User Manual

Models 4088 / 4089

RF Signal / Waveform Generator

bkprecision.com

BK PRECISION

Contents

Compliance Information

1.1 EMC

1.1.1 EC Declaration of Conformity - EMC

Compliance was demonstrated to the following specifications listed in the Official Journal of the European Communities: EMC Directive 2014/30/EU.

EN 61000-3-2: 2006 Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)

EN 61000-3-3: 1995+A1: 2001+A2: 2005 Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

EN 61000-4-2 / -3 / -4 / -5 / -6 / -11 Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques:

- Electrostatic discharge immunity test
- Radiated, radio-frequency, electromagnetic field immunity test
- Electrical fast transient/burst immunity test
- Surge immunity test
- Immunity to conducted disturbances, induced by radio-frequency fields
- Voltage dips, short interruptions and voltage variations immunity tests

EN 61326-1: 2006 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

1.2 Safety

1.2.1 EC Declaration of Conformity - Low Voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive: 2006/95/EC.

EN61010-1: 2001 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

1.3 IEC Measurement Category & Pollution Degree Definitions

Measurement Category (CAT) - classification of testing and measuring circuits according to the types of mains circuits to which they are intended to be connected.

Measurement Category other than II, III, or IV: circuits that are not directly connected to the mains supply.

Measurement Category II (CAT II): test and measuring circuits connected directly to utilization points (socket outlets and similar prints) of the low-voltage mains installation.

Measurement Category III (CAT III): test and measuring circuits connected to the distribution part of a building's low-voltage mains installation.

Measurement Category IV (CAT IV): test and measuring circuits connected at the source of the building's low-voltage mains installation.

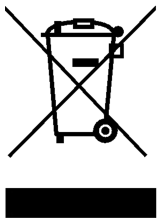
Mains Isolated: is for measurements performed on circuits not directly connected to a mains supply.

Pollution - addition of foreign matter, solid, liquid, or gaseous (ionized gases) that may produce a reduction of dielectric strength or surface resistivity.

Pollution Degree 2 (P2) - only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is expected.

1.4 Product End-of-Life Handling

The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product to an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This product is subject to Directive 2012/19/EU of the European Parliament and the Council of the European Union on waste electrical and electronic equipment (WEEE), and in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal waste. Please utilize your local WEEE collection facilities in the disposition of this product.

1.5 Terms and Symbols

1.5.1 Terms

CAUTION

A caution statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in damage to or destruction of parts or the entire product.

WARNING

A warning statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in injury or death to personnel.

NOTICE

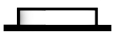
A note statement calls attention to an operating procedure, practice, or condition, which, should be noted before proceeding.

1.5.2 Symbols

WARNING - HIGH VOLTAGE - possibility of electric shock.

CAUTION – Statements or instructions that must be consulted in order to find out the nature of the potential hazard and any actions which must be taken.

On (Supply). This is the AC mains connect/disconnect switch on the front of the instrument.



Off (Supply). This is the AC mains connect/disconnect switch on the front of the instrument.

Alternating current

Chassis (earth ground) symbol

Earth (ground) TERMINAL - Refer to the instructions accompanying this symbol in this manual.

Safety Notices

The following safety precautions apply to both operating and maintenance personnel and must be followed during all phases of operation, service, and repair of this instrument.

Before applying power to this instrument:

1. Read and understand the safety and operational information in this manual.
2. Apply all the listed safety precautions.
3. Verify that the voltage selector at the line power cord input is set to the correct line voltage. Operating the instrument at an incorrect line voltage will void the warranty.
4. Make all connections to the instrument before applying power.
5. Do not operate the instrument in ways not specified by this manual or by B&K Precision.

Failure to comply with these precautions or with warnings elsewhere in this manual violates the safety standards of design, manufacture, and intended use of the instrument. B&K Precision assumes no liability for a customer's failure to comply with these requirements.

2.1 Electrical Power

This instrument is intended to be powered from a CATEGORY II mains power environment. The mains power should be 115 V RMS or 230 V RMS. Use only the power cord supplied with the instrument and ensure it is appropriate for your country of use.

Do not use this instrument in an electrical environment with a higher category rating than what is specified in this manual for this instrument.

You must ensure that each accessory you use with this instrument has a category rating equal to or higher than the instrument's category rating to maintain the instrument's category rating. Failure to do so will lower the category rating of the measuring system.

2.2 Ground the Instrument

WARNING

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical safety ground. This instrument is grounded through the ground conductor of the supplied, three-conductor AC line power cable. The power cable must be plugged into an approved three-conductor electrical outlet. The power jack and mating plug of the power cable meet IEC safety standards.

WARNING

Do not alter or defeat the ground connection. Without the safety ground connection, all accessible conductive parts (including control knobs) may provide an electric shock. Failure to use a properly-grounded approved outlet and the recommended three-conductor AC line power cable may result in injury or death.

WARNING

Unless otherwise stated, a ground connection on the instrument's front or rear panel is for a reference of potential only and is not to be used as a safety ground. Do not operate in an explosive or flammable atmosphere.

2.3 Environmental Conditions

This instrument is intended to be used in an indoor pollution degree 2 environment. The operating temperature range is 0°C to 40°C and 20% to 80% relative humidity, with no condensation allowed.

Measurements made by this instrument may be outside specifications if the instrument is used in non-office-type environments. Such environments may include rapid temperature or humidity changes, sunlight, vibration and/or mechanical shocks, acoustic noise, electrical noise, strong electric fields, or strong magnetic fields.

WARNING

Do not operate the instrument in the presence of flammable gases or vapors, fumes, or finely-divided particulates.

The instrument is designed to be used in office-type indoor environments. Do not operate the instrument:

- **In the presence of noxious, corrosive, or flammable fumes, gases, vapors, chemicals, or finely-divided particulates.**
- **In relative humidity conditions outside the instrument's specifications.**

WARNING

- **In environments where there is a danger of any liquid being spilled on the instrument or where any liquid can condense on the instrument.**
- **In air temperatures exceeding the specified operating temperatures.**
- **In atmospheric pressures outside the specified altitude limits or where the surrounding gas is not air.**
- **In environments with restricted cooling air flow, even if the air temperatures are within specifications.**
- **In direct sunlight.**

2.4 Do not operate instrument if damaged

WARNING

If the instrument is damaged, appears to be damaged, or if any liquid, chemical, or other material gets on or inside the instrument, remove the instrument's power cord, remove the instrument from service, label it as not to be operated, and return the instrument to B&K Precision for repair. Notify B&K Precision of the nature of any contamination of the instrument.

WARNING

Hazardous voltages may be present in unexpected locations in circuitry being tested when a fault condition in the circuit exists.

2.5 Clean the instrument only as instructed

WARNING

Do not clean the instrument, its switches, or its terminals with contact cleaners, abrasives, lubricants, solvents, acids/bases, or other such chemicals. Clean the instrument only with a clean dry lint-free cloth or as instructed in this manual. Not for critical applications.

2.6 Do not touch live circuits

WARNING

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified service-trained maintenance personnel who are aware of the hazards involved when the instrument's covers and shields are removed. Under certain conditions, even with the power cord removed, dangerous voltages may exist when the covers are removed.

To avoid injuries, always disconnect the power cord from the instrument, disconnect all other connections (for example, test leads, computer interface cables, etc.), discharge all circuits, and verify there are no hazardous voltages present on any conductors by measurements with a properly-operating voltage-sensing device before touching any internal parts. Verify the voltage-sensing device is working properly

before and after making the measurements by testing with known-operating voltage sources and test for both DC and AC voltages.

Do not attempt any service or adjustment unless another person capable of rendering first aid and resuscitation is present.

2.7 General Safety

WARNING **Do not insert any object into an instrument's ventilation openings or other openings.**

WARNING **This instrument is not authorized for use in contact with the human body or for use as a component in a life-support device or system.**

2.8 Servicing

WARNING

Do not substitute parts that are not approved by B&K Precision or modify this instrument. Return the instrument to B&K Precision for service and repair to ensure that safety and performance features are maintained.

WARNING

Fuse replacement must be done by qualified service-trained maintenance personnel who are aware of the instrument's fuse requirements and safe replacement procedures. Disconnect the instrument from the power line before replacing fuses. Replace fuses only with new fuses of the fuse types, voltage ratings, and current ratings specified in this manual or on the back of the instrument. Failure to do so may damage the instrument, lead to a safety hazard, or cause a fire. Failure to use the specified fuses will void the warranty.

2.9 For continued safe use of the instrument

- Do not place heavy objects on the instrument.
- Do not obstruct cooling air flow to the instrument.
- Do not place a hot soldering iron on the instrument.
- Do not pull the instrument with the power cord, connected probe, or connected test lead.
- Do not move the instrument when a probe is connected to a circuit being tested.

Introduction

3.1 Product Overview

4088 Model 1.5 GHz / 50 MHz

4089 Model 3 GHz / 80 MHz

Figure 3.1 RF Signal/Waveform Generators

The BK Precision 4088 and 4089 are versatile and high-performance arbitrary waveform and RF generators. These generators are capable of generating arbitrary waveforms with 16-bit resolution and length up to 16,000,000 points. Users can create arbitrary waveforms directly from the front panel using the generator's built-in waveform editing functions or load arbitrary waveforms via the instrument's remote interfaces.

In addition to the large waveform memory, these generators offer AM, FM, PM, PWM, BPSK and FSK modulation along with sweep, burst, and flexible triggering capabilities. The RF channel offers AM, FM, PM, and Pulse modulation.

The instrument can be remotely operated via the USBTMC, LAN, or GPIB (IEEE-488.2) interface supporting SCPI commands. Additionally, a RF channel allows for generation of high frequency signals up to 3 GHz.

3.2 Features

- 16-bit, 250 MSa/s, and up to 16M points arbitrary waveform generator
- Generate sine and square waveforms up to 100 MHz
- RF signal generation up to 3 GHz
- Color 4.3" LCD display
- AM, FM, PM, PWM, BPSK and FSK modulation functions
- Fully programmable ARB waveforms with internal wave editor
- Store/recall up to 49 different instrument setups
- Standard USBTMC and LAN, optional GPIB Interface
- SCPI-compliant command set

3.3 Contents

Please inspect the instrument mechanically and electrically upon receiving it. Unpack all items from the shipping carton, and check for any obvious signs of physical damage that may have occurred during transportation. Report any damage to the shipping agent immediately.
Save the original packing carton for possible future reshipment. Every power supply is shipped with the following contents:

- 1 x RF Signal/Waveform Generator (Model 4088 or 4089)
- 1 x AC Power Cord
- 1 x Certificate of Calibration
- 1 x Test Report

NOTICE **Ensure the presence of all the items listed above. Contact the distributor or B&K Precision if anything is missing.**

3.4 Dimensions

The 4088/89 dimensions are approximately: 213 mm x 88 mm x 300 mm (8.4” x 3.5” x 12”) (W x H x D).

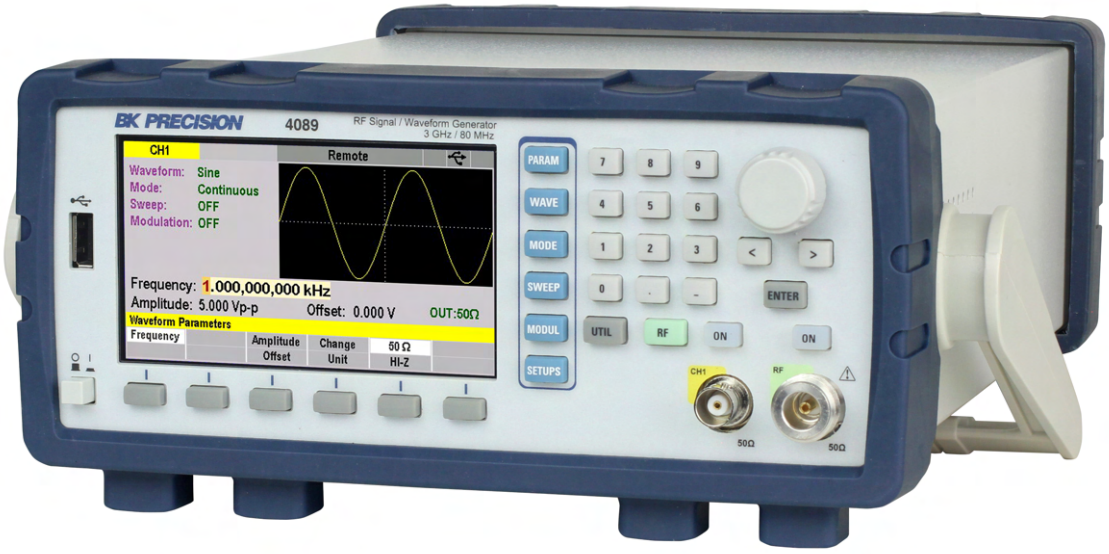


Figure 3.2 Dimensions

3.5 Rackmount Installation

The instrument can be installed in a standard 19-inch using the optional rackmount kit.

NOTICE

Remove the carrying handle before mounting the instrument. To remove the handle, grasp the handle by its sides, pull outwards, and rotate it until the arrow on the handle and the arrow on the plastic ears are in opposite directions. Then pull the handle outward.

3.6 Front Panel

The front panel interface allows for control of the unit.

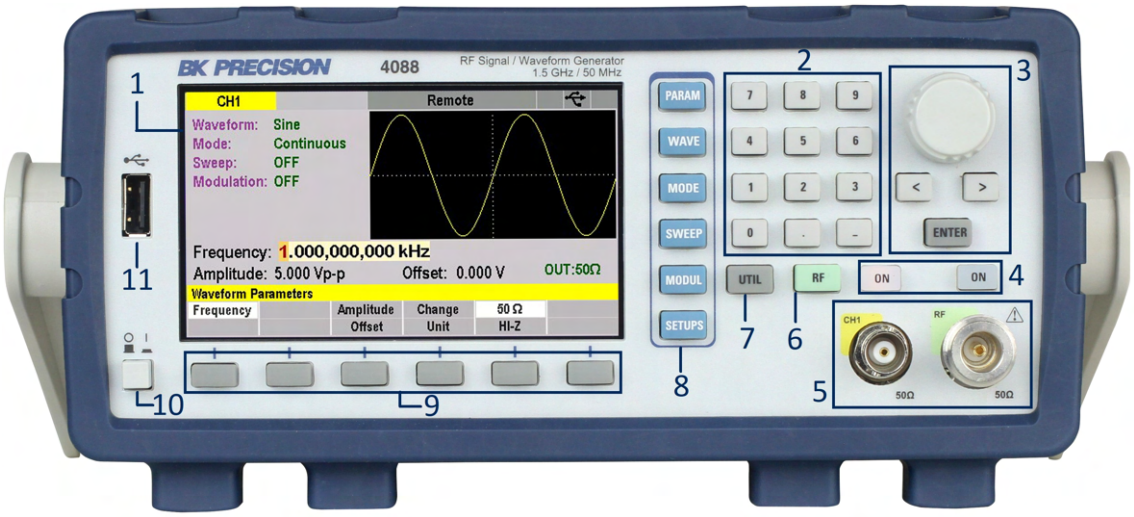


Figure 3.3 Front Panel

Item	Name	Description
1	Display	Visual presentation of the device function and measurements.
2	Numeric Keypad	Used to enter precise values.
3	Rotary Knob	Used to navigate menus or configure parameters.
4	Output Keys	Used to enable/disable the corresponding channel.
5	Output Terminals	Serves as the output terminal for the corresponding channel.
6	RF Key	Switches the instrument between AWG and RF function.
7	Utility Key	Opens the main menu, where the instruments settings can be configured.
8	Menu Keys	Open the menu of the selected key.
9	Soft Keys	Used to invoke any functions displayed above them.
10	Power Button	Power the unit **ON** or **OFF**.
11	USB host port	USB port used to connect flash drives.

Table 3.1 Front Panel Controls

3.7 Rear Panel

Figure 3.4 Rear Panel

Item	Name	Description
1	GPIB Interface	Connect a GPIB cable to remotely control the unit. (Optional)
2	Modulation In	Apply external modulation signals to carrier waveforms.
3	Trig In	Apply an external trigger or gate signal.
4	Sync Out	Generates a positive TTL sync pulse generated at each waveform cycle.
5	Marker Out	Generates a TTL signal at the specified points in an arbitrary waveform.
6	Ref In	Connect to an external reference clock for precise phase control.
7	Ref Out	Synchronize multiple instruments for precise phase control.
8	USB interface	Connect a USB type B to type A to remotely control the unit.
9	LAN interface	Connect a Cat 5/6 Ethernet straight-through patch cable to remotely control the unit.
10	Chassis ground	Provides a zero potential voltage reference and a dissipation point for interference, transient voltages and static.
11	Mains Input	Houses the fuse as well as the AC input.

Table 3.2 Rear Panel Connections

Getting Started

Before connecting and powering up the instrument, please review and go through the instructions in this chapter.

4.1 Input Power and Fuse Requirements

The supply has a universal AC input that accepts line voltage input within the following specifications:

Parameter	Specification
Voltage	100 - 240 VAC (+/- 10 %)
Frequency	50/60 Hz
Input Power	50 VA MAX.

Table 4.1 Input Power Specifications

Before connecting to an AC outlet or external power source, be sure that the power switch is in the **OFF** position and verify that the AC power cord, including the extension line, is compatible with the rated voltage/current and that there is sufficient circuit capacity for the power supply. Once verified, connect the cable firmly.

The included AC power cord is safety certified for this instrument operating in rated range. To change a cable or add an extension cable, be sure that it can meet the required power ratings for this instrument. Any misuse with wrong or unsafe cables will void the war-

SHOCK HAZARD: The power cord provides a chassis ground through a third conductor. Verify that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

4.2 Check or Replace Fuse

WARNING **For safety, no power should be applied to the instrument while changing line voltage operation. Disconnect all cables connected to the instrument before proceeding.**

Check and/or Change Fuse

- Disconnect the power in cable.
- Locate the fuse box next to the AC input connector in the rear panel. See **3.7**.
- With a small flat blade screwdriver, insert into the fuse box slit to pull and slide out the fuse box as indicated below.
- Check and replace fuse if necessary (see **4.1**).

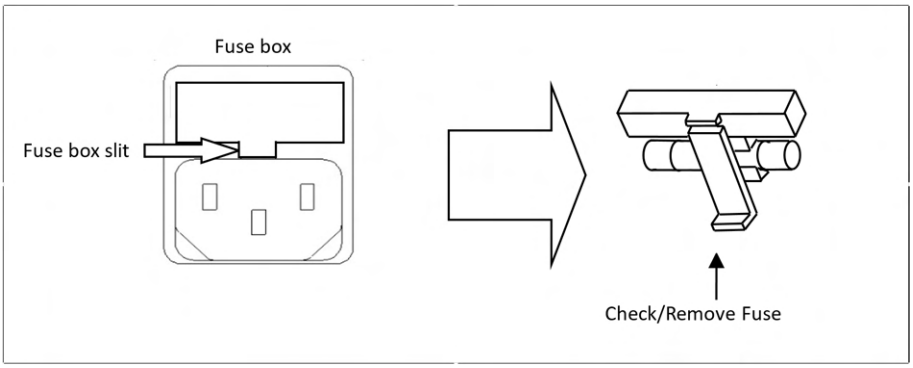


Figure 4.1 Fuse Removal

Use a slow blow fuse of 1 A 250 V, UL/CSA approved as indicated on the rear panel of the instrument. Should the fuse get blown, follow the steps below to replace:

WARNING **Any disassembling of the case or changing of the fuse not performed by an authorized service technician will void the warranty of the instrument.**

4.3 Output Connections

The waveform generator output circuits are protected against short circuit or nominal accidental voltages applied to the main output connector. The output circuits operate as a 50 Ω voltage source working into a 50 Ω load. At higher frequencies, a non-terminated or improperly terminated output may cause aberrations on the output waveform. In addition, loads with an impedance less than 50 Ω will reduce the waveform amplitude, while loads with an impedance greater than 50 Ω will increase waveform amplitude. Excessive distortion or aberrations caused by improper termination are less noticeable at lower frequencies, especially with sine and triangle waveforms. To ensure waveform integrity, follow these precautions:

- Use good quality 50 Ω coaxial cable and connectors.
- Make all connections tight and as short as possible.
- Use good quality attenuators, if it is necessary to reduce waveform amplitudes applied to sensitive circuits.
- Use termination or impedance-matching devices to avoid reflections.
- Ensure that attenuators and terminations have adequate power handling capabilities.

If there is a DC voltage across the output load, use a coupling capacitor in series with the load. The time constant of the coupling capacitor and load must be long enough to maintain pulse flatness.

4.3.1 Impedance Matching

If the waveform generator is driving a high impedance, such as a 1 MΩ input impedance (paralleled by a stated capacitance) of an oscilloscope vertical input, connect the transmission line to a 50 Ω attenuator, a 50 Ω termination and to the oscilloscope input. The attenuator isolates the input capacitance of the device and terminates the waveform generator properly.

4.4 Preliminary Check

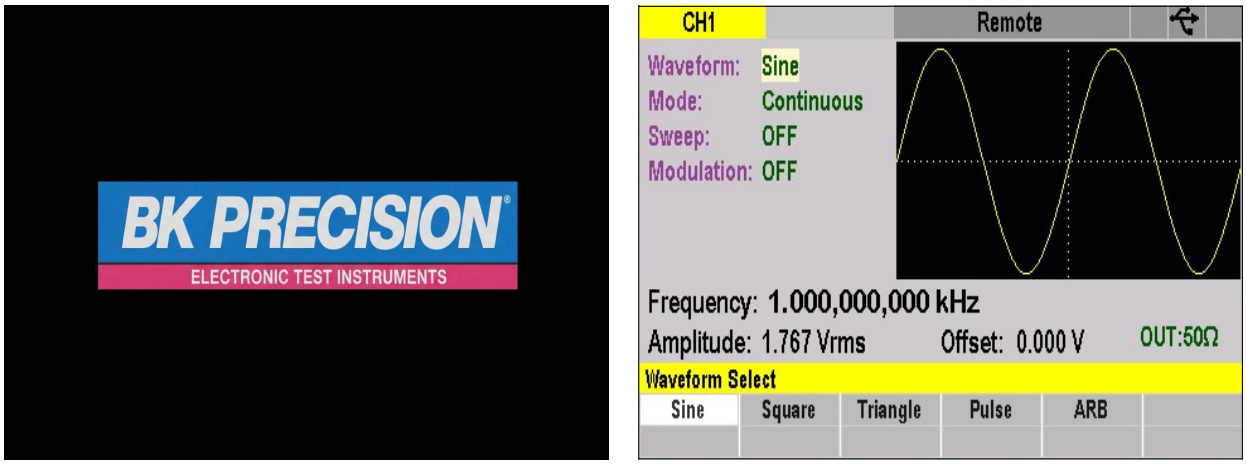
Complete the following steps to verify that the generator is ready for use.

4.4.1 Verify AC Input Voltage

Verify and check to make sure proper AC voltages are available to power the instrument. The AC voltage range must meet the acceptable specification as explained in section **4.1**.

4.4.2 Connect Power

Connect AC power cord to the AC receptacle in the rear panel and press the power button. The instrument will have a boot screen while loading, after which the main screen will be displayed.



Boot Screen Main Screen

Figure 4.2 Instrument Boot Up

4.4.3 Self Adjust

At power-on, the waveform generator performs a diagnostic self-test procedure to check itself for errors. If it finds an error, an error code and text will appear in the display window. Other error codes appear when you enter an invalid front-panel setting. For more information on error codes, see the **Self Test Error Table**. When the waveform generator finishes the diagnostic self-test routine, it enters the local state (LOCS) and assumes power-on default settings.

4.5 Self Test Errors

One or multiple of the errors listed in **table 2.1** will be displayed if the self-test did not complete successfully. If any of these errors occur, please contact B&K Precision.

Error Message	Description
Out of Range	Attempt to set variable out of instrument limits.
Setting Conflict	Can't have this parameter set with some other.
Trig Rate Short	Internal trigger rate too short for wave/burst.
Empty Location	Attempt to restore nonexistent setting.
SCALE too high	Attempt to set scale too high for current dot value.
Protected Ram	Attempt to write to protected ARB memory range.
Ram Error	Error in testing RAM.
Must divide by 4	Predefined wave length must be divisible by 4.
Must divide by 2	Predefined wave length must be divisible by 2.

Table 4.2 Self Test Errors

4.6 Output Check

Follow the steps below to do a quick check of the settings and waveform output.

1. Turn on the instrument and set the instrument to default settings. To set to default, press **Setups**, press **Recall** and select **0**, then **Enter**. The instrument will set both channels with the following parameters:

Parameter	Value
Waveform Shape	Sine
Frequency	1.000000000 kHz
Amplitude	5.000 Vpp
Offset	0.000 Vdc
Phase	0.0 °
Output Impedance	50 Ω

Table 4.3 Default Parameters

2. Connect the BNC output of CH1 into an oscilloscope.
3. Press the **ON** button on top of CH1 output BNC to turn on the output and observe a sine wave with the parameters above.
4. Press the **Frequency** button in the menu and use the rotary knob or the numeric keypad to change frequency. Observe the changes on the oscilloscope display.
5. Press the **Amplitude** button in the menu and use the rotary knob or the numeric keypad to change the amplitude. Observe the changes on the oscilloscope display.
6. Press the **Offset** option in the menu and use the rotary knob or the numeric keypad to change the DC offset. With the oscilloscope set for DC coupling, observe the changes on the display.
7. Now, connect the BNC output of CH2 into an oscilloscope and follow steps 3 to 6 to check its output.

Operation Instructions

5.1 Menu Keys

The menu keys select the main menus for displaying or changing a parameter, function or mode.

- PARAM
- MODE
- MODUL
- UTIL
- WAVE
- SWEEP
- SETUPS
- RF

For more information about each menu or mode click on the corresponding button above.

5.2 Soft Keys

The unit has six softkeys, which are located beneath the screen.

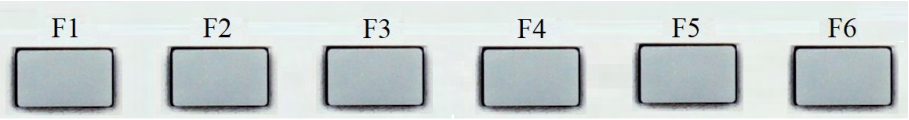


Figure 5.1 SoftKeys

Each key selects the corresponding function. Functions will vary depending on the current menu or display.

Certain warning messages and menus will require the softkeys to proceed. These displays will state to press the **F<#>** key as shown in figure 5.2. The **F** keys are the softkeys starting at **(F1)**, the key furthest left, and ending at **(F6)**, the key furthest to the right.

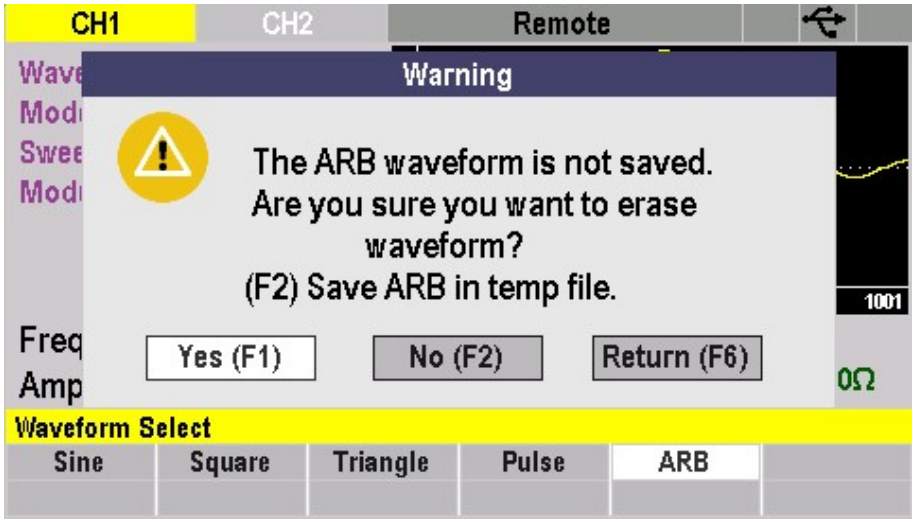


Figure 5.2 Warning F# Key

5.3 Numeric Keys

The numeric keys allow the configuration of various parameters. Using the numeric keys provides a fast and precise input.

Figure 5.3 Numeric Keys

If the numeric keypad is used to enter a value the unit of the value can be chosen by selecting the softkey corresponding to the desired unit.

5.4 Output Control

The 

buttons toggles the outputs On/Off of the corresponding channel. When output is enabled, the **ON** button will light up with a white LED.

Figure 5.4 Output Keys

The RF and AWG outputs can be enabled at the same time. (To enable the AWG/Waveform Generator set operation mode to AWG/Waveform Generator).
The corresponding mode must be selected to configure an output.
Toggle between the two modes by pressing the 

button.

5.5 Display

The display contains five components in both AWG and RF Mode.

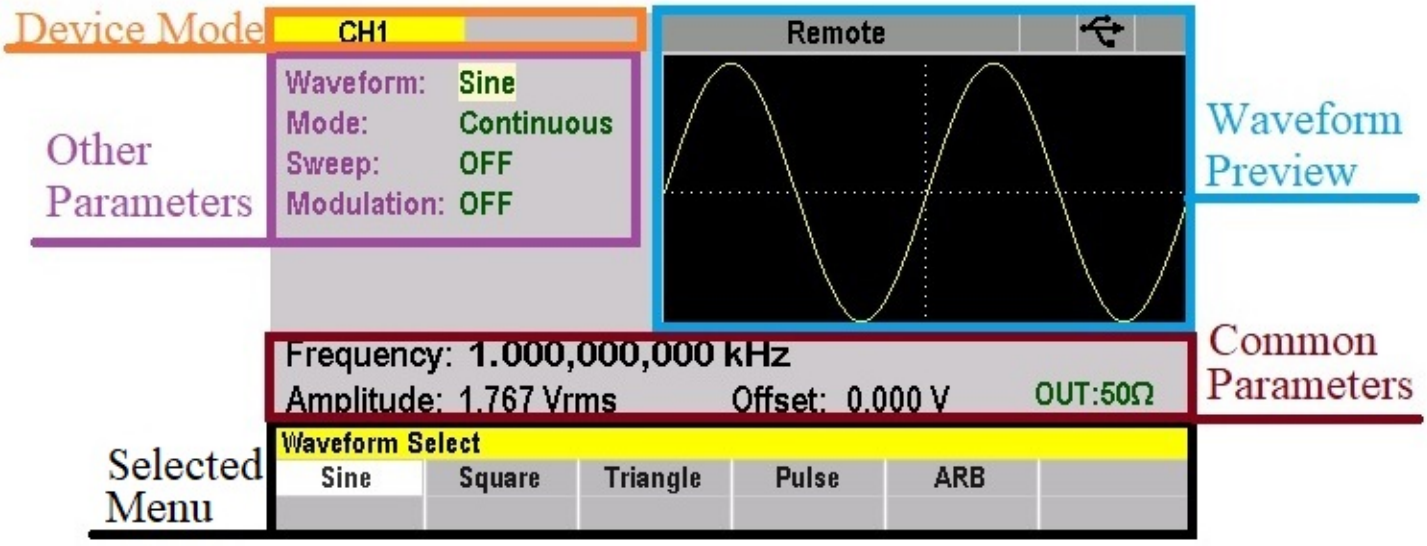


Figure 5.5 Display

5.5.1 Device Mode

Device Mode can be seen in the top left portion of the screen. When in **AWG Mode** CH1 will be displayed and highlighted in yellow. See figure **5.5**.
When in **RF Mode** RF will be displayed and highlighted in light green. See figure **5.6**.

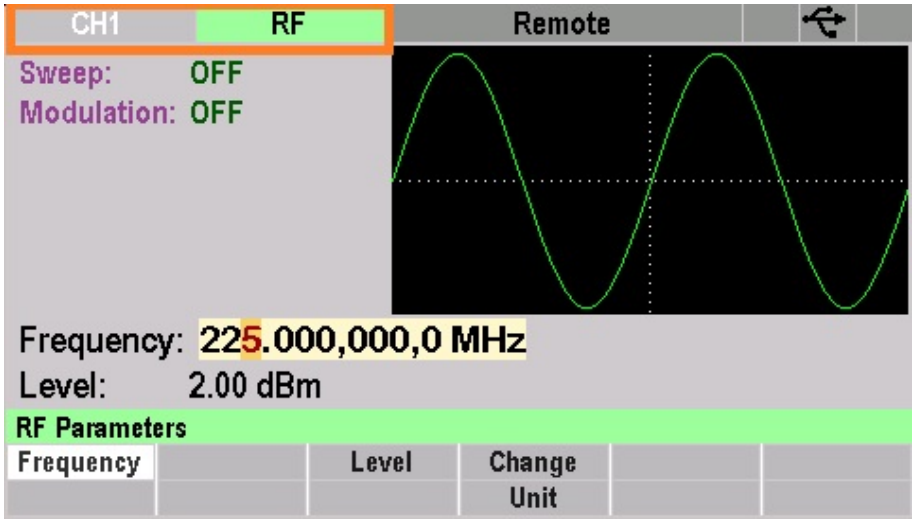


Figure 5.6 RF Display

5.5.2 Other Parameters

The **Other Parameters** section displays the parameters available in the current set settings. This does not include the **Common Parameters** of the waveforms.

Figure 5.7 Other Parameters

In figure 5.7 the chosen settings correspond to a sine wave. Despite currently being in the **Waveform Menu**, **Other Parameters** demonstrates that Mode, Sweep, and Modulation are applicable and can be configured with the sine wave.

5.5.3 Waveform Preview

Waveform Preview provides a view of the waveform based on the set parameters.

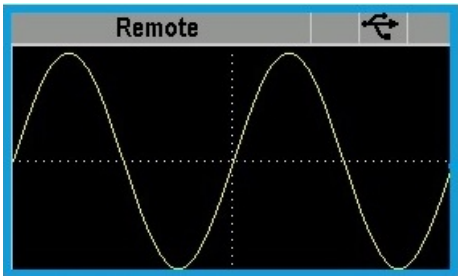


Figure 5.8 Waveform Preview

5.5.4 Common Parameters

Displays the parameters that are shared by all the waveforms. To edit these parameters press the PARAM key and use the **Selected Menu** section to select the parameter to be edited.

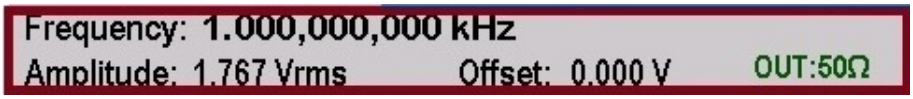


Figure 5.9 Common Parameters

5.5.5 Selected Menu

Selected Menu Displays the available settings in the selected menu. To select a setting use the corresponding softkey.

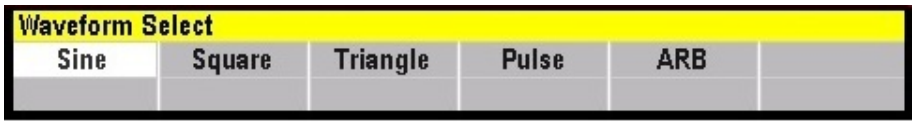


Figure 5.10 Selected Menu

PARAM Key

The PARAM key opens the **Waveform Parameters Menu**.

Select the parameter to be set. Depending on the chosen waveform the available parameters may change. The common parameters such as: frequency, amplitude, offset and internal impedance will always be available regardless of the waveform chosen.

To view the parameters available for each waveform view the chapter of desired waveform. View the available waveforms in the **Wave Key** section.

Frequency | Rate (Arb Mode Only)

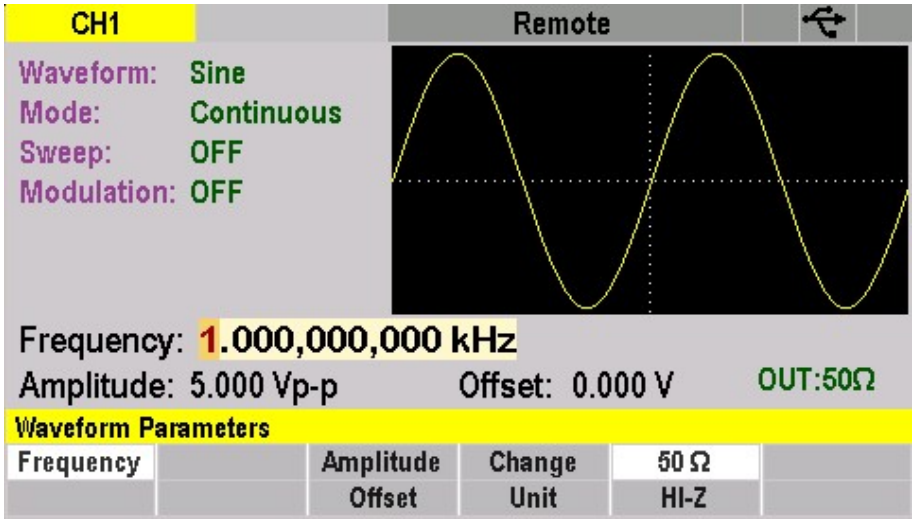


Figure 6.1 Frequency

Frequency - Selects and displays the frequency. Change the frequency setting using the cursor keys, rotary knob or the numerical keypad. If a certain wavelength can't produce the waveform at the desired frequency, the waveform generator displays a "Data out of range" error message.

Rate - Selects and displays the Point Rate (Arb Mode Only). The Rate parameter governs the rate at which waveform points are executed, and thus the frequency of the waveform output. When you set this parameter, the waveform generator will keep that execution rate for all waveform lengths until it is changed.

Amplitude | Offset

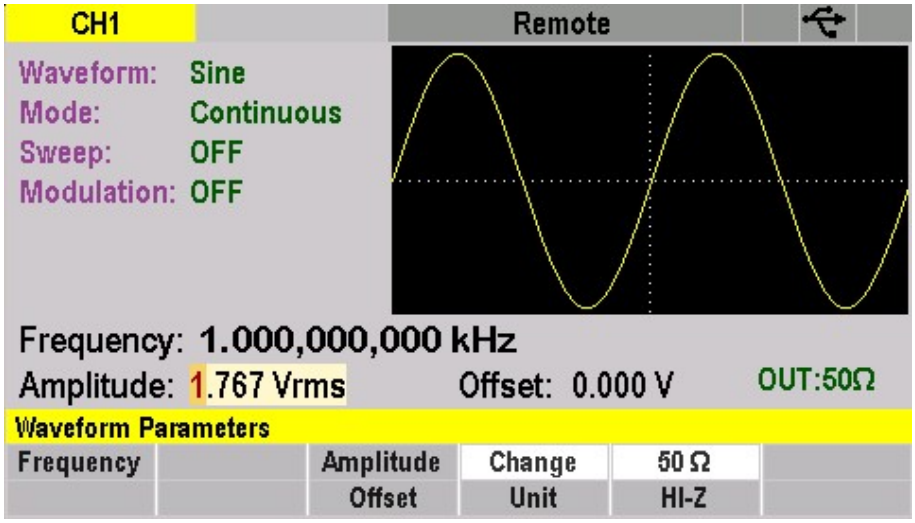


Figure 6.2 Amplitude/Offset

Amplitude | **Offset** - Selects the Amplitude or the Offset parameters. Change the offset by using the cursor keys, rotary dial or numerical keypad. If a certain setting cannot be produced, the waveform generator will display a “Setting conflict” message.

In Arbitrary mode, this setting defines the maximum peak-to-peak amplitude of a full-scale waveform. If the waveform does not use the full scale of data (-32767 to +32756), then its actual amplitude will be smaller.

Change Unit

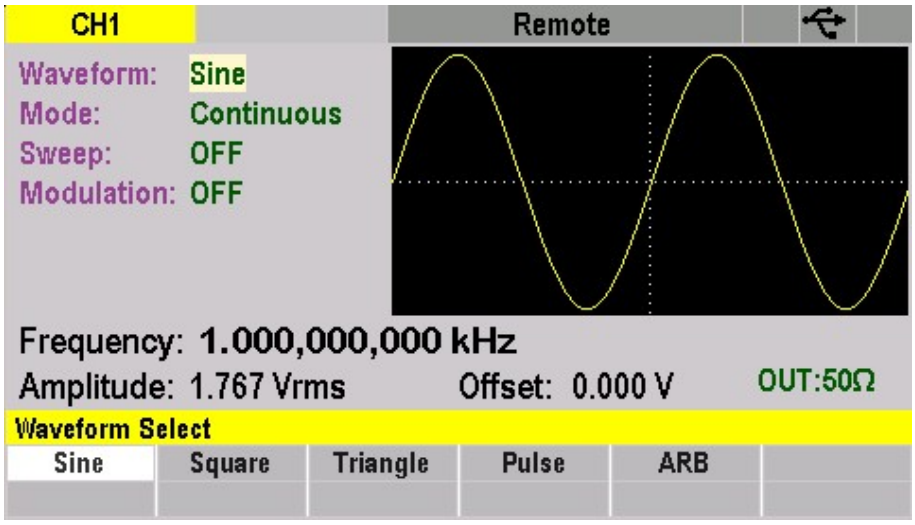
Selects the amplitude units: peak-to-peak, RMS or dBm (sine waves only). It is available only for Sine, Triangle and Square waveforms.

50 Ω / HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to an oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected).

WAVE Key

Press the WAVE button to enter the **Waveform Select Menu**.
Press the corresponding softkey to select one of the available waveforms.



- **Sine**
- **Square**
- **Triangle**
- **Pulse**
- **ARB**

For more information on each waveform click on the corresponding waveform listed above.

Sine Wave

Press the WAVE button then use the softkey **F1** to select **Sine**. The screen shown in figure **8.1** will be displayed. The parameters available for sine waveforms include frequency, period, amplitude, high level, low level, offset, and phase.

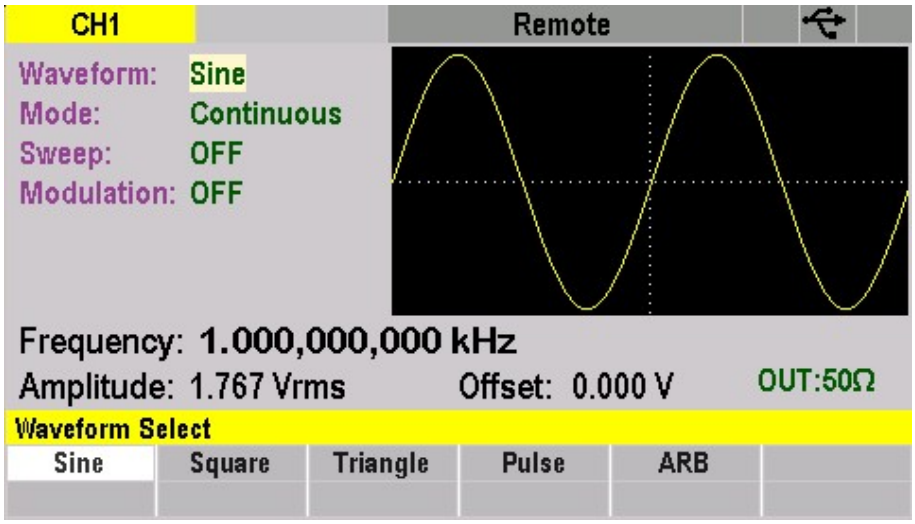


Figure 8.1 Sine

Parameter	Description
Frequency	Set the signal frequency.
Amplitude	Set the signal amplitude.
Offset	Set the signal offset.
Change Unit	Change the unit of the amplitude.
50 Ω/ HI-Z	Change the impedance.
Int. Ref./Ext. Ref.	Change the reference of the unit.

Table 8.1 Sine Wave Parameters

8.1 Frequency

Frequency is one of the most important parameters of basic waveforms. For different instrument models and waveforms, the available ranges of frequency are different. The 4088 has a range of 1 μHz to 50 MHz, while the 4089 has a range of 1 μHz to 80 MHz.

To select the **Sine Waveform**: Press the WAVE button then use the softkey **F1** to select **Sine**.

To configure the frequency of the waveform:

Step 1. Press the PARAM button then use the softkey to select **Frequency**.
- The frequency shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired frequency.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding softkey to select the parameter's unit.

- MHz
- KHz
- Hz
- mHz

Step 4. Or use the arrow keys to select the digit to be edit, and then use the knob to change its value.

WARNING **When using the numeric Keypad to enter the value, the navigating arrow keys cannot be used to move across already inputted values.**

8.2 Amplitude

To set the amplitude:

Press the PARAM button then use the softkey to select **Amplitude**.

Step 1. The amplitude shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Amplitude** softkey again to switch into the **Amplitude** parameter if **Offset** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- Vp-p
- mVp-p
- Vrms
- mVrms
- dBm

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

8.3 Offset

The default value is 0 Vdc.
To set the offset:
Press the PARAM button then use the softkey to select **Offset**.

Step 1. The offset shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Offset** softkey again to switch into the **Offset** parameter if **Amplitude** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric Keypad to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

- V
- mV

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

8.4 Change Unit

Press the corresponding softkey, **F4**, to toggle between the units of the **Amplitude**:

- Vp-p
- dBm
- mVrms

8.5 50 Ω/ HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected; 50 Ω path to match impedance and avoid reflections and other mismatch effects).
To set the internal impedance:
Press the PARAM button then use the softkey to select **50 Ω/ HI-Z**.

Step 1. Toggle the **50 Ω/ HI-Z** softkey to switch between 50 Ω and HI-Z. (The current operation is highlighted in a white color).

8.6 Int. Ref./Ext. Ref.

Selects internal or external reference source (the external reference must be connected to the rear panel Ref In connector).

Press the PARAM button then use the softkey to select **Int. Ref./Ext. Ref.**.

Step 1. Toggle the **Int. Ref./Ext. Ref.** softkey to switch between internal reference and External reference. (The current operation is highlighted in a white color).

Square Wave

Press the WAVE button then use the softkey **F2** to select **Square**. The screen shown in figure **9.1** will be displayed. The parameters available for the Square waveforms include frequency, period, amplitude, high level, low level, offset, and duty cycle.

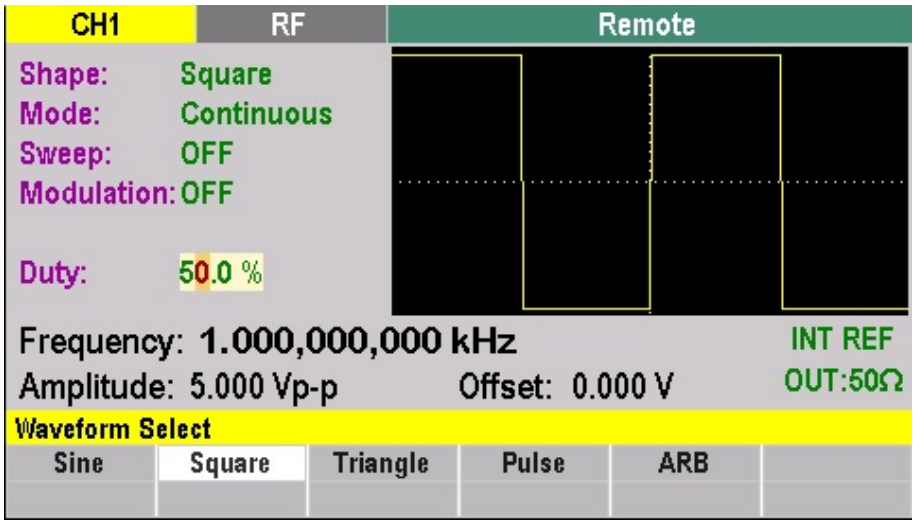


Figure 9.1 Square Wave

Parameter	Description
Duty Cycle	Set the duty cycle.
Frequency	Set the signal frequency.
Amplitude	Set the signal amplitude.
Offset	Set the signal offset.
Change Unit	Change the unit of the amplitude.
50 Ω/ HI-Z	Change the impedance.
Int. Ref./Ext. Ref.	Change the reference of the unit.
Duty Cycle	Change the duty cycle.

Table 9.1 Square Wave Parameters

9.1 Duty Cycle

To set the duty cycle:

Press the WAVE button then use the softkey to select **Square**.

Step 1. The duty cycle can be found between the **Other Parameters** and **Common Parameters** sections.

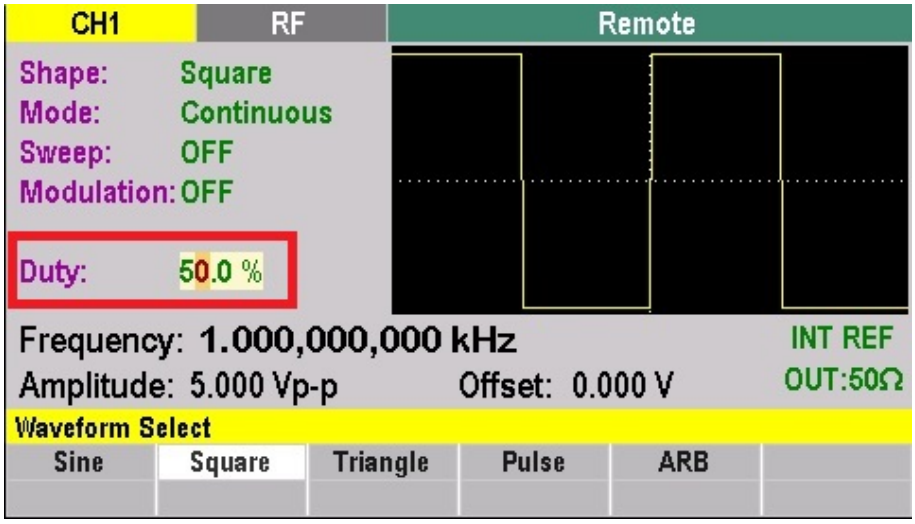


Figure 9.2 Duty Cycle

Step 2. Use the numeric keypad to input the parameter value directly and press ENTER.

Step 3. Or use the rotary knob to adjust the current duty cycle.

9.2 Frequency

Frequency is one of the most important parameters of basic waveforms. For different instrument models and waveforms, the available ranges of frequency are different. The 4088 has a range of 1 μHz to 50 MHz, while the 4089 has a range of 1 μHz to 80 MHz. The default frequency is 1 kHz.

To select the **Square Waveform**: Press the WAVE button then use the softkey to select **Square**.

To configure the frequency of the waveform:

Step 1. Press the PARAM button then use the softkey to select **Frequency**.
- The frequency shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired frequency.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- MHz
- KHz
- Hz
- mHz

Step 4. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

WARNING

When using the numeric Keypad to enter the value, the left arrow key cannot be used to move the cursor backward and edit the value of the previous digit.

9.3 Amplitude

To set the amplitude:

Press the PARAM button then use the softkey to select **Amplitude**.

Step 1. The amplitude shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Amplitude** softkey again to switch into the **Amplitude** parameter if **Offset** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- Vp-p
- mVp-p
- Vrms
- mVrms
- dBm

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

9.4 Offset

The default value is 0 Vdc.
To set the offset:
Press the PARAM button then use the softkey to select **Offset**.

Step 1. The offset shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Offset** softkey again to switch into the **Offset** parameter if **Amplitude** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric Keypad to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

- V
- mV

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

9.5 Change Unit

Press the corresponding softkey, **F4**, to toggle between the units of the **Amplitude**:

- Vp-p
- dBm
- mVrms

9.6 50 Ω/ HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected; 50 Ω path to match impedance and avoid reflections and other mismatch effects).

To set the internal impedance:

Press the PARAM button then use the softkey to select **50 Ω/ HI-Z**.

Step 1. Toggle the **50 Ω/ HI-Z** softkey to switch between 50 Ω and HI-Z. (The current operation is highlighted in a white color).

9.7 Int. Ref./Ext. Ref.

Selects internal or external reference source (the external reference must be connected to the rear panel Ref In connector).

Press the PARAM button then use the softkey to select **Int. Ref./Ext. Ref.**.

Step 1. Toggle the **Int. Ref./Ext. Ref.** softkey to switch between internal reference and external reference. (The current operation is highlighted in a white color).

Triangle Wave

Press the WAVE button then use the softkey **F2** to select **Triangle**. The screen shown in figure **10.1** will be displayed. The parameters available for the Triangle waveforms include duty cycle frequency, amplitude, and offset.

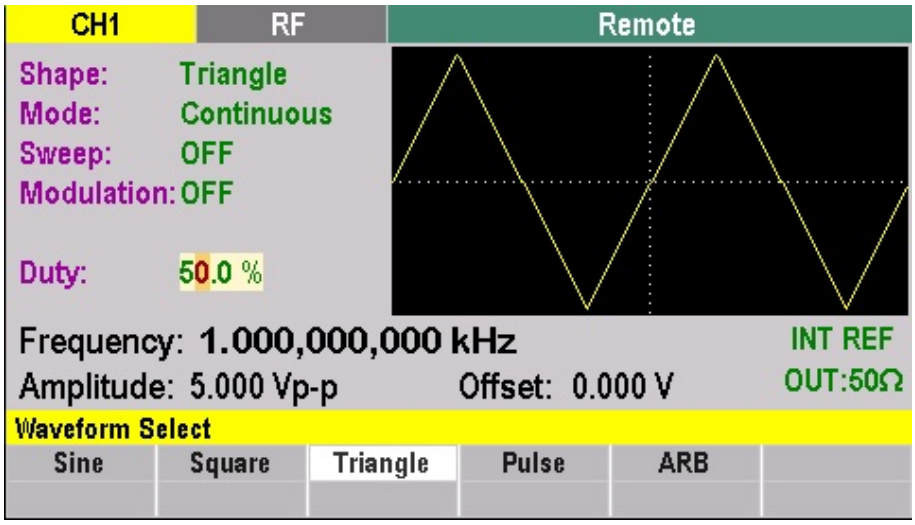


Figure 10.1 Triangle Wave

Parameter	Description
Duty Cycle	Set the duty cycle.
Frequency	Set the signal frequency.
Amplitude	Set the signal amplitude.
Offset	Set the signal offset.
Change Unit	Change the unit of the amplitude.
50 Ω/ HI-Z	Change the impedance.
Int. Ref./Ext. Ref.	Change the reference.

Table 10.1 Triangle Wave Parameters

10.1 Duty Cycle

To set the duty cycle:

Press the WAVE button then use the soft key to select **Square**.

Step 1. The duty cycle can be found between the **Other Parameters** and **Common Parameters** sections.

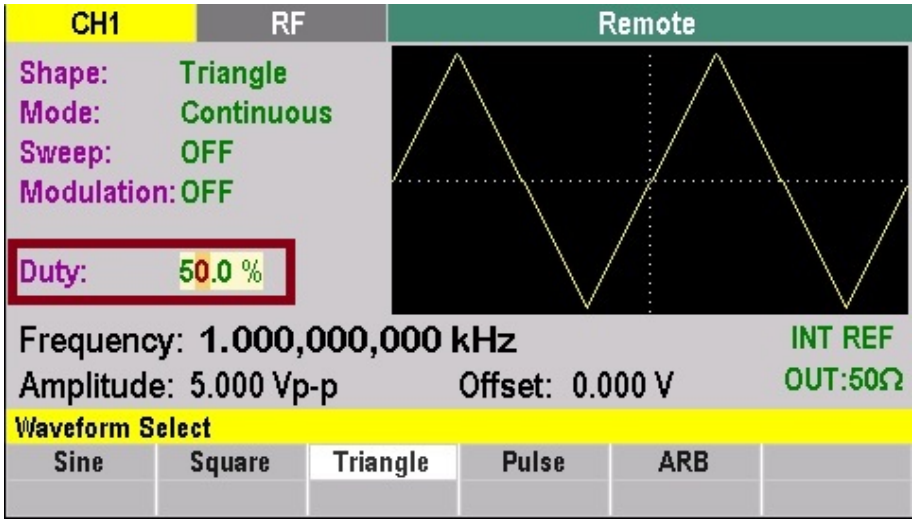


Figure 10.2 Duty Cycle

Step 2. Use the numeric keypad to input the parameter value directly and press ENTER.

Step 3. Or use the rotary knob to adjust the current duty cycle.

10.2 Frequency

Frequency is one of the most important parameters of basic waveforms. For different instrument models and waveforms, the available ranges of frequency are different. The 4088 has a range of 1 μHz to 50 MHz, while the 4089 has a range of 1 μHz to 80 MHz. The default frequency is 1 kHz.

To select the **Triangle Waveform**: Press the WAVE button then use the soft key to select **Triangle**.

To configure the frequency of the waveform:

Step 1. Press the PARAM button then use the soft key to select **Frequency**.
- The frequency shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired frequency.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- MHz
- KHz
- Hz
- mHz

Step 4. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

WARNING

When using the numeric Keypad to enter the value, the left arrow key cannot be used to move the cursor backward and edit the value of the previous digit.

10.3 Amplitude

To set the amplitude:

Press the PARAM button then use the soft key to select **Amplitude**.

Step 1. The amplitude shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Amplitude** softkey again to switch into the **Amplitude** parameter if **Offset** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- Vp-p
- mVp-p
- Vrms
- mVrms
- dBm

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

10.4 Offset

The default value is 0 Vdc.
To set the offset:
Press the PARAM button then use the soft key to select **Offset**.

Step 1. The offset shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Offset** softkey again to switch into the **Offset** parameter if **Amplitude** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric Keypad to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

- V
- mV

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

10.5 Change Unit

Press the corresponding softkey, **F4**, to toggle between the units of the **Amplitude**:

- Vp-p
- dBm
- mVrms

10.6 50 Ω/ HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected; 50 Ω path to match impedance and avoid reflections and other mismatch effects).

To set the internal impedance:

Press the PARAM button then use the soft key to select **50 Ω/ HI-Z**.

Step 1. Toggle the **50 Ω/ HI-Z** softkey to switch between 50 Ω and HI-Z. (The current operation is highlighted in a white color).

10.7 Int. Ref./Ext. Ref.

Selects internal or external reference source (the external reference must be connected to the rear panel Ref In connector).

Press the PARAM button then use the soft key to select **Int. Ref./Ext. Ref.**.

Step 1. Toggle the **Int. Ref./Ext. Ref.** softkey to switch between internal reference and external reference. (The current operation is highlighted in a white color).

Pulse Wave

Press the WAVE button then use the softkey **F4** to select **Pulse**. The screen shown in figure **11.1** will be displayed. The parameters available for the Pulse waveforms include frequency/period, amplitude, offset, width, edge, lead/trail, and fast edges.

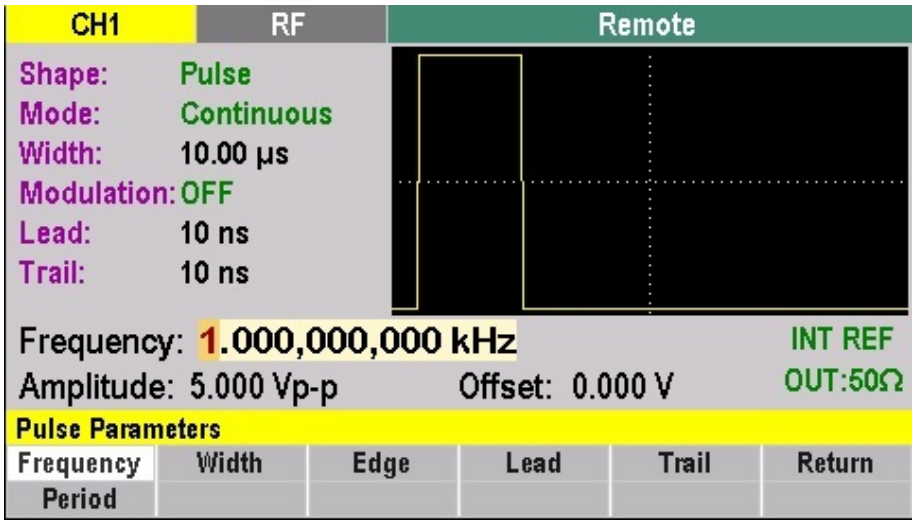


Figure 11.1 Pulse Wave

Parameter	Description
Frequency/Period	Set the signal frequency or period.
Width	Set the pulse width for the Pulse waveform.
Edge	Set the edge for the Pulse waveform.
Lead/Trail	Set the lead/trial for the Pulse waveform.
Fast Edges	Enable fast edge.
Amplitude	Set the signal amplitude or high level.
Offset	Set the signal offset or low level.

Table 11.1 Pulse Wave Parameters

11.1 Frequency / Period

Frequency is one of the most important parameters of basic waveforms. For different instrument models and waveforms, the available ranges of frequency are different. The 4088 has a range of 1 μHz to 50 MHz, while the 4089 has a range of 1 μHz to 80 MHz. The default frequency is 1 kHz.
To configure the frequency or period of the waveform:

Step 1. Press the WAVE button then use the soft keys to select **Pulse > Frequency**.
- The frequency shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Toggle between **Period** and **Frequency** by pressing softkey corresponding to **Frequency/Period**.
- The current value for the waveform's Period will now displayed in inverse color.

Step 3. Input the desired frequency/Period.

Step 4. Use the numeric keyboard to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

WARNING

When using the numeric keyboard to enter the value, the left arrow key can be used to move the cursor backward and delete the value of the previous digit.

11.2 Width

To selects the width of the pulse:

Press the WAVE button then use the soft key to select **Pulse** > **Width**.

Step 1. The width shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired width.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- s
- ms
- μs
- ns

Step 4. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

11.3 Edge

To select equal Rise (Leading edge) and Fall (Trailing edge) times of the pulse:

Press the WAVE button then use the soft key to select **Pulse** > **Edge**.

Step 1. The edge shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired edge.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- s
- ms
- μs
- ns

Step 4. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

11.4 Lead/Trial

To selects different Rise and Fall times of the Pulse:

Press the WAVE button then use the soft key to select **Pulse** > **Lead/Trial**.

Step 1. The rise and fall time shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Toggle between **Lead** and **Trial** by pressing softkey corresponding to **Lead/Trial**.

Step 3. Input the desired rise and fall time.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- s
- ms
- μs
- ns

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

11.5 Fast Edges

To set the lead and trail times to the fastest available time (5 ns):

Step 1. Press the WAVE button then use the soft key to select **Pulse** > **Fast Edge**.

11.6 Amplitude

To set the amplitude:

Press the PARAM button then use the soft key to select **Amplitude**.

Step 1. The amplitude shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Amplitude** softkey again to switch into the **Amplitude** parameter if **Offset** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- Vp-p
- mVp-p
- Vrms
- mVrms
- dBm

11.7 Offset

The default value is 0 Vdc.
To set the offset:
Press the PARAM button then use the soft key to select **Offset**.

Step 1. The offset shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Offset** softkey again to switch into the **Offset** parameter if **Amplitude** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric Keypad to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

- V
- mV

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

11.8 Change Unit

Press the corresponding softkey, **F4**, to toggle between the units of the **Amplitude**:

- Vp-p
- dBm
- mVrms

11.9 50 Ω/ HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected; 50 Ω path to match impedance and avoid reflections and other mismatch effects).
To set the internal impedance:
Press the PARAM button then use the soft key to select **50 Ω/ HI-Z**.

Step 1. Toggle the **50 Ω/ HI-Z** softkey to switch between 50 Ω and HI-Z. (The current operation is highlighted in a white color).

11.10 Int. Ref./Ext. Ref.

Selects internal or external reference source (the external reference must be connected to the rear panel Ref In connector).
Press the PARAM button then use the soft key to select **Int. Ref./Ext. Ref.**.

Step 1. Toggle the **Int. Ref./Ext. Ref.** softkey to switch between internal reference and external reference. (The current operation is highlighted in a white color).

ARB Wave

The Arb signal consists of two types: the system's built-in waveforms and the user-defined waveforms. Built-in waveforms are stored in the internal non-volatile memory.

Press the WAVE button then use the softkey **F5** to select **ARB**. The screen shown in figure **12.1** will be displayed. The parameters available for the ARB waveforms include frequency, rate, load temp, amplitude, offset, save temp, settings, and edit.

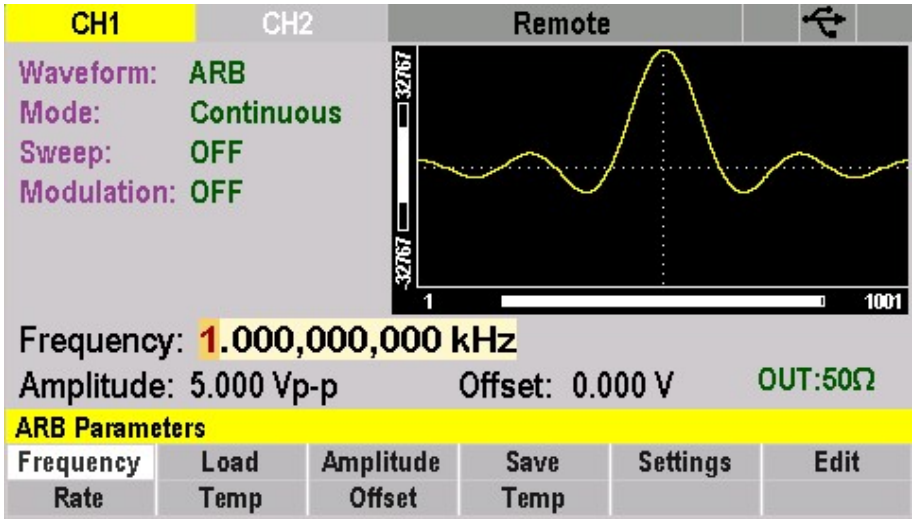


Figure 12.1 ARB Wave

Parameter	Description
Frequency	Set the signal frequency.
Rate	Set the duty cycle for the ARB waveform.
Load Temp	Load a waveform template.
Amplitude	Set the signal amplitude.
Offset	Set the signal offset.
Save Temp	Save the set parameters of the waveform as a template.
Settings	Enter the arbitrary waveform settings.
Edit	Edit the arbitrary wave.
50 Ω/ HI-Z	Change the impedance.
Int. Ref./Ext. Ref.	Change the reference of the unit.

Table 12.1 ARB Wave Parameters

12.1 Frequency

Frequency is one of the most important parameters of basic waveforms. For different instrument models and waveforms, the available ranges of frequency are different. The 4088 has a range of 1 μHz to 50 MHz, while the 4089 has a range of 1 μHz to 80 MHz. The default frequency is 1 kHz.

To select the **ARB Waveform**: Press the WAVE button then use the soft key to select **ARB**.

To configure the frequency of the waveform:

Step 1. Press the PARAM button then use the soft key to select **ARB > Frequency**.
- The frequency shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Input the desired frequency.

Step 3. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- MHz
- KHz
- Hz
- mHz

Step 4. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

WARNING

When using the numeric Keypad to enter the value, the left arrow key cannot be used to move the cursor backward and edit the value of the previous digit.

12.2 Rate

Selects and displays the Point Rate (Arb Mode Only). The Rate parameter governs the rate at which waveform points are executed, and thus the frequency of the waveform output. When you set this parameter, the waveform generator will keep that execution rate for all waveform lengths until it is changed. To set the rate:

Step 1. Press the WAVE button then use the soft key to select **ARB > Rate**.
- The rate shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Frequency/Rate** softkey again to switch into the **Rate** parameter if **Frequency** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired rate.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- s
- ms
- μs
- ns

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

12.3 Save Temp

To save a waveform temporarily:

Step 1. Press the WAVE button then use the soft key to select **ARB > Save Temp**.

The information will be saved in volatile memory. The information will be retained temporarily but will be lost after boot up or NISPOM.

12.4 Load Temp

To load an arbitrary waveform that was temporarily save:

Step 1. Press the WAVE button then use the soft key to select **ARB > Load Temp**.

12.5 Amplitude

To set the amplitude:

Step 1. Press the PARAM button then use the soft key to select **Amplitude**.
- The amplitude shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Amplitude** softkey again to switch into the **Amplitude** parameter if **Offset** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric keypad to input the parameter value directly, and press the corresponding key to select the parameter unit.

- Vp-p
- mVp-p
- Vrms
- mVrms
- dBm

The following equation represents the relative output amplitude voltage relationship between the front-panel amplitude peak-to-peak setting and the data point values in ARB waveform memory:

$$\text{Output Voltage} = \frac{\text{Amplitude pp setting} \times \text{data point value}}{65536} + \text{Offset}$$

Where 65536 is the total data point value range in waveform memory.

Front Panel Amplitude Settings	Data Point Value	Relative Output Amplitude Voltage
4 Vp-p	- 8191	- 1 V
5 Vp-p	32767	+ 2.5 V
5 Vp-p	16384	+1.25 V
5 Vp-p	0	0 V (offset voltage)
9 Vp-p	- 32767	- 4.5 V

Table 12.2 Output Voltage Examples

12.6 Offset

The default value is 0 Vdc.
To set the offset:

Step 1. Press the PARAM button then use the soft key to select **Offset**.
- The offset shown on the screen when the instrument is powered on is the default value or the set value of last power down.

Step 2. Press the **Offset** softkey again to switch into the **Offset** parameter if **Amplitude** was the chosen parameter (the current operation is highlighted in a white color).

Step 3. Input the desired amplitude.

Step 4. Use the numeric Keypad to input the parameter value directly, and press the corresponding softkey to select the parameter unit.

- V
- mV

Step 5. Or use the arrow keys to select the digit to edit, and then use the knob to change its value.

12.7 50 Ω/ HI-Z

Selects the amplitude voltage value based on the two different impedance termination (i.e. if connected to oscilloscope with 1 MΩ input impedance, generator will display the correct amplitude value for 1 MΩ termination when HI-Z is selected; 50 Ω path to match impedance and avoid reflections and other mismatch effects).
To set the impedance:

Step 1. Press the PARAM button then use the soft key to select **50 Ω/ HI-Z**.

Step 2. Toggle the **50 Ω/ HI-Z** softkey to switch between 50 Ω and HI-Z. (The current operation is highlighted in a white color).

12.8 Int. Ref./Ext. Ref.

Selects internal or external reference source (the external reference must be connected to the rear panel Ref In connector).

Step 1. Press the PARAM button then use the soft key to select **Int. Ref./Ext. Ref.**.

Step 2. Toggle the **Int. Ref./Ext. Ref.** softkey to switch between Internal reference and external reference. (The current operation is highlighted in a white color).

12.9 Settings

To enter the **Arbitrary Settings Menu**:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

In the **Arbitrary Settings Menu** the following parameters can be configured:

- Start
- Length
- Marker
  - Mark Addr
  - Mark Len
  - Full Screen
- Delete Temp

12.9.1 Start

To select the starting address of the arbitrary waveform:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Start/Length** softkey to toggle to the **Start** function. (The current operation is highlighted in a white color).

Step 3. Input the starting address.
- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

12.9.2 Length

To select the length of the arbitrary waveform:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Start/Length** softkey to toggle to the **Length** function. (The current operation is highlighted in a white color).

Step 3. Input the length value.
- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

WARNING **The maximum Length allowed depends on the instrument model.**

12.9.3 Marker

The marker output feature generates a positive TTL level output signal at the points specified by address and length.
To select the marker output address of the signal:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

The following parameters are available in the **Marker Menu**:

- **Mark Addr**
- **Mark Len**
- **On/Off**
- **Full Screen**

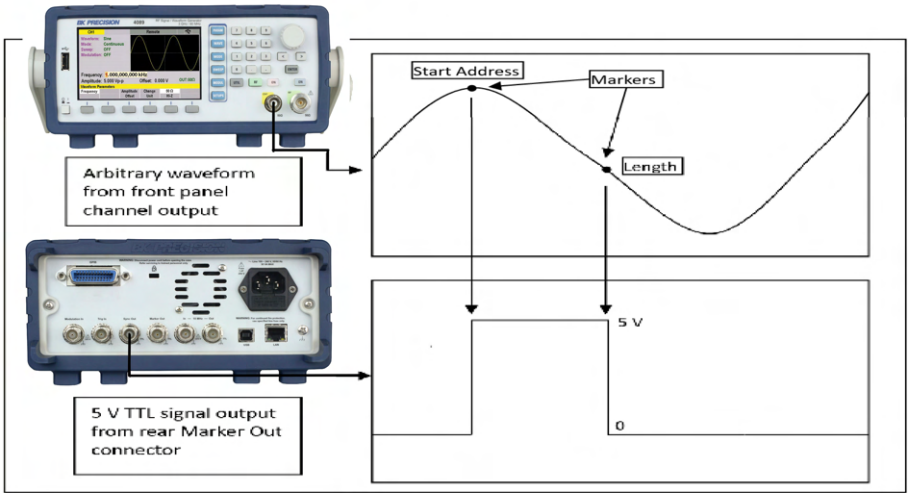


Figure 12.2 Marker Output Address

Mark Address

To set a marker on the waveform:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Mark Addr** softkey to set the address of the marker.

- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

WARNING **The range of the Mark Addr will vary based on the length of the waveform.**

Mark Len

To set the range (length) of the marker signal:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Mark Len** softkey to set the length of the marker.
- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

On/Off

To toggle the marker on and off:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **On/Off** softkey to toggle the marker **On** and **Off**. (The selected function will be highlighted in white.)

WARNING **The maximum Length allowed to be set for the marker is 4000 points, regardless of the total length of the waveform.**

Full Screen

Full Screen will allow to see the Marker with larger resolution and marker location on the waveform. To select full screen view and enter the **Full Screen Menu**:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter full screen mode and **Full Screen Menu**.

12.9.1 Full Screen Menu

The **Full Screen Menu** contains the following settings:

- **Mark Addr**
- **Mark Len**
- **On/Off**
- **Navigation**

Mark Address

To set a marker on the waveform:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Mark Addr** softkey to set the address of the marker.
- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

WARNING **The range of the Mark Addr will vary based on the length of the waveform.**

Mark Len

To set the range of the marker:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Mark Len** softkey to set the length of the marker.
- Use the numeric keypad to input the parameter value directly.
- Or use the rotary knob to change its value.

On/Off

To toggle the marker on and off:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **On/Off** softkey to toggle the marker **On** and **Off**. (The selected function will be highlighted in white.)

WARNING **The maximum Length allowed to be set for marker is 4000, regardless of the length of the waveform.**

Show/Hide

Display or hide the Marker as well as its parameters. Hiding the marker and its parameters allows for a complete view of the waveform in **Full Screen Mode**.
To toggle the marker:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Show/Hide** softkey to toggle the marker and the box displaying its parameters.

12.9.1 Navigation

To enter the **Navigation Menu**:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

The **Navigator Menu** contains the following settings:

- **Zoom X**
- **Zoom Y**
- **Pan X**
- **Pan Y**
- **Coarse**
- **Fine**
- **Reset**

Zoom X

To zoom in horizontally:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Zoom X** softkey.
- Use the rotary knob to zoom in (clockwise) and out (counter-clockwise).
- Select **Coarse/Fine** to determine how Zoom X is affected.

Zoom Y

To zoom in vertically:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Zoom Y** softkey.
- Use the rotary knob to zoom in (clockwise) and out (counter-clockwise).
- Select **Coarse/Fine** to determine how Zoom Y is affected.

Pan X

To pan horizontally:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Pan X** softkey.
- Use the rotary knob to pan horizontally (clockwise and counter-clockwise).

Pan Y

To pan vertically:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Pan Y** softkey.
- Use the rotary knob to pan vertically (clockwise and counter-clockwise).

Coarse

To set the navigation adjustment to coarse mode:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Coarse** softkey to enable large-step adjustments for Zoom and Pan functions.

Fine

To set the navigation adjustment to fine mode:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Fine** softkey to enable small-step, high-precision adjustments for Zoom and Pan functions.

Reset

To reset all navigation and zoom settings:

Step 1. Press the WAVE button then use the soft key to select **ARB > Settings**.

Step 2. Press the **Marker** softkey to enter the **Marker Menu**.

Step 3. Press the **Full Screen** softkey to enter the **Full Screen Menu**.

Step 4. Press the **Navigator** softkey.

Step 5. Press the **Reset** softkey to return the view to default parameters.

12.10 Edit

Arbitrary waveforms are created by entering data points into memory. You can enter data point by point, draw a line between two specified points, or use predefined waveform shapes. These methods can be combined to create complex custom signals.

Valid data values range from -32,767 to 32,767. This value governs the output amplitude of the point, scaled to the instrument settings: * **32767**: Positive peak amplitude. * **0**: Waveform offset. * **-32767**: Negative peak amplitude.

Memory addresses range from 1 to the maximum length supported by the instrument model.

To enter the **Waveform Editing mode**:

Step 1. Press the WAVE button then use the soft key to select **ARB > Edit**.

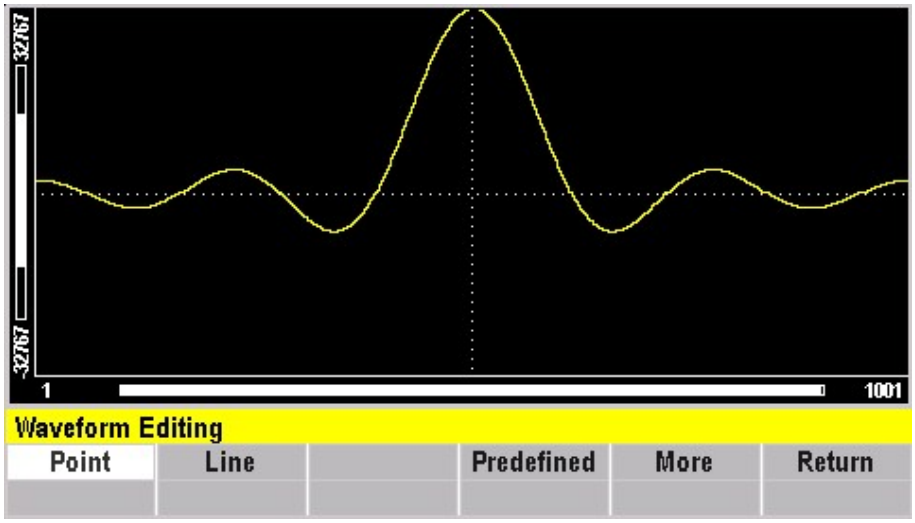


Figure 12.3 ARB Editing Menu

- **Point**
- **Line**
- **Predefined**
- **More**

12.10.1 Point

The **Point Menu** allows for specific editing of individual memory addresses.
To enter the **Point Menu**:

Step 1. Press **ARB** > **Edit** > **Point**.

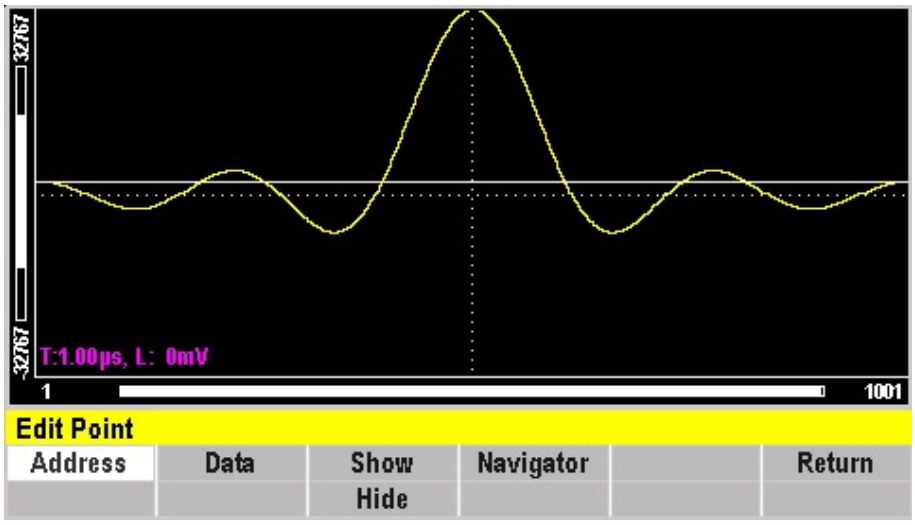


Figure 12.4 Point Menu

- **Point Addr**
- **Data**
- **Show/Hide**
- **Navigation**

Point Address

To select the target address in memory:

Step 1. Press the **Addr** softkey.

Step 2. Use the numeric keypad for direct input or the rotary knob for incremental changes.

Data

To set the amplitude value for the selected address:

Step 1. Press the **Data** softkey.

Step 2. Input the value (-32,767 to 32,767) using the keypad or rotary knob.

Show/Hide

To toggle the visibility of the point information box:

Step 1. Press the **Show/Hide** softkey to toggle the display.

Step 2. Rotate the knob to adjust the transparency of the information box.

12.10.1 Line

The **Line Menu** creates a linear interpolation between two points.
To enter the **Edit Line Menu**:

Step 1. Press **ARB** > **Edit** > **Line**.

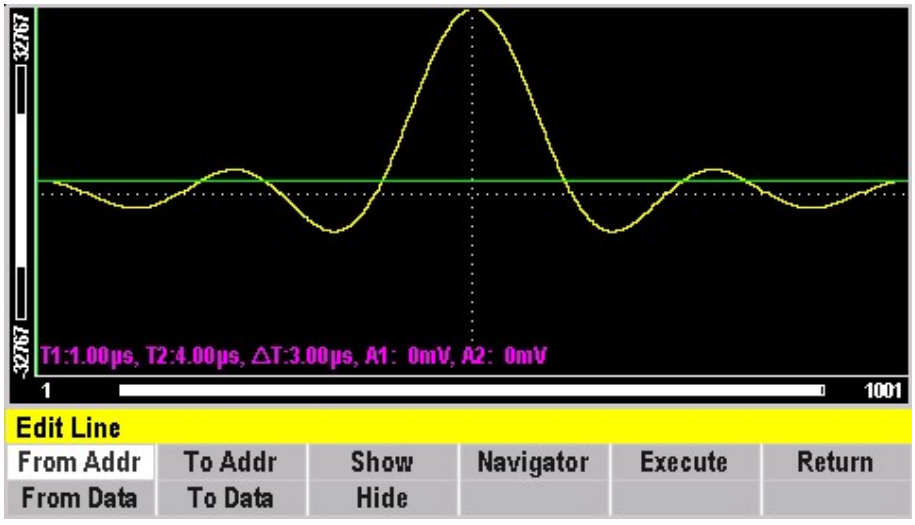


Figure 12.5 Line Menu

- From Addr/Data
- To Addr/Data
- Show/Hide
- Navigation
- Execute

From Addr/From Data

To define the starting point of the line:

Step 1. Press the **From Addr/From Data** softkey to toggle between address and data value.

Step 2. Input the desired value.

To Addr/To Data

To define the endpoint of the line:

Step 1. Press the **To Addr/To Data** softkey to toggle between address and data value.

Step 2. Input the desired value.

Show/Hide

Toggles the display and transparency of the line coordinate information box using the softkey and rotary knob.

Execute

Applies the line segment to the waveform memory based on the defined "From" and "To" points.

12.10.1 Predefined

Use built-in shapes as templates for custom waveforms.
To enter the **Edit Predefined Menu**:

Step 1. Press **ARB** > **Edit** > **Predefined**.

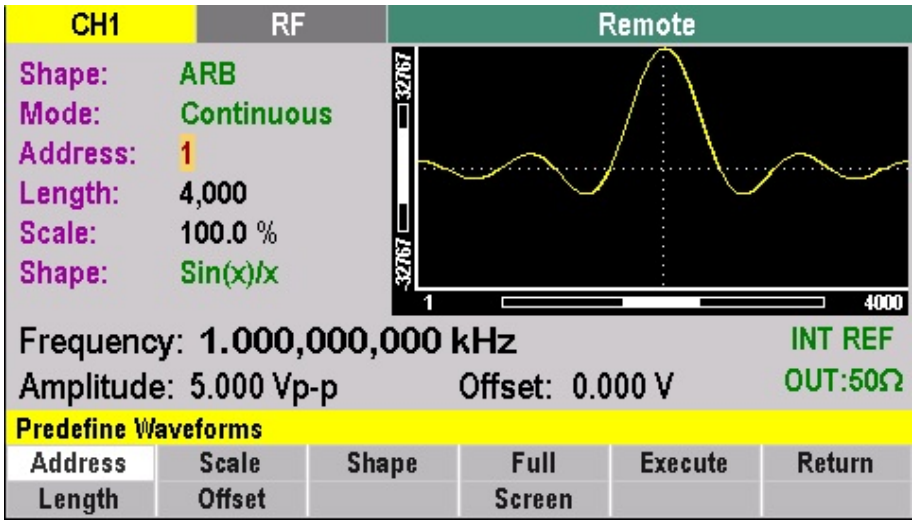


Figure 12.6 ARB Edit Predefined

- **Address**
- **Length**
- **Scale**
- **Offset**
- **Show/Hide**
- **Shape**

Address

Sets the starting address for the predefined wave.

WARNING **Changing the starting address affects the scale and offset calculations of the shape.**

Length

Defines the point count for one cycle of the shape.

WARNING **Length must be divisible by 4 (Sine/Triangle/Noise) or 2 (Square).**

Shape	Min Length	Divisibility
Sine	16	4
Triangle	16	4
Square	2	2
Noise	16	4

Table 12.3 Waveform Length Requirements

Scale

Sets the vertical scaling (0-100%) of the shape relative to the peak-to-peak range.

Predefined Offset

Sets the data point value used as the starting vertical offset for the shape.

Predefined Shape

Step 1. Press **Shape** to open the selection gallery.

Step 2. Highlight the wave with the knob and press **Select**.

Step 3. Press **Execute** to write the shape to memory.

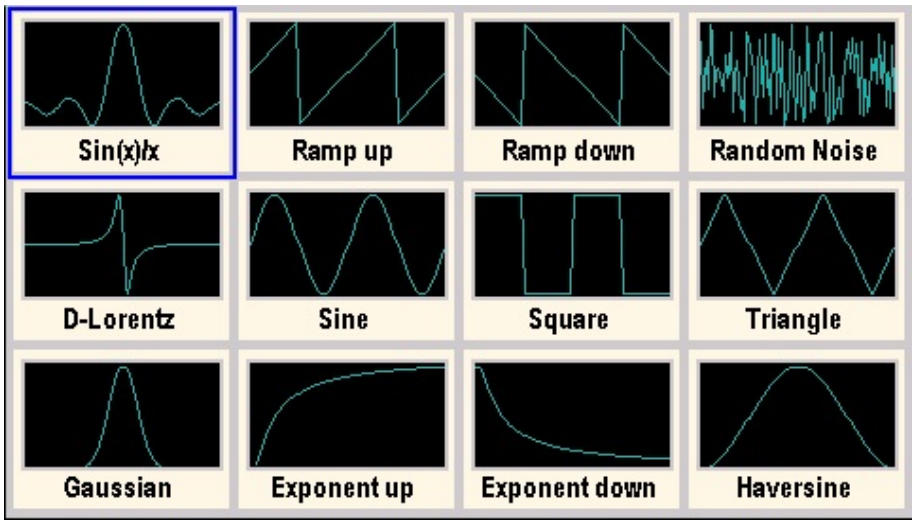


Figure 12.7 ARB Shape Menu

12.10.1 More

Access advanced memory management and file operations.

Step 1. Press **ARB** > **Edit** > **More**.

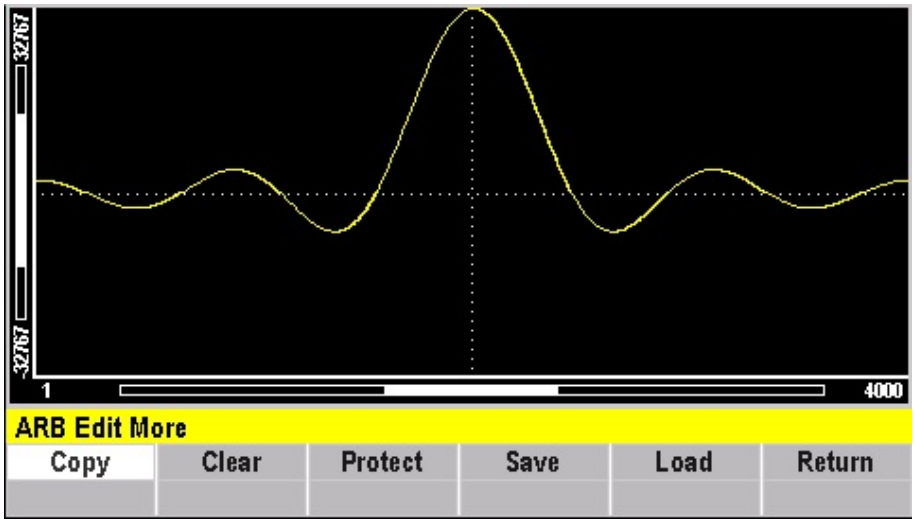


Figure 12.8 ARB More Menu

- **Copy**
- **Clear**
- **Protect**
- **Save**
- Load

Copy

Copies a memory segment to a new location.

Step 1. Set **From** (Start), **Copy Length**, and **Copy To** (Dest).

Step 2. Press **Execute**.

Clear

Sets data values to 0 for a specified range.

WARNING **To clear the entire memory, set Start Addr to Min and End Addr to Max.**

Protection

Protects a section of memory from being overwritten (read-only). Toggle **On/Off** and press **Update** to apply.

Save

Saves the current edits to internal memory or a flash drive.

WARNING **Unsaved edits will be lost when switching waveforms.**

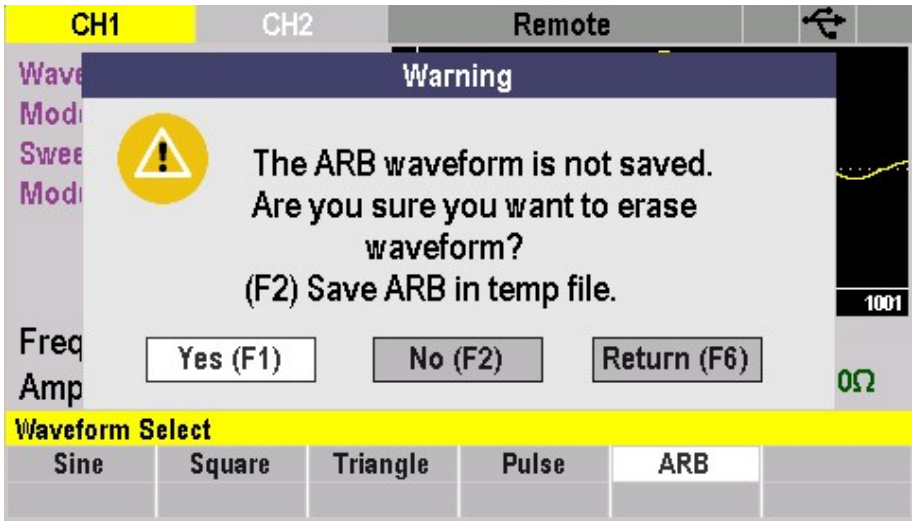


Figure 12.9 ARB Save Warning

MODE Key

Press the MODE button to select the output mode.

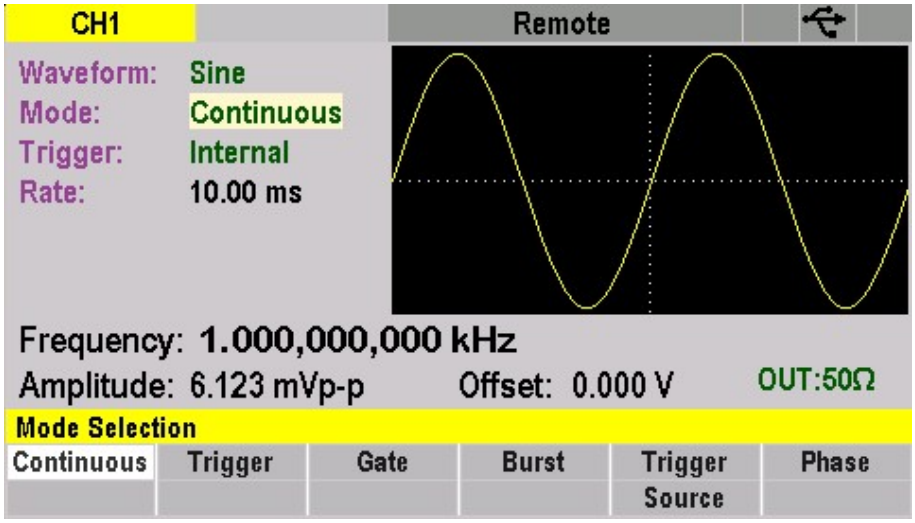


Figure 13.1 Output Modes Menu

- **Continuous**
- **Triggered**
- **Gated**
- **Burst**
- **Trigger Source**

13.1 Continuous

The waveform is outputted continuously without interruption.
To select **Continuous** mode:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Continuous**.

13.2 Trigger

In **Trigger Mode**, the waveform output is controlled by one of three trigger sources. Detailed information on these sources can be found in the **Trigger Source** section.
To select **Trigger** mode:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Trigger**.

13.3 Gated

In gated mode, the generator controls the waveform output according to the gate signal level. The menu identifies high level as **POS** and low level as **NEG**.
To select **Gated** mode:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Gate**.

- **External POS**: When the gated signal is "high", the generator outputs a continuous waveform. When the gated signal is "low", the generator first completes the output of the current period and then stops.
- **External NEG**: When the gated signal is "low", the generator outputs a continuous waveform. When the gated signal is "high", the generator first completes the output of the current period and then stops.

13.4 Burst

The Burst function generates a specific number of waveform cycles for each trigger event. Burst times last for a set number of waveform cycles.
To select **Burst** mode:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Burst**.

Step 3. Set the number of cycles (**N-Count**), adjustable from 2 to 999,999.

13.5 Trigger Source

Trigger events can be initiated in three ways: **Manual**, **Internal Rate**, and **External**.

Manual

A burst or triggered waveform is generated from the corresponding channel only when the user manually triggers the instrument.
To select **Manual** trigger:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Trigger Source** > **Manual**.

Step 3. Press the **Trigger** softkey to generate the event.

Internal Rate

The generator outputs continuous burst waveforms automatically based on an internal timer.
To select **Internal** trigger:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Trigger Source** > **Internal**.

Step 3. Change the internal trigger rate using the rotary knob or numeric keypad.

External

The generator accepts a trigger signal through the **TRIG IN** connector on the rear panel.
To select **External** trigger:

Step 1. Press the MODE button.

Step 2. Use the soft keys to select **Trigger Source** > **External**.

Step 3. Use the **POS / NEG** softkey to select the active level of the external trigger signal.

- **POS**: Specifies a high level to trigger the burst.
- **NEG**: Specifies a low level to trigger the burst.

Sweep Key

In **Sweep Mode**, the generator steps from the start frequency to the stop frequency over a specified sweep time. The waveforms that support the sweep function include Sine, Square, and Triangle.
To select the **Sweep Mode**:

Step 1. Press the SWEEP button.

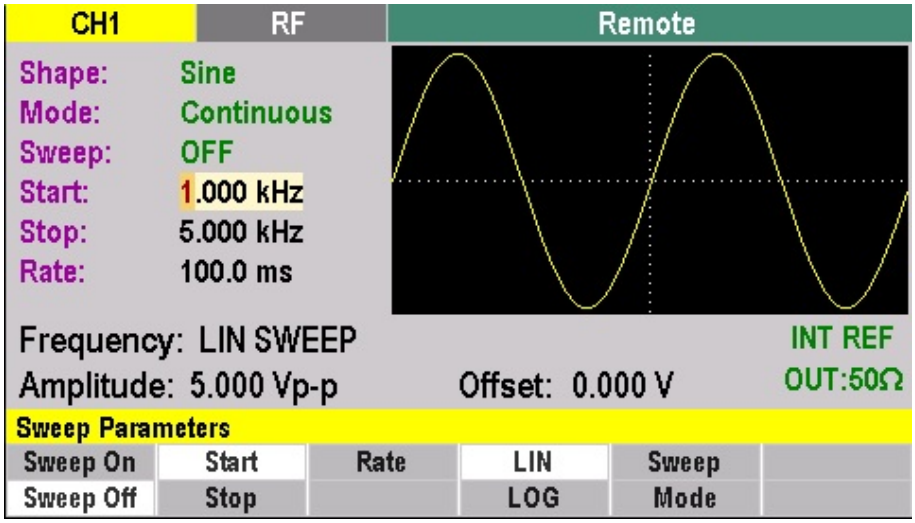


Figure 14.1 Sweep Mode Menu

Parameter	Description
Sweep On/Off	Toggle to enable or disable sweep mode.
Start/Stop	Toggle to set the start and stop frequencies.
Rate	Set the sweep rate.
LIN/LOG	Select between Linear or Logarithmic sweep spacing.
Sweep Mode	Select the operational sweep mode (Continuous, Trigger, Gate, Burst).

Table 14.1 Sweep Parameters

14.1 Sweep On/Off

To toggle the sweep function:

Step 1. Press the SWEEP button.

Step 2. Use the **Sweep On/Sweep Off** softkey to enable or disable the function.

WARNING **Sweep is not available for Pulse or ARB waveforms.**

14.2 Start/Stop

To set the frequency boundaries for the sweep:

Step 1. Press the SWEEP button.

Step 2. Use the **Sweep Start/Stop** softkey to toggle between **Start** and **Stop**.
- The selected parameter will be highlighted in white.

Step 3. Input the desired frequency value.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

14.3 Rate

To set the sweep rate:

Step 1. Press the SWEEP button.

Step 2. Use the soft keys to select **Rate**.

Step 3. Input the desired rate value.
- Use the numeric keypad to input the value directly, then press the corresponding softkey for the unit.
- Or use the arrow keys and the rotary knob to adjust the value.

14.4 LIN/LOG

This setting determines the spacing of the frequency steps during the sweep.
To select linear or logarithmic sweep:

Step 1. Press the SWEEP button.

Step 2. Use the **LIN/LOG** softkey to toggle between **LIN** (Linear) and **LOG** (Logarithmic).
- The selected parameter will be highlighted in white.

14.5 Sweep Mode

By default, enabling the sweep function sets the instrument to a continuous sweep.
To configure advanced sweep modes:

Step 1. Ensure **Sweep** is enabled.

Step 2. Follow the procedures outlined in the **MODE Key** chapter to select a specific mode (Triggered, Gated, or Burst).

Modul Key

The 4088/89 series can generate AM, FM, FSK, PWM, PM, and BPSK modulated waveforms. Modulating parameters vary depending on the type of modulation selected.
To enter the **Modulation Menu**:

Step 1. Press the MODUL button.

- **AM**
- **FM**
- **FSK**
- **PWM**
- **PM**
- **BPSK**

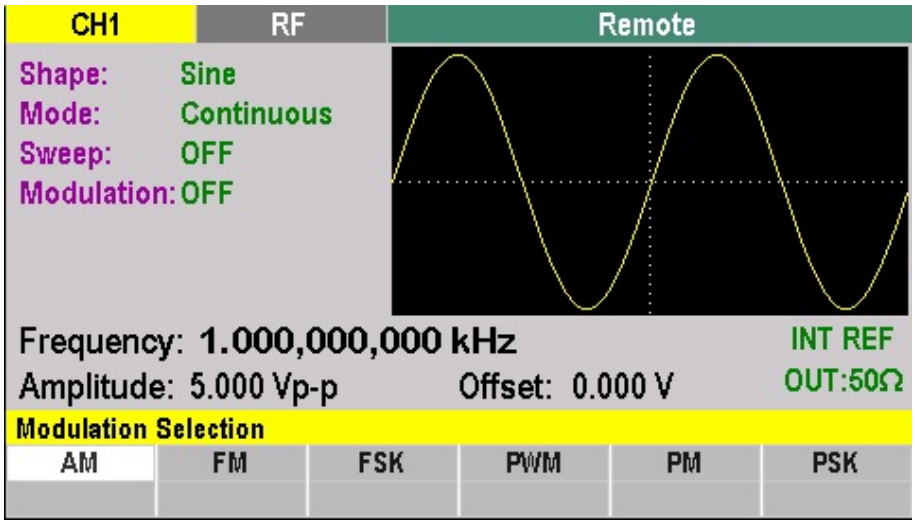


Figure 15.1 Modulation Menu

The available modulation modes vary depending on the basic waveform chosen. Refer to the table below for compatibility.

Modulation	SINE	SQUARE	TRIANGLE	PULSE	ARBITRARY
AM	YES	YES	YES	YES	YES
FM	YES	YES	YES	NO	NO
FSK	YES	YES	YES	NO	NO
PWM	NO	YES	NO	NO	NO
PM	YES	YES	YES	NO	NO
BPSK	YES	YES	YES	NO	NO

Table 15.1 Modulation Combinations

15.1 AM

The modulated waveform consists of two parts: the carrier and the modulating waveform. In Amplitude Modulation (AM), the amplitude of the carrier varies with the instantaneous voltage of the modulating waveform.
To enter the **AM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM**.

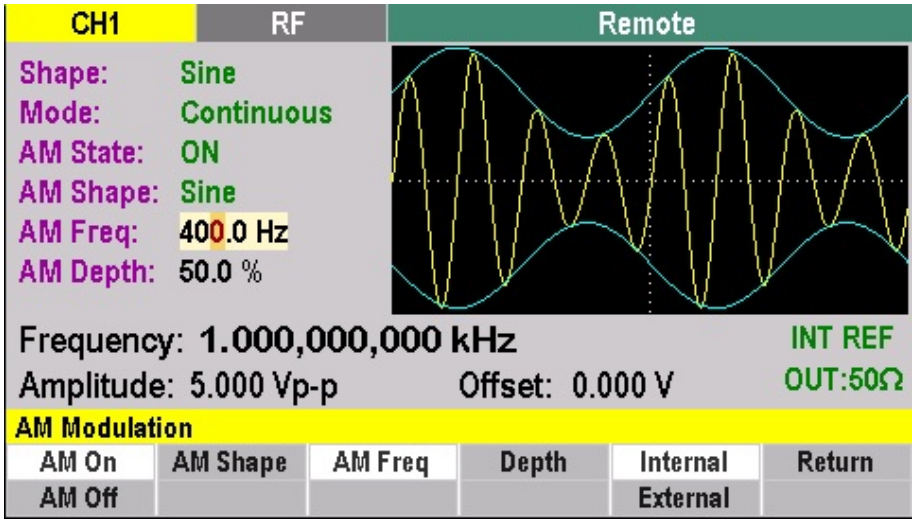


Figure 15.2 AM Menu

AM On/Off

To toggle the AM function:

Step 1. Press the MODUL button.

Step 2. Use the **AM On/AM Off** softkey to enable or disable the modulation.

AM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

AM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 20.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM Frequency**.

Step 3. Enter the desired modulation frequency.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

Depth

Modulation depth is expressed as a percentage and indicates the degree of amplitude variation. AM modulation depth can be set from 1% to 100%.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Depth**.

Step 3. Enter the desired depth percentage.
- Use the numeric keypad to input the value directly, followed by the % softkey.
- Or use the arrow keys and rotary knob to adjust the value.

Internal/External

The generator can modulate the carrier using either its internal oscillator or an external signal.

- **Internal**: The modulating waveform is generated by the instrument. Use the **AM Shape** softkey to select the waveform.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The amplitude of the carrier is controlled by the voltage level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
- The selected modulation source will be highlighted in white.

15.2 FM

The modulated waveform consists of two parts: the carrier and the modulating waveform. In Frequency Modulation (FM), the frequency of the carrier varies with the instantaneous voltage of the modulating waveform.
To enter the **FM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM**.

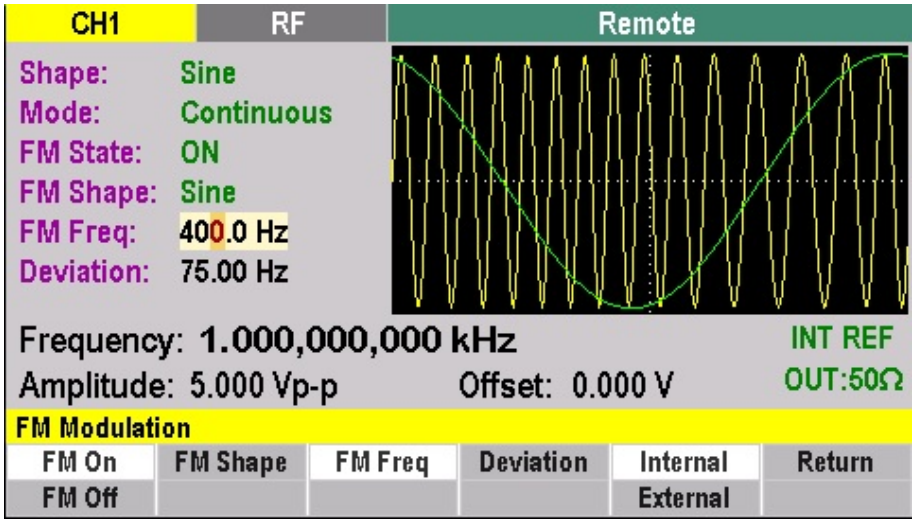


Figure 15.3 FM Menu

FM On/Off

To toggle the FM function:

Step 1. Press the MODUL button.

Step 2. Use the **FM On/FM Off** softkey to enable or disable the modulation.

FM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

FM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 20.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM Frequency**.

Step 3. Enter the desired modulation frequency.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

Deviation

Frequency deviation represents the maximum variation in frequency from that of the carrier wave.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Deviation**.

Step 3. Enter the desired frequency deviation.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys and rotary knob to adjust the value.

WARNING **The maximum deviation is half the maximum frequency of the instrument.**

Internal/External

The generator can modulate the carrier using either its internal oscillator or an external signal.

- **Internal**: The modulating waveform is generated by the instrument. Use the **FM Shape** softkey to select the waveform.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The frequency of the carrier is controlled by the voltage level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
– The selected modulation source will be highlighted in white.

15.3 FSK

FSK (Frequency Shift Keying) is a modulation scheme where the output frequency switches between two preset frequencies: the carrier frequency and the hop frequency (commonly referred to as mark and space frequencies).
To enter the **FSK Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FSK**.

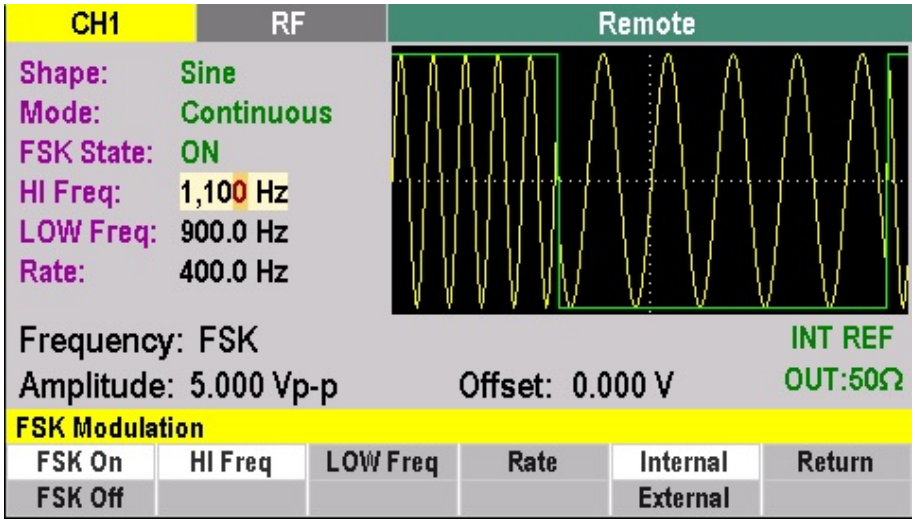


Figure 15.4 FSK Menu

FSK On/Off

To toggle the FSK function:

Step 1. Press the MODUL button.

Step 2. Use the **FSK On/FSK Off** softkey to enable or disable the modulation.

HI Freq

To set the high frequency (hop frequency) of the FSK signal:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **HI Freq**.

Step 3. Input the desired frequency value.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys and rotary knob to adjust the value.

LOW Freq

To set the low frequency (carrier frequency) of the FSK signal:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **LOW Freq**.

Step 3. Input the desired frequency value.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys and rotary knob to adjust the value.

Rate

Sets the rate at which the output switches between the low and high frequencies.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Rate**.

Step 3. Input the desired rate.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys and rotary knob to adjust the value.

Internal/External

The generator can switch frequencies based on either an internal clock or an external signal.

- **Internal**: The switching rate is governed by the internal generator settings. Use the Shape softkey to select the modulating waveform shape.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The output frequency is controlled by the logic level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
- The selected modulation source will be highlighted in white.

15.4 PWM

PWM (Pulse Width Modulation) uses a pulse carrier waveform to control average voltage by varying the duty cycle of the signal. The width of the pulse varies according to the instantaneous voltage of the modulating signal.
To enter the **PWM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PWM**.

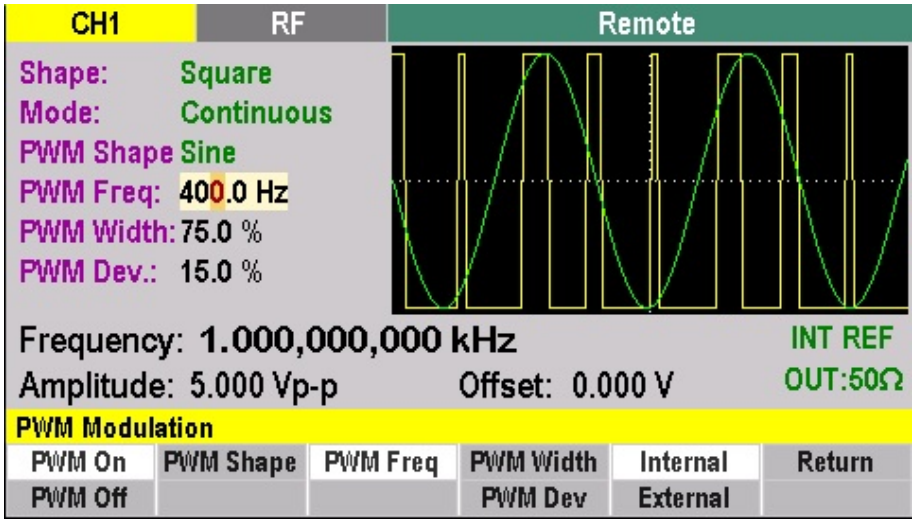


Figure 15.5 PWM Menu

PWM On/Off

To toggle the PWM function:

Step 1. Press the MODUL button.

Step 2. Use the **PWM On/PWM Off** softkey to enable or disable the modulation.

PWM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PWM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

PWM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 20.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PWM Frequency**.

Step 3. Enter the desired modulation frequency.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

PWM Width/PWM Dev

This parameter sets the base pulse width and the maximum width deviation.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PWM Width/PWM Dev** to toggle between the two parameters.
- The selected parameter will be highlighted in white.

Step 3. Enter the desired percentage (0% to 100%).
- Use the numeric keypad for direct input or the rotary knob to adjust the value.

WARNING **The sum of the pulse Width + Deviation is limited to 100%.**

Internal/External

The generator can modulate the pulse width using either its internal oscillator or an external signal.

- **Internal**: The modulating waveform is generated by the instrument. Use the **PWM Shape** softkey to select the waveform.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The pulse width is controlled by the voltage level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
- The selected modulation source will be highlighted in white.

15.5 PM

PM (Phase Modulation) consists of two parts: the carrier and the modulating waveform. In Phase Modulation, the phase of the carrier varies in proportion to the instantaneous voltage level of the modulating waveform.
To enter the **PM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM**.

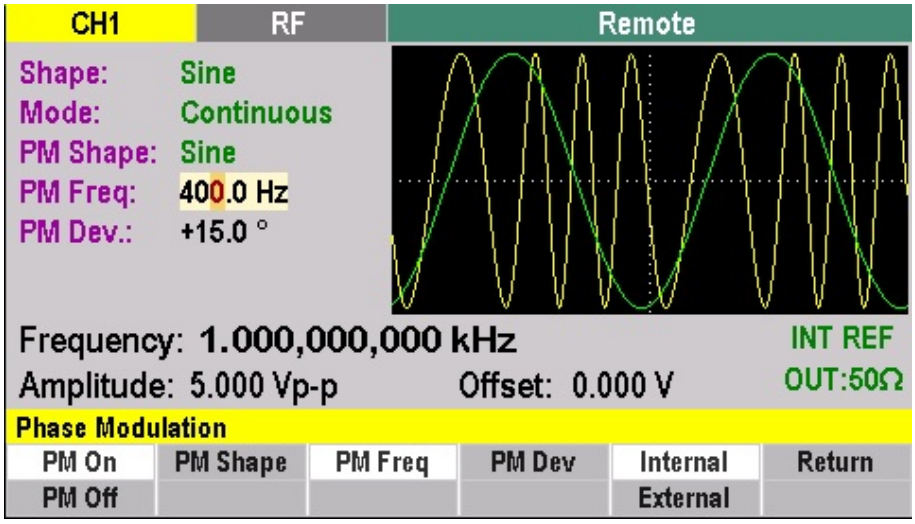


Figure 15.6 PM Menu

PM On/Off

To toggle the PM function:

Step 1. Press the MODUL button.

Step 2. Use the **PM On/PM Off** softkey to enable or disable the modulation.

PM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

PM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 20.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Shape**.

Step 3. Enter the desired modulation frequency.
- Use the numeric keypad to input the value directly, then press the corresponding softkey to select the unit.
- Or use the arrow keys to select the digit to edit and use the knob to change its value.

Phase Deviation

Phase deviation represents the maximum variation in phase relative to the carrier phase. The deviation can be set from 0° to 360°.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Dev**.

Step 3. Enter the desired phase deviation.
- Use the numeric keypad to input the value directly.
- Or use the arrow keys to select the digit to edit and use the knob to change its value.

Internal/External

The generator can modulate the carrier phase using either its internal oscillator or an external signal.

- **Internal**: The modulating waveform is generated by the instrument. Use the **PM Shape** softkey to select the waveform.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector at the rear panel. The phase of the carrier is controlled by the voltage level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkeys to toggle between **Internal** and **External**.
- The selected modulation source will be highlighted in white.

15.6 BPSK

BPSK (Binary Phase Shift Keying) is a digital modulation scheme where the phase of the carrier waveform switches between two preset phase settings (High Phase and Low Phase) based on a modulating signal.
To enter the **BPSK Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **BPSK**.

Hi. Phase/Lo. Phase

This parameter sets the two phase states used for the modulation, adjustable from 0° to 360°.

Step 1. Press the MODUL button.

Step 2. Use the **Hi. Phase/Lo. Phase** softkey to toggle between the two phase settings.
- The selected parameter will be highlighted in white.

Step 3. Enter the desired phase value.
- Use the numeric keypad to input the value directly.
- Or use the arrow keys to select a digit and the rotary knob to change its value.

Rate

The rate determines how frequently the output alternates between the High and Low phase settings.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Rate**.

Step 3. Enter the desired modulation rate.
- Use the numeric keypad to input the value, then select the unit via the softkeys.
- Or use the arrow keys and rotary knob to adjust the value.

Internal/External

The generator can switch phase states based on either an internal oscillator or an external trigger signal.

- **Internal**: The switching rate is governed by the internal rate setting defined in the menu.
- **External**: The generator accepts an external trigger signal from the **Trig In** connector on the rear panel. The phase shift is controlled by the signal level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the two sources.
- The selected modulation source will be highlighted in white.

Setups Key

The waveform generator can store the current front-panel configuration, referred to as a "setup," into one of 50 internal storage locations. Recalling a setup restores the instrument to the exact state saved in that location.

All parameters, including frequency, amplitude, and modulation settings, are preserved. However, actual waveform memory data (the raw points for arbitrary waves) is not included in a setup file.

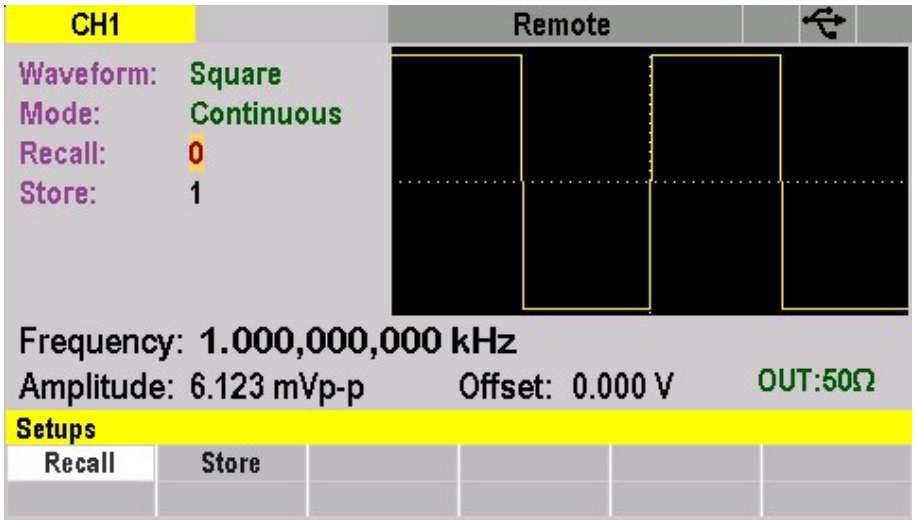


Figure 16.1 Setups Key Menu

16.1 Recall

Recalls a previously saved front-panel setup from a selected storage location.

To recall a setup:

Step 1. Press the SETUPS button.

Step 2. Use the soft keys to select **Recall**.

Step 3. Use the rotary knob to select the storage location number (0 to 49).

WARNING **Location 0 is a read-only buffer containing the power-on settings. Refer to the Default section for details.**

16.2 Store

Saves the current front-panel configuration to a specified storage location.
To store a setup:

Step 1. Press the SETUPS button.

Step 2. Use the soft keys to select **Store**.

Step 3. Select the storage location number (1 to 49) using the numeric keypad or rotary knob.

WARNING **Storing a setup does not save arbitrary waveform memory data.**

To save or load waveform memory data (raw points), use the following path:

Step 1. Press the WAVE button.

Step 2. Select **ARB** > **Edit** > **More** > **Load** (or **Save**).

Utility Key

The Utility menu allows for the configuration of remote interfaces, power-on settings, and system maintenance tasks such as firmware updates and security resets.
To enter the **Utility Menu**:

Step 1. Press the UTIL button.

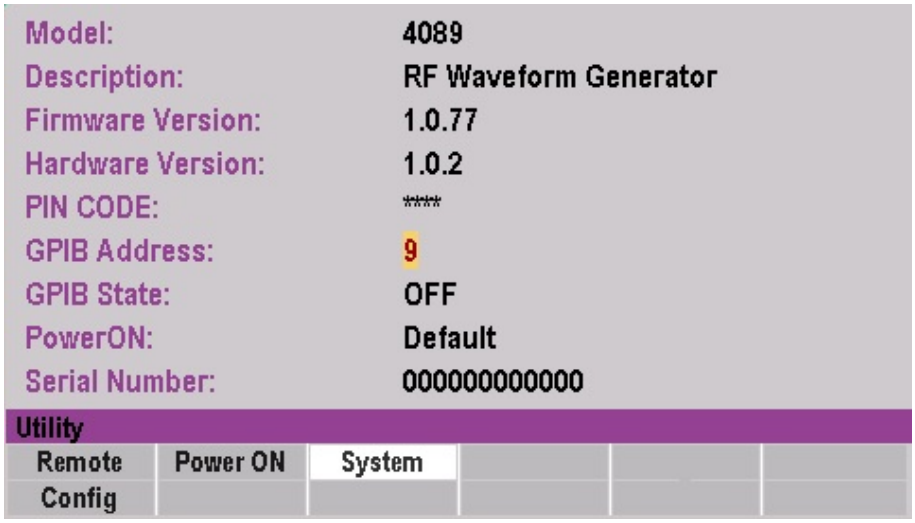


Figure 17.1 Utility Menu

17.1 Remote Config

The 4088 series supports remote communication on up to three interfaces: USB, LAN, and GPIB (optional).
To enter the **Remote Config Menu**:

Step 1. Press the UTIL button.

Step 2. Press the **F1** softkey to select **Remote Config**.

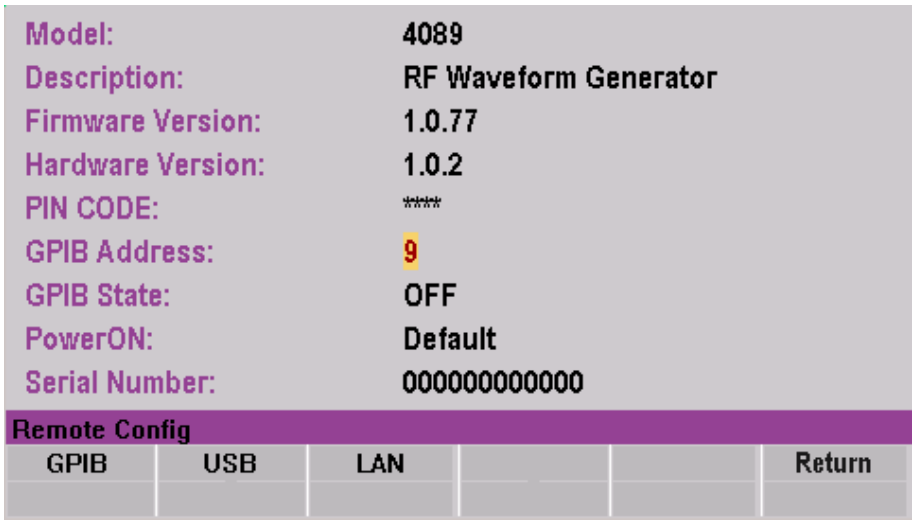


Figure 17.2 Remote Config Menu

- **USB**
- **LAN**
- **GPIB**

17.1.1 USB Settings

The USB remote port is located on the rear panel (see **3.7**). The 4088 series is USBTMC compliant. To configure **USB Settings**:

Step 1. Press the UTIL button.

Step 2. Use the soft key to select **Remote Config > USB**.

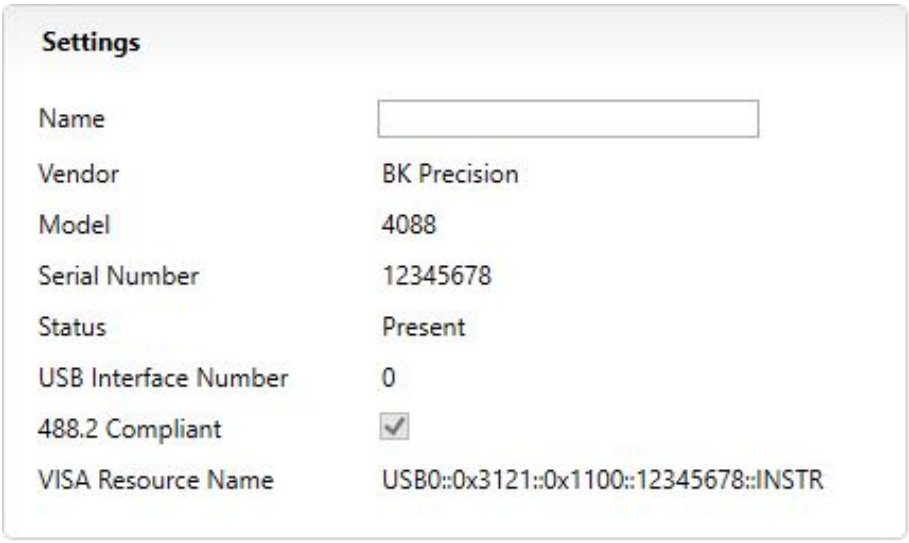


Figure 17.3 USB Details

The VISA Resource string provides the following information:

USB0::⟨Vendor ID⟩::⟨Product ID⟩::⟨Serial Number⟩::INSTR

Description: Example

Based on **17.3**:

- <Vendor ID> = 0x3121
- <Product ID> = 0x1100 (4088) or 0x1200 (4089)
- <Serial Number> = 123456789

WARNING **To communicate with the unit, you must install the USB driver. Users with LabVIEW™ or NI-VISA installed already have this driver; otherwise, download it from bkprecision.com.**

17.1.2 LAN Settings

The LAN status indicator in the upper right corner of the screen shows the connection state.
To configure **LAN Settings**:

Step 1. Press the UTIL button.

Step 2. Use the soft key to select **Remote Config** > **LAN**.

- **IP Address**
- **Gateway IP**
- **Mask**
- **DNS**
- **DHCP On/Off**
- **Hostname**
- **Default**
- **LAN Reset**

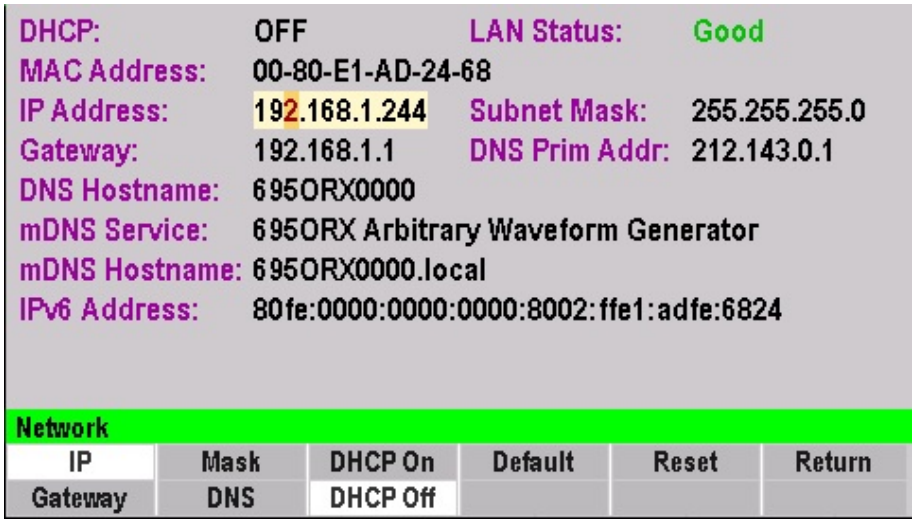


Figure 17.4 LAN Settings Interface

IP Address

To enter an IP address:

Step 1. Press **Utility** > **Remote Config** > **LAN** > **IP**.

Step 2. Use the numeric keypad to enter numbers.

Step 3. Use the keys to move between segments.

Step 4. Press ENTER to set the address.

Gateway IP

If IP Mode is set to DHCP, this is configured automatically. To set manually:

Step 1. Press **Utility** > **Remote Config** > **LAN** > **Gateway**.

Step 2. Enter the address using the keypad and arrow keys, then press Enter.

Mask

Step 1. Press **Utility** > **Remote Config** > **LAN** > **Mask**.

Step 2. Enter the subnet mask using the keypad and arrow keys, then press Enter.

DNS

Step 1. Press **Utility** > **Remote Config** > **LAN** > **DNS**.

Step 2. Enter the DNS address using the keypad and arrow keys, then press Enter.

DHCP On/ DHCP Off

Step 1. Press **Utility** > **Remote Config** > **LAN** > **DHCP On/Off**.

Step 2. **DHCP On**: Automatically assigns IP settings.

Step 3. **DHCP Off**: Allows manual configuration of settings.

Hostname

Each instrument has a fixed hostname in the format: **RF<model number><Model Name>**. Example: **Rf4088WG**.

Restore Default

Step 1. Press **Utility** > **Remote Config** > **LAN** > **Default**.

Step 2. Select **Yes (F1)** to confirm factory default restoration.

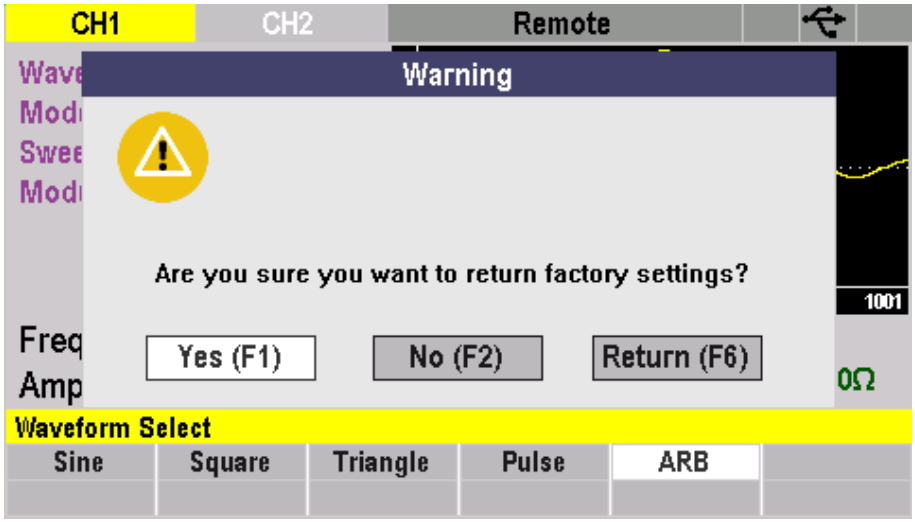


Figure 17.5 Restore Factory Defaults Warning

LAN Reset

Resets all LAN settings and webpage passwords.

Step 1. Press **Utility** > **Remote Config** > **LAN** > **Reset**.

Step 2. Select **Yes** to finalize the reset.

17.1.1 GPIB Settings

The GPIB address (1 to 31) is stored in non-volatile memory. Setting it to 31 puts the device in the off-bus state.
To configure **GPIB Settings**:

Step 1. Press the UTIL button.

Step 2. Use the soft key to select **Remote Config > GPIB**.

Step 3. Use the rotary knob or keypad to change the address (Default: 9).

WARNING **GPIB is an optional add-on. The rear panel connector is not isolated from chassis ground.**

17.2 Power On

Determines the instrument state at startup.

Step 1. Press **Utility > Power On**.

- **Default**
- **Location**
- **Last Settings**

Default

Powers on with factory default settings.

Parameter	Default Value
Waveform Shape	Sine
Frequency	1.000 kHz
Amplitude	5.00 Vpp
Offset	0.00 Vdc
Phase	0.0 °
Output Impedance	50 Ω

Table 17.1 Factory Default Values

Location

Powers on using a setup stored in memory.

Step 1. Press **Utility** > **Power On** > **Location**.

Step 2. Assign an address (1 to 49) using the keypad or knob.

Last Settings

Step 1. Press **Utility** > **Power On** > **Last Settings**.

17.3 System

To enter the System Menu:

Step 1. Press the 

button.

Step 2. Select the **System** softkey.

Step 3. Enter the password (Default: **1111**).

Sub-menus require a PIN. If forgotten, contact B&K Precision support.

- **System Info**
- **Firmware Update**
- **Calibration**
- Security

System Info

Displays: Model, Firmware Version, Hardware Version, Pin Code, Power On Location, and Serial Number.

Firmware Update

Step 1. Press **Utility** > **System** > **Firmware Update**.

Step 2. Enter the password and press any button to proceed.

Step 3. Press **F1** to choose the file from the USB drive or **F6** to exit.

Calibration

For technical personnel only. Access via **Utility** > **System** > **Calibrate**. Refer to ??.

17.3.1 Security

To enter the **Security Menu**:

Step 1. Press **Utility** > **System** > **Security**.

Step 2. Enter the four-digit PIN.

Pin Code Change

Step 1. Press **Security** > **Change Code**.

Step 2. Use the keypad to define a new four-digit password.

Serial Number

Step 1. Press **Security** > **Serial Number**.

Step 2. Use the rotary knob to navigate the on-screen keyboard and press **F1** to select characters.

NISPOM

Clears all settings, waveform memories, LAN parameters, and formats the flash memory.

Step 1. Press **Security** > **NISPOM**.

Step 2. Press **F1** to proceed or **F2** to cancel.

System Reset

Resets the settings within the Security Menu to their factory defaults.

Step 1. Press **Security** > **System Reset**.

RF Channel

The RF channel outputs an RF signal with a maximum frequency of 1.5 GHz for the 4088 and 3.0 GHz for the 4089.
To enter **RF Mode**:

Step 1. Press the RF button.

Step 2. To return to the AWG menu, press the RF button again.

18.1 RF Parameters

The **RF Parameter Menu** allows for the configuration of the signal's frequency and power level.
To enter the **RF Parameter Menu**:

Step 1. While in RF Mode, press the PARAM key.

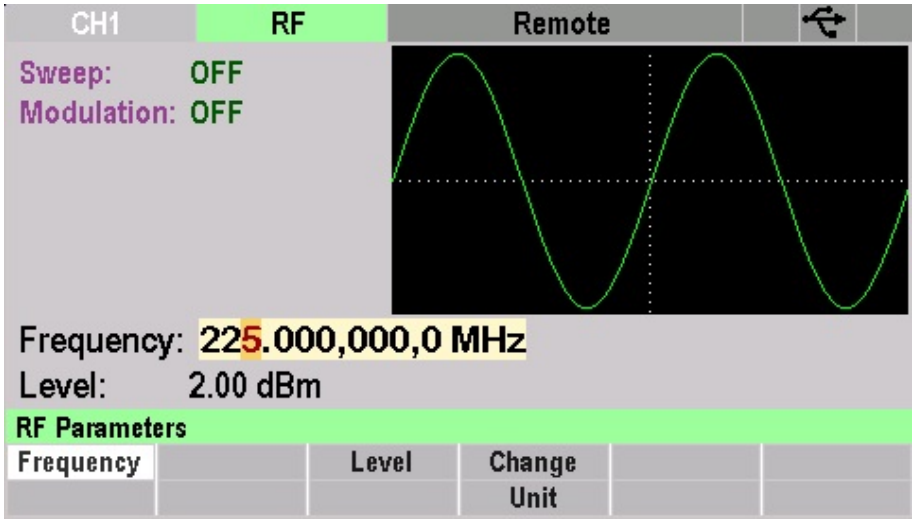


Figure 18.1 RF Parameter Menu

Frequency

To set the frequency of the signal:

Step 1. Press the PARAM button.

Step 2. Use the softkey to select **Frequency**.

Step 3. Enter the desired frequency (50 MHz to 3.0 GHz) using the numeric keypad.

Step 4. Use the softkeys to select the frequency units:
- **F1**: GHz
- **F2**: MHz

Level

To set the amplitude level of the signal:

Step 1. Press the PARAM button.

Step 2. Use the softkey to select **Level**.

Step 3. Enter the desired value (-90 dBm to 13 dBm) using the numeric keypad.

Step 4. Use the softkeys to select the level units:
- **F1**: μVrms
- **F2**: mVrms
- **F3**: dBm

Change Unit

To toggle the current unit of the signal's level:

Step 1. Press the PARAM button.

Step 2. Use the softkey to select **Change Unit**.

Description: Functionality

The unit will toggle between **mVrms** and **dBm**. The instrument maintains the correct ratio between units during the conversion.

18.2 Modulation Key

In RF Mode, AM, FM, PM, and Pulse modulation are available.
To enter the **RF Modulation Menu**:

Step 1. Press the MODUL button.

- **AM**
- **FM**
- **PM**
- **Pulse**

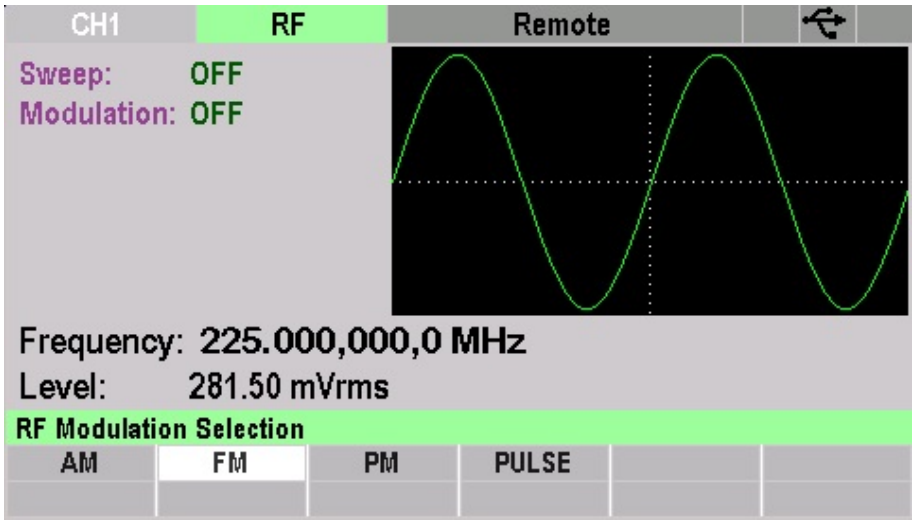


Figure 18.2 RF Modulation Menu

18.2.1 AM

In RF Amplitude Modulation, the amplitude of the high-frequency RF carrier is varied in proportion to the instantaneous voltage of the modulating signal.
To enter the **RF AM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM**.

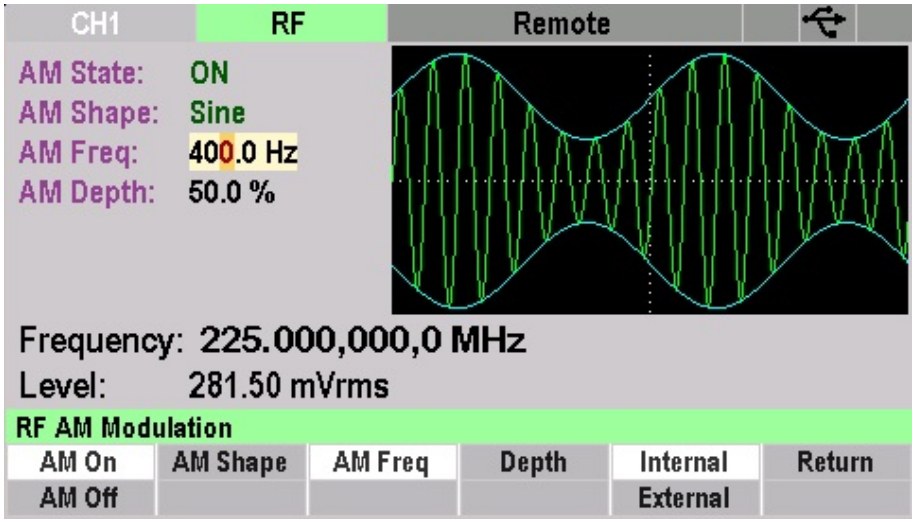


Figure 18.3 RF AM Menu

AM On/Off

To toggle the RF AM function:

Step 1. Press the MODUL button.

Step 2. Use the **AM On/AM Off** softkey to enable or disable the modulation.

AM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

AM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 100.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **AM Frequency**.

Step 3. Enter the desired modulation frequency:
- Use the numeric keypad to input the value directly, then press the corresponding softkey for the unit.
- Or use the arrow keys and rotary knob to adjust the value.

Depth

Modulation depth indicates the degree of amplitude variation, expressed as a percentage from 1% to 100%.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Depth**.

Step 3. Enter the desired depth value:
- Use the numeric keypad to input the percentage directly.
- Or use the arrow keys and rotary knob to adjust the value.

Internal/External

The RF carrier can be modulated by either the internal source or an external signal.

Description: Modulation Sources

- **Internal**: The modulating waveform is generated by the instrument. Shape is defined in the **AM Shape** menu.
- **External**: The generator accepts a signal via the **Modulation In** connector on the rear panel. The RF amplitude is controlled by the voltage level applied to this connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.

– The active source will be highlighted in white.

18.2.1 FM

The modulated waveform consists of two parts: the carrier and the modulating waveform. In Frequency Modulation (FM), the frequency of the carrier varies with the instantaneous voltage of the modulating waveform.
To enter the **RF FM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM**.

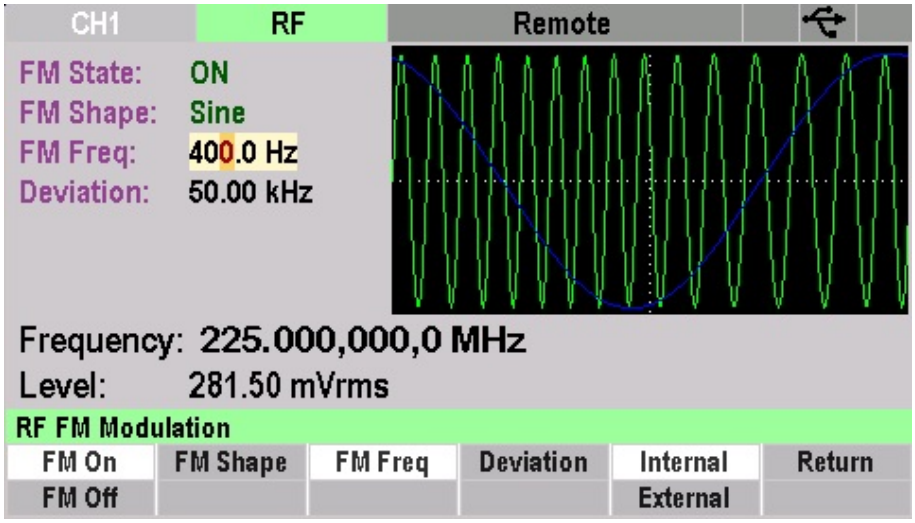


Figure 18.4 FM Menu

FM On/Off

To toggle the RF FM function:

Step 1. Press the MODUL button.

Step 2. Use the **FM On/FM Off** softkey to enable or disable the modulation.

FM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

FM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 100.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **FM Frequency**.

Step 3. Enter the desired modulation frequency:
- Use the numeric keypad to input the value directly, then press the corresponding unit softkey.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

Deviation

Frequency deviation represents the maximum variation in frequency from the carrier frequency. For RF FM, deviation can be set from 0.01 Hz to 1 MHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Deviation**.

Step 3. Enter the desired modulation deviation:
- Use the numeric keypad to enter the value, then select the unit softkey.
- Or use the arrow keys and rotary knob to adjust the value.

Internal/External

The RF carrier frequency can be modulated by either the internal source or an external signal.

Description: Modulation Sources

- **Internal**: The modulating waveform is generated by the instrument. Shape is defined in the **FM Shape** menu.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The frequency deviation is controlled by the voltage level applied to this connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
  – The active source will be highlighted in white.

18.2.1 PM

PM (Phase Modulation) consists of two parts: the RF carrier and the modulating waveform. In Phase Modulation, the phase of the carrier varies in proportion to the instantaneous voltage level of the modulating waveform.
To enter the **RF PM Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM**.

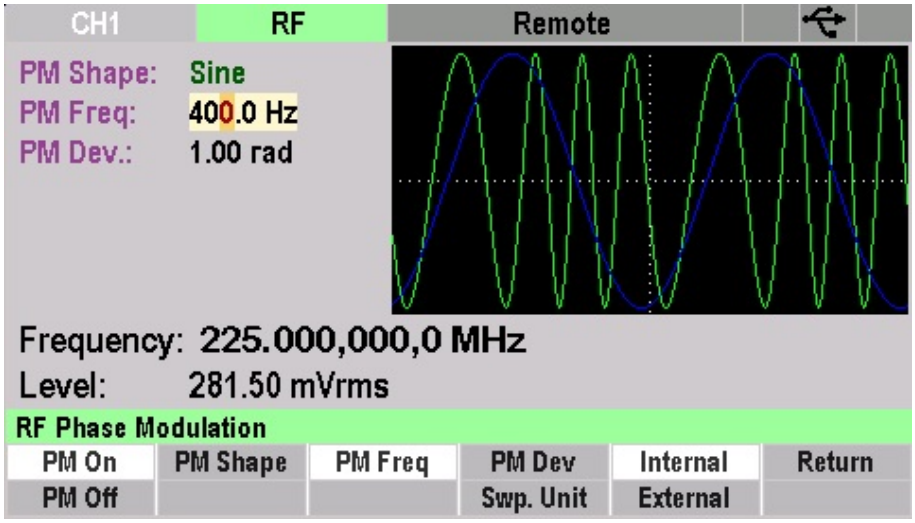


Figure 18.5 RF PM Menu

PM On/Off

To toggle the RF PM function:

Step 1. Press the MODUL button.

Step 2. Use the **PM On/PM Off** softkey to enable or disable the modulation.

PM Shape

To select the shape of the internal modulating wave:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Shape**.

Step 3. Use the corresponding softkey to select the desired shape: **Sine**, **Square**, or **Triangle**.

PM Frequency

Sets the frequency of the internal modulation source, from 0.01 Hz to 100.00 kHz.

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Shape**.

Step 3. Enter the desired modulation frequency:
- Use the numeric keypad to input the value directly, then press the corresponding unit softkey.
- Or use the arrow keys to select the digit and the rotary knob to change its value.

PM Dev/Swp Unit

Phase deviation represents the maximum variation in phase relative to the carrier phase.
To set the deviation:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **PM Dev/Swp Unit**.

Step 3. Enter the desired deviation value.
- Use the numeric keypad for direct input or the rotary knob for incremental adjustments.

Step 4. Toggle the **PM Dev/Swp Unit** softkey to switch units between **Radians** (0 to 6.28 rad) and **Degrees** (0 to 360°).

Internal/External

The RF carrier phase can be modulated by either the internal source or an external signal.

Description: Modulation Sources

- **Internal**: The modulating waveform is generated by the instrument. Shape is defined in the **PM Shape** menu.
- **External**: The generator accepts an external modulating signal from the **Modulation In** connector on the rear panel. The phase shift is controlled by the voltage level applied to this connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
- The active source will be highlighted in white.

18.2.1 Pulse

Pulse modulation for the RF channel acts as a high-speed switch, turning the RF output on and off. This is typically used to simulate radar signals or pulsed communication systems.
To enter the **RF Pulse Menu**:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Pulse**.

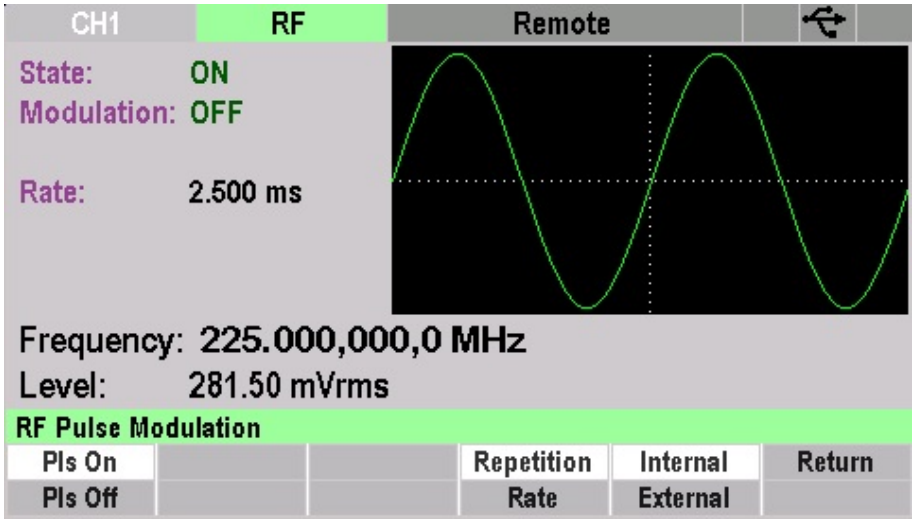


Figure 18.6 Pulse Menu

Pulse On/Off

To toggle the RF Pulse modulation function:

Step 1. Press the MODUL button.

Step 2. Use the **Pls On/Pls Off** softkey to enable or disable the modulation.

Repetition Rate

The Repetition Rate sets the frequency at which the RF pulses are generated when using the internal source. The range is from 10 s (0.1 Hz) to 1 μs (1 MHz).
To set the rate:

Step 1. Press the MODUL button.

Step 2. Use the soft keys to select **Repetition Rate**.

Step 3. Enter the desired rate:
- Use the numeric keypad to input the value directly, then press the corresponding unit softkey.
- Or use the arrow keys to select a digit and the rotary knob to change its value.

Internal/External

The instrument can trigger the RF pulses using the internal clock or an external control signal.

Description: Modulation Sources

- **Internal**: The RF output is gated by the internal pulse generator at the frequency defined by the **Repetition Rate**.
- **External**: The generator accepts an external logic signal via the **Modulation In** connector on the rear panel. The RF output is enabled or disabled based on the voltage level applied to the connector.

To toggle the modulation source:

Step 1. Press the MODUL button.

Step 2. Use the **Internal/External** softkey to toggle between the sources.
- The active source will be highlighted in white.

18.3 Sweep Key

A sweep is a series of consecutive data point measurements taken over a specified frequency range. In **Sweep Mode**, the generator steps from the start frequency to the stop frequency over a user-defined sweep time.
To select **Sweep Mode** in **RF Mode**:

Step 1. Press the SWEEP button.

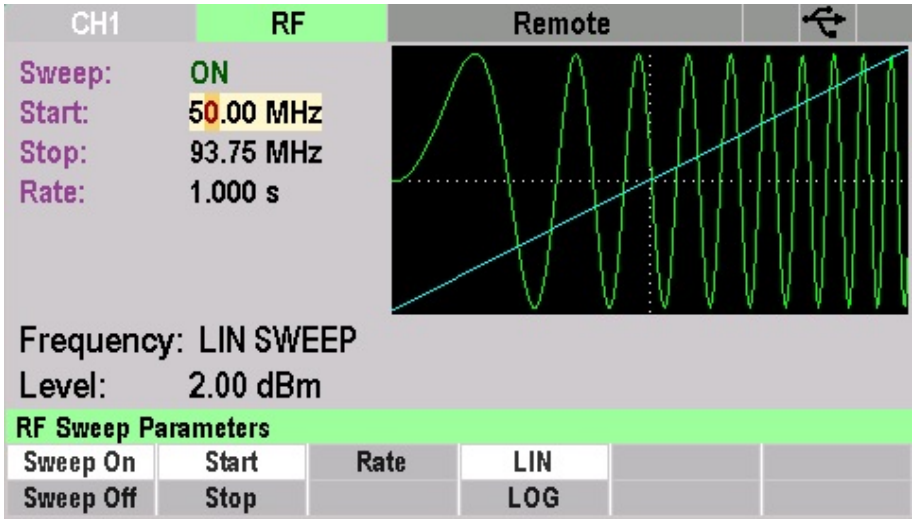


Figure 18.7 RF Sweep Menu

18.4 Sweep On/Off

To enable or disable the sweep function:

Step 1. Press the SWEEP button.

Step 2. Use the **Sweep On/Sweep Off** softkey to toggle the function.

18.5 Start/Stop

Sets the frequency boundaries for the RF sweep.
To set the frequencies:

Step 1. Press the SWEEP button.

Step 2. Use the **Sweep Start/Stop** softkey to toggle between **Start** and **Stop**.
– The active parameter will be highlighted in white.

Step 3. Input the frequency using the numeric keypad and select the units via the softkeys.

Step 4. Alternatively, use the arrow keys and rotary knob to adjust the value.

WARNING

The START and STOP frequencies must remain within the same octave range. If a frequency is set outside the current octave, the instrument will automatically adjust the boundary.

Description: RF Sweep Octave Ranges

- 50 MHz – 93.75 MHz
- 93.75 MHz – 187.5 MHz
- 187.5 MHz – 375 MHz
- 375 MHz – 750 MHz
- 750 MHz – 1500 MHz
- 1500 MHz – 3000 MHz

18.6 Rate

To set the duration of the sweep:

Step 1. Press the SWEEP button.

Step 2. Use the soft keys to select **Rate**.

Step 3. Input the desired rate value.
– Use the numeric keypad followed by the unit softkey.
– Or use the arrow keys and rotary knob to adjust the time.

18.7 LIN/LOG

Determines whether the frequency steps are spaced linearly or logarithmically.
To toggle the sweep type:

Step 1. Press the SWEEP button.

Step 2. Use the **LIN/LOG** softkey to toggle between **LIN** and **LOG**.
- The selected mode will be highlighted in white.

18.8 Setups Key

The waveform generator can store the current front-panel settings, called a setup, into one of 50 storage locations. When you recall a setup, the generator restores the front-panel settings to those that were stored in the selected location.
All parameters except for the raw waveform memory data are stored in the setup.
To enter the **RF Setups Menu**:

Step 1. Ensure the instrument is in **RF Mode**.

Step 2. Press the SETUPS button.

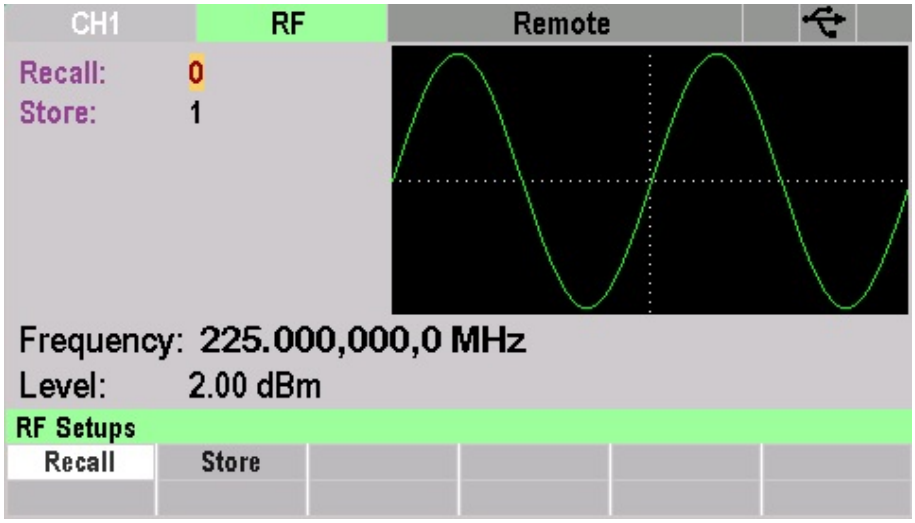


Figure 18.8 RF Setups Menu

18.9 Recall

This function restores a previously saved configuration from the internal memory.
To recall a setup:

Step 1. Press the SETUPS button.

Step 2. Use the soft keys to select **Recall**.

Step 3. Use the rotary knob to select the storage location number (0–49).

Description: Location 0

Location 0 is a read-only buffer that contains the power-on settings. For details on these parameters, see the **Default** section.

18.10 Store

This function saves the current front-panel configuration to the internal memory.
To store a setup:

Step 1. Press the SETUPS button.

Step 2. Use the soft keys to select **Store**.

Step 3. Use the numeric keypad or the rotary knob to select the storage location number (1–49).

WARNING **Storing a setup does not preserve raw waveform memory data.**

To save or load waveform memory data (raw points), use the following procedure:

Step 1. Press the WAVE button.

Step 2. Use the soft keys to select **ARB** > **Edit** > **More** > **Load** (or **Save**).

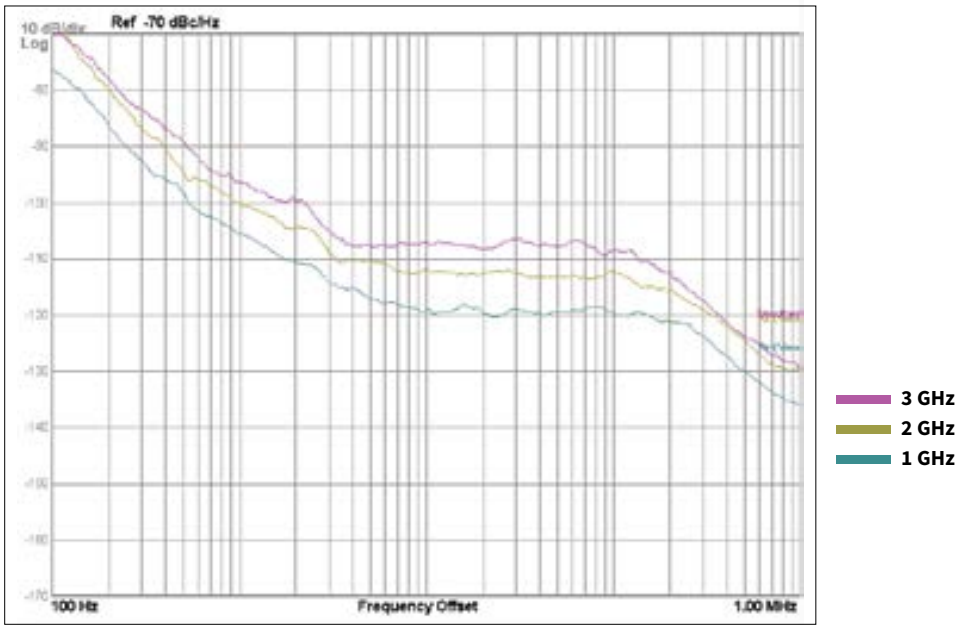
Specifications

Note: All specifications apply to the unit after a temperature stabilization time of 20 minutes over an ambient temperature range of 23 °C ± 5 °C and a maximum relative humidity of 90%. Specifications are subject to change without notice.

Model	4088	4089
Frequency		
Range	50 MHz to 1.5 GHz	50 MHz to 3.0 GHz
Resolution	0.1 Hz, 11 digits	
Reference Frequency		
Accuracy	± 3 ppm, 0 to 40 °C	
Stability	± 1 ppm, 0 to 40 °C	
Aging Rate	± 1 ppm/year	
Spectral Purity		
Harmonics	< -25 dBc at 0 dBm output in CW mode	
Non-harmonics (Spurious)	< -60 dBc at 0 dBm output in CW mode	
SSB Phase Noise		
At 1 GHz, 10 kHz Offset	< -117 dBc/Hz	
Residual FM	50 Hz rms (0.1 Hz to 20 kHz bandwidth)	
Residual AM	0.02% rms (0.1 Hz to 20 kHz bandwidth)	

Output Characteristics		
Amplitude		
Output Impedance	50 Ω, AC coupled	
Range	-110 to +13 dBm	-110 to +13 dBm to 2.0 GHz -90 to +13 dBm, 2.0 GHz to 3.0 GHz
Resolution	0.01 dB	
Accuracy	< ± 1 dB, -90 to +13 dBm	
Units	dBm or Vrms	
VSWR	< 1.8 (typical)	
Reverse Output Protection	Up to 30 V DC or +25 dBm RF power	

4088 Series SSB Phase Noise (Typical)



RF Generator Specifications (cont.)

Model	4088	4089
Modulation Characteristics		
Amplitude Modulation (AM)		
AM Range	0 to 100%	
Resolution	0.1%	
Modulation Source	INT / EXT	
Modulation Accuracy	< 5% of reading at 0 dBm, 50% modulation, 1 kHz sine wave	
Modulation Distortion	< 3%, at 30% modulation with 1 kHz sine wave	
Frequency Modulation (FM)		
Frequency Deviation	0 to 500 kHz ($f_{out} \leq$ 150 MHz) 0 to 1 MHz (f_{out}: 150 MHz to 3 GHz)	
Resolution	1 Hz or 4 Digits	
Modulation Source	INT / EXT	
Deviation Accuracy	< 5%	
Modulation Distortion	< 1%, at 100 kHz deviation with 1 kHz sine wave	
Phase Modulation (PM)		
Phase Deviation	0 to 6.28 rad (0º to 360°)	
Resolution	0.01 rad	
Modulation Source	INT / EXT	
Deviation Accuracy	< 5%	
Modulation Distortion	< 1%, at 5 rad deviation with 1 kHz sine wave	
Pulse Modulation		
ON/OFF Ratio	> 60 dBc at 1 GHz	
Source	INT / EXT	
Repetition Rate	1 µs to 10 s (0.1 Hz to 1 MHz)	
Mode	Logic HI for RF ON	
Rise and Fall Times	< 50 ns	
EXT Input Levels	TTL	
Internal Modulation Source		
Frequency	0.01 Hz to 100 kHz	
Resolution	1 Hz, 4 digits	
Waveform	Sine, Triangle, Square	
External Modulation	DC to 100 kHz	
External Input Level	2.5 Vpp for ± full deviation	

Sweep Characteristics		
Ranges	50 MHz to 93.75 MHz	
	93.75 MHz to 187.5 MHz	
	187.5 MHz to 375 MHz	
	375 MHz to 750 MHz	
	750 MHz to 1500 MHz	
	-	1500 MHz to 3000 MHz
Frequency Resolution	1 kHz	
Sweep Shape	Linear or Logarithmic	
Sweep Time	10 ms to 100 s	
Time Resolution	3 digits	

AWG/Function Generator Specifications

Model	4088	4089
Maximum Frequency	50 MHz	80 MHz
Waveforms		
Standard	Sine, Square, Triangle/Ramp, Pulse	
Built-in Arbitrary	Sine, Triangle, Square, Noise, Ramp Up, Ramp Down, Sine(X)/X, Exponential Up, Exponential Down, Gaussian, Lorentz, Haversine	
User-defined Arbitrary	4 Mpts	4 Mpts
Operating Modes		
Operating Modes	Continuous, Triggered, Burst, Gated, Phase	
Triggered	Frequency of waveform cycle is limited to 10 MHz	
Sine		
Frequency Range	1 μHz to 50 MHz	1 μHz to 80 MHz
Resolution	1 μHz	
Amplitude Flatness (relative to 1 kHz, 5 Vpp output)		
$f_{OUT} \leq$ 1 MHz	± 0.1 dB	
$f_{OUT} \leq$ 1 MHz to 30 MHz	± 0.5 dB	
$f_{OUT} \leq$ 30 MHz to 80 MHz	± 1 dB	
Harmonic Distortion (typical)		
$f_{OUT} \leq$ 100 kHz	-65 dBc	
$f_{OUT} \leq$ 1 MHz	-55 dBc	
$f_{OUT} \leq$ 20 MHz	-40 dBc	
$f_{OUT} \leq$ 50 MHz	-35 dBc	
$f_{OUT} \leq$ 80 MHz	-30 dBc	
THD: 20 Hz to 20 kHz	< 0.04%	
Spurious		
$f_{OUT} \leq$ 1 MHz	-70 dBc	
$f_{OUT} \geq$ 2 MHz	-70 dBc, increasing +20 dB/decade	
Phase Noise (f_{out}=10 MHz)		
10 kHz offset	-117 dBc	
Square		
Frequency Range	1 μHz to 50 MHz	1 μHz to 80 MHz
Rise & Fall Time	< 5 ns (10% to 90%) at full amplitude into 50 Ω	
Overshoot	< 2% at 5 Vpp	
Variable Duty Cycle Range	20.0%-80.0% up to 10 MHz square frequency	
Duty Cycle Resolution	0.1%	
Duty Cycle Accuracy	< ± 0.1% ± 5 ns	
Jitter (rms)	< 25 ps	

Ramp & Triangle		
Frequency Range	1 μHz to 5 MHz	
Resolution	1 μHz	
Variable Duty Cycle	0%-100% to 500 kHz 20%-80% to 2 MHz Fixed 50% to 5 MHz	
Duty Cycle Resolution	0.1%	
Linearity	< 0.1% of signal amplitude from 5%-95%, up to 200 kHz	
Pulse		
Frequency Range	1 mHz to 10 MHz	
Resolution	1 μHz	
Pulse Width	20 ns minimum, 1 ns resolution, 999 s max	
Variable Edge Time	< 10 ns to pulse period (depending on pulse width)	
Jitter (rms)	< 25 ps	
Arbitrary Waveform Characteristics		
Waveform Length	2 pt to 16,777,216 pt	2 pt to 33,554,432 pt
Sampling Rate	250 MSa/s, point execution rate adjustable from 4 ns to 100 s	
Vertical Resolution	16 bits (65,536 levels)	
Noise	Programmable 1% to 100% or added to arbitrary waveform	
Bandwidth	50 MHz max (2-point waveform length)	
Frequency	Accuracy: ± 10 ppm	
	Rate Resolution: 10 ps, up to 8 digits	
Rise & Fall Time	< 5 ns (typical)	
Jitter (rms)	< 25 ps	
Sweep Characteristics		
Sweep Shape	Linear and Logarithmic, up or down	
Sweep Time	10 ms to 500 s	
Sweep Trigger Mode	Internal, External, Continuous, or Burst	

AWG/Function Generator Specifications (cont.)

Output Characteristics	
Signal Output	
Output Impedance	50 Ω (typical)
Output Protection	Protected against short circuit or nominal accidental voltages applied to the main output connector
Output ON-OFF Feed-through	> 80 dB at 10 MHz
Amplitude	
Range	3 mVpp to 10 Vpp into 50 Ω
Resolution	1 mV, 4 digits (10,000 counts)
Units	Vpp, Vrms, or dBm selectable
Accuracy (at 1 kHz)	± 1% of setting ± 1 mVpp
DC Offset	
Range	± 5 V into 50 Ω
Resolution	1 mV, 4 digits resolution
Accuracy	± 1% of offset setting ± 0.25% of amplitude setting ± 2 mVpp
Frequency	
Accuracy	± 3 ppm, 0 to 50° C
Aging	± 1 ppm/year

Burst Characteristics	
Waveforms	Sine, Square, Triangle, Pulse, Arb
Count	1-999,999 cycles
Trigger Source	Manual, Internal, External

Inputs and Outputs	
Trigger IN	TTL Compatible Maximum rate: 20 MHz Minimum width: 20 ns Input impedance: 10 kΩ nominal
Sync OUT	TTL pulse at programmed frequency, 50 Ω impedance
Modulation IN	2.5 Vpp for 100% modulation 1 kΩ input impedance DC to 50 kHz bandwidth
Marker OUT	Positive TTL pulse, user programmable in arbitrary waveform, 50 Ω impedance
External Reference OUT	10 MHz clock for synchronization, TTL, 50 Ω impedance
External Reference IN	10 MHz from an external source, > 1 kΩ impedance, > 1 Vpp

Modulation Characteristics	
Modulation Types	AM, FM, PM, PWM, FSK, BPSK
Amplitude Modulation (AM)	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Depth	0% to 100%
Frequency Modulation (FM)	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Deviation	1 μHz to max frequency/2
Frequency-shift Keying (FSK)	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Rate	0.01 Hz to 1 MHz
Phase Modulation (PM)	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Deviation	0 to 360°, 0.1° resolution
Binary Phase-shift (BPSK)	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Rate	0.01 Hz to 1 MHz
Pulse Width Modulation (PWM)	
Carrier	Square
Source	Internal, External
Internal Modulation	0.01 Hz to 100 kHz
Deviation	0% to 100% of pulse width, 0.1% resolution
Internal Modulation	
Waveform	Sine, Square, or Triangle
Frequency	0.01 Hz to 20 kHz
Resolution	4 digits

Internal Trigger	
Repetition	1 μs to 100 s (0.01 Hz to 1 MHz)
Resolution	4 digits
Accuracy	± 10 ppm

General

General		
Display Resolution		4.3" color LCD with IPS technology, 480 x 272 dots
I/O interfaces		USB (USBTMC-compliant), LAN, GPIB (optional)
Storage Memory		99 full panel settings at power-off, including last working set-up 1 Gbit flash file system for arbitrary waveform storage
Dimensions (W x H x D)		8.4" x 3.5" x 12" (213 mm x 88 mm x 300 mm)
Weight		6.61 lbs (3 kg)
AC Input		90 to 264 VAC (< 40 VA)
Temperature	Operation	32 °F to 122 °F (0 °C to 50 °C)
	Storage	-4 °F to 158 °F (-20 °C to 70 °C)
Humidity		95% RH, 0 °C to 30 °C
Warranty		3 Years
Standard Accessories		Power cord, USB cable, test report, and certificate of calibration

Regulatory Compliance	
Electromagnetic Compatibility	According to EN55011 for radiated and conducted emissions
Electrical Discharge Immunity	According to EN55082
Safety	According to EN61010, CE approved

Ordering information

Model	Description
4088	1.5 GHz/50 MHz RF Signal/Waveform Generator
4089	3 GHz/80 MHz RF Signal/Waveform Generator
4089GPIB	3 GHz/80 MHz RF Signal/Waveform Generator with GPIB

Service Information

Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain an RMA #. Return the product in the original packaging with proof of purchase to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device.

Non-Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain an RMA #. Return the product in the original packaging to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on an open account must include payment in the form of a money order or credit card. For the most current repair charges please refer to the service and support section on our website.
Return all merchandise to B&K Precision Corp. with prepaid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North America is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
bkprecision.com
714-921-9095

LIMITED THREE-YEAR WARRANTY

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of **13years** from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To help us better serve you, please complete the warranty registration for your new instrument via our website www.bkprecision.com

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.
B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.
This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

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714-921-9095

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