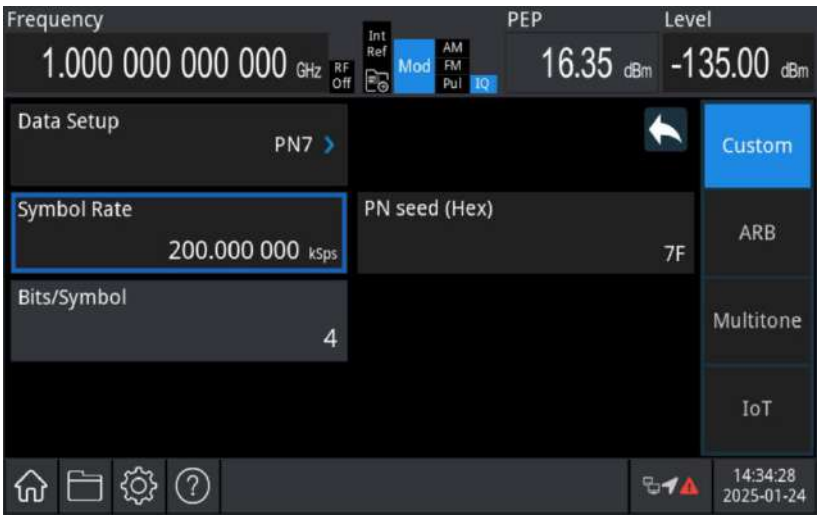
1) Enable Custom Modulation

Press the I/Q→ Home key in the analog stream mapper on the screen, check the I/Q modulation ON, and press the Baseband→Custom→Enable key to activate Custom modulation.



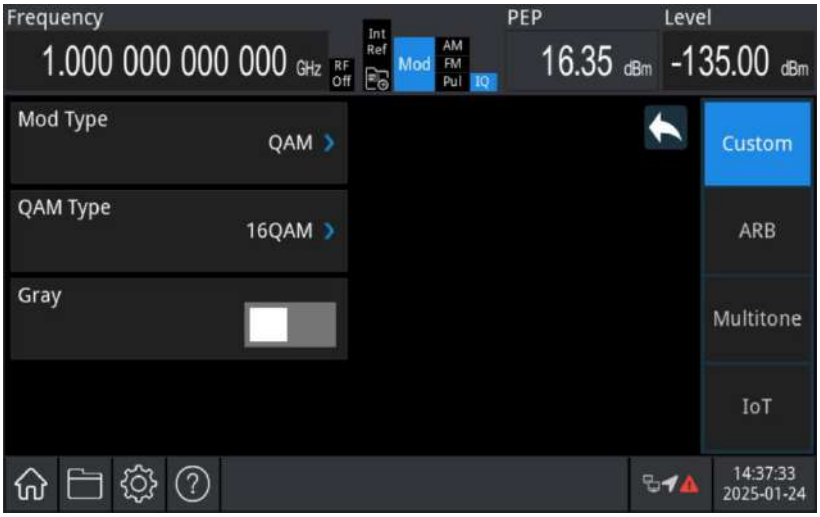
2) Set Data Source

Press the Home key in the analog stream mapper on the screen, press the Baseband Custom →Data Source key to open the data source setting menu. Select Symbol Rate and use the numeric keypad to enter 200, then select the unit as kSps.



3) Set Modulation Type

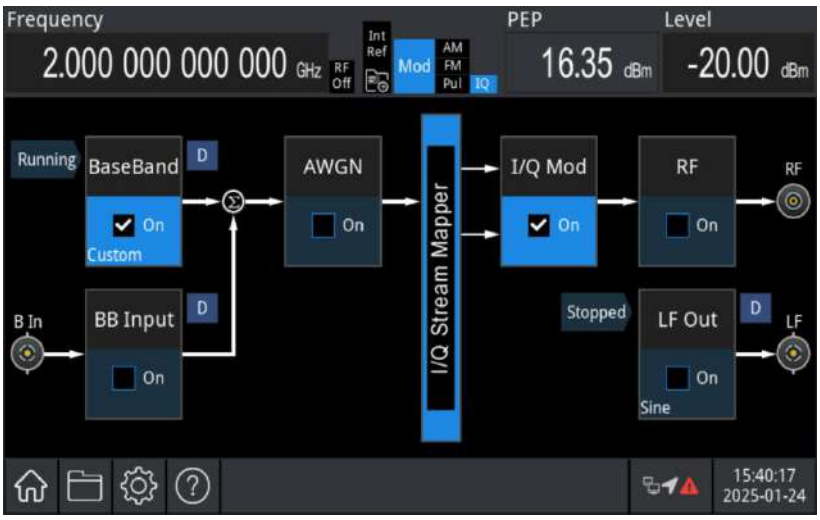
Press the Home key in the analog stream mapper on the screen, then press the Baseband Custom→Mod Type key to open the modulation setting menu. Press the Mod Type key to choose QAM. Next, press the QAM Type, and on the QAM type setting menu, use the multi-function knob or touchscreen to select the modulation type to 16QAM.



4) Set Carrier Signal

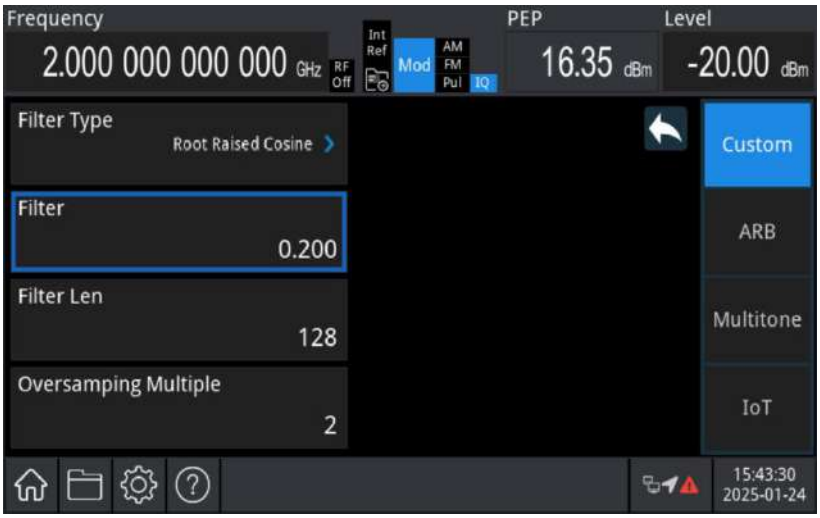
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -20 and select the unit dBm for this parameter, as shown in the following figure.



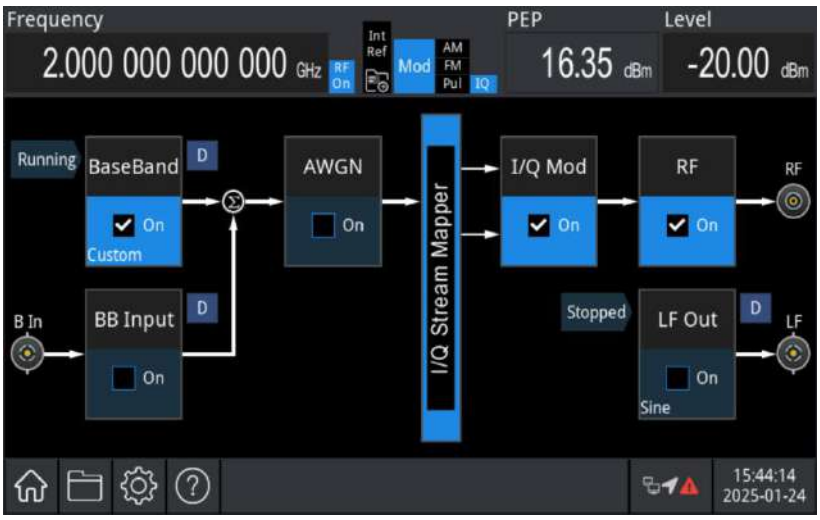
5) Set Filter Parameter

After setting the carrier parameters, press the Home key in the analog stream mapper on the screen, then press the Baseband Custom→Filter Setting key in sequence to open the filter setting menu. Press the Filter Type key, and in the drop-down menu, select Root Raised Cosine. Return to the filter setting menu, press the Filter Alpha key, and use the numeric keypad to enter 0.2.



6) Enable Channel Output

Press the RF On/off key, if the key is illuminated, the channel output is enabled.

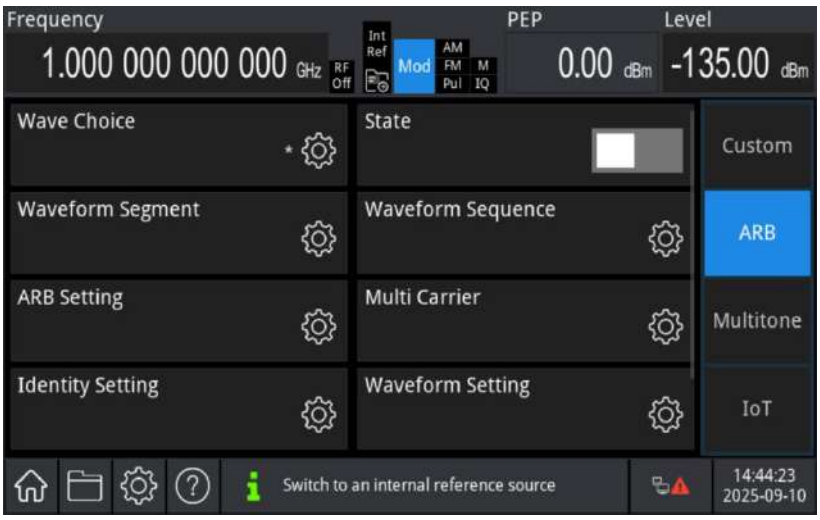


View the Custom modulation waveform on a spectrum analyzer, as shown in the following figure.

4.2.3 I/Q ARB Modulation

ARB Modulation

Press the I/Q → Home key, check I/Q modulation ON in the analog stream mapper on the screen, then press the Baseband →ARB →State key to turn on the ARB modulation. The instrument will output the modulated waveform according to the current setting.

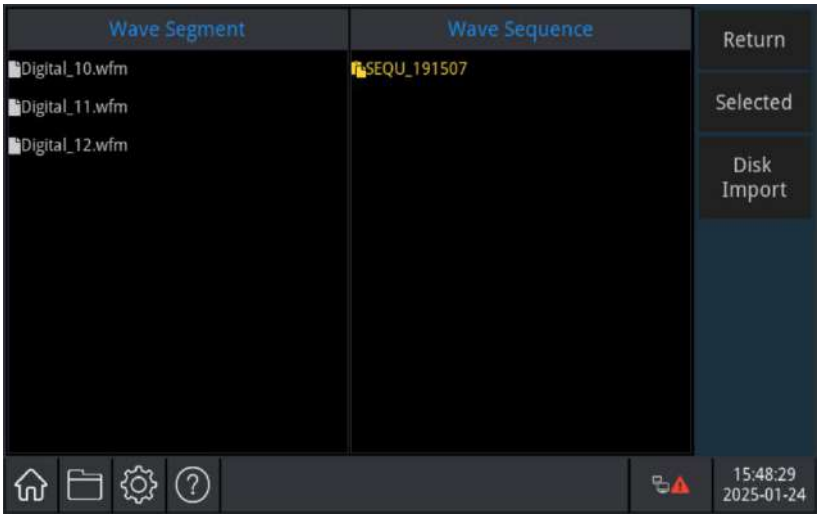


Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in I/Q Custom Modulation section for more details.

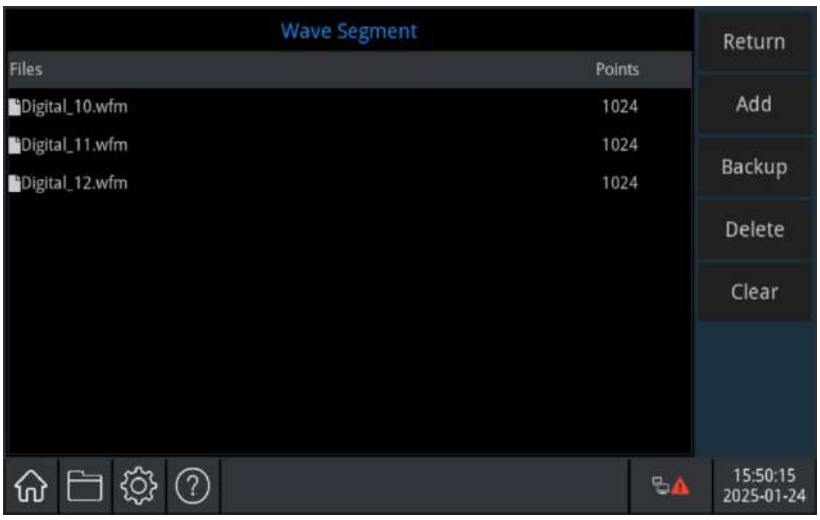
Arbitrary Wave

Press the Mod key to open the modulation type menu, then press the ARB →ARB Select key in sequency to access the ARB modulation setting menu, where waveform segments or waveform sequences can be configured for playback.



Waveform Segment Setting

Press the Mod key to open the modulation type menu, then press the ARB →Wave Segment key in sequency to access the setting menu to access the volatile waveform file directory. Waveform segments must be stored in the volatile storage medium to be played, edited, or included in a sequence.



As shown in the figure above, the volatile waveform file directory interface consists of a waveform segment list and operation buttons at the bottom. The waveform segment list includes the waveform name and the number of points in each waveform segment.

1) Add

Add waveform segment files from non-volatile memory to volatile memory. After a successful addition, the name and number of points of the waveform segment will appear in the waveform segment list. The user can then select and play the waveform segment as follows:

a. Press ARB > Arbitrary Wave Selection to choose the waveform segment to be played.

b. Turn on the ARB Enable switch.

c. Turn on the I/Q MOD module switch on the main page.

d. Configure the RF output.

At this point, the [RF OUTPUT 50Ω] connector of the signal generator will output the carrier modulated by the waveform segment.

2) Backup

Copy and back up the selected waveform segment to the current memory.

3) Delete

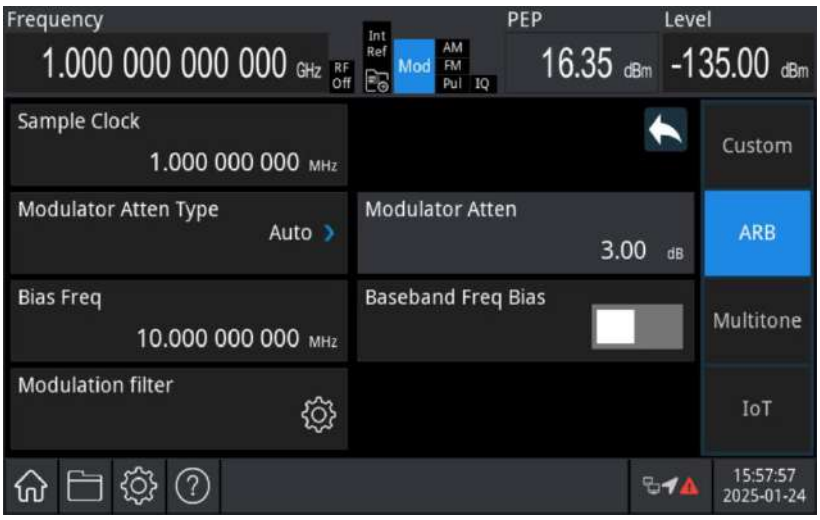
Delete the selected waveform segment from volatile memory. After deletion, the waveform segment can no longer be selected for playback in ARB Select.

4) Clear

Delete all files in the waveform segment list.

ARB Setting

Press the Mod key to open the modulation type menu, then press the ARB →ARB Setup key in sequency to access the ARB setting menu. The waveform generator supports configurable settings for any waveform, allowing it to meet a wide range of application requirements.



1) Sample Clock

Set the sampling rate of the arbitrary waveform.

Maximum limit: 250 MHz.

To change the sample clock:

On the ARB setting interface, use the multi-function knob or press the Sample Clock to adjust it, then use the numeric keypad to enter the desired value.

2) Modulation Attenuation Type

Set the modulation attenuation type for the current modulation.

Options: Auto, Manual

Default: Auto

When set to Manual, the modulation attenuation becomes editable.

3) Modulation Attenuation

Adjust the amplitude of the I and Q data signals before they enter the I/Q modulator. When set to Manual, the waveform generator allows adjustment of the modulation attenuation to obtain the best ACPR performance.

To change the modulation attenuation:

Press the Mode →ARB →ARB Setting →Mod Atten key in sequence. On the modulation attenuation interface, use the multi-function knob or touchscreen to adjust it.

- Auto: Modulation attenuation is fixed at 3 dB.
- Manual: Modulation attenuation can be set from 0 to 20 dB to optimize ACPR performance.

4) Modulation Filter

Set whether the ARB waveform passes through a filter.

Filter types: Raised Cosine, Root Raised Cosine, Gaussian, Half-Sine, None

Default: None

To change the modulation filter:

Press the Mode →ARB →ARB Setting →Mod Filter key in sequence. On the modulation attenuation interface, use the multi-function knob or touchscreen to adjust it.

Note: This filter is applied during waveform playback, not to the waveform data itself.

5) Offset Frequency

Set a frequency offset for the baseband spectrum. Adjustable range: -60 MHz to 60 MHz.

To change the offset frequency:

On the ARB setting interface, use the multi-function knob or press the Offset Freq to adjust it, then use the numeric keypad to enter the desired value.

Typical applications:

- Shift the carrier away from LO feedthrough (spurs at the carrier frequency)
- Combine the baseband signal with an external I/Q input to create a multi-carrier signal
- Output the baseband signal with a frequency offset directly as an IF signal

6) Baseband Frequency Offset

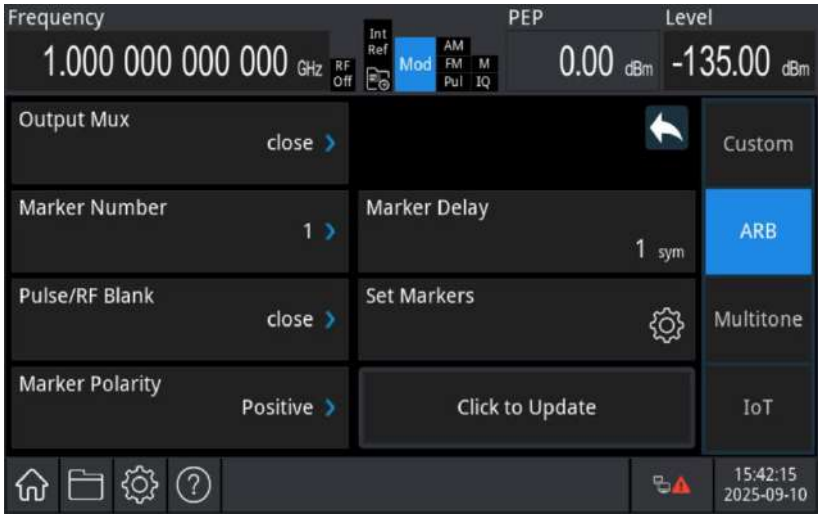
Enable the frequency offset.

Marker Setting

Four waveform markers are available to label specific points within a waveform segment. The polarity and position of each marker (whether on a single sampling point or a range of sampling points) can be configured. When the signal generator detects an active marker, an auxiliary signal is routed to the [EVENT] connector on the rear panel for output.

This auxiliary output signal can be used to synchronize another instrument with the waveform or to serve as a trigger signal for initiating measurements at a specific point on the waveform. Markers can also be configured to trigger RF blanking.

Press the Mode →ARB →Marker Setting key in sequency to access the marker setting menu.



1) Marker Code

Select the waveform marker to be configured. Four markers (1, 2, 3, 4) are available for selection.

To change the marker code:

On the marker code interface, press the Marker Code key, then use the multi-function knob or touchscreen to adjust the desired marker code.

2) Output Marker

Select the marker to be output. Four markers (1, 2, 3, 4) are available for selection. The [EVENT] connector on the rear panel outputs a pulse signal corresponding to the selected marker and its settings.

To change the output marker:

On the output marker interface, press the Output Mux key, then use the multi-function knob or touchscreen to adjust the desired output marker.

Note: The [EVENT] connector can output only one marker signal at a time.

3) Marker Polarity

Options: Positive Phase, inverted phase

Default: Inverted Phase

- Positive phase: The pulse signal outputs a high level (3.3 V) at marker points and a low level (0 V) at non-marker points.
- Inverted phase: The pulse signal outputs a low level (0 V) at marker points and a high level (3.3 V) at non-marker points.

To change the marker polarity:

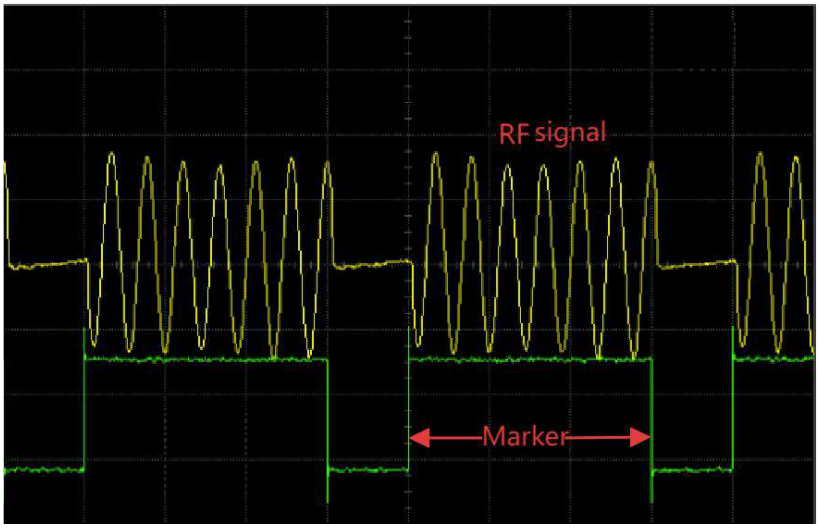
On the output marker interface, press the Marker Polarity key, then use the multi-function knob or touchscreen to adjust the desired marker polarity.

4) Pulse/RF Blanking

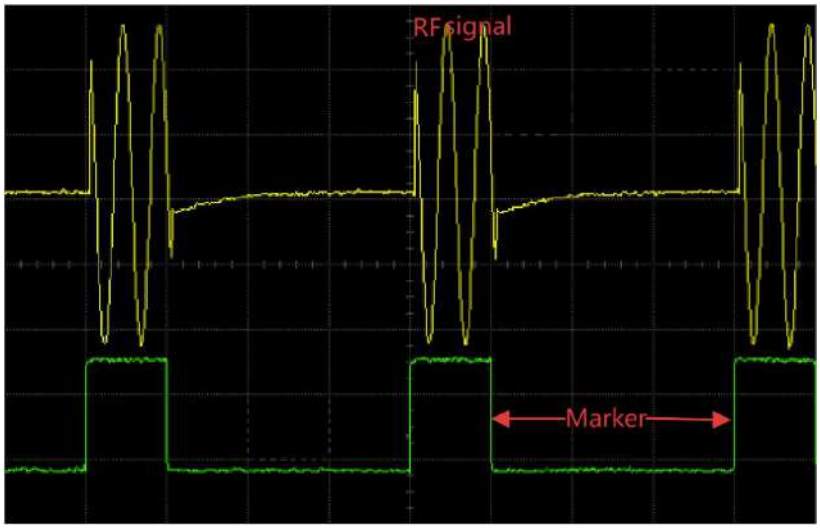
When this option is enabled, the signal generator blanks the RF output whenever the marker signal is at a low level.

The figures below illustrate the effect of RF blanking on the output waveform when the marker polarity is set to Positive Phase and Inverted Phase, respectively.

When the marker polarity is Positive Phase, the RF output is blanked during the non-marker (off) periods, as shown below.



When the marker polarity is set to Inverted Phase, the RF output is blanked during the marker-on points period, as shown in the following figure.



5) Marker Delay

Set the delay time of the pulse signal output from the [EVENT] connector relative to the RF signal.

Delay range: 0 to 1023

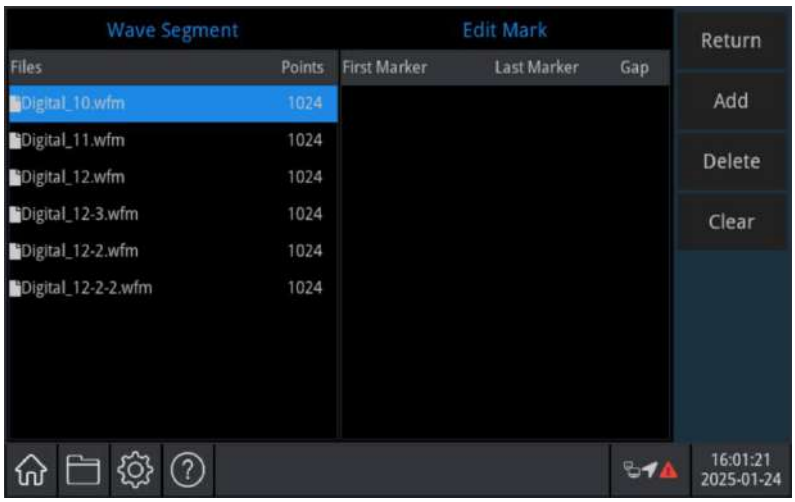
Default value: 1 sym.

To change the marker delay:

On the marker setting interface, use the multi-function knob or press the Marker Delay key to adjust it, then use the numeric keypad to enter the desired value.

6) Marker Point

Press this option to enter the Set Markers interface.



As shown in the figure, the marker point settings page consists of three parts: the waveform segment selection area, the marker point configuration area, and the menu bar.

a. Waveform Segment Selection Area

This area lists all waveform segments in the current volatile memory along with their corresponding number of sampling points.

Select a waveform segment to configure its marker points in the marker point configuration area on the right.

b. Marker Point Configuration Area

Each row of parameters in this area represents the marker point settings for one marker segment:

First Marker Point: Sets the sampling point corresponding to the first marker point of the marker segment.

Last Marker Point: Sets the sampling point corresponding to the last marker point of the marker segment. The value of the last marker point must be less than or equal to the total number of points in the waveform and greater than or equal to the value of the first marker point.

Interval: Sets the number of sampling points to skip. This means a marker point will be output only every specified number of sampling points within the marker segment. When defining new marker points, they will not overwrite existing ones but will be appended to them. For example, if Marker Segment 1 is set with marker points 1–30 and Marker Segment 2 with marker points 20–50, the combined marker signal will start at the 1st sampling point and end at the 50th sampling point.

c. Menu Bar

Functions of each option in the menu bar at the bottom of the interface are as follows:

Return: Navigate back to the previous menu.

Add: Insert a new row before the currently selected row. The newly inserted row duplicates

the data of the currently selected row.

Delete: Remove the currently selected row from the marker list.

Clear: Delete all marker settings in the marker list.

Waveform Sequence Setting

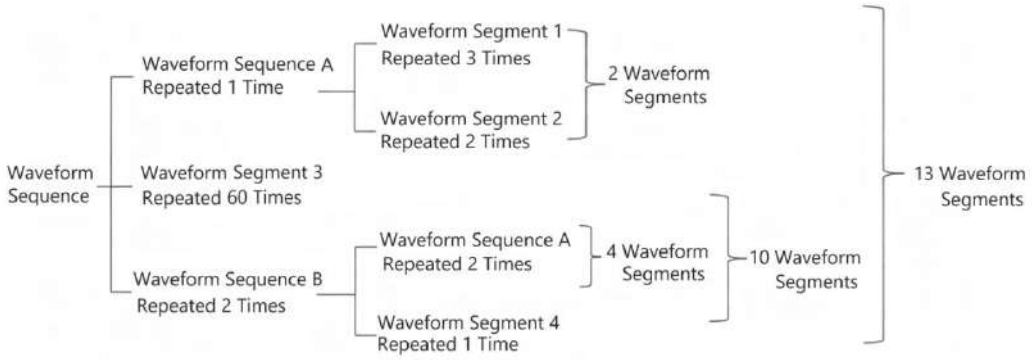
A waveform sequence can include one or more waveform segments, or a combination of waveform segments and other waveform sequences. Since a waveform sequence stores pointers to waveform segments or nested sequences rather than the actual waveform data, it occupies minimal memory space.

When playing a waveform sequence, the signal generator concatenates the referenced waveform segments and loads them into DDR3 memory for playback.

A single waveform sequence can contain up to 1024 waveform segments, and can include both waveform segments and nested sequences simultaneously.

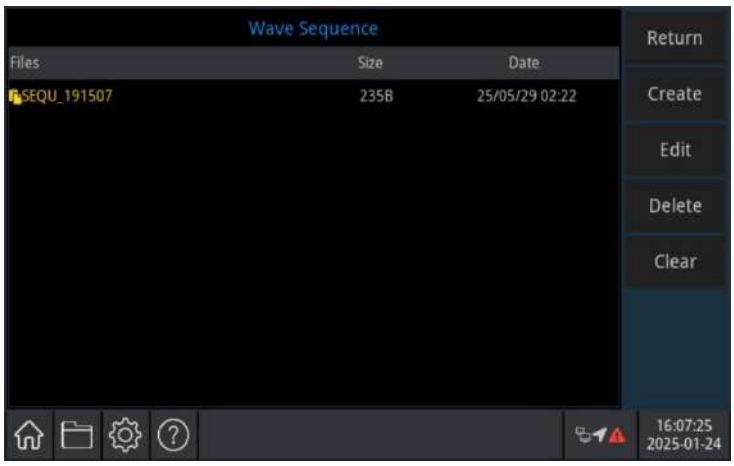
Each waveform segment can be repeated multiple times but is counted as one waveform segment only.

Each repetition of a sequence is counted as an additional waveform segment.



As shown in the following figure:

Press the Mode →ARB →Wave Sequency key in sequency to access the wave sequency file directory.



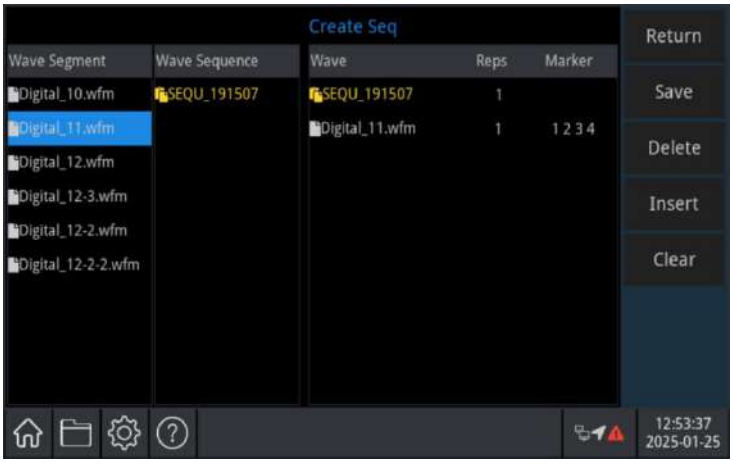
As shown in the figure above, the waveform sequence file directory interface includes a sequence list and operation buttons at the bottom. The sequence list displays the created waveform sequences, including the sequence name and sequence size.

Users can edit existing waveform sequences or create new ones.

Operations are as follows:

a. Create

Click Create to enter the waveform sequence creation window.



All operations can be performed via the waveform generator touchscreen.

- Add a waveform segment or waveform sequence from the left panel.
- Change the repetition count of waveform segments or sequences in the composition list on the right.
- Modify the on/off Marker of the waveform segment or sequence.
- Use the operation buttons on the right to Delete, Insert, Clear, or Save

Note: Only waveform segments stored in volatile memory can be added to a waveform sequence.

b. Edit

Select a waveform sequence in the sequence list and click Edit to modify its waveform, repetition count, or marker settings.

c. Delete

Delete a waveform sequence from the sequence list. Once deleted, the sequence cannot be selected for playback in Waveform Selection.

d. Clear

Clear all waveform sequences in the sequence list.

Multi-Carrier Wave

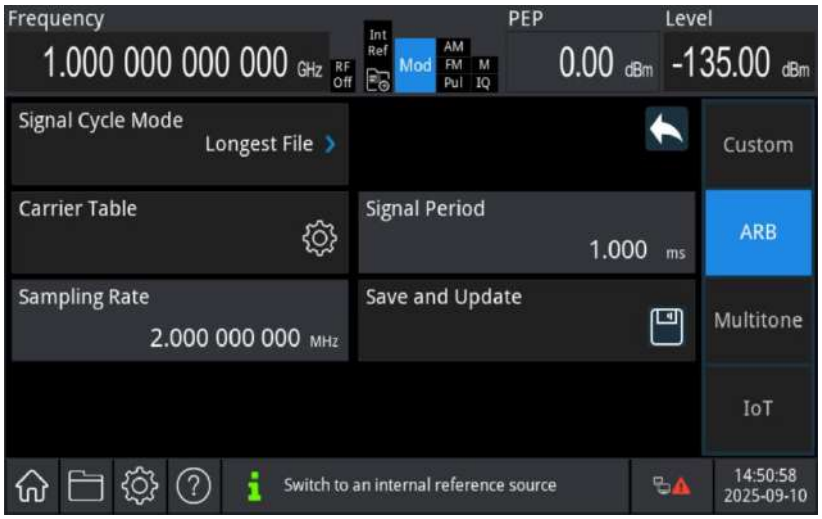
The signal generator provides a multi-carrier waveform function to simulate complex scenarios with

multiple baseband signals. This function supports up to 100 carriers, each modulated by the same or different user-selectable baseband signals, allowing users to create multi-carrier scenarios composed of signals from different digital standards.

Since multi-carrier files are processed by the Arbitrary Waveform Generator (ARB), the combined waveform file must be created before being loaded into and played by the ARB. The generated multi-carrier waveform file can be stored with a user-defined name.

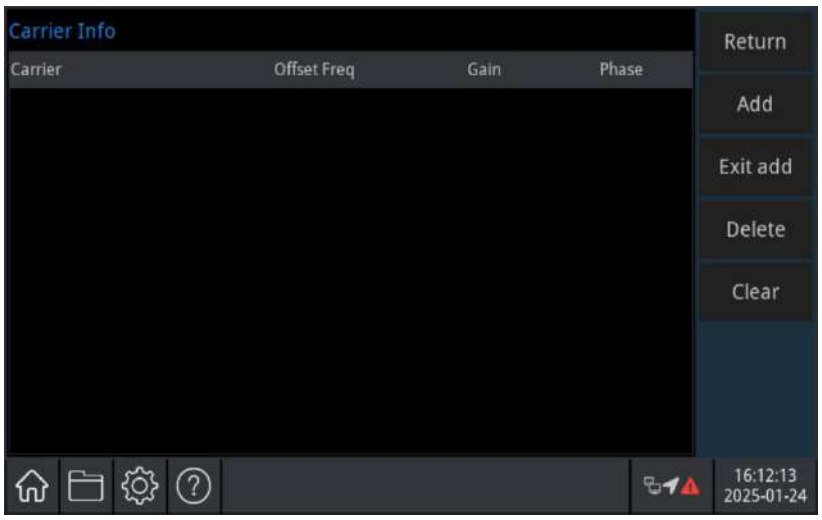
Carrier spacing is adjustable within the total available bandwidth, and the total RF bandwidth of the composed multi-carrier signal must not exceed the instrument's available RF bandwidth (refer to the datasheet). Each carrier can be individually defined with respect to power, phase, and modulated input signal. After completing all processing steps, the instrument calculates the peak and RMS power of the total signal and records these values in the waveform file.

Press the Mode →ARB →Wave Sequency key in sequency to access the multi-carrier wave setting menu.



1) Carrier Wave List

Press the Mode →ARB →Multi-Carrier Setting →Carrier Wave List key in sequency to access the multi-carrier wave setting menu.



Multi-carriers are displayed in a tabular format, with each row representing a carrier.

Each column in the table corresponds to a parameter setting for a single carrier.

a. Carrier: Sets the carrier signal and allows selection of a waveform segment from volatile memory.

b. Offset frequency: Sets the carrier's frequency relative to the center frequency.

c. Gain: Sets the carrier gain.

d. Phase: Sets the carrier phase.

e. Current carrier information: Displays the selected carrier's name, sampling rate, number of samples, and signal period.

The menu bar at the bottom of the interface provides the following functions.

a. Add: Inserts a new carrier before the currently selected row and copies the settings of the selected carrier.

b. Exit Add: Closes the local waveform segment list.

c. Delete: Removes the currently selected carrier from the multi-carrier list.

d. Clear: Removes all carriers and leaves only the default carrier.

e. Return: Returns to the previous menu.

2) Signal Period Mode

Defines how the signal period of a multi-carrier waveform is calculated. All carriers in the multi-carrier table are used in the calculation. To view the sampling rate and number of points for each carrier, access the Carrier List and click Info in the information column.

The available signal period modes:

- Longest File: The signal period is determined by the waveform file with the longest period in the carrier list. Shorter waveform files will repeat periodically.
- Shortest File: The signal period is determined by the waveform file with the shortest period in the carrier list. Longer waveform files will be truncated to match this period

- LCM (Least Common Multiple): The signal period is set based on the least common multiple of all waveform file periods in the carrier list.
- Custom: The signal period can be manually set in the Signal Period menu. Shorter waveform files will repeat periodically, while longer files will be truncated to the specified period.

  To change the signal period mode:

  Press the Mode →ARB →Multi-Carrier Setting →Signal Period Mode key in sequency. On the signal period mode interface, press the Marker Polarity key, then use the multi-function knob or touchscreen to adjust the desired signal period.

3) Signal Period

   Displays the current signal period of the multi-carrier waveform. This is configurable only when the Signal Period Mode is set to Custom.

4) Sample Rate

   Displays the current sample rate of the multi-carrier waveform, determined by the waveform settings in the carrier list.

5) Create and Load

   Click Create and Load to generate a multi-carrier waveform based on the current settings. The waveform is loaded into volatile memory and automatically selected in the Arbitrary Wave function.

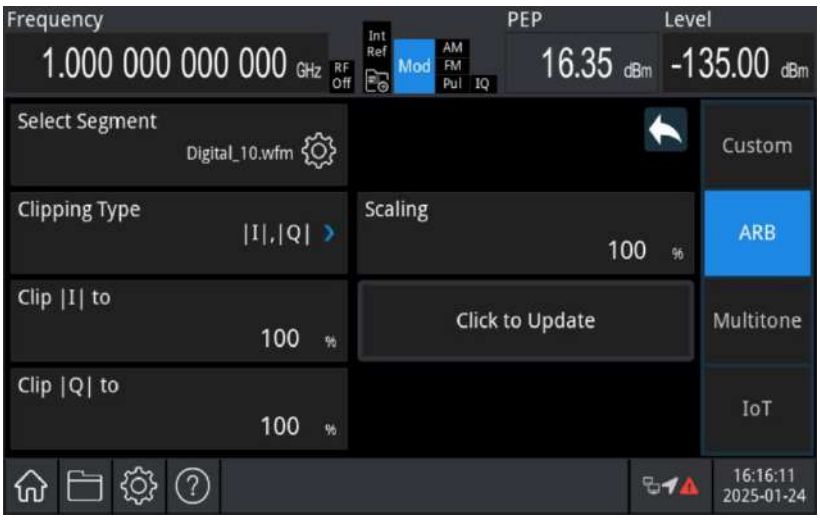
6) Multi-Carrier Creation Process

   To create a multi-carrier waveform file, follow these steps:

   a. Access the Carrier List, add the required carriers, and configure their corresponding parameters such as offset frequency, gain, and phase. The Auxiliary Settings function allows adding multiple carriers to the carrier list at once.
   b. Set the Power Reference and Signal Period Mode for the multi-carrier signal.
   c. Click Create and Load to generate the multi-carrier waveform. The newly created waveform will be added to volatile memory and automatically selected for playback.

Waveform Settings

Press the Mod key to open the modulation type selection interface. Then press ARB → Waveform Settings to open the waveform settings interface, where scaling and clipping for waveform segments can be configured.



1) Waveform Segment Selection

In the waveform settings interface, press the Select Segment key. On the waveform segment selection interface, select the desired waveform segment using the multi-function knob or the touchscreen.

2) Scaling

Set the amplitude scaling percentage of the waveform segment.

The signal generator reconstructs the waveform using an interpolation algorithm between I/Q data points. For certain waveforms, this interpolation may cause overshoot, leading to DAC out-of-range errors. These errors can be eliminated by reducing the amplitude of the I/Q data. Amplitude scaling lowers the amplitude of the baseband waveform while preserving its overall shape and characteristics. However, excessive scaling may degrade waveform integrity. To maintain maximum precision and optimize dynamic range, the amplitude scaling should not exceed the level required to eliminate DAC out-of-range errors.

To change the scaling:

On the waveform settings interface, use the multi-function knob or press the Scaling key, then touchscreen to adjust it, then use the numeric keypad to enter the desired value.

3) Clipping

Waveform clipping reduces the Peak-to-Average Power Ratio (PAPR) and minimizes spectral regrowth. It limits the waveform's power peaks by clipping the I and Q data to a specified percentage of the maximum peak value.

a. Clipping Type

The signal generator provides two clipping methods: circular clipping and rectangular clipping to prevent power amplifier saturation distortion.

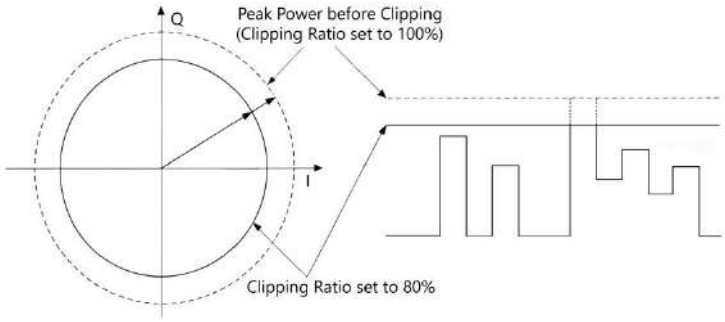
To change the clipping type:

Press the Mode →ARB →Multi-Carrier Setting →Clipping key in sequency. On the clipping

interface, use the multi-function knob or touchscreen to adjust the desired clipping type.

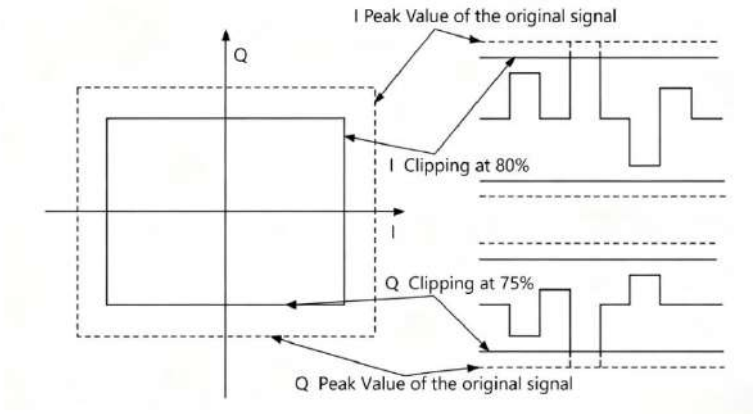
- |I+jQ| (Circular Clipping)

  This method applies clipping to the combined I/Q data, where both the I and Q components are clipped equally. The clipping level remains constant across all vector phases, forming a circular boundary in the vector representation.



- |I|,|Q| (Rectangular Clipping)

  This method applies clipping independently to the I and Q components. As a result, the clipping levels for I and Q may differ, forming a rectangular boundary in the vector representation.



b. Clipping Value

Clipping to |I+jQ|: Sets the percentage at which the magnitude of the I/Q signal (i.e, $\sqrt{I^2+Q^2}$) is clipped relative to its peak value.

Clipping to |I|: Sets the percentage at which the I-channel component of the I/Q signal is clipped relative to the peak value of the I-channel.

Clipping to |Q|: Sets the percentage at which the Q-channel component of the I/Q signal is clipped relative to the peak value of the Q-channel.

4) Click to Update

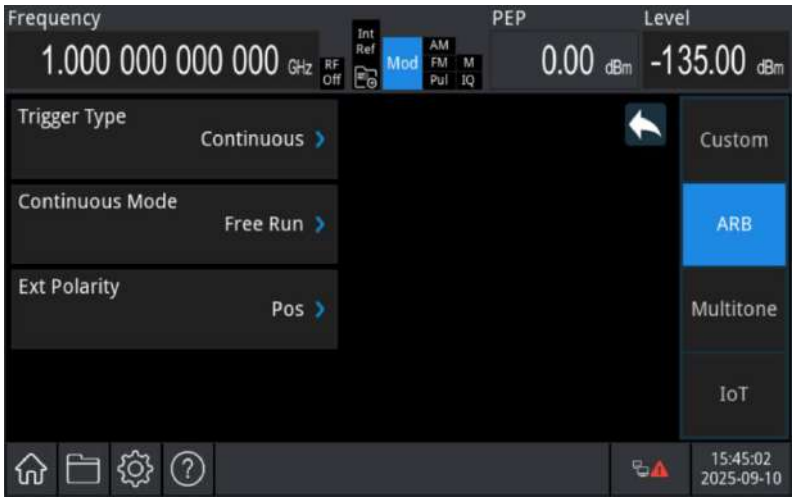
Click Click to Update to apply the current waveform scaling or clipping settings.

Note: Once Click to Update is pressed, waveform scaling or clipping becomes irreversible. Any data lost due to amplitude scaling or clipping cannot be recovered. It is recommended to save

a copy of the waveform file before applying these settings.

Trigger Settings

Press the Mod key to open the modulation type selection interface. Then press ARB → Trigger Settings key in sequence to access the trigger settings interface. This menu controls when the signal generator transmits the modulated signal.



1) Trigger Type

The trigger type can be set to continuous, single, segment advance, or gate, with continuous as the default. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Continuous Mode: The signal generator continuously repeats the modulated signal until the user stops the output, changes the trigger type, or selects another waveform for playback.
- Single Mode: The waveform plays once upon receiving a trigger signal.
- Segment Advance Mode: Plays only one waveform segment in the sequence per trigger. The trigger source controls transitions between waveform segments and ignores segment repetitions. A trigger received during the loop of the last waveform segment advances playback to the first segment in the sequence.
- Gate Mode: Accepts only an external trigger source. The users can choose between high-level gating or low-level gating. The waveform plays when the gate signal is active and stops when it becomes inactive.

2) Continuous Trigger Mode

The continuous trigger mode can be set to free running, trigger & play, or reset & play, with free running as the default. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Free Running: Triggers and plays the waveform immediately. The waveform runs continuously and ignores all subsequent triggers.

- Trigger & Play: Starts continuous waveform playback upon receiving a trigger and ignores further triggers.
- Reset & Play: Starts continuous waveform playback upon receiving a trigger. If another trigger is received, the waveform restarts from the beginning.

3) Single Trigger Mode

The single trigger mode can be set to ignore retrigger, trigger buffering, or trigger restart, with ignore retrigger as the default. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Ignore Retrigger: Plays the waveform once and ignores any triggers received during playback.
- Trigger Buffering: If a trigger signal is received while the waveform is playing, it queues the trigger, playback restarts once the current waveform completes.
- Trigger Restart: If a trigger signal is received during playback, the waveform restarts immediately and plays once again.

4) Segment Advance Trigger Mode

The segment advance trigger mode can be set to single or continuous, with single as the default. To modify it, use the multi-function knob on the trigger setting interface or select directly via the touchscreen

- Single: Upon receiving a trigger, the first waveform segment in the sequence plays once (ignoring repetition settings), then stops and waits for the next trigger. Each subsequent trigger plays the next segment sequentially until all segments are completed, then the playback loops back to the first segment.

  If a trigger is received while a waveform segment is playing, the current segment finishes before advancing to the next.
- Continuous: Continuously plays the first waveform segment in the sequence until another trigger is received, then begins continuous playback of the next segment. The process repeats through all segments and loops back to the beginning.

  If a trigger is received during playback, the current segment completes before advancing to the next, which then plays continuously.

5) Gate Trigger Mode

The gate trigger mode can be set to active low or active high, with active low as the default. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

The waveform plays while the trigger source is active and stops when it is inactive.

6) Trigger Source

The trigger source can be set to key, bus, or external. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Key: A trigger signal is generated each time the front-panel trigger key or on-screen Trigger button is pressed.
- Bus: A trigger signal is generated each time a command is sent.
- External: The signal generator receives an external trigger signal via the [PATTERN_TRIG] connector on the rear panel.

Note: The trigger source setting is unavailable for continuous Free Running or Gate Trigger modes.

7) External Trigger Polarity

When the trigger source is set to external, the polarity can be configured as positive phase or inverted phase. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Positive Phase: The waveform responds to the rising edge of the trigger signal.
- Inverted Phase: The waveform responds to the falling edge of the trigger signal.

8) Trigger Delay Mode

When the trigger source is set to external, a trigger delay can be configured to define the time between receiving the external trigger signal and the trigger taking effect. The delay type can be set to off, time, or samples. To modify it, use the multi-function knob on the trigger settings interface or select directly via the touchscreen.

- Off: Disables trigger delay.
- Time: Sets trigger delay based on a specific delay time, adjustable via the delay time button.
- Samples: Sets trigger delay based on the number of delay samples, adjustable via the delay samples button.

延迟时间 = 延迟采样点数 ÷ 采样率

Delay time = The number of delay samples ÷ Sample rate

Note: When selecting a trigger mode for the first time or switching between trigger modes, the RF output carrier may disappear until the modulated signal is triggered. This occurs because the signal generator sets the I and Q signals to 0 V before the first trigger event.

9) Delay Time

Used when delay type is set to time, to configure the trigger delay duration.

10) Number of samples

Used when delay type is set to samples, to configure the trigger delay in terms of sample count.

11) External Trigger Holdoff

When the trigger source is external, the holdoff time for the external trigger can be configured

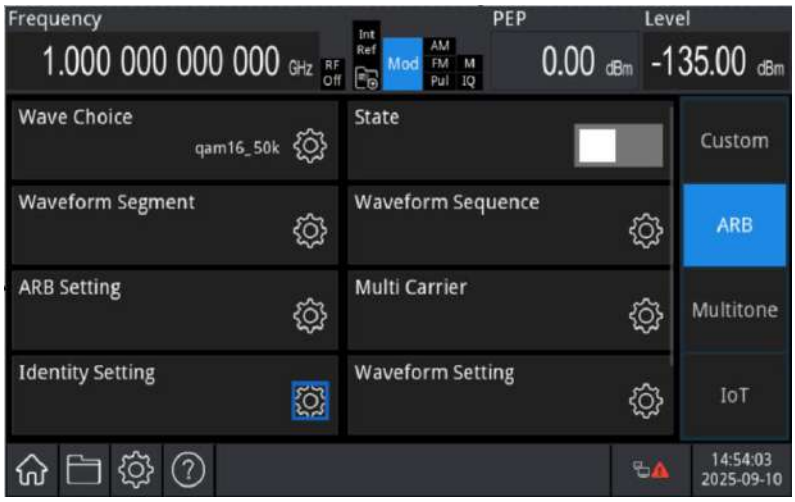
to prevent immediate retriggering.

Comprehensive Example

First, set the instrument to I/Q Modulation mode and configure the internal modulation source. Then select ARB Modulation and choose an ARB waveform. Set the carrier signal frequency to 2 GHz and the amplitude to -20 dBm. The procedure is as follows.

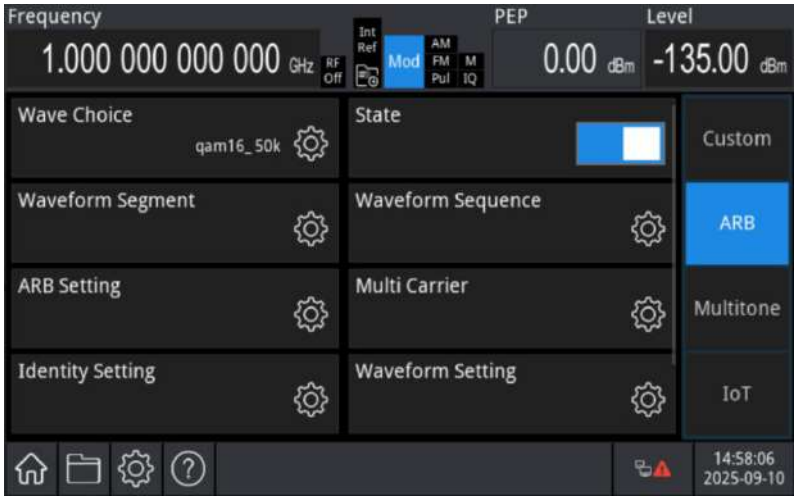
1) Set ARB Wave

Press the I/Q→ Home key in the analog stream mapper on the screen, check the I/Q modulation ON, and press the Baseband→ARB key to open the ARB modulation setting menu. Press the Wave Choice key to access the arbitrary wave menu and select the waveform "16QAM_50k.wfm" for playback.



2) Enable ARB Modulation

Press the Home key in the analog stream mapper on the screen, check the I/Q modulation ON, and press the Baseband→ARB→State key to activate ARB modulation.

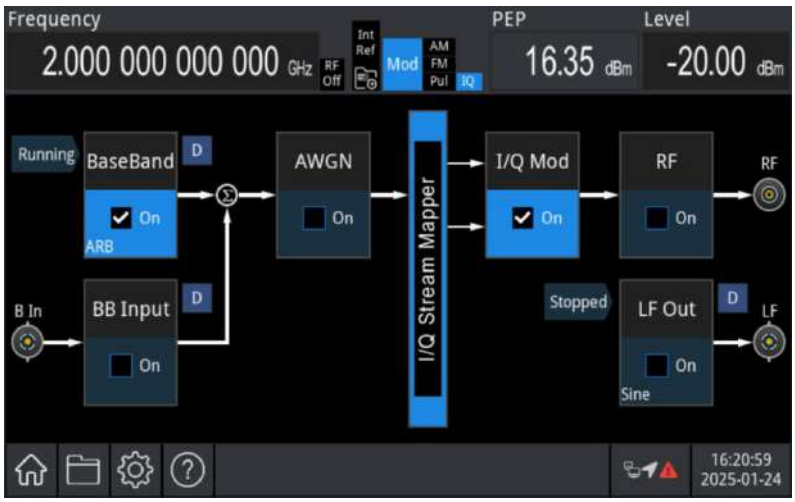


3) Set Carrier Signal

Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the

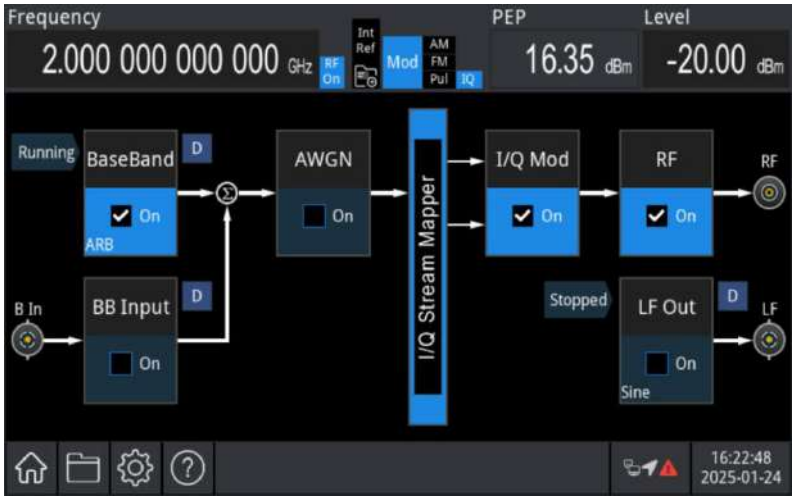
unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -20 and select the unit dBm for this parameter, as shown in the following figure.

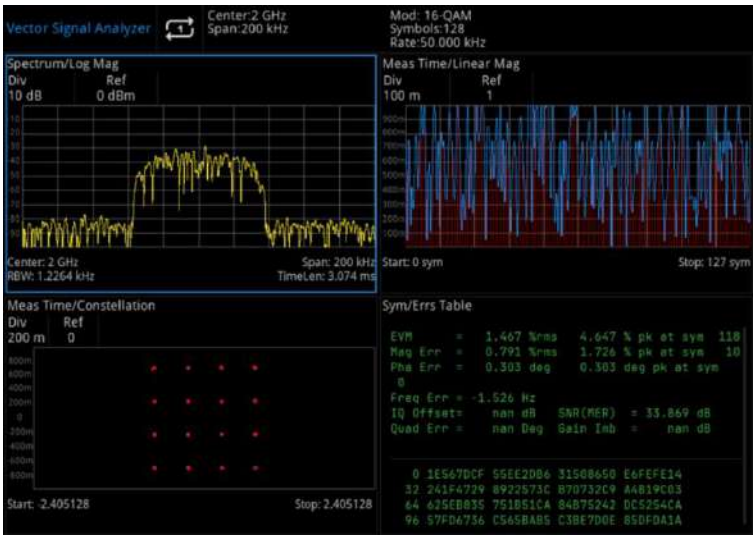


4) Enable Channel Output

Press the RF On/off key, if the key is illuminated, the channel output is enabled.



View the AARB modulation waveform on a spectrum analyzer, as shown in the following figure.

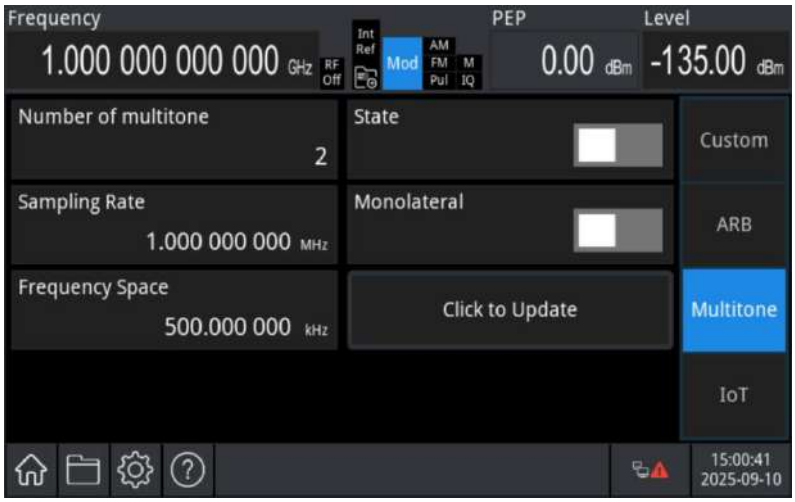


4.2.4 I/Q Multi-Tone Modulation

The multi-tone mode supports up to 20 tones, with a maximum sampling rate of 120 MHz and a maximum spectral spacing of 93.75 MHz. It offers two spectrum modes: Single-Sideband (SSB) and Double-Sideband (DSB).

Multi-Tone Modulation

Press the I/Q → Home key, check I/Q modulation ON in the analog stream mapper on the screen, then press the Baseband →Multitone →State key to turn on the multi-tone modulation. The instrument will output the modulated waveform according to the current setting.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in I/Q Custom Modulation section for more details.

Number of Multi-Tones

Set the number of multi-tones, with a maximum of 20.

To change the modulation type:

Press the Mod key to open the modulation type setting menu. Press the Multitone key to access the multi-tone interface. Use the multi-function knob or press Number of multitone key to adjust it, then use the numeric keypad to enter the desired value.

Sample Rate

Set the sampling rate for generating the multi-tone waveform, up to a maximum of 240 MHz.

To change the sample rate:

Press the Mode→Multitone key in sequency. On the multi-tone setting interface, use the multi-function knob or press Sample Rate key to adjust it, then use the numeric keypad to enter the desired value.

Frequency Space

Set the frequency space of the multi-tone spectrum, defined as the interval between the leftmost

and rightmost tones.

To change the frequency space:

Press the Mode→Multitone key in sequency. On the multi-tone setting interface, use the multi-function knob or press Frequency Space key to adjust it, then use the numeric keypad to enter the desired value.

Single-Sideband (SSB)

Enable or disable single-sideband (SSB) mode. When SSB is enabled, the spectrum on the left side of the multi-tones (relative to the center frequency) is suppressed.

To modify it, select the option using the multi-function knob or directly via the touch screen on the Multi-tone settings interface.

Comprehensive Example

First, set the instrument to I/Q Modulation mode and configure the internal modulation source.

Select Multi-tone Modulation, then configure the multi-tone parameters as follows:

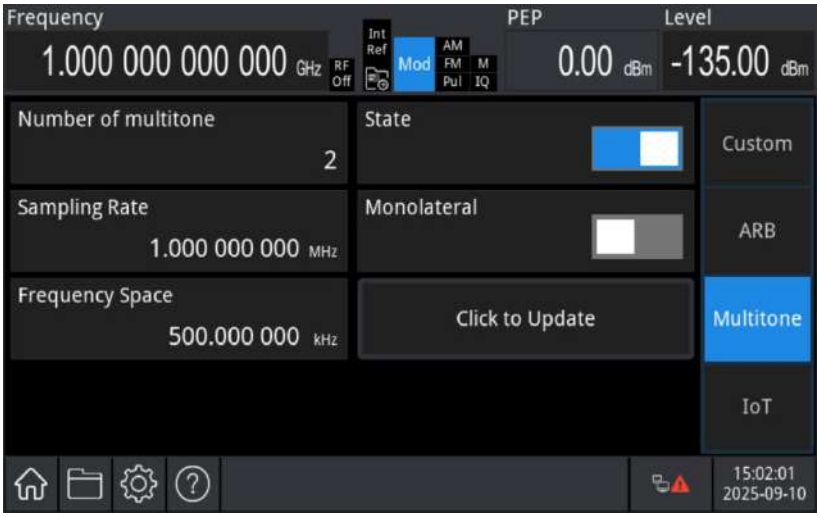
- Number of Multi-Tones: 2
- Sampling Rate: 10 MHz
- Frequency Spacing: 1 MHz
- Single-Sideband (SSB) mode: Enabled

Next, set the carrier signal frequency to 2 GHz and the amplitude to -10 dBm.

The procedure is as follows.

1) Enable Multi-tone Modulation

   Press the I/Q→ Home key in the analog stream mapper on the screen, check the I/Q modulation ON, and press the Baseband→Multi-tone→State key to activate Multi-tone modulation.



2) Set Multi-tone Parameters

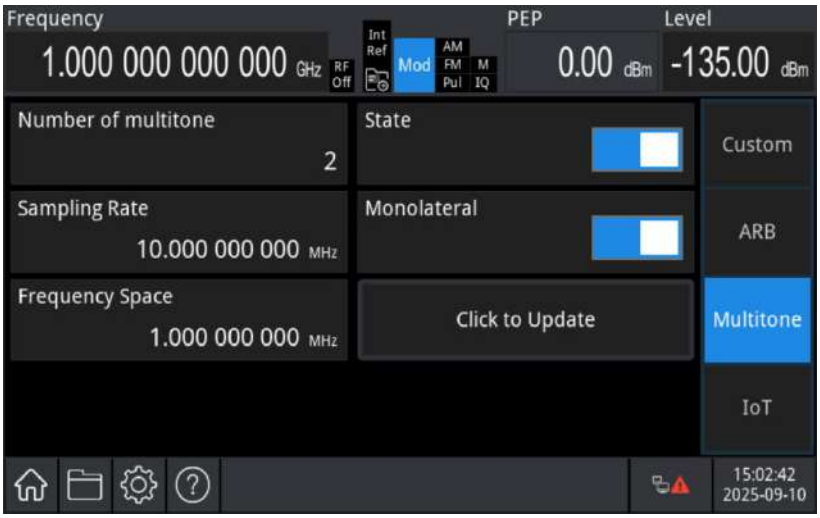
Press the Home key in the analog stream mapper on the screen, and press the Baseband→Multi-tone to open the multi-tone setting menu.

Press Number of multitone to enter 2.

Press Sample Rate to enter 10 and select the unit MHz for this parameter.

Press Frequency Space to enter 1 and select the unit MHz for this parameter.

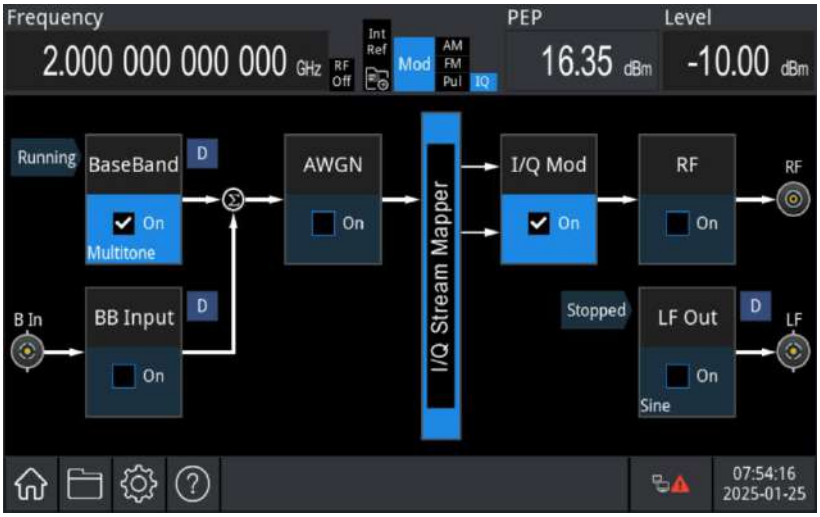
Open the SSB, and click Click to Update.



3) Set Carrier Signal

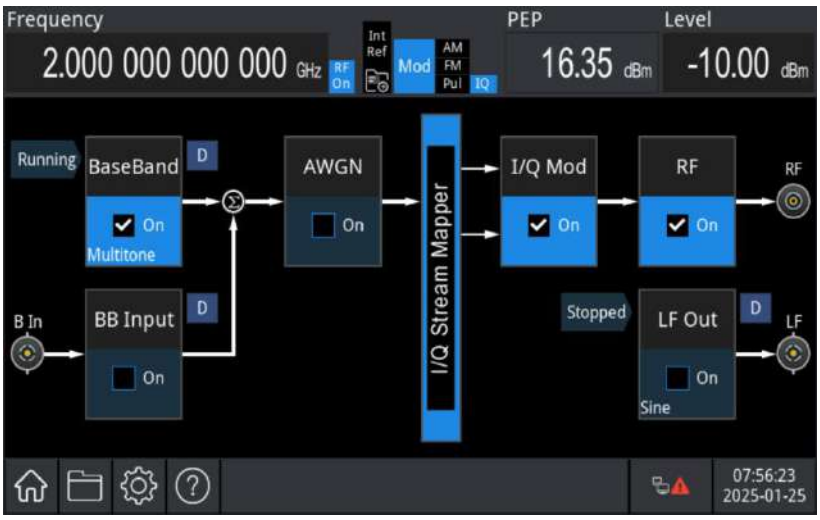
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -10 and select the unit dBm for this parameter, as shown in the following figure.



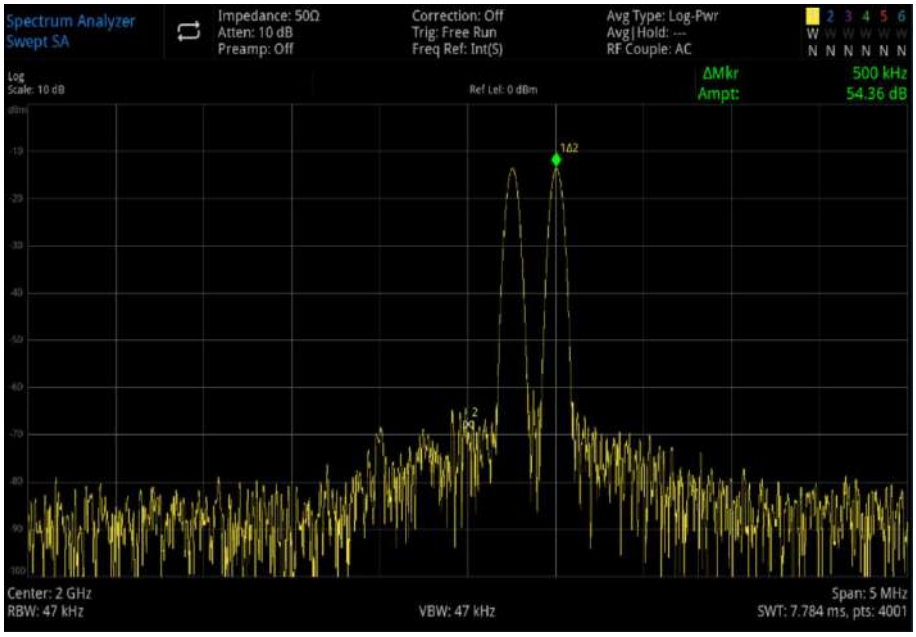
4) Enable Channel Output

Press the RF On/off key, if the key is illuminated, the channel output is enabled.



View the multi-tone modulated waveform using a spectrum analyzer, as shown in the figure below. The waveform is a two-tone continuous wave (CW) signal with a carrier frequency of 2 GHz and a frequency spacing of 1 MHz.

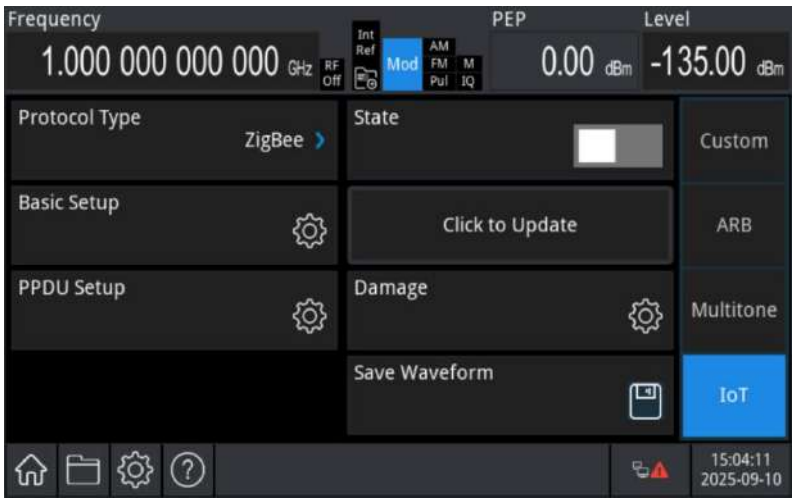
Input this signal into the active device and measure its output. The OIP3 (Output Third-Order Intercept Point) characteristic can then be obtained, as illustrated in the following figure.



4.2.5 I/Q IoT Modulation

IoT Modulation

Press the I/Q → Home key, check I/Q modulation ON in the analog stream mapper on the screen, then press the Baseband →IoT →State key to turn on the IoT modulation. The instrument will output the modulated waveform according to the current setting.



Carrier Wave Frequency

Refer to the *Carrier Wave Frequency* in I/Q Custom Modulation section for more details.

Protocol Type

In IoT mode, two protocol types are supported: ZigBee and Z-Wave.

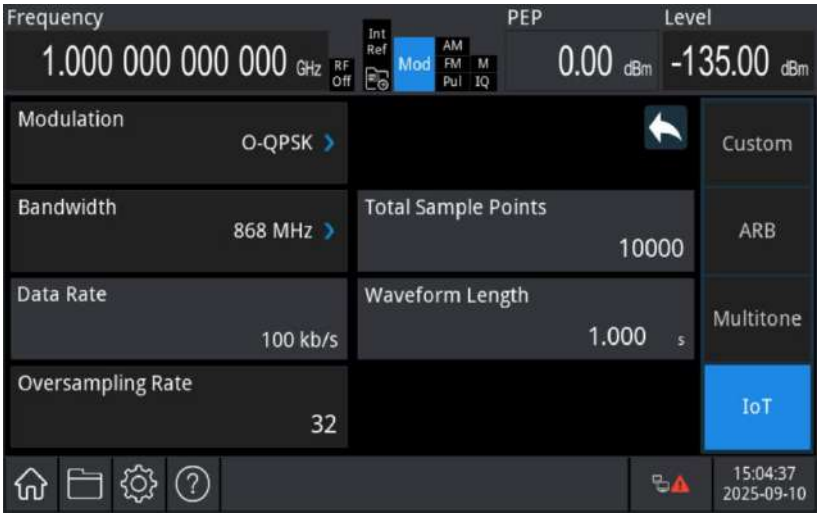
To change the protocol type:

Press the Mode →IoT →Protocol Type key in sequence. On the protocol type setting interface, use the multi-function knob or the touchscreen to adjust it.

- ZigBee: A low-power IoT communication standard based on the IEEE 802.15.4 specification.
- Z-Wave: A wireless communication protocol defined by the ITU-T G.9959 recommendation.

Basic Settings

Press the Mod key to open the modulation type menu, then press the IoT →Protocol Type key in sequence to access the basic settings menu, where oversampling rate and number of frames of protocol type can be configured.



1) Oversampling Rate

   Sets the oversampling rate of the waveform.

Range: 2 to 64

Default: 8

To change the oversampling rate:

On the basic settings interface, use the multi-function knob or press the Oversampling Rate to adjust it, then use the numeric keypad to enter the desired value.

Once the oversampling rate is configured, the waveform sampling rate is determined as follows:

$$采样率 = Chip rate * 过采样率$$

Sample rate = Chip rate ÷ Oversampling Rate

where, Chip rate depends on the selected frequency band.

2) Total Number of Sampling Points

Displays the total number of sampling points in the waveform.

This parameter is read-only and is determined by the protocol type, PPDU length, idle interval, and oversampling rate.

3) Waveform Length

Displays the waveform duration (unit: seconds [s]).

This parameter is read-only and can be calculated using the total number of sampling points and sampling rate:

$$波形长度 = 总采样点数 \div 采样率$$

Waveform length = Total number of sampling points ÷ Sample rate

4) Modulation Scheme

Specifies the physical layer modulation scheme.

- For ZigBee: O-QPSK | BPSK (Default: O-QPSK)
- For Z-Wave: FSK | GFSK (Default: GFSK)

To chang the modulation scheme:

On the basic settings interface, use the multi-function knob or the touchscreen to adjust it.

5) Frequency Band

Selects the frequency band for the ZigBee physical layer.

Options: 868 MHz, 915 MHz, 2450 MHz (Default: 915 MHz)

To chang the modulation scheme:

On the basic settings interface, use the multi-function knob or the touchscreen to adjust it.

The Chip rate is determined by the selected frequency band. For ZigBee protocol data rates, refer to the figure showing the relationship between modulation scheme and frequency band.

PHY (MHz)	Frequency band (MHz)	Spreading parameters		Data parameters		
		Chip rate (kchip/s)	Modulation	Bit rate (kb/s)	Symbol rate (ksymbol/s)	Symbols
868/915	868–868.6	300	BPSK	20	20	Binary
	902–928	600	BPSK	40	40	Binary
868/915 (optional)	868–868.6	400	ASK	250	12.5	20-bit PSSS
	902–928	1600	ASK	250	50	5-bit PSSS
868/915 (optional)	868–868.6	400	O-QPSK	100	25	16-ary Orthogonal
	902–928	1000	O-QPSK	250	62.5	16-ary Orthogonal
2450	2400–2483.5	2000	O-QPSK	250	62.5	16-ary Orthogonal

Notes:

(1) If the physical layer scheme is set to BPSK, the 780 MHz and 2450 MHz frequency bands cannot be selected.

(2) The selected frequency band does not change the signal source's center frequency.

6) Data Rate

Sets the data rate for the Z-Wave protocol physical layer scheme.

Options: R1–9.6 kbps, R2–40 kbps, R3–100 kbps

Default: R3–100 kbps

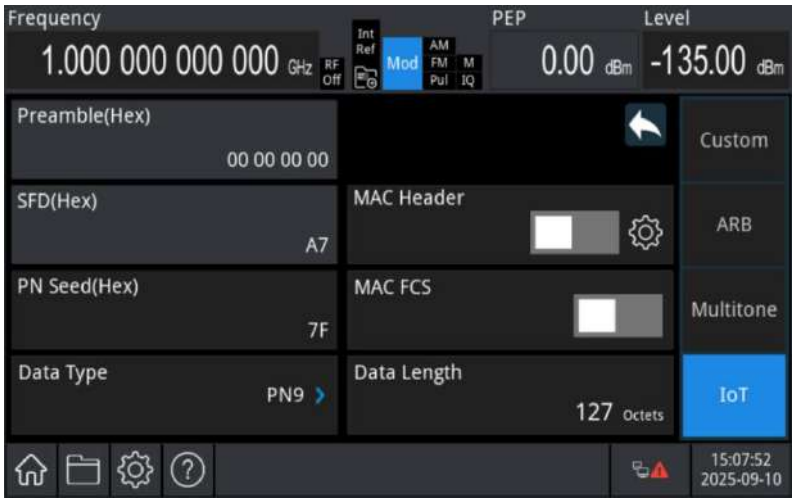
To chang the modulation scheme:

On the basic settings interface, use the multi-function knob or the touchscreen to adjust it.

For the ZigBee protocol, the data rate is non-configurable. Once the modulation scheme and frequency band are set, the data rate is automatically determined.

PPDU Settings

Press the Mod key to open the modulation type selection interface. Then press IoT → PPDU Settings key in sequence to access the PPDU settings interface, where various parameters of the Physical Layer Protocol Data Unit (PPDU) can be configured.



1) Preamble Length

Sets the length of the preamble in the SHR (Synchronization Header) in bytes.

Range: 10 to 100

Default: 10

For more information about the preamble, refer to Preamble field in section 7.1.3.2 of *ITU-T G.9959-2015*.

2) Preamble (Hex)

Displays the preamble field of the PPDU (Physical Layer Protocol Data Unit) in hexadecimal format.

Note: This parameter is display-only and cannot be modified.

3) SFD (Hex) (Start of Frame Delimiter)

Sets the SOF (Start of Frame) field in the SHR (Synchronization Header). The SOF is an 8-bit field that marks the end of the preamble and the start of the PSDU (Physical Layer Service Data Unit).

Configurable range: 00 to FF (hexadecimal)

Default: F0

To chang the SFD:

On the PPDU interface, use the multi-function knob or press the SFD key to adjust it, then use the numeric keypad to enter the desired value.

For more details, refer to Start of frame (SOF) field in section 7.1.3.3 of *ITU-T G.9959-2015*.

4) MAC Header

Use the drop-down menu to enable or disable the MAC Header field.

To modify it, on the PPDU interface, use the multi-function knob or select directly via the touchscreen.

For more details, refer to MPDU format in section 8.1.3 of *ITU-T G.9959-2015*.

5) Frame Start (Hex)

Sets the SOF (Start of Frame) field in the SHR (Synchronization Header). The SOF is an 8-bit field that indicates the end of the preamble and the start of the PSDU.

Range: 00 to FFFF (hexadecimal)

Default: F0

For more details, refer to Start of frame (SOF) field in section 7.1.3.3 of *ITU-T G.9959-2015*.

6) PN Seed (Hex)

Sets the seed value for generating the Pseudo-Random Binary Sequence (PRBS).

To chang the PN seed:

On the PPDU interface, use the multi-function knob or press the PN Seed key to adjust it, then use the numeric keypad to enter the desired value.

- When Data Type = PN9: Range 0x0 ~ 0x1FF; Default 0x1FF.
- When Data Type = PN15: Range 0x0 ~ 0x7FFF; Default 0x7FFF.

Note: This parameter is editable only when the data type is set to PN9 or PN15.

7) MAC FCS

Enables or disables the MAC FCS (Frame Check Sequence).

To modify it, on the **PPDU interface**, use the multi-function knob or select directly via the touchscreen.

8) End of Frame Delimiter

Enables or disables the EOF (End of Frame) delimiter in the PPDU.

The EOF field is transmitted only when data is transferred at Data Rate R1.

For more details, refer to End of frame (EOF) field in section 7.1.3.5 of *ITU-T G.9959-2015*.

9) Data Type

Options: PN9, PN15, USER

Default: PN9

PN9: Fills the packet payload with a 9th-order Pseudo-Random Binary Sequence (PRBS-9).

PN15: Fills the packet payload with a 15th-order Pseudo-Random Binary Sequence (PRBS-15).

USER: Fills the packet payload with a user-defined binary sequence.

10) Data Length

Sets the length of the packet payload in bytes.

Range: 0 to 64 (for R1 or R2); 0 to 170 (for R3)

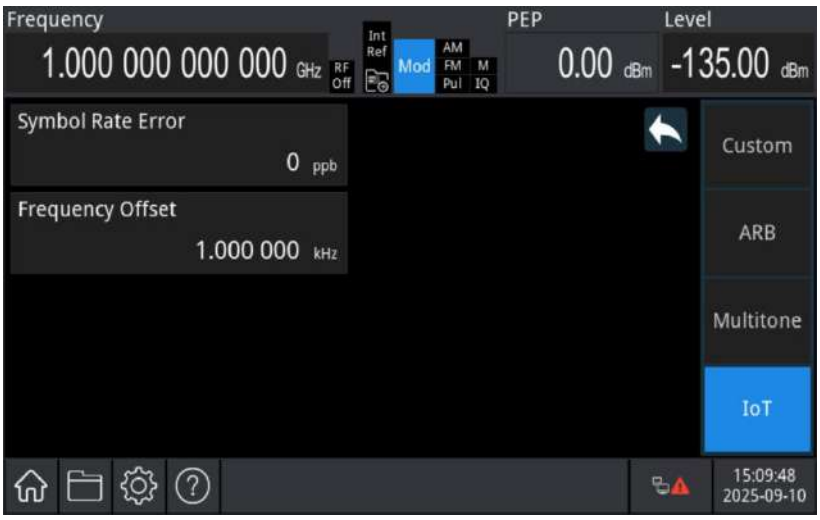
Default: 32

To chang the data length:

On the **PPDU interface**, use the multi-function knob or press the Data Length key to adjust it, then use the numeric keypad to enter the desired value.

Impairment Settings

Press the Mod key to open the modulation type selection interface. Then press IoT → Impairment Settings key in sequence to access the impairment settings window.



1) Symbol Rate Offset

Sets the offset of the transmitted standard symbol rate. This parameter alters the symbol rate of the Bluetooth signal and is used to simulate Bluetooth devices transmitting with a slight sampling clock deviation.

2) Carrier Frequency Offset

Sets the static offset of the carrier frequency.

Range: -200 kHz to 200 kHz

Default value: 0 kHz

To chang the carrier frequency offset:

On the impairment interface, use the multi-function knob or press the Carrier Frequency Offset key to adjust it, then use the numeric keypad to enter the desired value.

Note: This parameter is used to simulate Bluetooth devices transmitting at a frequency slightly offset from the specified carrier frequency.

Comprehensive Example

First, set the instrument to operate in I/Q Modulation mode, configure the internal modulation source, and select IoT Modulation. Then configure the IoT parameters as follows:

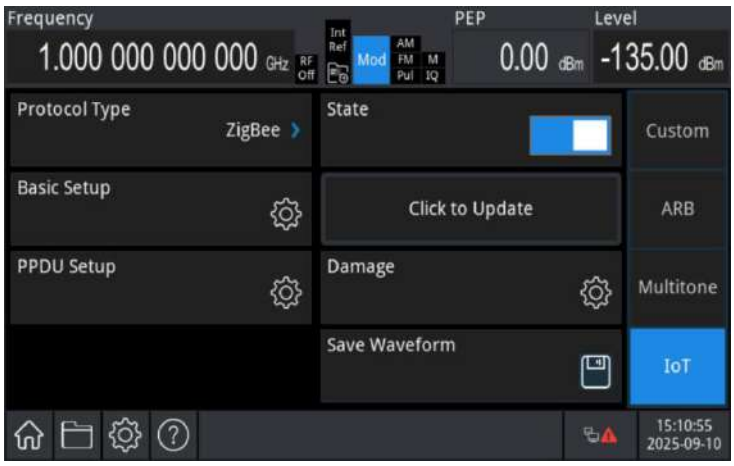
- Protocol Type: Z-Wave
- Modulation Scheme: FSK
- Oversampling Rate: 8
- Data Rate: R2 – 40 kbps

Finally, set the carrier signal frequency to 2 GHz and the amplitude to -20 dBm.

The procedure is as follows.

1) Enable IoT Modulation

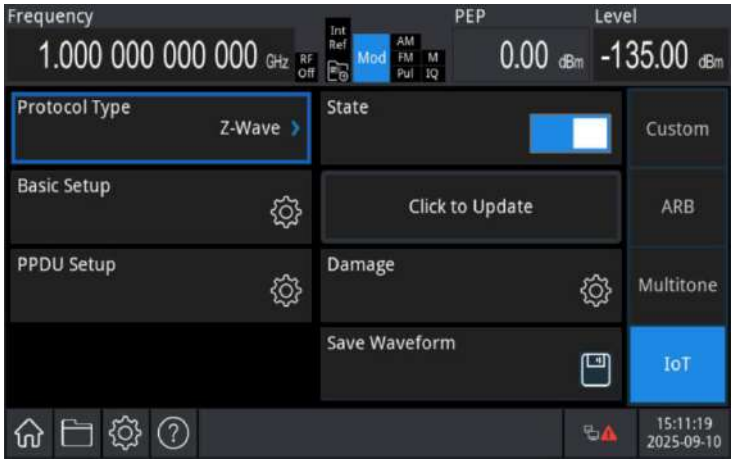
Press the I/Q→ Home key in the analog stream mapper on the screen, check the I/Q modulation ON, and press the Baseband→ IoT→State key to activate the IoT modulation.



2) Set Z-Wave Protocol

Press the Home key in the analog stream mapper on the screen, then press the Baseband→IoT to access the IoT modulation setting interface.

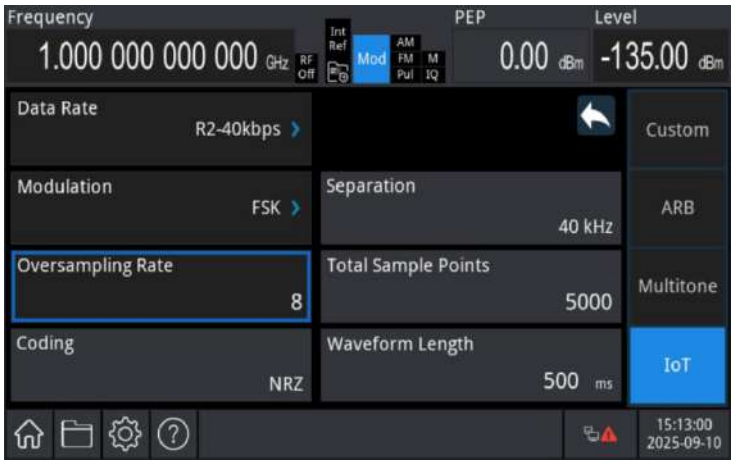
Press the Protocol Type to select the Z-Wave.



3) General Setting

Press the Home key in the analog stream mapper on the screen, then press the Baseband→IoT→Basic Setup key to access the basic setting interface.

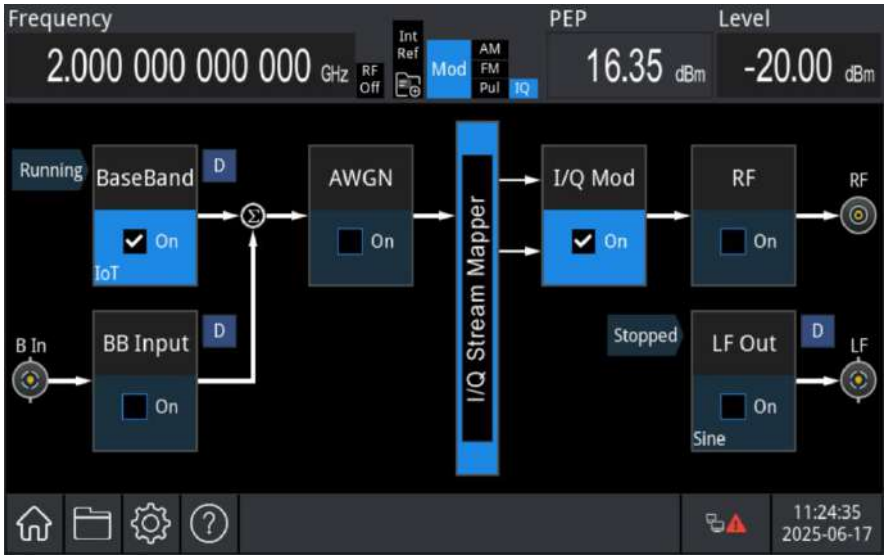
Press the Modulation Type key to select FSK, press the Data Rate key to select R2-40 kbps, and press the Oversampling Rate key to select 8.



4) Set Carrier Signal

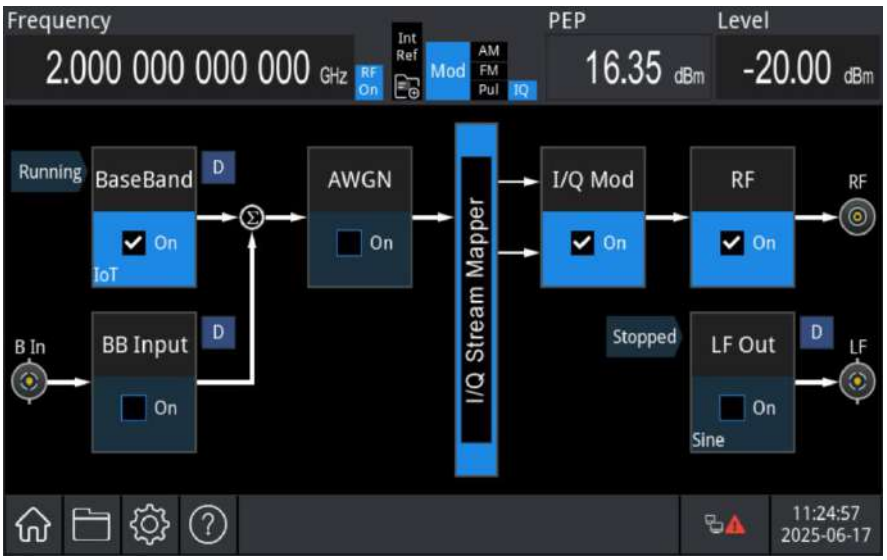
Press the Freq key to set the frequency, then use the numeric keypad to enter 2 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter -20 and select the unit dBm for this parameter, as shown in the following figure.

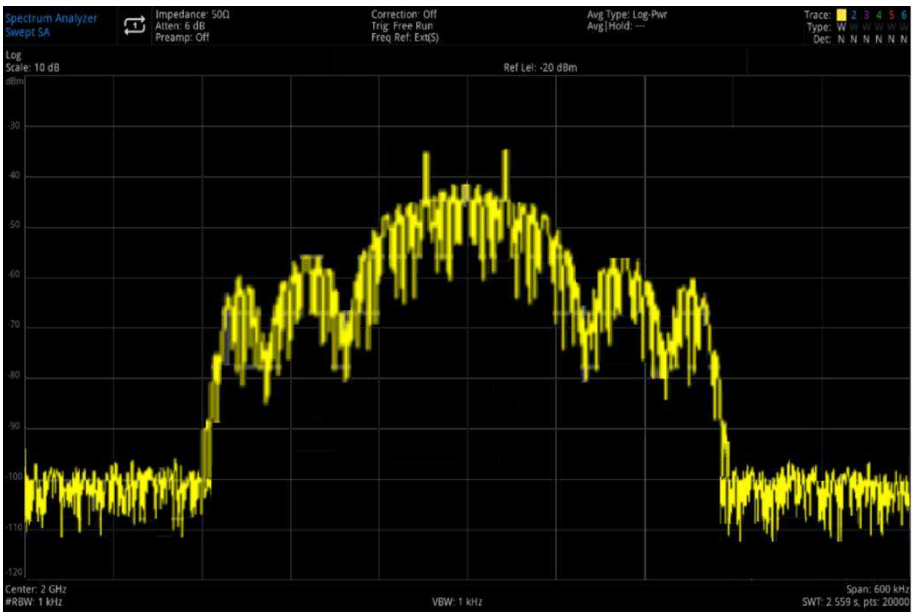


5) Enable Channel Output

Press the RF On/off key, if the key is illuminated, the channel output is enabled.

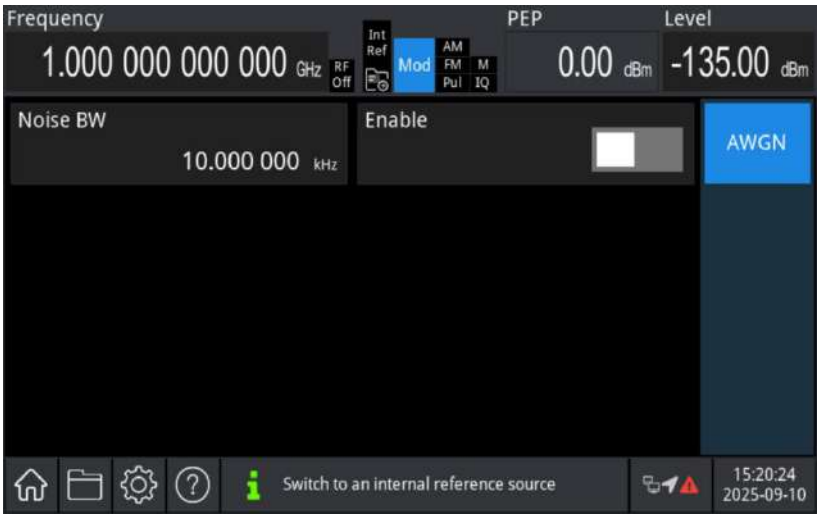


View the IoT modulation waveform on a spectrum analyzer, as shown in the following figure.



4.2.6 I/Q Noise Superposition

Configure parameters for adding Additive White Gaussian Noise (AWGN), including the noise superposition status and noise bandwidth. Gaussian white noise can be used to modulate the carrier.



Noise Superposition Enable

Enable or disable the noise superposition function. When enabled, a blue AWGN indicator will appear in the status bar of the user interface.

To enable the noise superposition:

Press the Mod key in the analog stream mapper on the screen. Press the NoiseSum →Enable key to turn on/off the noise superposition function.

Noise Bandwidth

Set the AWGN bandwidth, which can range from the system bandwidth up to 50 MHz. The default value is 10 kHz.

To change the noise superposition:

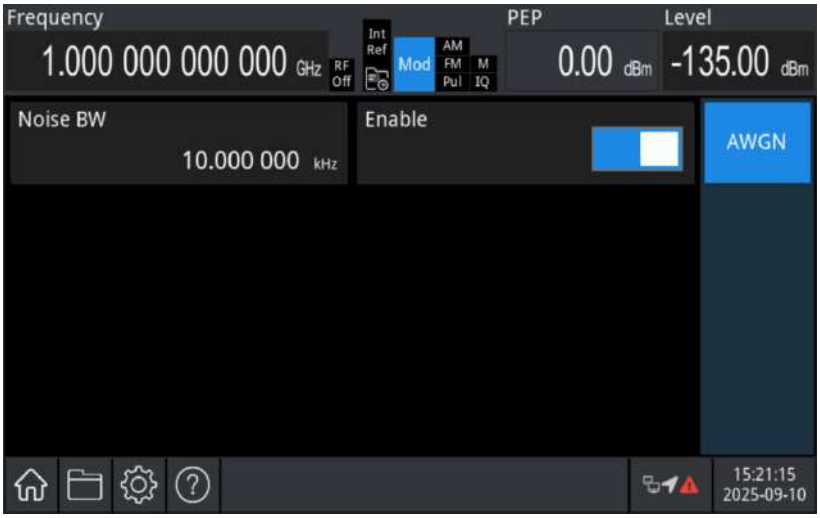
Press the Mod key in the analog stream mapper on the screen. On the noise superposition setting interface, use the multi-function knob or press Noise BW key to adjust it, then use the numeric keypad to enter the desired value.

Comprehensive Example

First, enable the noise superposition function on the instrument and set the noise bandwidth. Then enable I/Q Modulation, set the carrier frequency to 1 GHz and the amplitude to 0 dBm, and finally turn on the RF output. The procedure is as follows.

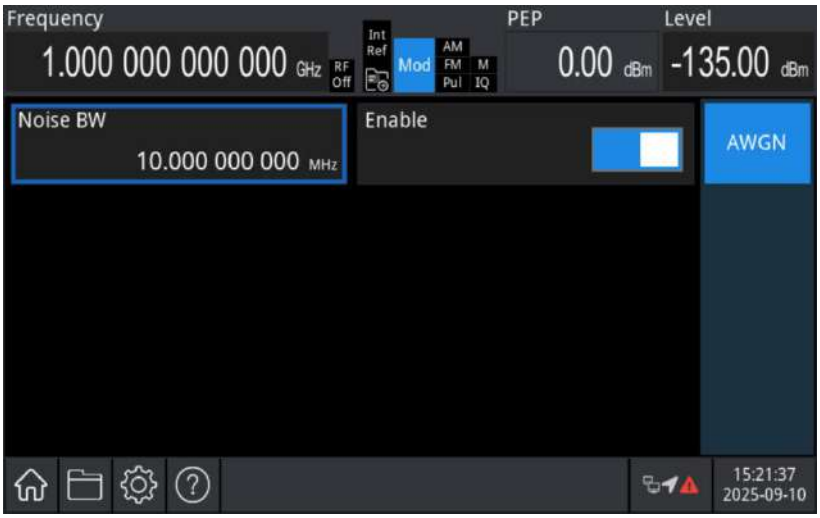
1) Enable Noise Superposition Modulation

   Press the NoiseSum →Enable key in the analog stream mapper on the screen to activate the noise superposition function.



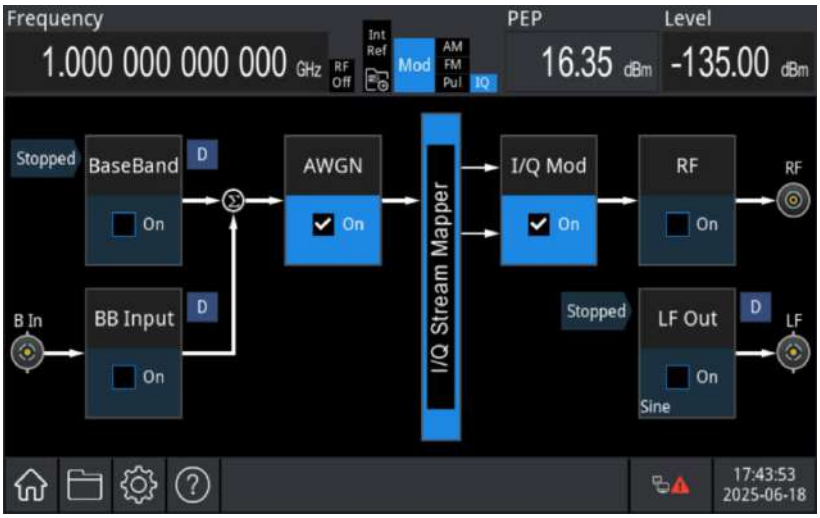
2) Set Bandwidth

   Press the Home key in the analog stream mapper on the screen, then press the NoiseSum →Noise BW key to set the bandwidth to 10 MHz.



3) Enable I/Q modulation

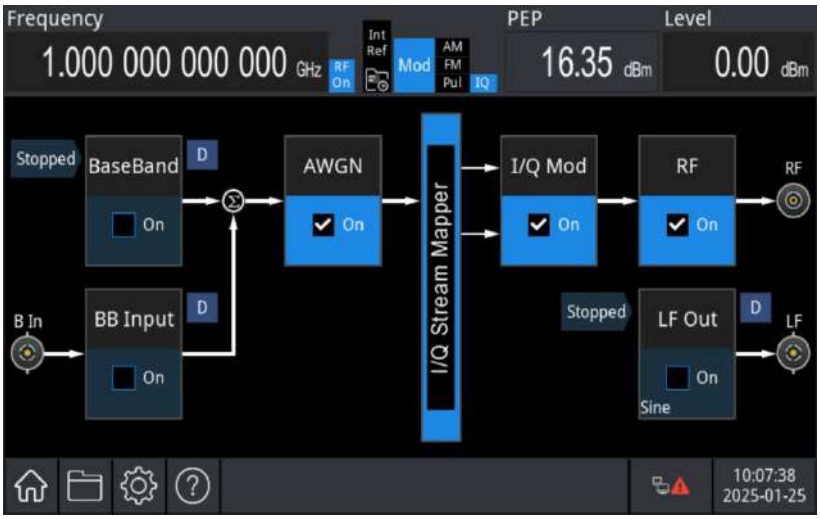
Press the Home key in the analog stream mapper on the screen, check the I/Q modulation ON,



4) Configure RF Carrier

Press the Freq key to set the frequency, then use the numeric keypad to enter 1 and select the unit GHz for this parameter.

Press the Ampt to set the amplitude, then use the numeric keypad to enter 0 and select the unit dBm for this parameter, as shown in the following figure.



5) Enable Channel Output

Press the RF On/off key. If the key is illuminated, the channel output is enabled.

At this point, the [RF OUTPUT 50Ω] connector of the signal generator outputs the carrier signal with noise superposition applied.

4.3 RF Output Sweep Waveform

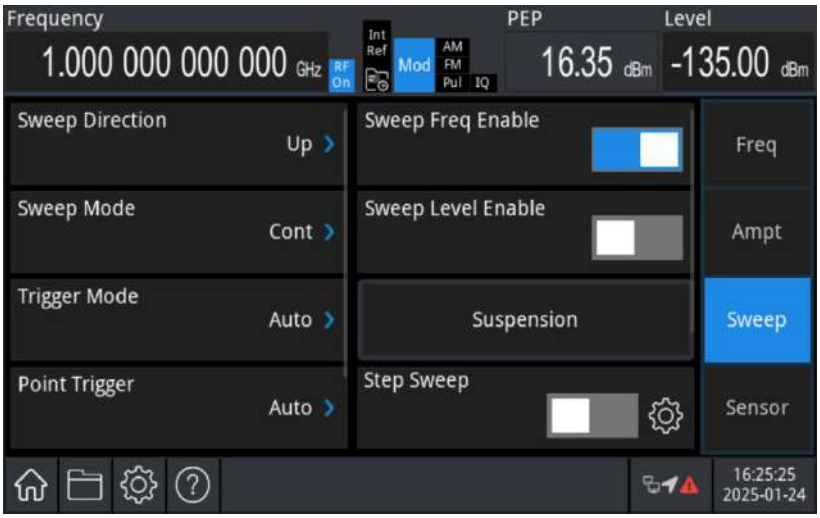
In RF sweep mode, the instrument outputs a signal that varies in frequency or amplitude, sweeping from the start frequency to the stop frequency or from the start amplitude to the stop amplitude,

according to the specified dwell time and number of sweep points. The sweep can be performed in linear, logarithmic, or list mode.

4.3.1 Sweep Mode

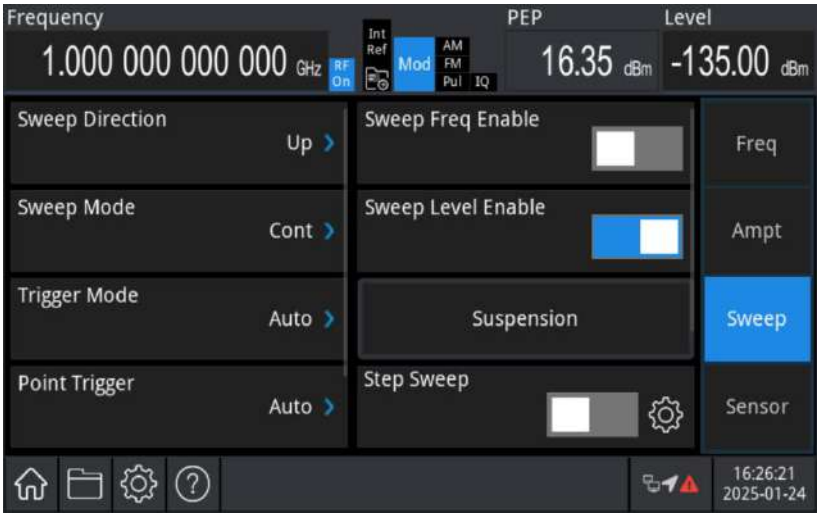
1) Enable Frequency Sweep

Press the Home key in the analog stream mapper on the screen, check RF ON, then press the Function Gen →Sweep →SweepFreq ON/OFF key to enable the frequency sweep mode. The instrument will output the frequency-sweep waveform according to the current settings, as shown in the following figure.



2) Enable Amplitude Sweep

Press the Sweep → SweepAmpt ON/OFF key, select the amplitude sweep mode. The instrument will output the sweep- amplitude waveform according to the current settings, as shown in the following figure.



3) Disable Sweep Function

Press the Sweep → SweepAmpt ON/OFF key to disable the amplitude sweep function; press the

SweepFreq ON/OFF key to disable the frequency sweep function.

4.3.2 List Sweep Setting

Press the Sweep key to the sweep setting interface, press the step sweep to open the step sweep parameter interface.

1) Start and Stop Frequency

The start frequency and stop frequency define the lower and upper limits of the frequency range for frequency to sweep. The RF Vector Signal Generator always sweeps from the start frequency to the stop frequency and then returns to the start frequency.

The start and stop frequency can be adjusted by using the multi-function rotary knob in frequency sweep interface or pressing the Start Freq, Stop Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

The default start frequency is 1 GHz, while the default stop frequency is 3 GHz. The range of the start and stop frequencies varies with the frequency of sweep waveform. Refer to the table below for the frequency range for each sweep waveform.

Frequency							
USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
9 kHz	4.5 GHz	9 kHz	6.5 GHz	9 kHz	14 GHz	9 kHz	22 GHz

2) Start and Stop Amplitude

The start frequency and stop amplitude define the lower and upper limits of the amplitude range for amplitude sweep. The RF Vector Signal Generator always sweeps from the start amplitude to the stop amplitude and then returns to the start amplitude.

The start and stop amplitude can be adjusted by using the multi-function rotary knob in amplitude sweep interface or pressing the Start Ampt, Stop Ampt key and using the numeric keypad to enter the number and select the unit to complete this setting.

3) Dwell Time

Set the interval of time between two sweep points.

The dwell time can be adjusted by using the multi-function rotary knob in step sweep interface or pressing the Dwell Time key and using the numeric keypad to enter the number and select the unit to complete this setting.

4) Sweep Point

Set the number of sweep points. The parameters for each sweep point are interpolated from the start and stop values.

The sweep point can be adjusted by using the multi-function rotary knob in step sweep interface or pressing the Sweep Point key and using the numeric keypad to enter the number and select the unit to complete this setting.

5) Sweep Shape

The sweep shape represents the cyclic pattern of multiple sweeps. There are two types: Sawtooth wave and triangular wave.

Sawtooth wave: The sweeping period progresses from the start frequency or level to the stop frequency or level, resembling the pattern of a sawtooth wave.

Triangular wave: The sweeping period progresses from the start frequency or level to the stop frequency or level, then returns to the start frequency or level, resembling the pattern of a triangular wave.

The sweep shape can be adjusted by using the multi-function rotary knob in step sweep interface or pressing the Sweep Shape key and using the numeric keypad to enter the number and select the unit to complete this setting.

6) Sweep Mode

The sweep mode represents the transition from one frequency or amplitude to another within a single step.

Linear: During the sweep, the function generator changes the output frequency at a constant rate.

Logarithmic: During the sweep, the function generator changes the output frequency at a rate proportional to the logarithm of time.

The sweep mode can be adjusted by using the multi-function rotary knob in step sweep interface or pressing the Sweep Mode key and using the numeric keypad to enter the number and select the unit to complete this setting.

4.3.3 List Sweep Setting

Press the Sweep key to the sweep setting interface, press the list sweep to open the list sweep parameter interface.

1) Insert a row

Click the (Add a row) key to insert a row at the end of the list by default.

2) Delete row

Select a row in the list, then click the (Aelete a row) key to remove the selected row.

3) Edit the parameter in the list

In the list of sweep parameters, use the multi-function knob and arrow keys, or select a specific value to make changes.

4) Delete list

Click the (Clear) key to clear and reset the list.

5) Save list

Click the (Save) key to input a filename and save the list sweep data.

4.3.4 Sweep Direction

Press the Sweep key to the sweep setting interface; the sweep direction can be set to either Up or Down. The default direction is set to Up.

The sweep direction can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Sweep Direction key and using the numeric keypad to enter the number and select the unit to complete this setting.

1) Up: When Up is selected, the signal generator sweeps from the start frequency or start level to the stop frequency or stop amplitude.
2) Down: When Down is selected, the signal generator sweeps from the stop frequency or stop amplitude back to the start frequency or start level.

4.3.5 Sweep Mode

Press the Sweep key to the sweep setting interface, the sweep mode can be set to either Single or Continuous. The default trigger mode is set to Continuous.

The sweep mode can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Sweep Mode key and using the numeric keypad to enter the number and select the unit to complete this setting.

1) Continuous: When Continuous is selected, the signal generator will perform continuous sweeping once the triggering conditions are met, based on the current settings.
2) Single: When Single is selected, the signal generator will perform a single sweep based on the current settings and then stop.

4.3.6 Trigger Mode

Press the Sweep key to the sweep setting interface, the trigger mode can be set to Auto, Key, Bus, or External. The default trigger mode is set to Auto.

The trigger mode can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Trigger Mode key and using the numeric keypad to enter the number and

select the unit to complete this setting.

1) Auto

   Continuous mode: Selecting a sweep type (frequency or amplitude) initiates sweeping automatically.

   Single mode: Sweeping starts only after the single-sweep conditions are met and stops after one sweep.

2) Key

   Continuous mode: Each press of the front-panel Trigger button or the Trigger key on the Sweep Settings page triggers a single-point sweep.

   Single mode: Each press of the front-panel Trigger button or the Trigger key triggers a single-point sweep only after the single-sweep conditions are met. Sweeping stops after one sweep.

3) Bus

   Continuous mode: Each trigger SCPI command initiates a single-point sweep.

   Single mode: Sweeping starts only after the single-sweep conditions are met and stops after one sweep.

4) External

   The signal generator receives a trigger signal via the [TRIG IN/OUT] connector on the rear panel.

   Continuous mode: Each TTL pulse with the specified polarity triggers a single-point sweep.

   Single mode: Sweeping starts only after the single-sweep conditions are met and stops after one sweep.

4.3.7 Trigger Edge

When the trigger mode is set to External, the trigger edge type can be selected to specify whether the rising edge or falling edge of the external signal will be used for triggering.

The trigger edge can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Trigger Edge key and using the numeric keypad to enter the number and select the unit to complete this setting.

1) Rising edge: When the rising edge is selected, a sweep is triggered by the rising edge of the external trigger signal.
2) Falling edge: When this option is selected, a sweep is triggered by the falling edge of the external trigger signal.

4.3.8 Point Trigger Mode

Press the Sweep key to open the Sweep Settings page. Four trigger modes are available: Auto, Key,

Bus, and External, with Auto being the default.

The trigger edge can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Sweep Settings key to select the point trigger mode.

1) Auto

   Continuous sweep mode: Enabling a sweep type (frequency or amplitude) starts continuous scanning of all sweep points within a single sweep cycle.

   Single sweep mode: Scanning starts only after the single-sweep conditions are met and stops when the sweep cycle is completed.

2) Key

   Continuous mode: Each press of the front-panel Trigger button or the Trigger key on the sweep settings page triggers the scanner to sweep one point.

   Single mode: Each press of the front-panel Trigger button or the Trigger key triggers a single-point sweep only after the single-sweep conditions are met. The sweep stops after one sweep cycle.

3) Bus

   Continuous sweep mode: Each trigger SCPI command triggers the scanner to scan one point.

   Single sweep mode: Each trigger SCPI command triggers the scanner to scan one point only after the single-sweep conditions are met. The sweep stops after one sweep cycle.

4) External

   The signal generator receives a trigger signal from the [TRIG IN/OUT] connector on the rear panel.

   Continuous sweep mode: Each TTL pulse with the specified polarity triggers the scanner to scan one point.

   Single sweep mode: Each TTL pulse with the specified polarity triggers the scanner to scan one point only after the single-sweep conditions are met. The sweep stops after one sweep cycle.

4.3.9 Comprehensive Example

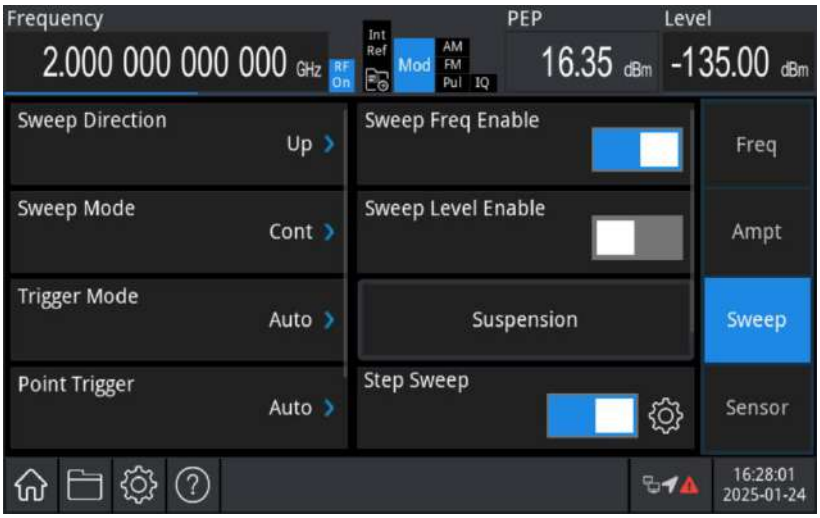
When the instrument is operating in sweep mode, configure a frequency-sweep signal with an amplitude of -10 dBm. Set the sweep type to linear and the sweep shape to triangular. Define the start frequency as 10 kHz and the stop frequency as 60 MHz. Set the number of sweep points to 100 and the dwell time to 100 μs. Use the internal source to trigger the output of the frequency-sweep waveform.

The procedure is as follows.

1) Enable Frequency Sweep Function

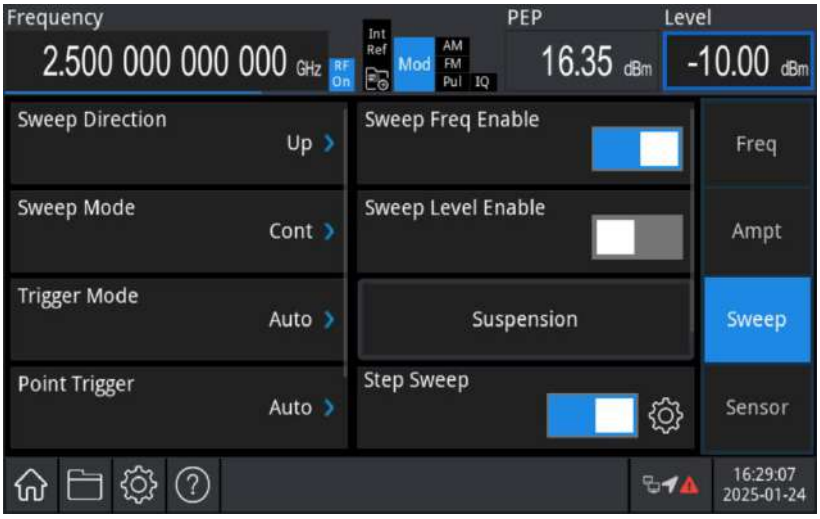
   Press the Home key in the analog stream mapper on the screen, then press the RF→Sweep

→Sweep ON/OFF →Step Sweep key to enable frequency sweep function.



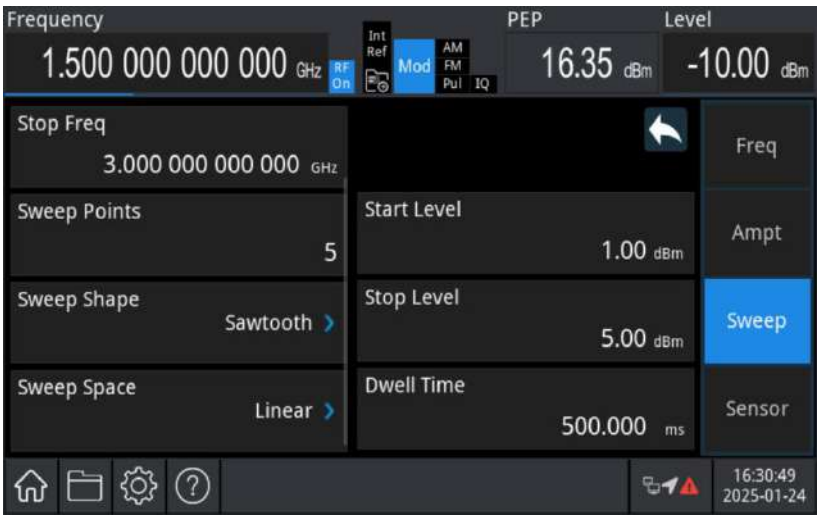
2) Set Amplitude for Frequency Sweep Signal

Press the Ampt key to set the amplitude, use the numeric keypad to enter -10, and select the unit dBm for this parameter.



3) Set Start/Stop Frequency, Dwell Time, and Sweep Point

Press the Home key in the analog stream mapper on the screen, then press the RF →Sweep key to enter the sweep setting interface, click the step sweep ⚙ to open the sweep parameter interface to enter linear sweep.

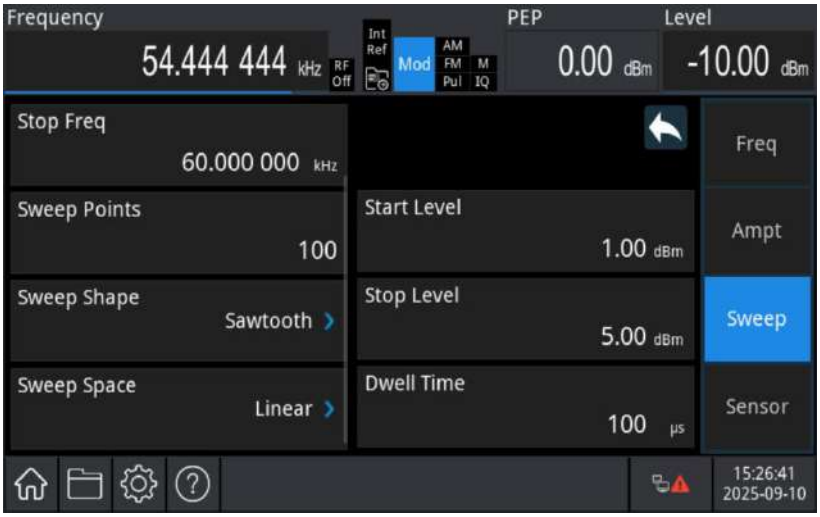


Press the Start Freq key to set the frequency, then use the numeric keypad to enter 10 and select the unit kHz for this parameter.

Press the Stop Freq key to set the frequency, then use the numeric keypad to enter 60 and select the unit kHz for this parameter.

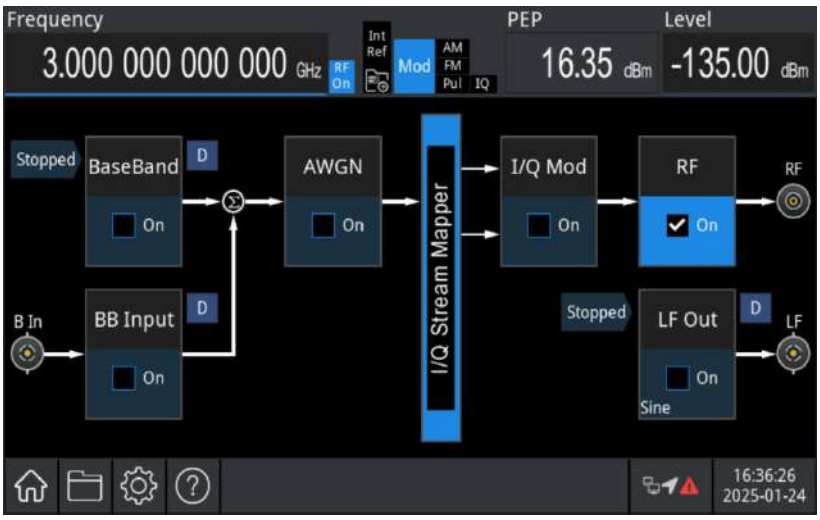
Press the Dwell Time to set the dwell time, then use the numeric keypad to enter 100 and select the unit μs for this parameter.

Press the Sweep Point to set the sweep point, then use the numeric keypad to enter 100.

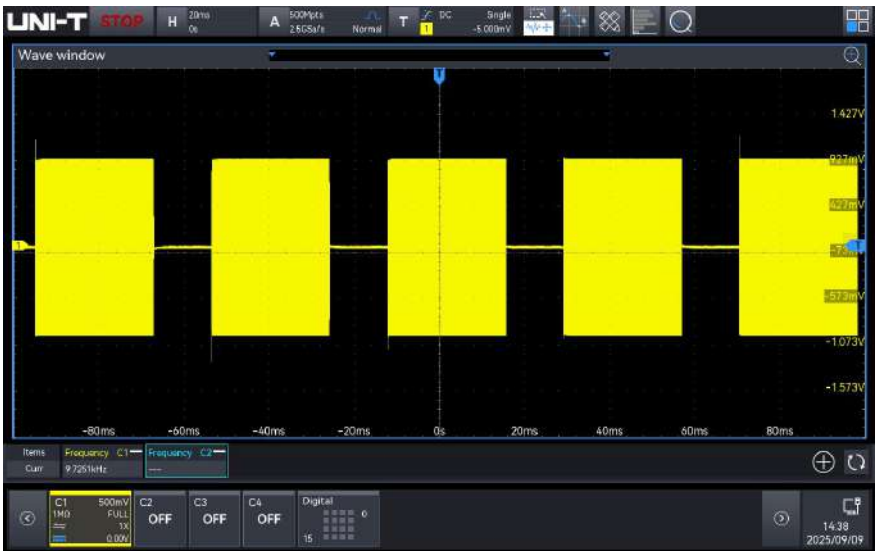


4) Enable Channel Output

Press the Home key in the analog stream mapper on the screen, check RF ON. Press the RF On/off key. If the key is illuminated, the channel output is enabled.



View the frequency sweep waveform on an oscilloscope, as shown in the following figure.



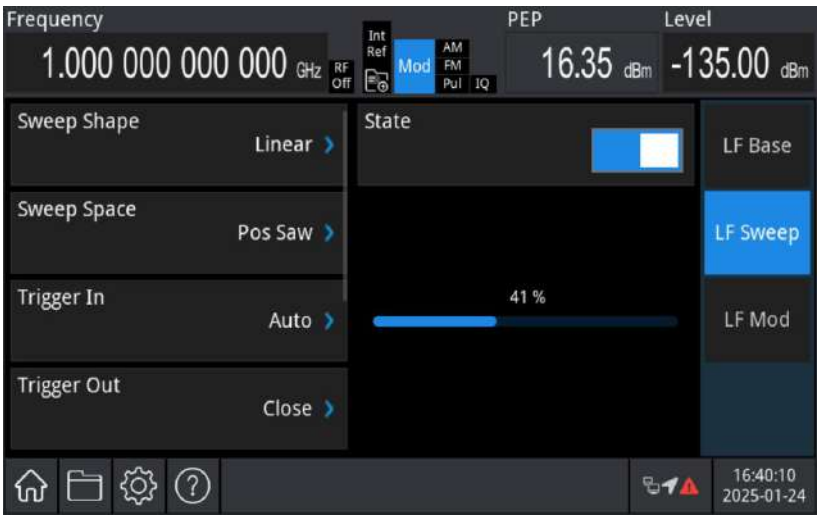
4.4 LF Output Sweep Waveform

In LF sweep mode, the instrument's output frequency changes from the start frequency to the stop frequency within the specified scan duration. The sweep can be linear, logarithmic, or step. Frequency-sweep outputs can be generated using sine, square, triangular, or arbitrary waveforms.

4.4.1 Sweep Mode

1) Enable Frequency Sweep

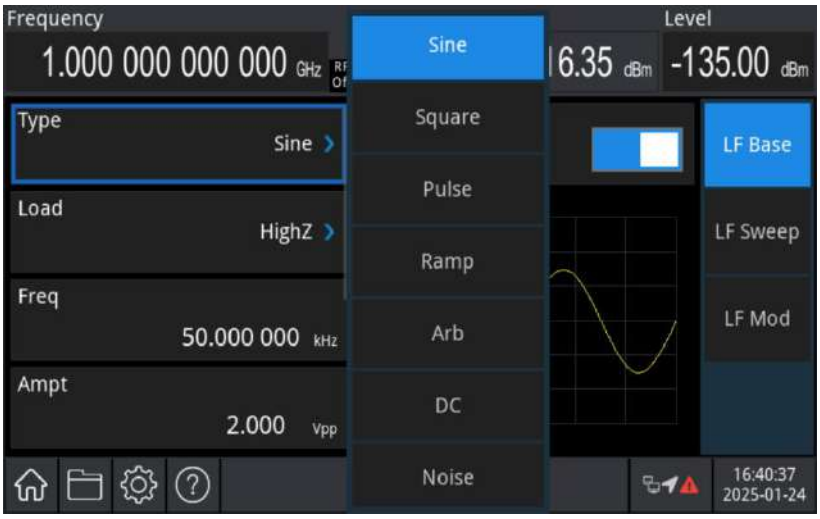
Press the Home key in the analog stream mapper on the screen, check RF ON, then press the Function Gen →Sweep →State key to enable the frequency sweep mode. The instrument will output the frequency-sweep waveform according to the current settings, as shown in the following figure.



2) Select Frequency Sweep Wave

The frequency sweep wave can be set to sine wave, square wave, triangular wave, or arbitrary wave. The default wave is sine wave.

After the frequency sweep setting, press the LF Carrier →Type key to open the carrier wave list.



4.4.2 Start and Stop Frequency

The start frequency and stop frequency define the lower and upper limits of the frequency range for frequency sweep. The RF Vector Signal Generator always sweeps from the start frequency to the stop frequency and then returns to the start frequency.

Press the Sweep key to access the sweep settings menu. The start and stop frequency can be adjusted by using the multi-function rotary knob in sweep settings interface or pressing the Start Freq, Stop Freq key and using the numeric keypad to enter the number and select the unit to complete this setting.

Note

- When the start frequency is less than the stop frequency, the DDS RF analog signal generator

sweeps from low frequency to high frequency.

- When the start frequency is greater than the stop frequency, the DDS RF analog signal generator sweeps from high frequency to low frequency.
- When the start frequency equals the stop frequency, the DDS RF analog signal generator outputs a fixed frequency.

The default start frequency is 1 MHz and the default stop frequency is 10 MHz. However, the configurable ranges of the start and stop frequencies vary depending on the selected frequency-sweep waveform. For the frequency-setting ranges of each sweep waveform, refer to the table below.

Carrier Wave	Frequency							
	USG3045V/V-P		USG3065V/V-P		USG5014V/V-P		USG5022V-P	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Sine Wave	1 MHz	50 MHz	1 MHz	50 MHz	1 MHz	50 MHz	1 MHz	50 MHz
Square Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz
Pulse Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz
Triangular Wave	1 MHz	3 MHz	1 MHz	3 MHz	1 MHz	3 MHz	1 MHz	3 MHz
Arbitrary Wave	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz	1 MHz	15 MHz

4.4.3 Sweep Manner

On the Sweep Settings page, press the Sweep Mode button to select Linear or Logarithmic:

Linear: During the frequency sweep, the function generator changes the output frequency in a linear manner.

Logarithmic: During the frequency sweep, the function generator changes the output frequency in a logarithmic manner.

4.4.4 Sweep Time

When the frequency sweep function is enabled, the sweep time can be set within a range of 1 ms to 500 s. The default sweep time is 2 s.

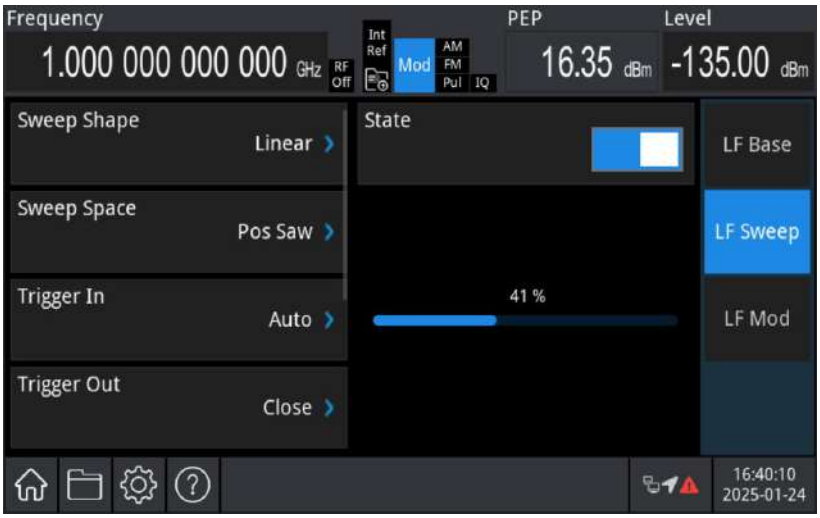
The sweep time can be adjusted by using the multi-function rotary knob in sweep interface or pressing the Sweep Time key and using the numeric keypad to enter the number and select the unit to complete this setting.

4.4.5 Comprehensive Example

When the instrument is operating in sweep mode, configure a square wave signal with an amplitude of 1 Vpp and a duty cycle of 50% as the frequency-sweep waveform. Set the sweep type to linear. Specify the start frequency as 1 kHz, the stop frequency as 50 kHz, and the sweep time as 2 ms. Use the internal source to trigger the output of the frequency-sweep waveform. The procedure is as follows.

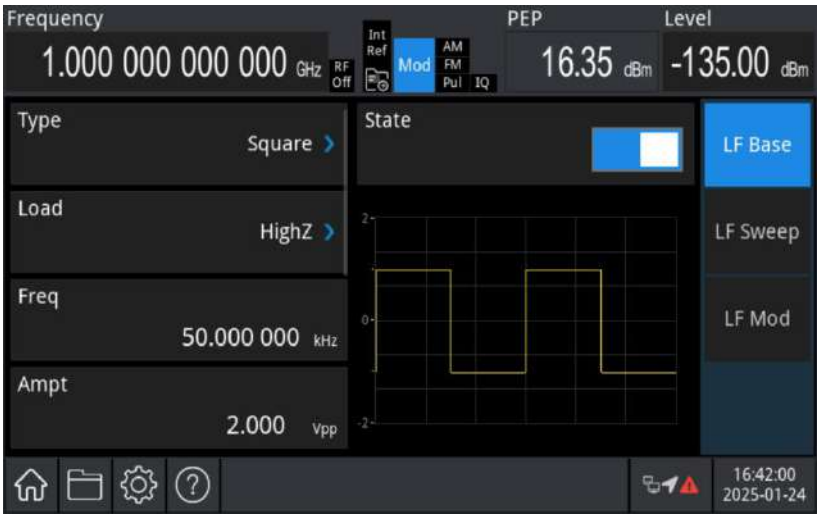
1) Enable Linear Sweep Function

Press the Home key in the analog stream mapper on the screen, then press the Function Gen →Sweep →State key to enable linear sweep function.



2) Select Frequency Sweep Wave

Press the LF Carrier →Type key to open the carrier wave list to select the square wave (Default: sine wave).



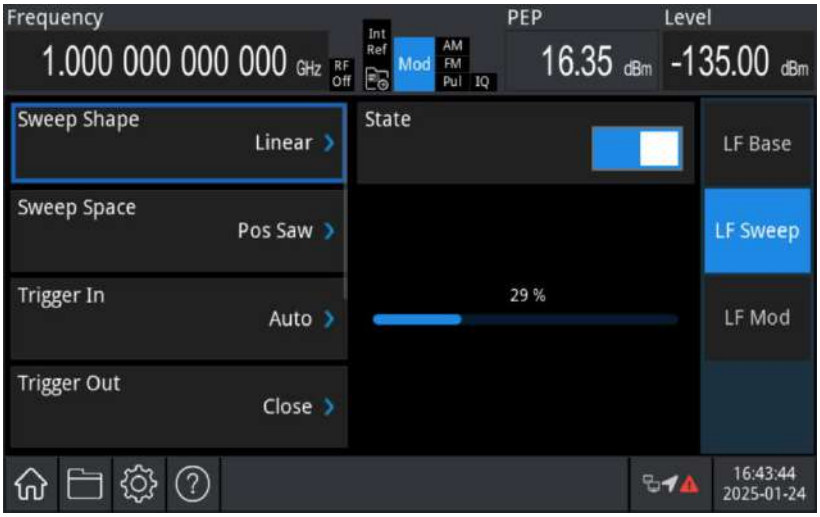
Press the Ampt key to set the amplitude, then use the numeric keypad to enter 1 and select the unit Vpp for this parameter.

Press the Duty key to set the duty ratio, then use the numeric keypad to enter 50 and select the

unit % for this parameter. The default duty ratio is 50%.

3) Set Start/Stop Frequency and Sweep Time

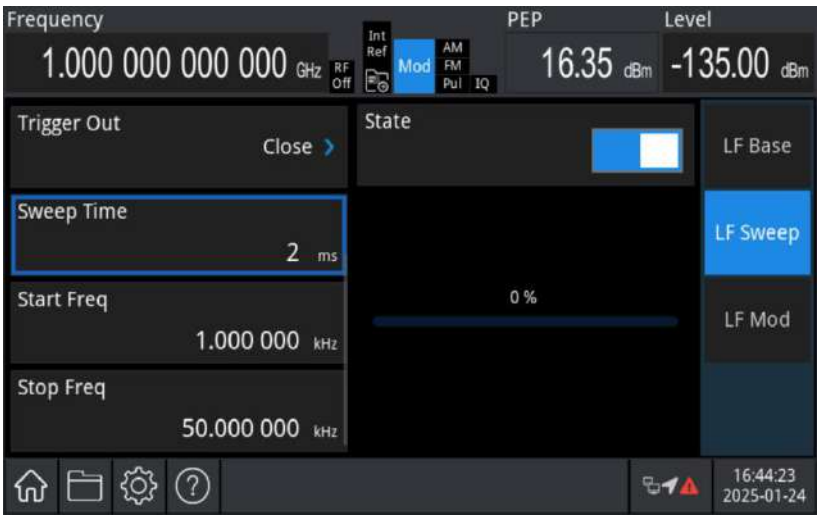
Press the Sweep →Sweep Manner →Linear key to enter the linear sweep.



Press the Start Freq key to set the frequency, then use the numeric keypad to enter 1 and select the unit kHz for this parameter. The default start frequency is 1 MHz.

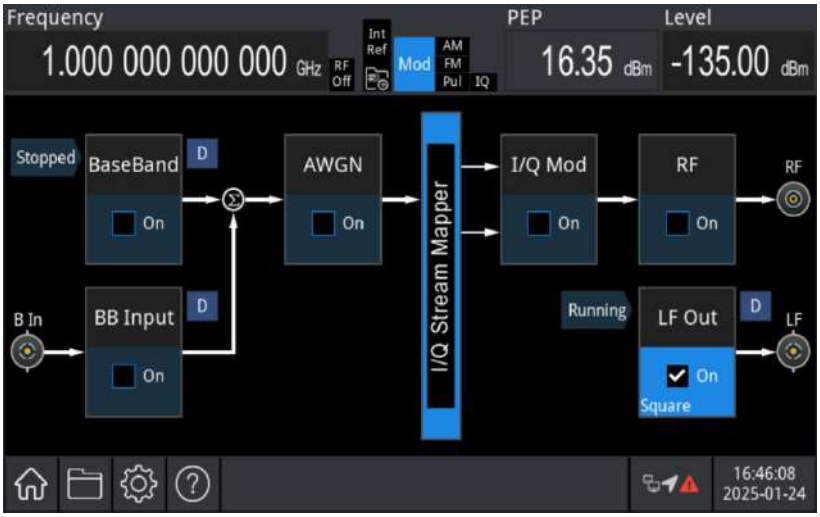
Press the Stop Freq key to set the frequency, then use the numeric keypad to enter 50 and select the unit kHz for this parameter.

Press the Sweep Time to set the sweep time, then use the numeric keypad to enter 2 and select the unit ms for this parameter.



4) Enable Channel Output

Press the LF key. If the key is illuminated, the channel output is enabled.



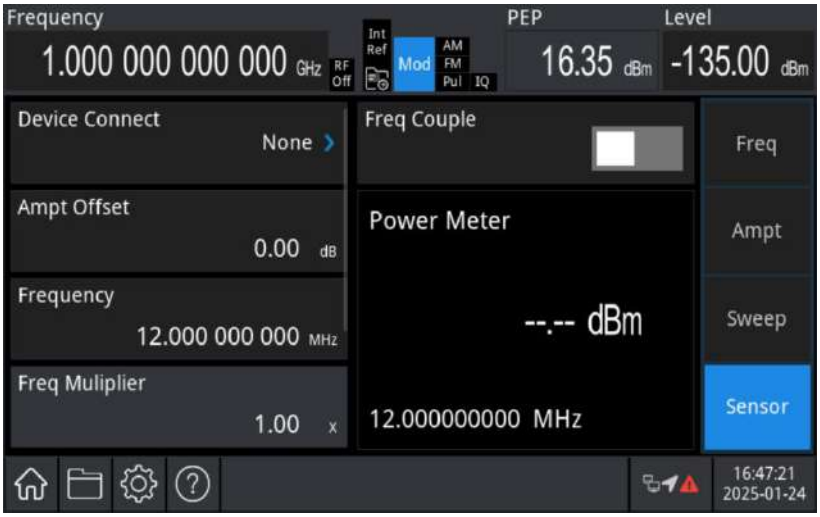
View the linear sweep waveform on an oscilloscope, as shown in the following figure.

4.5 Power Meter

Connect the USB power sensor through the USB Host interface.

1) Enable Power Meter

Press the Home →RF →Power Sensor key to enter the power meter setting, as shown in the following figure.



2) Connect Device

Press the Device Connect key to open the connected device menu. Select a device to perform the power measurement.

3) Amplitude Offset

Press the Ampt Offset key to set the amplitude offset, use the numeric keypad to enter the number, and select the unit to complete this setting.

At this point, the displayed value will include the offset value in addition to the actual measurement result. This function is particularly useful in scenarios where amplifiers and attenuators are present in the signal path.

4) Measurement Frequency

The measurement frequency is the frequency value used by the power meter for measurement. Press the Frequnecy key to set the amplitude offset, use the numeric keypad to enter the number, and select the unit to complete this setting.

5) Frequency Coupling

The frequency coupling is disabled by default. Click the Freq Couple key to enable it. When frequency coupling is enabled, the measurement frequency becomes uneditable, but the frequency multiplier factor and frequency offset can be adjusted.

Click the Freq Multiplierkey, enter the value using the virtual keypad or the numeric keypad on the front panel, then select the unit to complete the setting.

Resulting measurement frequency: Actual Measurement Frequency = Measurement Frequency × Frequency Multiplier Factor

Click the Freq Offset key, enter the value using the virtual keypad or the numeric keypad on the front panel, then select the unit to complete the setting.

Resulting measurement frequency: Actual Measurement Frequency=Measurement Frequency−Frequency Offset

6) Average Time

Set the number of averages for the power meter during measurement. Click the Average Time key, tap the virtual keypad or the numeric keypad on the front panel to enter the number, then select the unit to complete this setting.

7) Measurement Result

Displays the power measurement at the current frequency, with the unit in dBm.

Chapter 5 Troubleshooting

The following lists faults and troubleshooting methods during the instrument's operation. Please follow the corresponding steps to resolve them. If the issue cannot be resolved, contact the distributor or local office, and provide the instrument's device information (obtainment method: press the keys in sequence: Utility → System Information).

5.1 No Display (Blank Screen)

If the signal generator remains blank with no display after pressing the front-panel power switch:

1) Verify that the power supply is properly connected.
2) Ensure that the front-panel power switch has been fully pressed.
3) Restart the instrument.
4) If the instrument still does not operate normally, contact your distributor or local service center for assistance.

5.2 No Waveform Output

If the settings are correct but the instrument does not output a waveform:

1) Verify that the BNC cable and output terminal are properly connected.
2) Ensure that the LF or RF key is enabled.
3) If the instrument still does not operate, contact your distributor or local service center for maintenance.

Chapter 6 Maintenance

6.1 Maintenance and Cleaning

(1) General Maintenance

Keep the instrument away from the direct sunlight.

Caution

Keep sprays, liquids, and solvents away from the instrument or probe to avoid damaging the instrument or probe.

(2) Cleaning

Inspect the instrument regularly according to its operating conditions. Follow these steps to clean the external surfaces:

a) Use a soft cloth to remove dust from the exterior of the instrument.

b) When cleaning the LCD screen, handle it carefully to protect the transparent display.

c) When cleaning the dust screen, remove the screws of the dust cover with a screwdriver, then take out the dust screen. After cleaning, reinstall the dust screen in the correct sequence.

d) Disconnect the power supply before cleaning. Wipe the instrument with a damp, but not dripping, soft cloth. Do not use abrasive chemical cleaners on the instrument or probes.

Warning

Please confirm that the instrument is completely dry before use, to avoid electrical shorts or even personal injury caused by moisture.

Appendix A: Factory Setting

Parameter	Default Setting
RF Channel	
Channel Output	OFF
Analog Modulation	OFF
Modulation Source	OFF
Modulation Input	OFF
Carrier Wave	
Frequency	1G Hz
Amplitude	-135 dBm
Frequency Offset	0 Hz
Phase Offset	0 deg
Internal TB Calibration	0 ppb
Reference Source	Auto
Amplitude Offset	0 dB
User-defined Maximum Power	25 dBm
ALC Status	Auto
Internal Modulation Source	
Modulation Wave	Sine wave
Modulation Frequency	10 kHz
Amplitude	2 Vpp
Phase	0 deg
DC Offset	0 mV
External Modulation Source	
Load	50 Ω
AM (Amplitude Modulation)	
Modulation Depth	50%
FM (Frequency Modulation)	
Frequency Offset	1 kHz

ΦM (Phase Modulation)	
Phase Offset	0 deg
PM (Pulse Modulation)	
Pulse Type	Free-running
Period	200 μs
Delay	0ns
Pulse Width	100 μs
Sync Pulse	1 μs
External Polarity	Normal
Sweep	
Sweep Direction	Sweep Direction
Sweep Manner	Sweep Manner
Sweep Mode	Sweep Mode
Trigger Mode	Trigger Mode
Step Sweep	
Start Frequency	1 GHz
Stop Frequency	3 GHz
Sweep Point	5
Sweep Shape	Sawtooth
Sweep Manner	Linear
Start Amplitude	1 dBm
Stop Amplitude	5 dBm
Dwell Time	500 ms
List Sweep	
Data	1 point: frequency 10 MHz, amplitude -120 dBm, dwell time 500 ms
LF Channel	
Carrier Type	Sine wave
Load	High resistance
Channel Output	OFF

Carrier Wave	
Frequency	500 kHz
Amplitude	2 Vpp
DC Offset	0 mV
Square Wave Duty Ratio	50%
Triangle Wave Symmetry	50%
Pulse Wave Duty Ratio	50%
Pulse Wave Rising Edge	20 ns
Pulse Wave Falling Edge	20 ns
Noise Superposition	OFF
Arbitrary Wave	
Built-in Arbitrary Wave	ACosH.bsv
AM (Amplitude Modulation)	
Modulation Wave	Sine wave
Modulation Frequency	1 Hz
Modulation Depth	50%
FM (Frequency Modulation)	
Modulation Wave	Sine wave
Modulation Frequency	1 Hz
Frequency Offset	10 kHz
ΦM (Phase Modulation)	
Modulation Wave	Sine wave
Modulation Frequency	1 Hz
Phase 1	0 deg
Pulse (Pulse Modulation)	
Pulse Frequency	20 kHz
Duty Ratio	50%
QAM (Quadrature Modulation)	
QAM Mode	QAM4

Symbol	PN7
Modulation Rate	20 kHz
ASK (Amplitude Shift Keying)	
Symbol	PN7
Rate	20 kHz
FSK (Frequency Shift Keying)	
Mode	2-
Symbol	PN7
Modulation Rate	20 kHz
Hopping Frequency 1	20.000002 kHz
4 FSK (Four Frequency Shift Keying)	
Symbol	PN7
Modulation Rate	20 kHz
Hopping Frequency 1	20.000002 kHz
Hopping Frequency 2	25 kHz
Hopping Frequency 3	50 kHz
PSK (Phase Shift Keying)	
Mode	2-
Symbol	PN7
Modulation Rate	20 kHz
Phase 1	0 deg
Phase 1	90 deg
QPSK (Quadrature Phase Shift Keying)	
Symbol	PN7
Modulation Rate	20 kHz
Phase 1	0 deg
Phase 1	90 deg
Phase 位 3	180 deg
Phase 4	270 deg

Sweep	
Sweep Mode	Linear
Sweep Shape	Positive sawtooth
Trigger Input	Auto
Trigger Output	OFF
Sweep Time	2s
Start Frequency	1 MHz
Stop Frequency	33 MHz
Step	10
System Parameter	
Language	Factory setting
Backlight	70%
Time Format	24-hour
Date/Time	2018-03-22 16: 19
Picture Format	png
Screenshot Inverse	OFF

Appendix B:

Chinese-English Parameter Comparison Table

中文菜单			English Menu		
	类型	参数		Type	Params
RF基波	频率	频率	RF	Freq	Freq
		频率偏移			Freq Offset
		参考频率			Freq Ref
		相位偏移			Phase Offset
		相位参考			Phase Ref
		内部TB校准			Inner TB calibration
		参考源			Ref Oscillator Source
	幅度	幅度		Ampt	Ampt
		幅度偏移			Ampt Offset
		幅度参考			Ampt Ref
		用户最大功率			User Power Max
		设置衰减			Set Atten
		设置ALC电平			Set ALC Level
		ALC状态			ALC State
		平坦度			Flatness
RF扫描	步进/列表	扫描方向	Sweep	Step Sweep/List Sweep	Sweep Direction
		扫描模式			Sweep Mode
		触发方式			Trigger Mode
		点触发方式			Point Trigger
		触发输出			Trigger Out
		步进扫描			Step Sweep
		列表扫描			List Sweep
		起始频率			Start Freq
		停止频率			Stop Freq
		起始幅度			Start Level
		停止幅度			Stop Level
		驻留时间			Dwell Time
		扫描点数			Sweep Points
		扫描形状			Sweep Shape

		扫描方式			Sweep Space
RF 功 率 计	功率计	连接设备	Sensor	Sensor	Device Connect
		幅度偏移			Ampt Offset
		测量频率			Frequency
		频率倍乘系数			Freq Muliplier
		频率偏移			Freq Offset
		平均次数			Average Count
		频率耦合			Freq Couple
RF调制	内部调制源	类型	Mod	Mod Gen	Type
		频率			Freq
		幅度			Ampt
		相位			Phase
		直流偏移			DC Offset
	外部调制源	负载		Mod In	Load
	调幅	调制源		AM	Source
		调制深度			Depth
	调频	调制源		FM	Source
		频率偏移			Deviation
	调相	调制源		ΦM	Source
		相位偏移			Phase
	脉冲	脉冲类型		Pulse	Type
		周期			Period
		延迟			Delay
		脉宽			Width
		同步脉宽			Sync Width
		外部极性			Ext Polarity
		速率			Rate
		触发模式			Trigger Mode
IQ调制	I/Q调制	I/Q源		I/Q Mod	I/Q Source
		补偿通道			Compensation
		I/Q状态			I/Q State
		I/Q交换			I/Q Exchange
		自动校准			AUTO Cal
	I/Q调制-I/Q调节	增益平衡		I/Q Mod-I/Q	Gain Balance
		I偏置			I Offset
		Q偏置			Q Offset

		I延迟			I Delay
		Q延迟			Q Delay
		正交相位调节			Quad Angle
	I/Q调制-I/Q输出	I/Q输出衰减		I/Q Mod-I/Q	I/Q Output Atten
		I/Q输出增益平			I/Q Output Gain
		I输出偏置			I Output Offset
		Q输出偏置			Q Output Offset
		I/Q共模偏置			Common Mode
	Custom-数据源设置	PN类型		Custom-Source	Date Setup
		符号率			Symbol Rate
		位/符号			Bits/Symol
		PN种子			PN seed
		符号长度			Symbol Len
		自定义填充			User full
		自定义数据			User Data
	Custom-调制设置	调制类型		Custom-Modulate	Mod Type
		QAM类型			QAM Type
		格雷码			Gray
		ASK类型			ASK Type
		PSK类型			PSK Type
		FSK类型			FSK Type
		FSK偏移			FSK Dev
		自定义表格			Custom Table
		自定义填充			Custom Full
		已选中的符号			The Selected Symbol
		I值			I Value
		Q值			Q Value
	Custom-滤波器设置	滤波器类型		Custom-Filter	Filter Type
		过采样倍数			Oversampling
		滤波器Alpha			Filter Alpha
		滤波器长度			Filter Len
		滤波器BT			Filter BT
	ARB-任意波选择	任意波选择		ARB-Wave Choice	Wave Choice
		本地波形段			Waveform Segment
		本地波形序列			Waveform Sequence
	ARB-ARB设置	采样时钟		ARB-ARB	Sample Clock

		输入衰减器类			Modulator Atten
		偏置频率			Bias Freq
		调制衰减			Modulator Atten
		基带频率偏置			Baseband Freq Bias
		滤波器类型			Filter Type
		滤波器			Filter
		滤波器长度			Filter Len
		过采样倍数			Oversampling
	ARB-多载波	功率参考		ARB-Multi Carrier	Power Reference
		信号周期模式			Signal Cycle Mode
		信号周期			Signal Period
		载波列表			Carrier Table
		当前载波信息			Carrier Info
		采样率			Sampling Rate
	ARB-标识设置	输出标识		ARB-Identity Setting	Output Mux
		标识编码			Marker Number
		标识延迟			Marker Delay
		脉冲RF 消隐			Pluse/RF Blank
		标识极性			Marker Polarity
		标识点设置			Set Markers
	ARB-波形设置	波形段选择		ARB-Waveform Setting	Select Segment
		消减类型			Clipping Type
		|I+jQ|消减至			Clip |I+jQ| to
		|I|消减至			Clip |I| to
		|Q|消减至			Clip |Q| to
		缩放			Scaling
	ARB-触发设置	触发类型		ARB-Trigger Setting	Trigger Type
		连续模式			Continuous Mode
		单次模式			Single Mode
		触发源			Trigger Source
		延迟模式			Delay Type
		延迟时间			Delay Time
		外触发抑制			Ext Trig Inhibition
		外触发极性			Ext Polarity
		门选通模式			Gate Mode
		段模式			Segment Mode

	多音	多音个数		Multitone	Number of multitone
		采样率			Sampling Rate
		频率间隔			Frequency Space
		状态			State
		单边			Monolateral
	IoT	协议类型		IoT	Protocol Type
	IoT-基本设置	过采样率		IoT-Basic Setup	Oversampling Rate
		帧数			Frame Count
		总采样点数			Total Sample Points
		波形长度			Waveform Length
		调制方式			Modulation
		空闲间隔			Idle Interval
		频带			Bandwidth
		数据速率			Data Rate
		斜坡符号类型			Ramp Symbol
		斜坡符号数			Ramp Symbols
		编码方式			Coding
		频率间隔			Separation
	IoT-PPDU设置	前导码		IoT-PPDU Setup	Preamble
		SFD			SFD
		PHR			PHR
		PN种子			PN Seed
		MAC Header			MAC Header
		帧结束分隔符			End of Frame
		MAC帧类型			MAC Frame Type
		数据类型			Data Type
		数据模式			Data Mode
		数据长度			Data Length
	IoT-触发设置	触发类型		ARB-Trigger Setting	Trigger Type
		连续模式			Continuous Mode
		触发源			Trigger Source
		触发极性			Ext Polarity
		延迟采样点数			Delayed Sampling
		单次			Single
		门选通			Gate
		门选通模式			Gate Mode

	IoT-标识设置	标识1		IoT-Identity Setup	Identifier 1
		标识2			Identifier 2
	IoT-损伤	符号率偏差		IoT-Damage	Symbol Rate Error
		载波频率偏移			Frequency Offset
LF波形	正弦波	负载	LF Base	Sine	Load
		频率			Freq
		幅度			Amp
		直流偏移			DC Offset
		相位			Phase
		噪声叠加			NoiseSum
	方波	负载		Square	Load
		频率			Freq
		幅度			Amp
		直流偏移			DC Offset
		相位			Phase
		占空比			Duty
		噪声叠加			NoiseSum
	三角波	负载		Ramp	Load
		频率			Freq
		幅度			Amp
		直流偏移			DC Offset
		相位			Phase
		对称度			Symmetry
		噪声叠加			NoiseSum
	脉冲波	负载		Pulse	Load
		频率			Freq
		幅度			Amp
		直流偏移			DC Offset
		相位			Phase
		占空比			Duty
		上升沿			Rise Edge
		下降沿			Fall Edge
		噪声叠加			NoiseSum
	任意波	负载		Arb	Load
		任意波文件			Arb wave file
		频率			Freq

		幅度			Amp
		直流偏移			DC Offset
		相位			Phase
		噪声叠加			NoiseSum
	噪声	负载		Noise	Load
		噪声幅度			Amp
		直流偏移			DC Offset
		噪声带宽			Noise BW
	直流	负载		DC	Load
		直流			DC Offset
LF调制	调幅	调制波	Modulate	AM	Mod wave
		调制频率			Freq
		调制深度			Depth
	调频	调制波		FM	Mod wave
		调制频率			Freq
		频偏			Freq Dev
	调相	调制波		ΦM	Mod wave
		调制频率			Freq
		相位偏移			Phase Dev
	脉冲调制	脉冲频率		Pulse	Pulse Freq
		占空比			Pulse Duty
	幅移键控	码元		ASK	Source
		调制速率			Mod Rate
	频移键控	FSK模式		FSK	FSK Mode
		码元			Source
		调制速率			Mod Rate
		跳跃频率1			Hop Freq1
	四频频移键控	FSK模式		4FSK	FSK Mode
		码元			Source
		调制速率			Mod Rate
		跳跃频率1			Hop Freq1
		跳跃频率2			Hop Freq2
		跳跃频率3			Hop Freq3
	双相移键控	PSK模式		PSK	PSK Mode
		码元			Source
		调制速率			Mod Rate

		相位偏移			Phase Dev
		相位2			Phase2
	四相移键控	PSK模式		QPSK	PSK Mode
		码元			Source
		调制速率			Mod Rate
		相位偏移			Phase Dev
		相位2			Phase2
		相位3			Phase3
		相位4			Phase4
	正交调制	QAM模式		QAM	QAM Mode
		码元			Source
		调制速率			Mod Rate
LF扫描	线性/对数/步进	扫描方式	Sweep	Linear/Log/Step	Sweep Shape
		扫描形状			Sweep Space
		触发输入			Trigger In
		触发输出			Trigger Out
		扫描时间			Sweep Time
		起始频率			Start Freq
		停止频率			Stop Freq
		驻留时间			Dwell Time
		步数			Steps
Utility	基本设置	语言	Utility	Setting	Language
		时间格式			Clock Format
		日期/时间			Date/Time
		图片格式			Pictrue Format
		上电参数			Power On
		预设文件			User Preset
		用户状态			User Status
		背光			Backlight
		屏保			Screen Protection
	网络设置	适配器		Network	Adapter
		DHCP			DHCP
		IPv4地址			IPv4 Address
		子网掩码			IP Mask
		网关地址			Gateway
		MAC地址			MAC Address

	接口设置	Web登陆用户名		IO Config	Web User Name
		Web登陆密码			Web Password
	恢复默认	设置		Defaults	Setup
		数据			Data
		全部			All
	GPIB总线	GPIB设置		GPIB Bus	GPIB Set
		GPIB地址			GPIB Addr

Appendix C: Built-in Arbitrary Wave Table

Type	Name	Description
Common function (15)	AbsSine	Absolute sine wave
	AbsSineHalf	Absolute half-sine wave
	AmpALT	Amplify sine wave
	AttALT	Attenuates sine wave
	Gaussian_monopulse	Gaussian monocycle
	GaussPulse	Gaussian pulse
	NegRamp	Falling ramp
	NPulse	N-Pulse signal
	PPulse	P-Pulse signal
	SineTra	TraSine wave signal
	SineVer	VerSine wave signal
	StairUD	Stair up and down
	StairDn	Stair down
	StairUp	Stair up
	Trapezia	Trapezoid
Engine (25)	BandLimited	Band limited signal
	BlaseiWave	Vibration of blasting “time-vibration velocity” curve
	Butterworth	Butterworth filter
	Chebyshev1	Chebyshev filter I
	Chebyshev2	Chebyshev filter II
	Combin	Combined function
	CPulse	C-Pulse signal
	CWPulse	CW pulse signal
	DampedOsc	Damped oscillation “time-offset” curve
	DualTone	Double audio signal
	Gamma	Gamma signal
	GateVibar	Gate self-oscillation signal
	LFMPulse	Linear FM pulse signal
	MCNoise	Mechanical noise
	Discharge	Ni-MH battery discharge curve

	Pahcur	Brushless DC motor current wave
	Quake	Quake wave
	Radar	Radar signal
	Ripple	Power ripple
	RoundHalf	Half round wave
	RoundsPM	RoundsPM wave
	StepResp	Step response signal
	SwingOsc	Swing oscillation - time curve
	TV	Television signal
	Voice	Voice signal
Maths (27)	Airy	Airy function
	Besselj	Besselj function I
	Besselk	Besselk function
	Bessely	Besselj function II
	Cauchy	Cauchy distribution
	Cubic	Cubic function
	Dirichlet	Dirichlet function
	Erf	Error function
	Erfc	Complementary error function
	ErfcInv	Inverse complementary error function
	ErfInv	Inverse error function
	ExpFall	Exponential falling function
	ExpRise	Exponential rising function
	Gammaln	Natural logarithm of Gamma function
	Gauss	Gaussian distribution (Normal distribution)
	HaverSine	Haversed sine
	Laguerre	Quartic Laguerre polynomial
	Laplace	Laplace distribution
	Legend	Quintic Legendre Polynomials
	Log10	Logarithm function based on 10
	LogNormal	Logarithmic normal distribution
	Lorentz	Lorentzian function
	Maxwell	Maxwell distribution
	Rayleigh	Rayleigh distribution

	Versiera	Versiera
	Weibull	Weibull distribution
	ARB_X2	Square function
SectMod (5)	AM	Sine wave amplitude modulation
	FM	Sine wave frequency modulation
	PFM	Pulse wave modulation
	PM	Sine wave phase modulation
	PWM	Pulse width modulation
Bioelect (6)	Cardiac	Electrocardio signal
	EOG	Electro-oculogram
	EEG	Electroencephalogram
	EMG	Electromyography
	Pulseilogram	Sphygmus curve of common people
	ResSpeed	Expiration rate curve of common people
Medical (4)	LFPulse	Low frequency pulse electrotherapy waveform
	Tens1	Transcutaneous electric nerve stimulation waveform 1
	Tens2	Transcutaneous electric nerve stimulation waveform 2
	Tens3	Transcutaneous electric nerve stimulation waveform 3
Automotive (17)	Ignition	Ignition waveform of automobile internal-combustion engine
	ISO16750-2 SP	Profile map of automobile starting oscillation
	ISO16750-2 Starting1	Automobile starting voltage waveform 1
	ISO16750-2 Starting2	Automobile starting voltage waveform 2
	ISO16750-2 Starting3	Automobile starting voltage waveform 3
	ISO16750-2 Starting4	Automobile starting voltage waveform 4
	ISO16750-2 VR	Operating voltage profile map of automobile under resetting
	ISO7637-2 TP1	Transient phenomena of automobile

		caused by power cut
	ISO7637-2 TP2A	Transient phenomena of automobile caused by inductance in wiring
	ISO7637-2 TP2B	Transient phenomena of automobile caused by turning off start-up changer
	ISO7637-2 TP3A	Transient phenomena of automobile caused by conversion
	ISO7637-2 TP3B	Transient phenomena of automobile caused by conversion
	ISO7637-2 TP4	Working profile map of automobile under start-up
	ISO7637-2 TP5A	Transient phenomena of automobile caused by power cut of battery
	ISO7637-2 TP5B	Transient phenomena of automobile caused by power cut of battery
	SCR	SCR (sintering temperature distribution)
	Surge	Surge signal
Trigonome (21)	CosH	Hyperbolic cosine
	CosInt	Cosine integral
	Cot	Cotangent function
	CotHCon	Concave hyperbolic cotangent
	CotHPro	Convex hyperbolic cotangent
	CscCon	Concave cosine
	CscPro	Convex cosine
	CotH	Hyperbolic cotangent
	CscHCon	Concave hyperbolic cosecant
	CscHPro	Convex hyperbolic cosecant
	RecipCon	Reciprocal of the depression
	RecipPro	Reciprocal of the projection
	SecCon	The secant of the depression
	SecPro	The secant of the projection
	SecH	Hyperbolic secant
	Sinc	Sinc function
	SinH	Cotangent function
	SinInt	Sine integral

	Sqrt	Square root function
	Tan	Tangent function
	TanH	Hyperbolic tangent
AntiTrigonome (16)	ACosH	Arc-cosine function
	ACotCon	Arc- hyperbolic cosine function
	ACotPro	Arc- hyperbolic cosine function
	ACotHCon	Convex arc cotangent function
	ACotHPro	Concave arc- hyperbolic cosine function
	ACscCon	Convex arc- hyperbolic cosine function
	ACscPro	Concave arc cosecant function
	ACscHCon	Convex arc cosecant function
	ACscHPro	Concave arc hyperbolic cosecant function
	ASecCon	Convex arc hyperbolic cosecant function
	ASecPro	Concave arc secant function
	ASecH	Convex arc secant function
	ASin	Arc hyperbolic secant function
	ASinH	Arcsin function
	ATan	Arc hyperbolic sine function
	ATanH	Arctan function
Noise (6)	NoiseBlue	Blue noise
	NoiseBrown	Brown noise (red noise)
	NoiseGray	Gray noise
	NoisePink	Pink noise
	NoisePurple	Purple noise
	Noisewhite	White noise
Window Function (17)	Bartlett	Bartlett window
	BarthannWin	Amended Bartlett window
	Blackman	Blackman window
	BlackmanH	BlackmanH window
	BohmanWin	Bohman window
	Boxcar	Rectangle window
	ChebWin	Chebyshev window

	GaussWin	Gaussian window
	FlattopWin	Flat-top window
	Hamming	Hamming window
	Hanning	Hanning window
	Kaiser	Kaiser window
	NuttallWin	The minimum of four Blackman Harris window
	ParzenWin	Parzen window
	TaylorWin	Taylaor window
	Triang	Quarter window (Fejer window)
	TukeyWin	Tukey window
Complex Wavelets (7)	Complex Frequency B-spline	Complex Frequency B-spline function
	Complex Gaussian	Complex Gaussian function
	Complex Morlet	Complex Morlet wavelet
	Complex Shannon	Complex Shannon function
	Mexican hat	Mexican hat wavelet
	Meyer	Meyer wavelet
	Morlet	Morlet wavelet
Other (34)	ABA_1_1	
	ABA_1_2	
	ALT_03	
	ALT_04	
	ALT_05	
	AUDIO	
	COIL_2_1	
	COIL_2_2	
	DC_04	
	ECT_1_2	
	EGR_2	
	EGR_3_2	
	EST_03_2	
	IAC_1_1	
	INJ_1_1	
	INJ_2	
	INJ_3	

	INJ_4	
	INJ_5_6	
	INJ_7	
	KS_1_1	
	MAF_1_1	
	MAF_1_2	
	MAF_5_3	
	MAP_1_1	
	MAP_1_2	
	MC_3	
	Mexican hat	Mexican hat wavelet
	O2PROPA1	
	O2PROPA2	
	O2SNAP	
	STAR02_1	
	TPS_1_1	
	TPS_1_2	

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