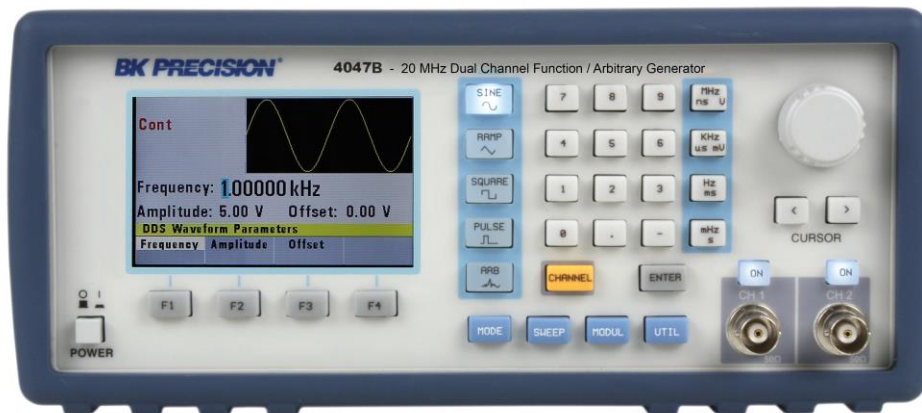


# BK PRECISION®

Model: 4047B

## Dual Channel Function/Arbitrary Waveform Generator

USER MANUAL



## Safety Summary

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.

### **WARNING**

Before applying power to this instrument:

- Read and understand the safety and operational information in this manual.
- Apply all the listed safety precautions.
- 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.
- Make all connections to the instrument before applying power.
- 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.

### **Category rating**

The IEC 61010 standard defines safety category ratings that specify the amount of electrical energy available and the voltage impulses that may occur on electrical conductors associated with these category ratings. The category rating is a Roman numeral of I, II, III, or IV. This rating is also accompanied by a maximum voltage of the circuit to be tested, which defines the voltage impulses expected and required insulation clearances. These categories are:

Category I (CAT I): Measurement instruments whose measurement inputs are not intended to be connected to the mains supply. The voltages in the environment are typically derived from a limited-energy transformer or a battery.

Category II (CAT II): Measurement instruments whose measurement inputs are meant to be connected to the mains supply at a standard wall outlet or similar sources. Example measurement environments are portable tools and household appliances.

Category III (CAT III): Measurement instruments whose measurement inputs are meant to be connected to the mains installation of a building. Examples are measurements inside a building's circuit breaker panel or the wiring of permanently-installed motors.

Category IV (CAT IV): Measurement instruments whose measurement inputs are meant to be connected to the primary power entering a building or other outdoor wiring.

### **WARNING**

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

specified in this manual for this instrument.

## **WARNING**

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.

### ***Electrical Power***

This instrument is intended to be powered from a CATEGORY II mains power environment. The mains power should be 120 V RMS or 240 V RMS. Use only the power cord supplied with the instrument and ensure it is appropriate for your country of use.

### ***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***

## **WARNING**

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

## **WARNING**

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.
- 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.

## **CAUTION**

This instrument is intended to be used in an indoor pollution degree 2 environment. The operating temperature range is 0 °C to 50 °C and the operating humidity is  $\leq 95$  % relative humidity at  $< 30$  °C, 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.

***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.

***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***

**⚠ 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.

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

**⚠ WARNING**

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

***Fuse replacement***

**⚠ 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.

## *Servicing*

### **CAUTION**

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.

## *Cooling fans*

### **CAUTION**

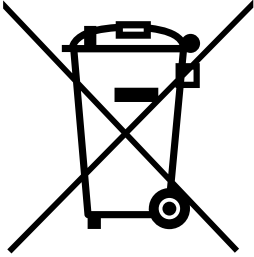
This instrument contains one or more cooling fans. For continued safe operation of the instrument, the air inlet and exhaust openings for these fans must not be blocked nor must accumulated dust or other debris be allowed to reduce air flow. Maintain at least 25 mm clearance around the sides of the instrument that contain air inlet and exhaust ports. If mounted in a rack, position power devices in the rack above the instrument to minimize instrument heating while rack mounted. Do not continue to operate the instrument if you cannot verify the fan is operating (note some fans may have intermittent duty cycles). Do not insert any object into the fan's inlet or outlet.

## *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.

# Compliance Statements

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Union and other European countries with separate collection systems)



This product is subject to Directive 2002/96/EC 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 and otherwise observe all applicable requirements.

## CE Declaration of Conformity

This instrument meets the requirements of 2006/95/EC Low Voltage Directive and 2004/108/EC Electromagnetic Compatibility Directive with the following standards.

### Low Voltage Directive












- EN61010-1: 2001

### EMC Directive

- EN 61000-3-2: 2006
- EN 61000-3-3: 1995+A1: 2001+A2: 2005
- EN 61000-4-2 / -3 / -4 / -5 / -6 / -11
- EN 61326-1: 2006



## Safety Symbols

	Refer to the user manual for warning information to avoid hazard or personal injury and prevent damage to instrument.
	Electric Shock hazard
	Alternating current (AC)
	Chassis (earth ground) symbol.
	Ground terminal
	On (Power). This is the In position of the power switch when instrument is ON.
	Off (Power). This is the Out position of the power switch when instrument is OFF.
	Power Switch (On/Off). This is the power switch located in front of the instrument.
	CAUTION indicates a hazardous situation which, if not avoided, will result in minor or moderate injury
	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury
	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

# Contents

<b>Safety Summary</b> .....	<b>2</b>
Compliance Statements.....	7
Safety Symbols.....	9
<b>1 General Information</b> .....	<b>13</b>
1.1 Product Overview .....	13
1.2 Package Contents.....	13
1.3 Front Panel Overview.....	14
1.4 Rear Panel Overview .....	15
1.5 Display Overview.....	16
<b>2 Getting Started</b> .....	<b>17</b>
2.1 Input Power and Fuse Requirements.....	17
2.2 Connectors .....	18
2.3 Output Connections.....	18
2.4 Preliminary Check .....	19
<b>3 Operating Instructions</b> .....	<b>21</b>
3.1 Menu Keys.....	21
3.1.1 WAVEFORM Keys .....	21
3.1.2 MODE Key .....	22
3.1.3 UTILITY Key .....	24
3.1.4 SWEEP Key .....	25
3.1.5 MODULATION Key.....	26
3.1.6 ARBITRARY Key .....	31
3.1.7 Arbitrary EDIT Menu.....	33
3.2 ON Key.....	36
3.3 Cursor Keys.....	36
3.4 Rotary Input Knob .....	36
3.5 Power-On Settings .....	36
3.6 Memory.....	37
3.7 Displaying Errors .....	37
3.8 Quick Start.....	38
3.8.1 Selecting a Standard Waveform .....	38

3.8.2	<i>Setting the Output</i> .....	38
3.8.3	<i>Using Voltage Offset</i> .....	38
3.8.4	<i>Storing and Recalling a Waveform Generator Setup</i> .....	39
3.8.5	<i>Creating an Arbitrary Waveform</i> .....	40
3.8.6	<i>Entering Individual Data Points</i> .....	40
3.8.7	<i>Setting the Arbitrary Frequency</i> .....	41
3.8.8	<i>Setting the Amplitude</i> .....	41
3.8.9	<i>Executing an Arbitrary Waveform</i> .....	42
<b>4</b>	<b>Programming</b> .....	<b>43</b>
4.1	Overview .....	43
4.1.1	<i>Connecting to USB (Virtual COM) Interface</i> .....	43
4.1.2	<i>USB (Virtual COM) Settings</i> .....	46
4.2	Device States .....	47
4.2.1	<i>Local State (LOCS)</i> .....	47
4.2.2	<i>Remote State (REMS)</i> .....	47
4.3	Message Exchange Protocol.....	47
4.3.1	<i>The Input Buffer</i> .....	47
4.3.2	<i>The Output Queue</i> .....	48
4.3.3	<i>Response Messages</i> .....	48
4.4	Instrument Identification .....	48
4.5	Instrument Reset.....	48
4.6	Command Syntax .....	48
4.6.1	<i>General Command Structure</i> .....	48
4.7	Status Reporting.....	51
4.7.1	<i>The Error Queue</i> .....	51
4.7.2	<i>Error Codes</i> .....	51
4.8	Common Commands .....	54
4.8.1	<i>System Data Commands</i> .....	54
4.8.2	<i>Internal Operation Commands</i> .....	55
4.8.3	<i>Device Trigger Commands</i> .....	55
4.8.4	<i>Stored Settings Commands</i> .....	55
4.9	Instrument Control Commands .....	56
4.9.1	<i>Default Subsystem</i> .....	57
4.9.2	<i>Arbitrary Subsystem</i> .....	67

**5 Troubleshooting Guide..... 72**  
**6 Specifications..... 74**  
**SERVICE INFORMATION ..... 78**  
**LIMITED THREE-YEAR WARRANTY..... 79**

# 1 General Information

## 1.1 Product Overview

The 4047B is a versatile dual-channel function generator with arbitrary capabilities. Implemented using a DDS (direct digital synthesis) architecture, this instrument generates stable and precise sine, square, triangle, and arbitrary waveforms. The unit also provides linear and logarithmic sweep for users needing sweep capability. An auxiliary TTL output at the generator's set frequency is available to synchronize external devices. The instrument can also be remotely operated via the USB interface and is SCPI compatible.

## 1.2 Package 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 generator is shipped with the following contents:

- **4047B DDS function generator**
- **AC Power Cord**
- **USB (type A to B) interface cable**
- **Certificate of Calibration**

Verify that all items above are included in the shipping container. If anything is missing, please contact B&K Precision.

## 1.3 Front Panel Overview

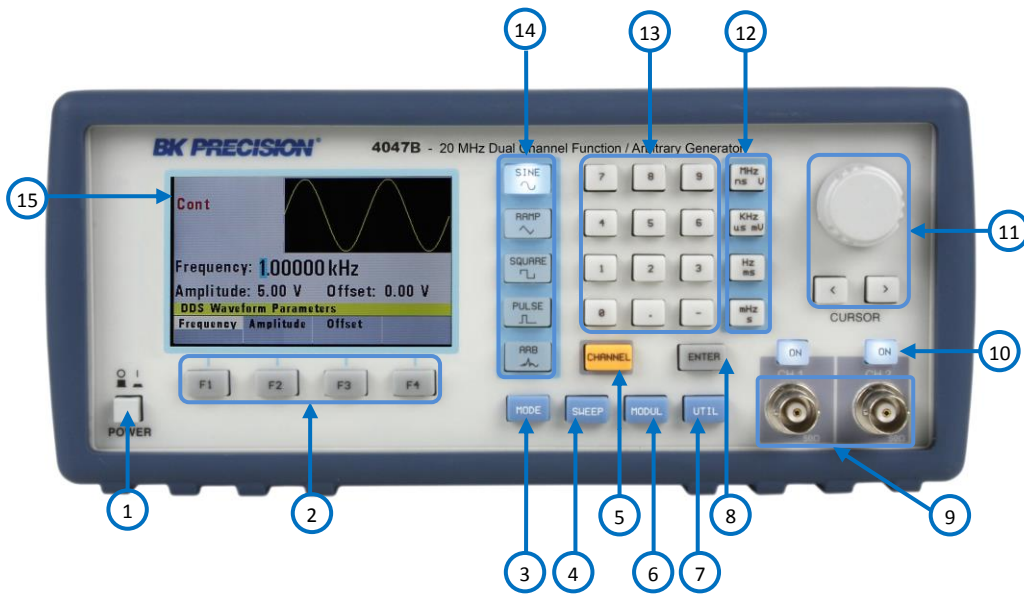


Figure 1 - Front Panel Overview

### Front Panel Description

①	Power On/Off Switch
②	Function Keys (F1-F4)
③	Mode Key
④	Sweep Key
⑤	Channel Key
⑥	Modulation Key
⑦	Utility Key
⑧	Enter Key
⑨	Output BNCs
⑩	Output On/Off Key
⑪	Rotary Knob and Cursor Keys
⑫	Units Keys
⑬	Numeric Keypad
⑭	Waveform Keys
⑮	LCD Display

The front-panel controls select, display, and change parameter, function, and mode settings. Use the numerical keypad, rotary input knob and the cursor movement keys to enter data into the waveform generator.

To change a setting:

1. Press the key that leads to the parameter to change.
  2. Move cursor using cursor keys to the appropriate position in the numeric field (if applicable).
  3. Use the rotary input or the numerical keyboard to change the value of the displayed parameter.
- Changes take effect immediately.

## 1.4 Rear Panel Overview

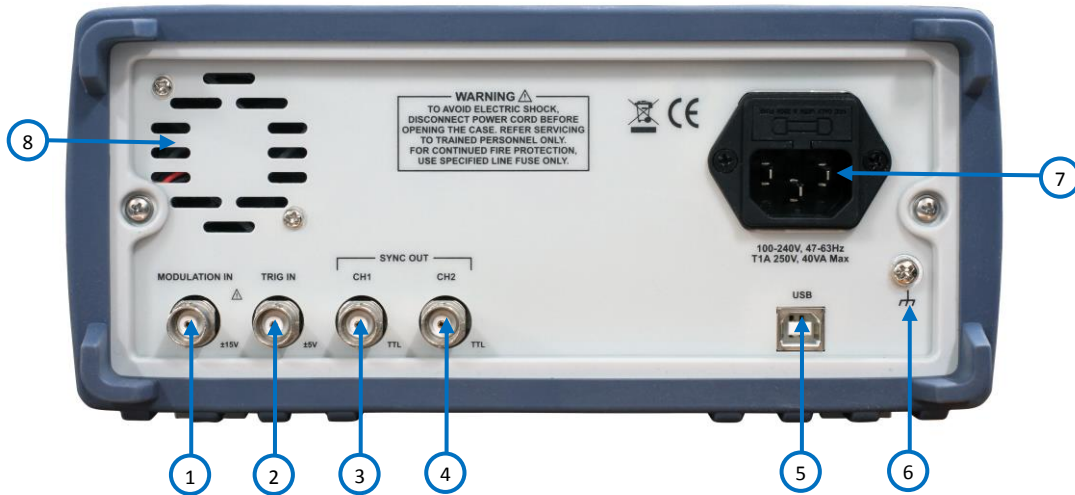


Figure 2 - Rear Panel Overview

### Rear Panel Description

①	<b>Modulation Input BNC</b>
②	<b>External Trigger Input and Counter BNC</b>
③	<b>CH1 Sync Output BNC</b>
④	<b>CH2 Sync Output BNC</b>
⑤	<b>USB Interface</b>
⑥	<b>Earth Ground</b>
⑦	<b>AC Power Connector and Fuse Box</b>
⑧	<b>Rear Cooling Fan</b>

## 1.5 Display Overview

The function generator has a color LCD display that can display up to 400 x 240 dots. When powering on the unit, sine waveform is selected and current settings will appear in the display. The bottom of the display shows a menu (selectable with function keys) that corresponds to the function, parameter, or mode display selected.

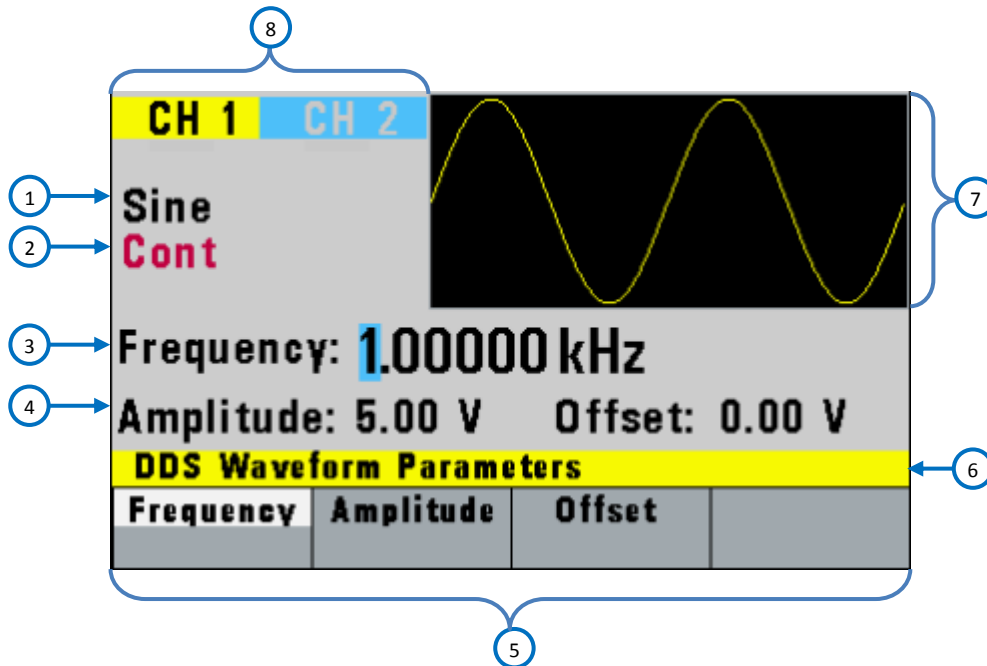


Figure 3 - Display Overview

### Display Description

①	Wave Type
②	Trigger Mode
③	Frequency
④	Menu Parameters Values
⑤	Menu Options
⑥	Menu Title
⑦	General Waveform Display
⑧	Channel Selection Indicator



## 2 Getting Started

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

### 2.1 Input Power and Fuse Requirements

#### Input Power

The instrument has a universal AC input that accepts line voltage and frequency input within:

**90 V to 264 V, 48 Hz to 66 Hz**

The maximum power consumption is 30 VA. Use a slow blow fuse of 1A, UL/CSA approved as indicated on the rear panel of the instrument.

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.

---

**⚠ WARNING**

**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 warranty.**

---

#### Fuse Requirements

The instrument power fuse is located in the AC input plug. To access the fuse, first disconnect the power cord and then remove the fuse box.

There is a 1A, 250V rated slow blow fuse at the AC input. Should the fuse ever get blown, follow the steps below to replace:

1. Locate the fuse box next to the AC input connector in the rear panel.
2. With a small flat blade screwdriver, insert into the fuse box slit to pull and slide out the fuse box as indicated below.
3. Check and replace fuse if necessary.

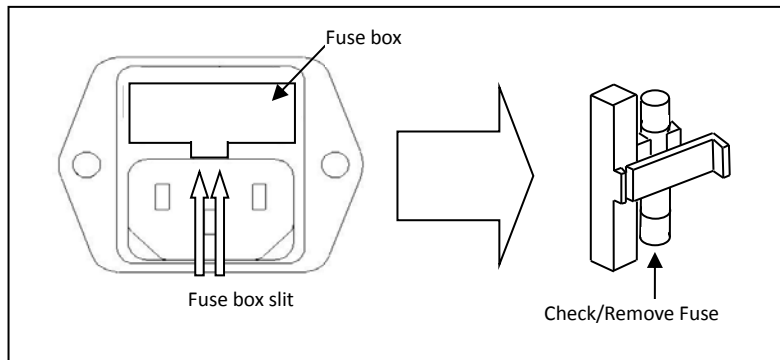


Figure 4 - Fuse Replacement

## 2.2 Connectors

The function generator has two BNC connectors on the front panel where you can connect coaxial cables. These coaxial cables serve as carrier lines for output signals delivered from the function generator.

### Output Connector

Use this connector to transfer the main output signal from the function generator. One connector is available for each channel.

### Trig In Connector

Use this connector to apply an external trigger or gate signal, depending on the waveform generator setting, to the generator. When the built-in frequency counter is enabled, this connector becomes an input for the counter. The connector is common to both channels acting as the MODE selected for each channel.

### Sync Out Connector

Use this connector to output a positive TTL sync pulse generated at each waveform cycle. One connector is available for each channel.

### Modulation In Connector

5V p-p signal for 100% modulation, 10Kohms input impedance with DC - >20 KHz bandwidth. The connector is common to both channels acting as the MODULATION function selected for each channel.

## 2.3 Output Connections

The waveform generator output circuits operate as a 50  $\Omega$  voltage source working into a 50  $\Omega$  load. At higher frequencies, non-terminated or improperly terminated output causes aberrations on the output waveform. In addition, loads less than 50  $\Omega$  reduce the waveform amplitude, while loads more than 50  $\Omega$  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:

1. Use good quality 50  $\Omega$  coaxial cable and connectors.
2. Make all connections tight and as short as possible.
3. Use good quality attenuators if it is necessary to reduce waveform amplitudes applied to sensitive circuits.
4. Use termination or impedance-matching devices to avoid reflections.
5. 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.

### **Impedance Matching**

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

## **2.4 Preliminary Check**

The 4047B is intended for bench use. The instrument includes a front feet tilt mechanism for optimum panel viewing angle. The instrument does not require special cooling when operated within conventional temperature limits. It may be installed in a closed rack or test station if proper air flow can assure removing about 15 W of power dissipation.

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

### **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 2.1 Input Power and Fuse Requirements.

### **2. Connect Power**

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

### **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 3.7 Displaying Errors. When the waveform generator

finishes the diagnostic self-test routine, it enters the local state (LOCS) and assumes power-on default settings.

## ***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 Default Setup**. The instrument will set both channels with the following parameters:  
Waveform Shape: **Sine**  
Frequency: **1.000000000 kHz**  
Amplitude: **5 .000 Vpp**  
Offset: **0.000 Vdc**  
Phase: **0.0 °**  
Output Impedance: **50 OHM**
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 **Freq** option 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 **Ampl** option 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.

## 3 Operating Instructions

### 3.1 Menu Keys

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

#### 3.1.1 WAVEFORM Keys

These keys select the waveform output and display the waveform parameter menu (frequency, amplitude and offset).

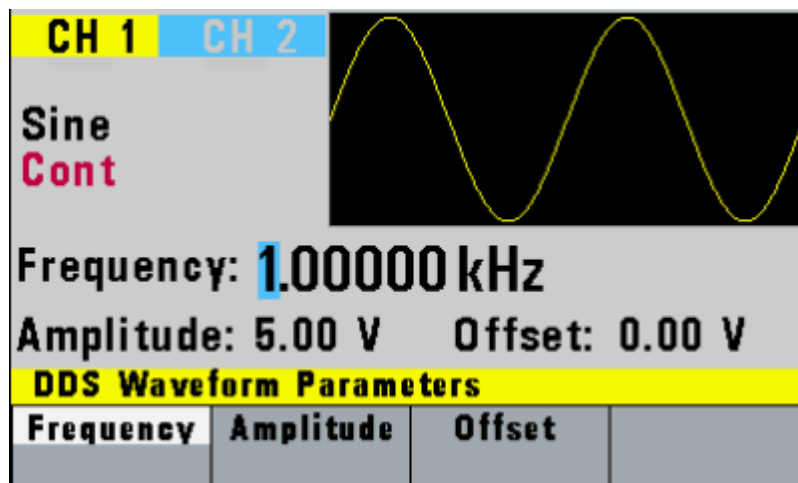


Figure 5 - Sine Menu

- F1: Frequency** – Selects and displays the frequency. Change the frequency setting using the cursor keys, rotary knob, or numerical keys.
- F2: Amplitude** – Selects and displays the amplitude. Change the amplitude setting using the cursor keys, rotary knob, or numerical keys.
- F3: Offset** – Selects and displays the offset parameter. Change the offset by using the cursor keys, rotary knob, or numerical keys. If a certain setting cannot be produced, the waveform generator will display a “**Setting Conflict**” message.

Amplitude and offset settings interact and are bound by hardware restrictions. To obtain the desired waveform, the amplitude and offset must satisfy the following formula:

$$(V_{p-p})/2 + |\text{offset}| \leq 5 \text{ volts}$$

#### F4: Symmetry

– When the Square or Triangle waveforms are selected, the SYMMETRY (duty cycle) parameter is available. Change the symmetry (Triangle) or duty cycle (Square) by using the cursor keys, rotary knob, or numerical keys. If a certain setting cannot be produced, the waveform generator will display a warning message.

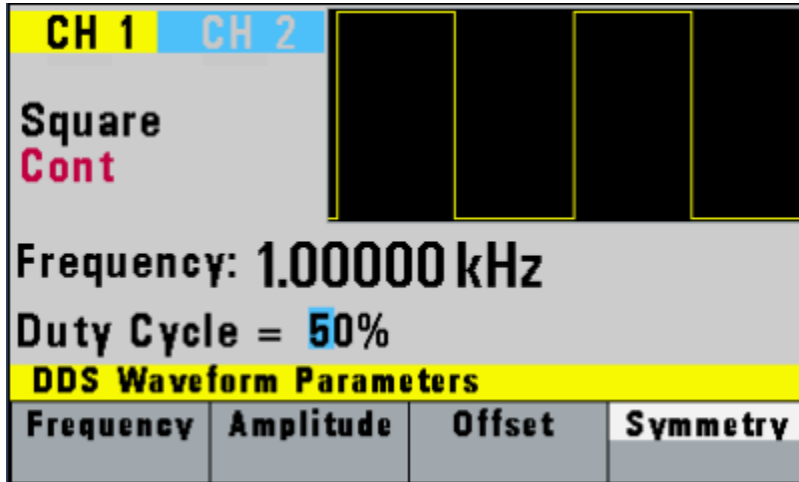


Figure 6 - Square Menu

#### 3.1.2 MODE Key

Selects the output mode: CONT (Continuous), TRIG (Triggered), GATE (Gated), and BRST (Burst). To select the output mode, press MODE, then press the function key that corresponds to the desired Mode menu option, as shown:

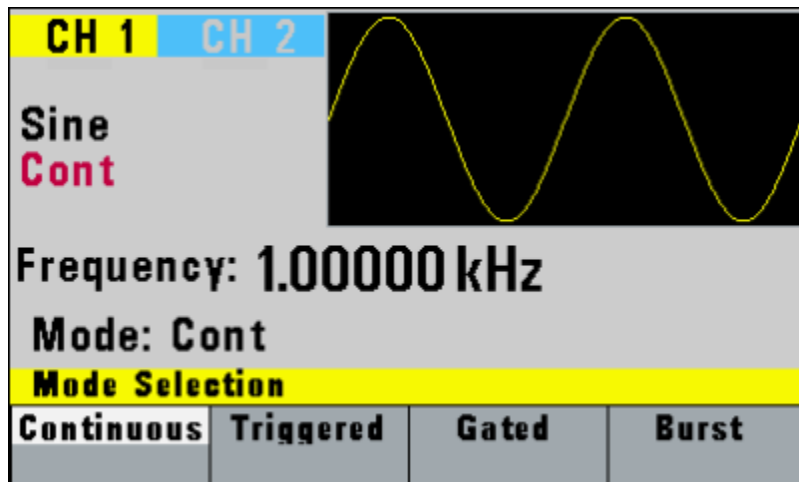


Figure 7 - Mode Menu

- F1: Continuous** – Selects continuous output.
- F2: Triggered** – Triggers one output cycle of the selected waveform for each trigger event.
- F3: Gated** – Triggers output cycles as long as the trigger source asserts the gate signal.
- F4: Burst** – Triggers 'N' number of output cycles for each trigger event, where N ranges from 2 to 65,535.

After selecting the TRIGGERED, GATED, or BURST menu, the trigger source menu is available:

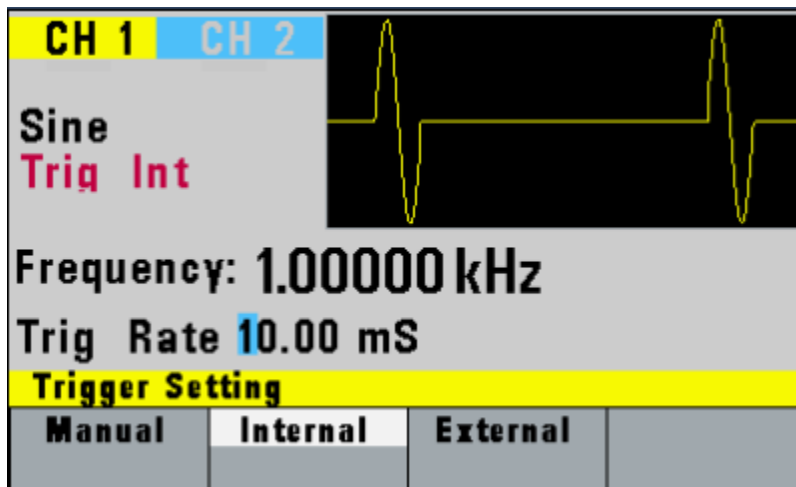


Figure 8 - Trigger Menu

- F1: Manual** – Selects manual as the trigger source. To trigger the waveform generator, press this MANUAL trigger button again.
- F2: Internal** – Selects the internal trigger generator as the trigger source. Change the internal trigger rate displayed with the rotary input knob.
- F3: External** – Selects the external trigger signal as the trigger source. The trigger source is supplied through the **TRIG IN** connector.

In BURST MODE, the **F4** key displays **N-Burst**, representing the number of burst cycles to output with each trigger. The **N** value can be changed from 2 to 65,535.

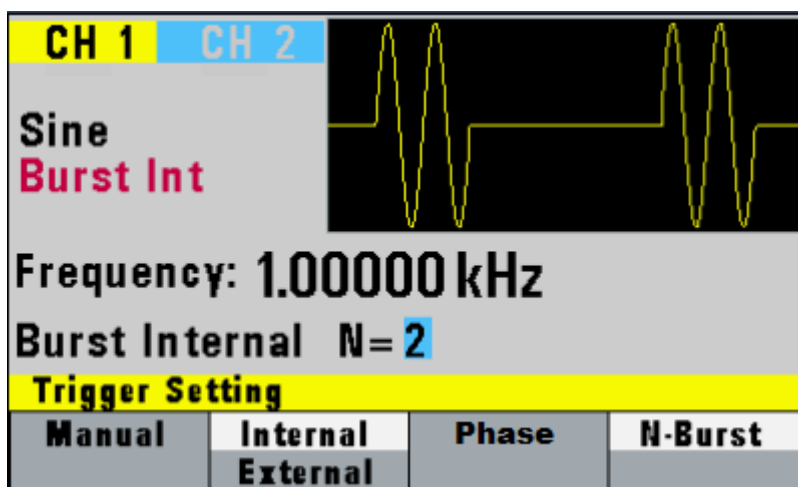
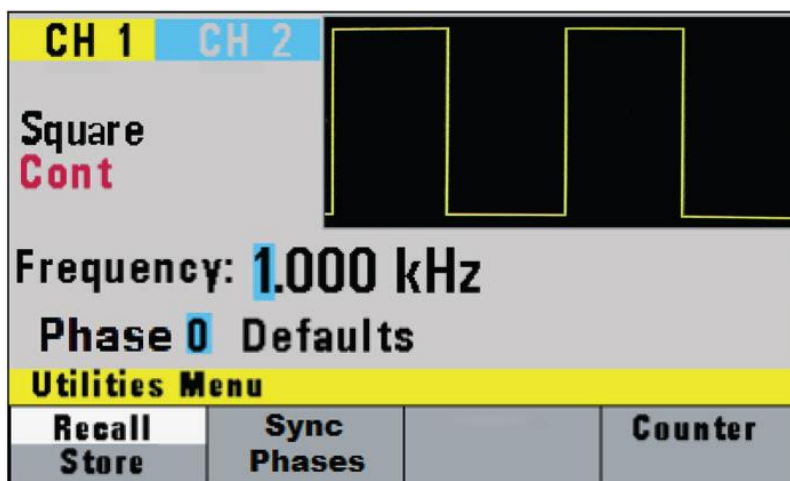


Figure 9 - Burst Menu

### 3.1.3 UTILITY Key



Utility Menu

#### F1: Recall/Store

– Recalls a previously stored front-panel setup from the selected buffer. Change the buffer number by using the rotary input knob. Valid storage buffer numbers are from 1 to 19 Buffer 0 is the factory default setup.

– Stores the current front-panel setup to the specified storage buffer. Change the buffer number by using the data keys or the rotary input knob. Valid storage buffer numbers range from 1 to 19.

#### F2: Sync Phases

– Synchronizes both channels with a phase shift as in the Phase parameter entered.



**F4: COUNTER**

– Enables the built-in frequency counter. The frequency of the signal connected to the **TRIG IN** connector will be displayed. The counter is auto ranging with up to 8 digits of resolution.

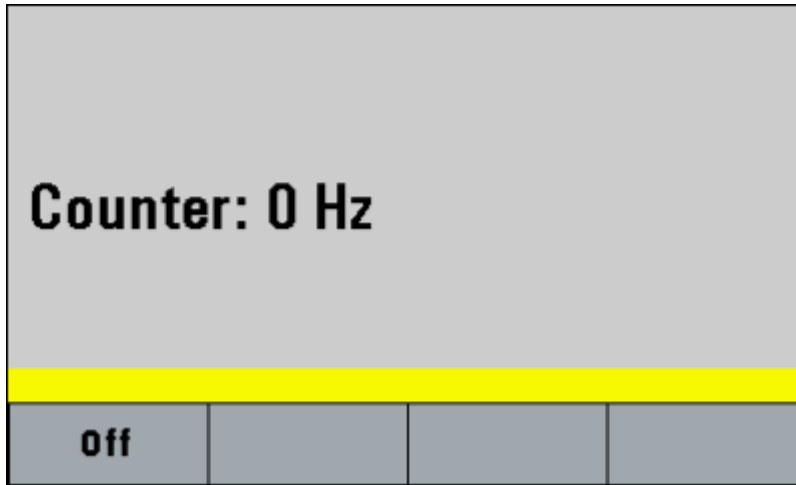


Figure 10 - Counter Screen

Press **F1 - Off** to turn off the counter.

**3.1.4 SWEEP Key**

Selects the Sweep Mode and allows entering of sweep parameters: Sweep Start, Sweep Stop, and Sweep Rate.

To select the sweep mode, press SWEEP, then press the function key that corresponds to the desired Sweep menu option, as shown:

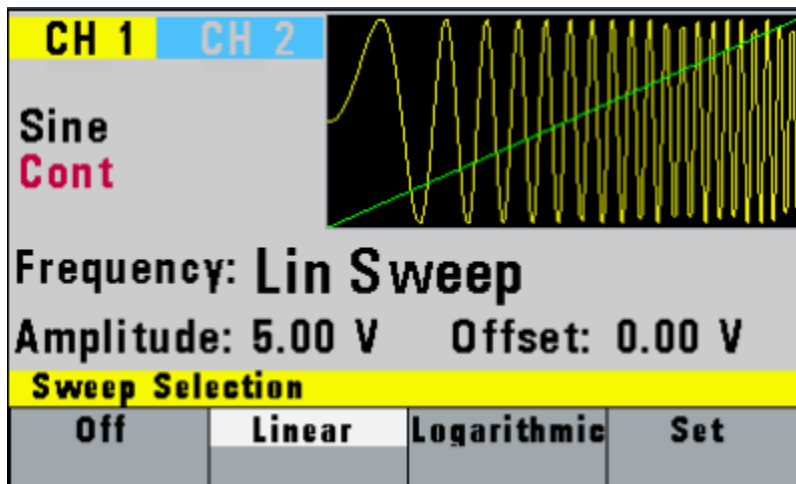


Figure 11 - Sweep Menu

**F1: Off** – Disables the sweep function.

**F2: Linear** – Selects the Linear sweep shape.

- F3: Logarithmic** – Selects the Logarithmic sweep shape.
- F4: Set** – Defines the Sweep Start and Stop frequencies.

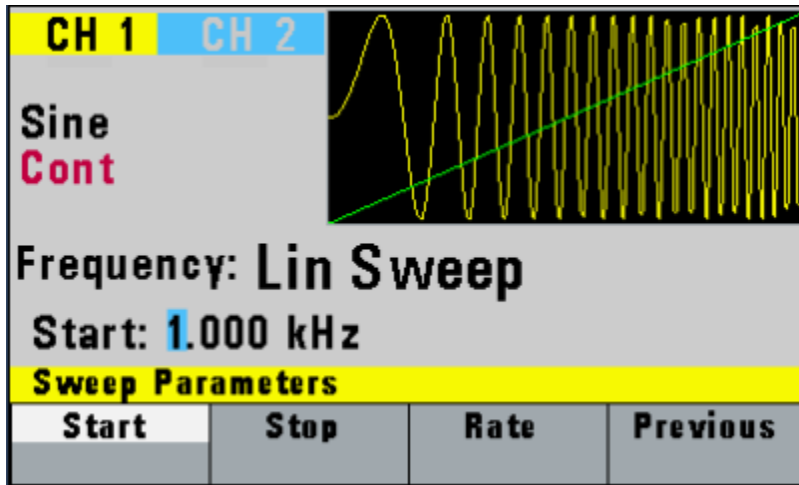


Figure 12 - Set Sweep Menu

### 3.1.5 MODULATION Key

Selects the AM, FM, FSK, PM, or PWM modulation mode. To select the output mode, press MODUL key, then press the function key that corresponds to the desired menu option, as shown:

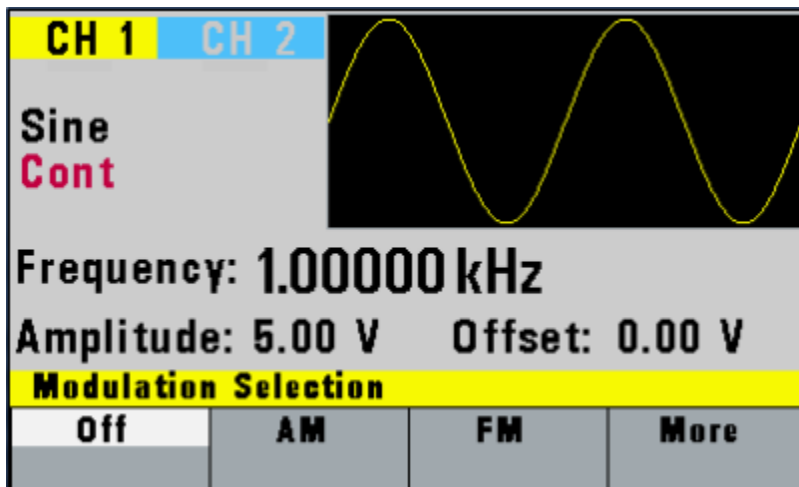


Figure 13 - Modulation Menu 1 of 2

Press **F2** to select **AM** menu:

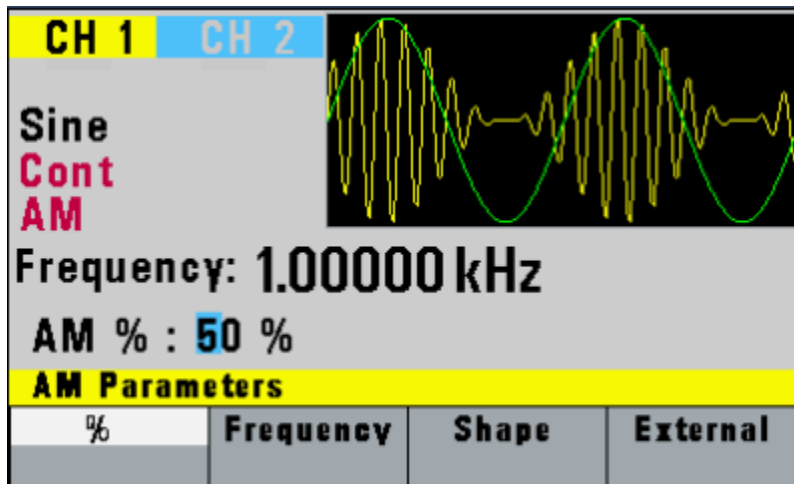


Figure 14 - AM Menu

**F1: %** - Defines the modulation depth (from 0 to 100%)

**F2: Frequency** - Selects the modulation frequency, from 0.1 Hz to 20.00 kHz.

**F3: Shape** - Selects the modulating waveform between Sine, Square, or Triangle.

**F4: External** - Selects and enables the external modulation by an external signal applied to the **Modulation In** connector on the rear panel.

Press **F3** to select **FM** menu:

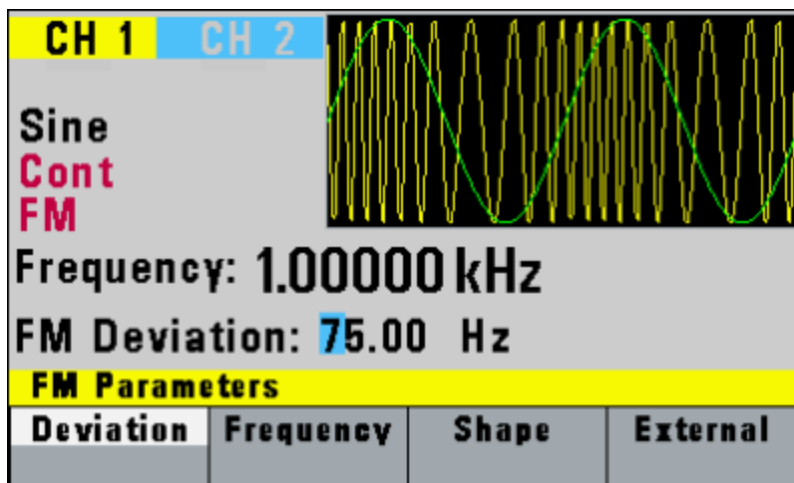


Figure 15 - FM Menu

**F1: Deviation** - Defines the FM deviation frequency.

**F2: Frequency** - Selects the modulation frequency, from 0.1 Hz to 20.00 kHz.

**F3: Shape** - Selects the shape of the modulating waveform between Sine, Triangle, or Square.

**F4: External** - Selects and enables the external modulation by an external signal applied to the **Modulation In** connector on the rear panel.

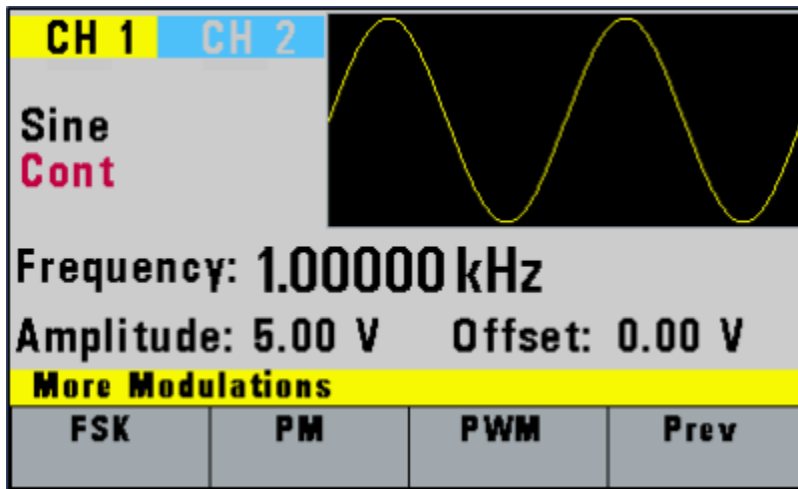


Figure 16 - Modulation Menu 2 of 2

Press **F1** to select **FSK** menu:

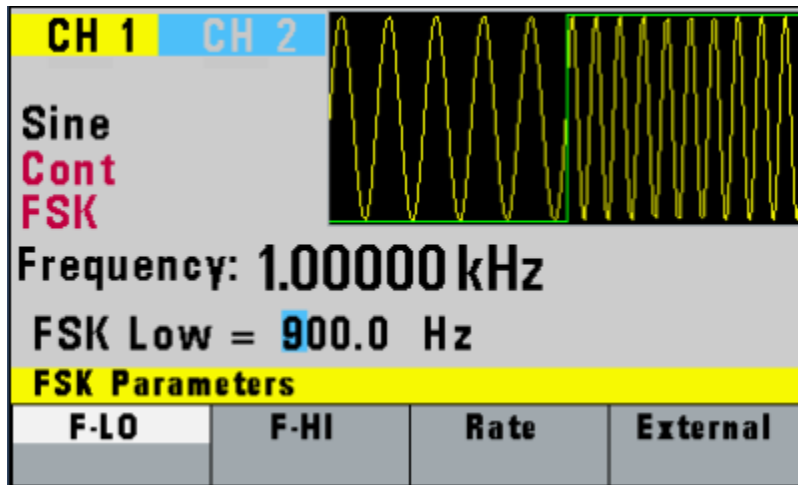


Figure 17 - FSK Menu

- F1: F-LO** - Defines the low frequency of the FSK.
- F2: F-HI** - Defines the high frequency of the FSK.
- F3: Rate** - Selects the rate of the alternating between the low and high frequencies.
- F4: External** - Selects and enables the external modulation by an external signal applied to the **Modulation In** connector on the rear panel.

Press **F2** to select **PM** menu:

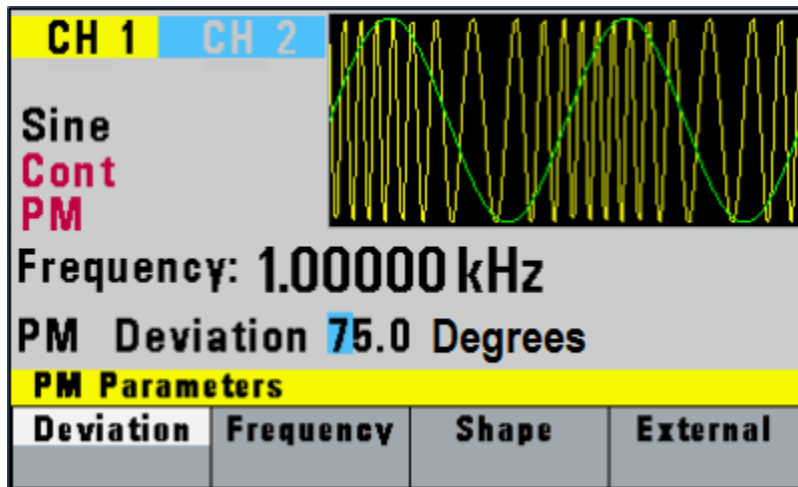


Figure 18 - PM Menu

**F1: Deviation** - Defines the phase deviation of the PM in degrees.

**F2: Frequency** - Defines the PM frequency.

**F3: Shape** - Selects the shape of the modulating waveform between Sine, Triangle, or Square.

**F4: External** - Selects and enables the external modulation by an external signal applied to the **Modulation In** connector on the rear panel.

Press **F3** to select **PWM** menu:

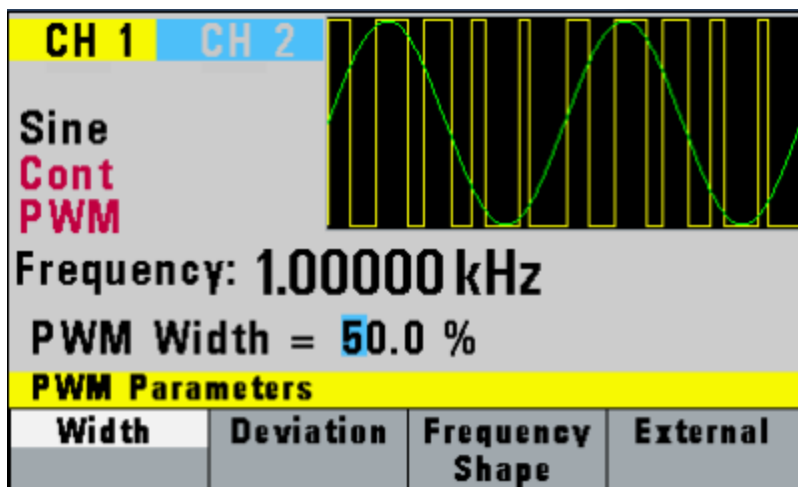


Figure 19 - PWM Menu

**F1: Width** - Defines the pulse width of the PWM.

**F2: Deviation** - Defines the pulse width deviation of the PWM.

**F3: Frequency/Shape** - Adjusts the PWM frequency. Selects the shape of the modulating waveform between Sine, Triangle, or Square.

**F4: External** - Selects and enables the external FSK when the unit frequency is alternating between the low and high frequencies by an external signal applied to the **Trig In** connector.

### 3.1.6 PULSE Key

Selects the Pulse waveform menu shown below:

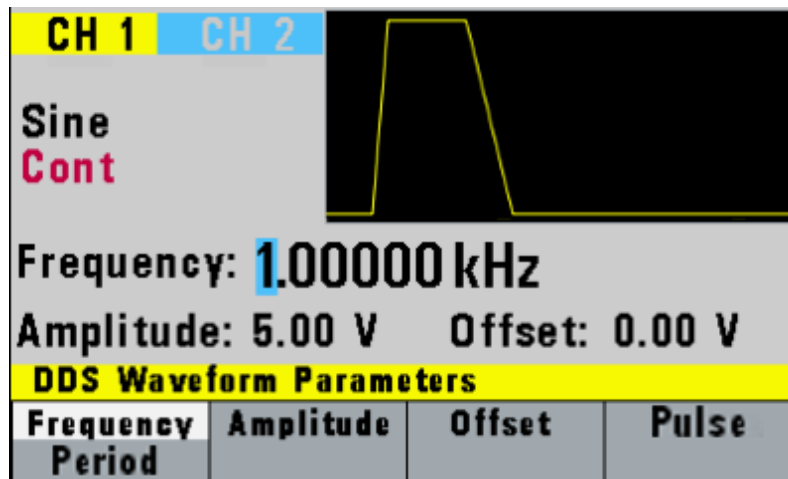


Figure 20 – Pulse Menu

**F1: Frequency/Period**- Selects the parameter definition of the Pulse repetition period.

**F2: Amplitude** - Selects the Amplitude parameter.  
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 (data points from -8191 to +8191), then its actual amplitude will be smaller.

**F3: Offset** - Selects the Offset parameter. Change the offset by using the cursor keys, rotary dial or numerical keys. If a certain setting cannot be produced, the waveform generator will display a “Setting Conflict” error message.

**F4: Pulse** - Selects the Pulse Width and edge edit menu

### 3.1.7 Pulse Width and Edge Edit Menu

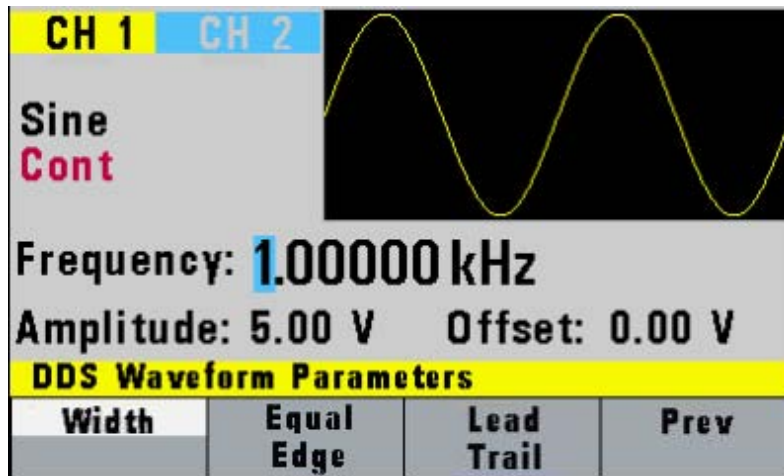


Figure 21 - Pulse Width and Edge Edit Menu

- F1: Width** - Selects the Width of the generated pulse.
- F2: Equal Edge** - Selects equal Rise (Leading edge) and Fall (Trailing edge) times of the pulse.
- F3: Lead/Trail** - Selects different Rise and Fall times of the Pulse.
- F4: Prev** - Returns to previous menu.

### 3.1.8 ARBITRARY Key

Selects the Arbitrary waveform menu shown below:

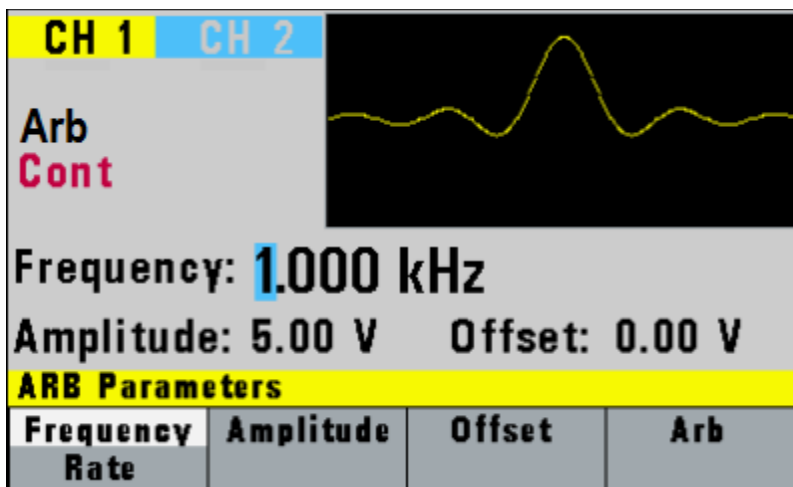


Figure 22 - Arbitrary Menu

- F1: Frequency/Rate** - (Frequency) Selects and displays the frequency. Change the frequency setting using the cursor keys, rotary knob or numerical keys. If a certain wavelength

can't produce the waveform at the desired frequency, the waveform generator will display an "Out of Range" error message.

Displays the Point Rate (for Arbitrary Waveform only). The Rate parameter governs the rate at which waveform points are executed and thus the frequency of the output. When you set this parameter, the waveform generator will keep that execution rate for all waveform lengths until it is changed.

**F2: Amplitude**

- Selects the Amplitude parameter.

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 (data points from -8191 to +8191), then its actual amplitude will be smaller.

**F3: Offset**

- Selects the Offset parameter. Change the offset by using the cursor keys, rotary dial or numerical keys. If a certain setting cannot be produced, the waveform generator will display a "Setting Conflict" error message.

**F4: Arb**

- Selects the Arbitrary waveform editing menu:

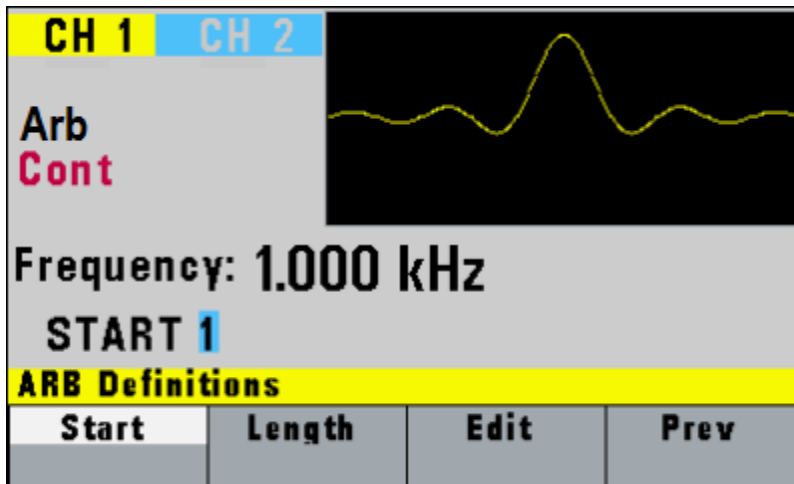


Figure 23 - Arbitrary Editing Menu

**F1: Start** - Selects the arbitrary waveform start address.

**F2: Length** - Selects the arbitrary waveform length. Use the START and LENGTH keys to mark a selection of the waveform memory that will be executed.

Changing one of the arbitrary parameters as start and length cause an updating of the output waveform to the new parameters. When exiting the Arbitrary Menu by selecting a different waveform, a message to save the Arbitrary wave will be displayed. Select YES or NO to save the new waveform.

**F3: Edit** – Enters the Arb Edit menu.



### 3.1.9 Arbitrary EDIT Menu

Enters data for creating arbitrary waveforms. You can enter data one point at a time, as a value at an address, draw a line from one point (a value at an address) to another point, create a predefined waveform, or combine these to create complex waveforms. The valid data values range is -8191 to 8191. The valid waveform memory addresses range from 1 to 16,382.

The data value governs the output amplitude of that point of the waveform, scaled to the instrument output amplitude. Therefore, a value of 8191 corresponds to positive peak amplitude, 0 corresponds to the waveform offset, and -8191 corresponds to the negative peak amplitude.

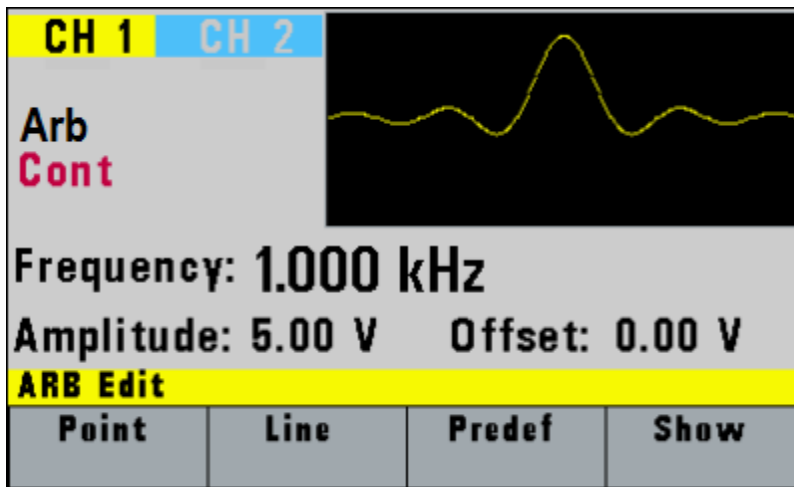


Figure 24 - Edit Menu

**F1: Point** - This menu allows point-by-point waveform editing. When selected, the following menu is displayed:

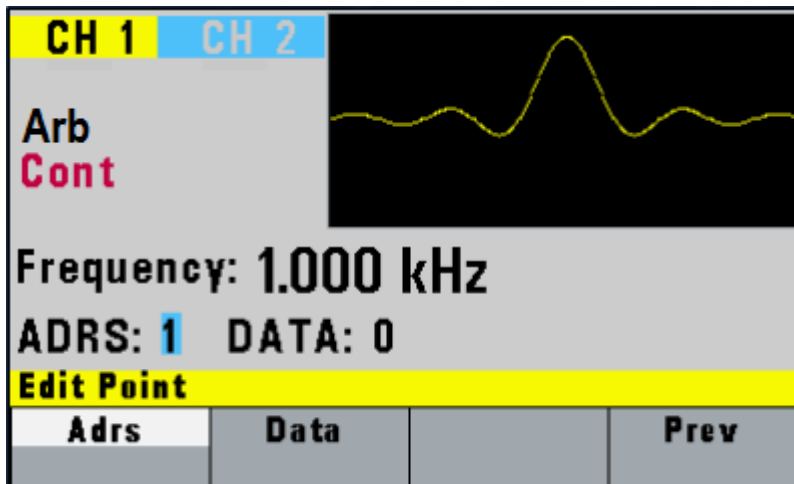


Figure 25 - Point Menu

**F1: Adrs** - Select the current address in the arbitrary waveform memory.

**F2: Data** - Selects the data point value at the current address. You can change the point

value from -8191 to 8191.

- F2: Line** - This menu allows a line to be drawn between two selected points. When selected, the following menu is displayed:

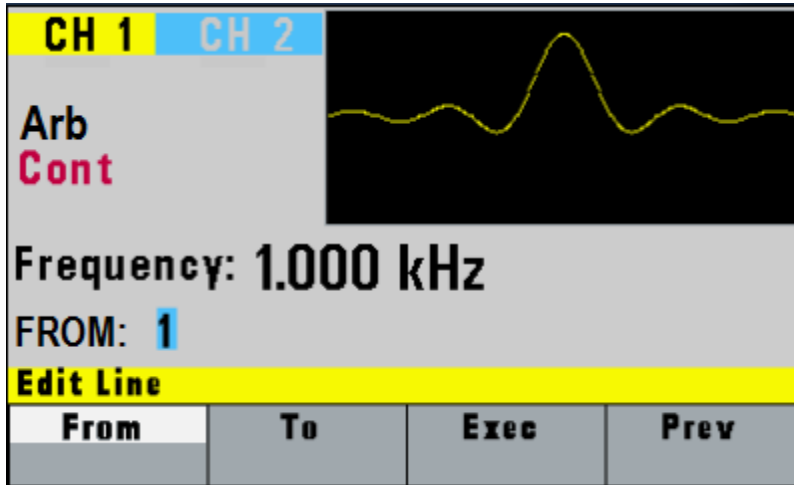


Figure 26 - Line Menu

**F1: From** - Selects the starting point address.

**F2: To** - Selects the ending point address.

**F3: Exec** - Displays the Confirmation menu, **F1:NO** and **F2:YES**

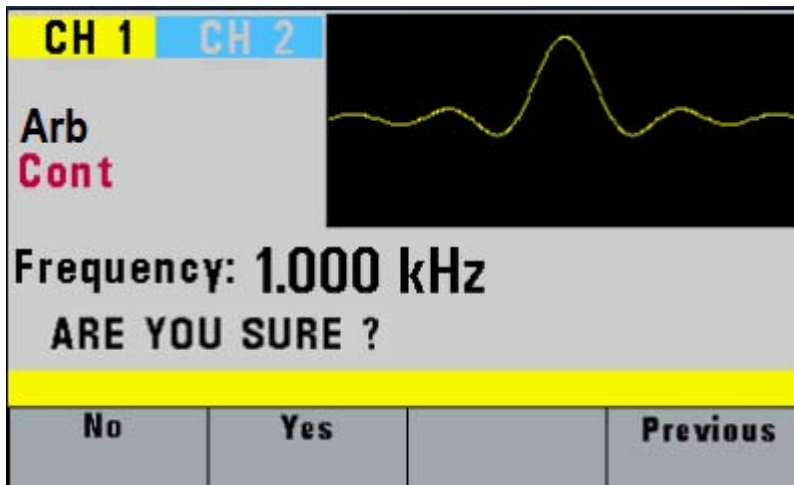


Figure 27 - Confirmation Menu

- F3: Predef** - (Predefined Waveforms) Selects one of the predefined waveforms: Sine, Triangle, Square and Noise. Displays the Predefined waveforms menu:

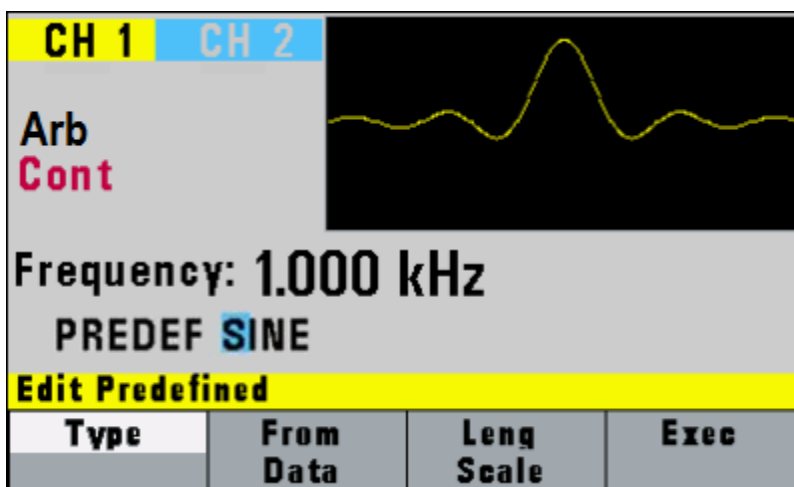


Figure 28 - Predefined Menu

**F1: Type** - Use the rotary dial to select the waveform Sine, Triangle, Square or Noise. If Noise function is selected, a submenu is displayed to allow adding the noise to an available waveform or to generate it as a new noise waveform.

**F2: From Data** - Selects the starting point of the generated waveform and data value.

**F3: Leng/Scale** - Selects the length of the predefined waveform (number of points for a full wave). Different waveforms have different limitations on the length, as shown in Table 3-1.

**Table 3-1: Waveform Length Limits for Predefined Waveforms**

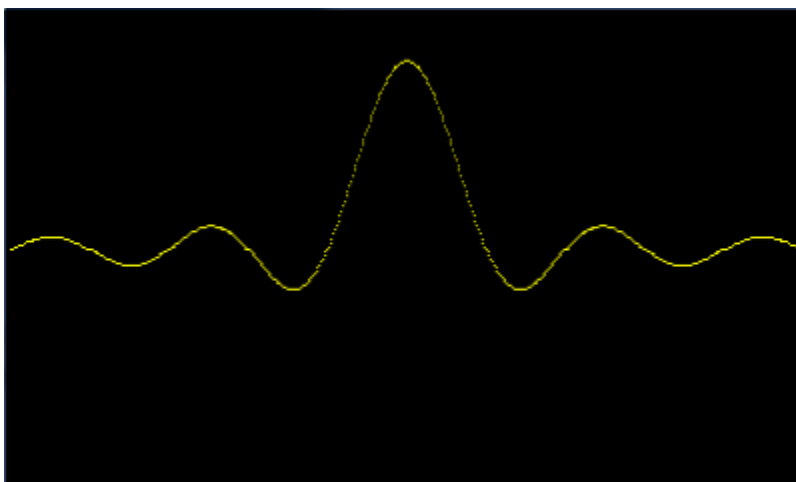
Wave	Minimum Length	Divisible by
Sine	16	4
Triangle	16	4
Square	2	2
Noise	16	1

**F3: Scale** - Selects the scale factor of the waveform. 100% means that the waveform spans the full scale of -8191 to 8191. Scale factors are limited by the point data value of the starting point and automatically calculated by the unit.

**F4: Exec** - Prompts you to confirm whether to execute the selected predefined waveform. Press NO to abort executing the predefined waveform; press YES to execute the predefined waveform. On the NOISE function menu options, ADD and NEW are available. Select ADD to add noise to an existing waveform, or NEW to create a new noise waveform.

**F4: Show** - Displays the Arbitrary waveform on the full LCD display. Press any button to return to

the MENU selection display.



*Full Display*

## 3.2 ON Key

Use this key to control the main output signal. When the output is active, the **ON** key will be lit. By default, this will be OFF (disabled) from a power-up.

## 3.3 Cursor Keys

Use these keys to move the cursor (when visible) either left or right. They are used in conjunction with the rotary input knob to set the step size of the rotary input knob.

## 3.4 Rotary Input Knob

Use this knob to increase and decrease numeric values. The cursor indicates the low-order position of the displayed value which changes when you rotate the knob (for straight numeric entries only). For other types of data, the whole value changes when you rotate the knob.

## 3.5 Power-On Settings

At power-on, the waveform generator performs a diagnostic self-test procedure to check itself for errors. If an error is found, 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 Error Indication section.

When the waveform generator finishes the diagnostic self-test routine, it enters the local state (LOGS) and assumes power-on default settings. Table 1 lists the factory default settings or selected after RECALL 0.

**Table 1 – Power-on Default Settings**

Key Function	Value	Description
Function	Sine	Output Waveform
Frequency	1.0000 kHz	Waveform Frequency
Amplitude	5.00 V	Peak-to-peak output amplitude
Offset	0.00 V	Zero DC offset
Output	OFF	Output disabled
Sweep	OFF	Sweep function disabled
Modulation	OFF	Modulation function disabled
N-BURST	2	Wave per burst for burst mode
Trig Source	Continuous	Continuous trigger
Trig Rate	10 ms	Internal trigger rate

### 3.6 Memory

The waveform generator uses non-volatile flash memory for storing the front panel settings. Up to 20 front panel settings can be stored (includes storage location 0 for factory default settings). One 16382-point arbitrary waveform is stored in the flash non-volatile memory.

### 3.7 Displaying Errors

The waveform generator displays error messages when front-panel settings are either invalid or may produce unexpected results.

**Table 2 – Error Messages**

Message Text	Description
Out of range	The set value is out of the instrument's limits.
Setting conflict	Settings conflict with another parameter setting or value.
Empty location	Attempt to recall settings from an empty storage location.
Trig rate short	Internal trigger rate is too short to output waveform or burst.
Save RAM	New firmware installed.
Must divide by 4	Predefined wave length must be divisible by 4.
Must divide by 2	Predefined wave length must be divisible by 2.

## 3.8 Quick Start

This section explains how to generate various waveforms and modify the output waveform.

- \* Generating a waveform output
- \* Modifying waveform output
- \* Storing and recalling a waveform generator setup

### 3.8.1 *Selecting a Standard Waveform*

You can select several standard waveforms as: sine, triangle, square. Creating a standard waveform requires selecting the waveform type, parameters and their settings that define the waveform.

Generating a standard waveform requires the following:

- \* Selecting the waveform
- \* Setting the output frequency
- \* Setting the output amplitude and offset

### 3.8.2 *Setting the Output*

To set the output channel, press the Output **ON** key. The key will lit indicating the output is enabled.

### 3.8.3 *Using Voltage Offset*

Through the offset parameter you can add a positive or negative DC level to the output waveform.

To set voltage offset:

1. Select a waveform to display its menu.
2. Press F3: Offset to display the offset setting.
3. Use the rotary input knob or the numerical keys to set the voltage offset.

To turn the voltage offset OFF, repeat the steps above, but set the offset voltage level to 0.

### **3.8.4 Storing and Recalling a Waveform Generator Setup**

You can store front-panel setups inside the internal non-volatile flash memory. When you recall a stored setup, the front-panel settings change to match the settings in the stored setup.

#### **Storing Setups**

To store the front-panel setup:

1. Press UTILITY to display the menu.
2. Press F1:Store to select the Store mode.
3. Use the rotary input knob to select a buffer number. Valid buffer numbers range from 1 to 19  
Buffer 0 is a read-only buffer that contains the default setup/power-on settings from Table 1.

The function generator will overwrite and store settings into a buffer that had settings previously stored inside without a warning.

#### **Recalling Setups**

To recall stored front-panel setup:

1. Press UTILITY to display the menu.
2. Press F1:Recall to select the Recall mode.
3. Use the rotary input knob to select a buffer number. Valid buffers numbers range from 0 to 19. Buffer 0 is a read-only buffer that contains the default power-on setup.

### **3.8.5 Creating an Arbitrary Waveform**

You can create an arbitrary waveform using the following methods:

- \* Enter individual data points
- \* Draw lines between data points
- \* Create a predefined waveform
- \* Combine any of these methods

You can program any number of waveforms into waveform memory, keeping in mind the addresses where one waveform ends and the other begins.

The waveform's frequency and amplitude are influenced by the number of data points and their value in the waveform.

### **3.8.6 Entering Individual Data Points**

The most basic way to program an arbitrary waveform is to enter data points for the waveform, one data point at a time. While this can become tedious the auto-increment function helps this process.

To enter individual data points into waveform memory, follow these steps:

1. Press ARB main key to display the selection menu.
2. Press F4:ARB to display the Arbitrary menu.
3. Press F3:EDIT to display the Edit menu.
4. Press F1:POINT, to select the point by point programming mode.
5. Press F1:ADDRESS.
6. Use the rotary knob or the numerical keys to enter the address.
7. Press F2:DATA.
8. Use the rotary knob or the numerical keys to enter the value for the data point. Valid entries range from -8191 to 8191.
9. Repeat steps 5 through 9 until you finish programming your arbitrary waveform.

NOTE:

*Each time you press ENTER to complete a data point entry in numerical mode, the auto-increment address advances by one.*



### 3.8.7 Setting the Arbitrary Frequency

The arbitrary waveform frequency is a function of the number of data points used to run the waveform (the length parameter in the ARBITRARY menu) and the waveform execution point rate. The waveform execution point rate is the execution time between each point in the waveform. The total time taken to run one period of the waveform is given by:

$$\text{number of points} \times \text{rate}$$

Because the output frequency is a function of the rate and the number of points being executed, the formula is given as:

$$\text{frequency} = \frac{1}{\text{Number of points} \times \text{rate}}$$

For example, to set the output frequency to 1000Hz, given the number of data points used for the waveform output is 1000, calculate:

$$\text{rate} = \frac{1}{1000 \text{ points} \times 1000 \text{ Hz}} = 1\mu\text{s}$$

EXAMPLE: Setting the Output Frequency

To set the output frequency of a 1000 point waveform in execution memory to 1000Hz, set the rate to 1us:

<b>ACTION</b>	<b>KEYSTROKES</b>
Step 1: Set the output rate to 1 us (equivalent to 1000 Hz output frequency)	PARAMETER F1:RATE 1 kHz/us

### 3.8.8 Setting the Amplitude

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 waveform memory:

$$\text{output voltage} = \frac{\text{Amplitude } p - p \text{ setting} \times \text{data point value}}{16382} + \text{offset}$$

Where 16382 is the data point value range in waveform memory.

**Table 3-4: Relative Amplitude for Waveform Output (Examples)**

<b>Front Panel Amplitude Setting</b>	<b>Data Point Value</b>	<b>Relative Output Amplitude Voltage</b>
5 Vp-p	8191	+2.5 V
5 Vp-p	4095	+1.25 V
5 Vp-p	0	0V (offset voltage)
4 Vp-p	-8191	-2 V

### **3.8.9 Executing an Arbitrary Waveform**

To load a waveform into execution memory, specify its starting address and length in the ARBITRARY menu.

1. Select the channel to ON.
2. Press the ARB key and select the F4:ARB function.
3. Press F1:START to set the address. Valid entries range from 1 to 999.
4. Press F2:LENGTH to display the length of the waveform.
6. Use the rotary input knob or the numerical keys to enter the waveform length. Valid entries range from 2 to 16382.

## 4 Programming

### 4.1 Overview

This section provides detailed information on programming the generator via the USB (virtual COM) interface.

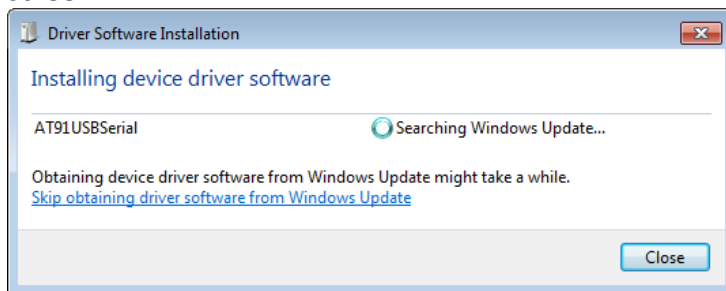
#### 4.1.1 Connecting to USB (Virtual COM) Interface

Currently, the USB (virtual COM) interface supports Windows® XP/7 operating systems.

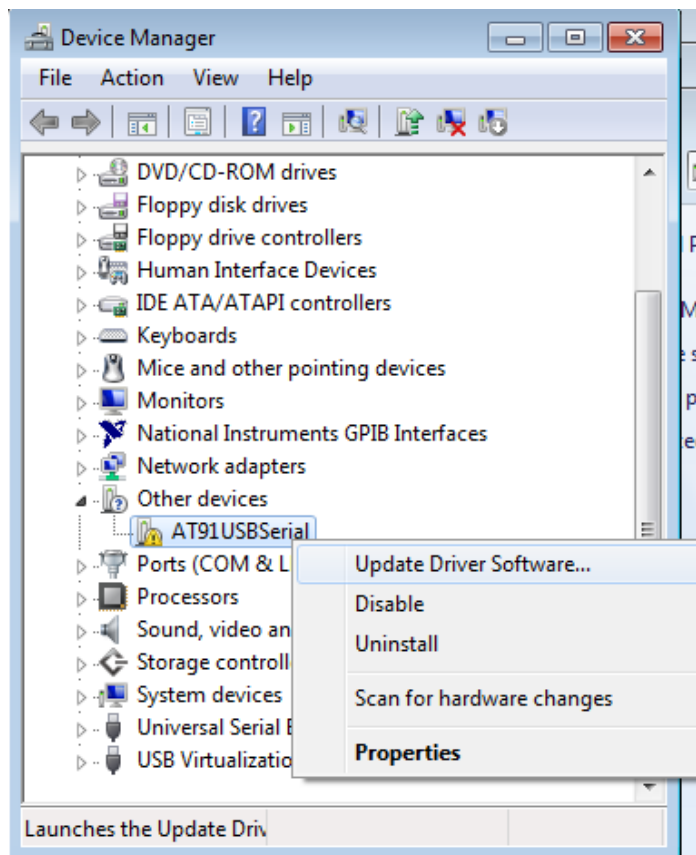
To connect to a PC for remote communication, please follow the steps below:

##### For Windows 7:

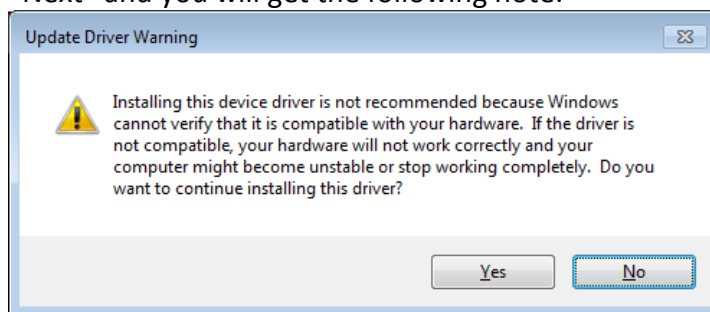
1. The USB driver is included in the CD that comes with the instrument.
2. Connect the included USB Type A to Type B cable to the generator and the computer, then power on the instrument.
3. On most operating systems, it will attempt to automatically install, showing the following screen:



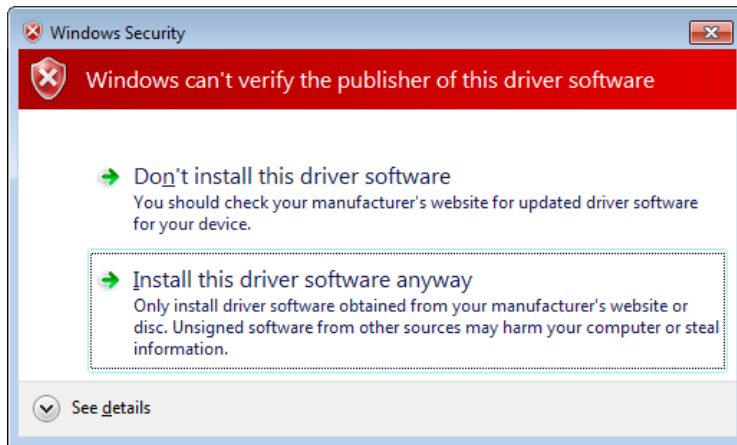
4. Click the “Close” button to stop the automatic search of the driver from Windows Update.
5. Now, go to **Device Manager** on the computer (Open up the “start” button, and right-click “Computer” and select “Properties”. Click “Device Manager” link on the top left of the side menu)
6. There will be an item listed under “Other devices” labeled “AT91USBSerial”. Right-click the item and select “Update Driver Software...”



7. In the following window, select “Browse my computer for driver software”, and following this, select “Let me pick from a list of device drivers on my computer”.
8. Now there will be a window listing Common hardware types. Click the “Next” button and select on the following screen “Have Disk...”
9. From the “Install From Disk” window, click “Browse...” and locate and double-click the USB driver file downloaded from the website labeled “atm6124\_cdc.inf”.
10. Now click “OK”. It will show in the window under Model “AT91 USB to Serial Converter”. Click “Next” and you will get the following note:



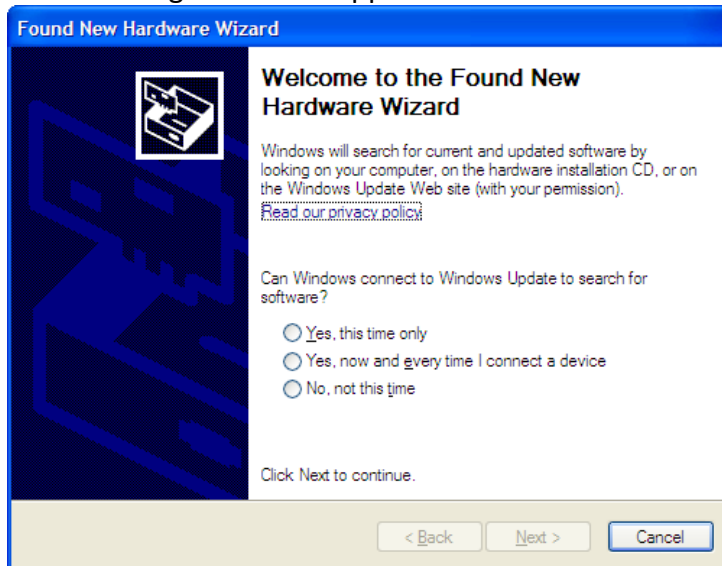
11. Go ahead and click “Yes”. When you get the following prompt, select “Install this driver software anyway”.



12. The driver will now install. Once finished, under “Device Manager”, you should see under “Ports (COM & LPT)” an item labeled “BK Precision USB to Serial Converter (COM#)”. The “COM#” is the com port that can be used to access the virtual COM port for remote communication.

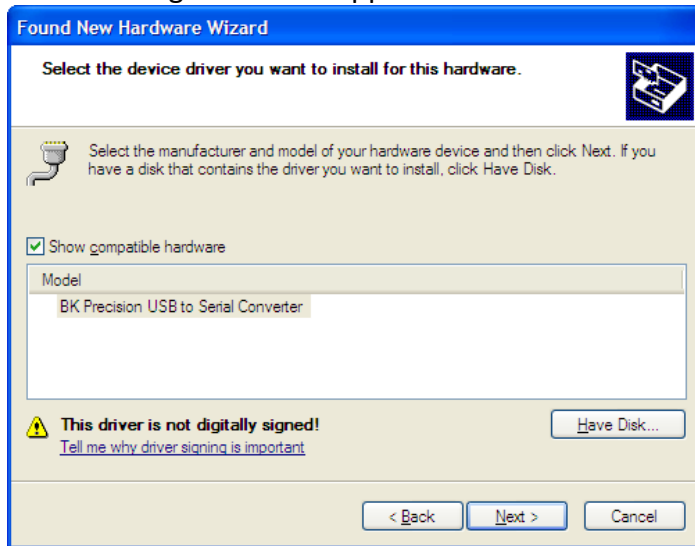
**For Windows XP:**

1. The USB driver is included in the CD that comes with the instrument.
2. Connect the included USB Type A to Type B cable to the generator and the computer, then power on the instrument.
3. The following screen will appear.



4. Select “No, not this time” and click “Next”.
5. In the following screen, select “Install from a list or specific location (Advanced)” and click “Next”.
6. In the next screen, select “Don’t search. I will choose the driver to install.” and click “Next” again.
7. In the following screen, click “Have Disk...”

- From the "Install From Disk" window, click "Browse..." and locate and double-click the USB driver file downloaded from the website labeled "atm6124\_cdc.inf". Select it and click "OK".
- The following screen will appear.



- Click "Next", and a prompt will appear:



- Click on "Continue Anyway" and the driver will now install.
- The driver will now install. Once finished, under "Device Manager" (This can be opened by: Right-click "My Computer" -> Select "Properties" -> Select "Hardware" tab -> Click "Device Manager"), you should see under "Ports (COM & LPT)" an item labeled "BK Precision USB to Serial Converter (COM#)". The "COM#" is the com port that can be used to access the virtual COM port for remote communication.

#### 4.1.2 USB (Virtual COM) Settings

The USB (virtual COM) interface settings for the communication port are as follows:

**BAUDRATE:** 115200  
**PARITY:** NONE  
**DATA BITS:** 8  
**STOP BIT:** 1  
**FLOW CONTROL:** NONE

## 4.2 Device States

The device may be in one of the two possible states described below.

### 4.2.1 *Local State (LOCS)*

In the LOCS state, the device may be operated from the front panel.

### 4.2.2 *Remote State (REMS)*

In the REMS state, the device may be operated from the USB interface. Actuating any front panel key will cause the device state to revert to the LOCS.

## 4.3 Message Exchange Protocol

The device decodes messages using the Message Exchange Protocol similar to the one defined in IEEE 488.2. The following functions implemented in the MEP must be considered:

### 4.3.1 *The Input Buffer*

The device has a 128-byte long cyclic input buffer. Decoding of remote messages is begun as soon as the input buffer is not empty, that is, as soon as the controller has sent at least one byte to the device. Should the input buffer be filled up by the controller faster than the device can remove the bytes and decode them, the bus handshake (CTS/RTS) is used to pause data transfer until room has been made for more bytes in the buffer. This prevents the controller from overrunning the device with data.

### **4.3.2 The Output Queue**

The device has a 100-byte long output queue in which it stores response messages for the controller to read. If at the time a response message is formatted the queue contains previously formatted response messages, such that there are not enough places in the queue for the new message, the device will hold off putting the message in the queue until there is a place for it.

### **4.3.3 Response Messages**

The device sends a Response Message in response to a valid query. All queries return a single Response Message Unit.

## **4.4 Instrument Identification**

The \*IDN? common query is used to read the instrument's identification string. The string returned is as follows:

```
B&K Precision, 4047B, 0, 0.33
```

The "0.33" reflects the firmware version number and will change accordingly.

## **4.5 Instrument Reset**

The \*RST common command effects an instrument reset to the factory default power up state.

## **4.6 Command Syntax**

### **4.6.1 General Command Structure**

A Program Message is defined as a string containing one Program Message Units, which is an instrument command or query. The Program Message is terminated by the Program Message Terminator.

The Program Message Terminator consists of optional white space characters, followed by the Linefeed (LF) character (0x0A).



The Program Message Unit can be divided into three sections as follows:

a) Program Header

The Program Header represents the operation to be performed, and consists of ASCII character mnemonics. Two types of Program Headers are used in the MODEL 4047B: Instrument-control headers and Common Command and Query headers. Common Command and Query Program Headers consist of a single mnemonic prefixed by an asterisk (\*').

The mnemonics consist of upper - or lower-case alpha characters.

Example: The command to set the frequency to 1KHZ may be written in the following ways:

```
FREQ 1KHZ
FREQ 1000HZ
FREQ 1000
FREQ 1E3
freq 1khz
freq 1000hz
freq 1000
freq 1e3
```

b) Program Header Separator

The Program Header Separator is used to separate the program header from the program data. It consists of one or more white space characters, denoted as <ws>. Typically, it is a space.

c) Program Data

The Program Data represent the values of the parameters being set, for example, the '1KHZ' in the above examples. Different forms of program data are accepted, depending on the command. The Program Data types used in the instrument are:

i) Character program data

This form of data is comprised of a mnemonic made up of lower - or upper-case alpha characters. As with Program Header mnemonics, some Character Data mnemonics have short and long forms. Only the short or the long form may be used.

ii) Boolean data

Boolean data indicate that the parameter can take one of two states, ON or OFF. The parameter may be character type

ON or OFF

or numeric. A numeric value is rounded to an integer. A non-zero result is interpreted as 1 (ON), and a zero result as 0 (OFF).

Queries return the values 0 or 1.

iii) NRf

This is a decimal numeric data type, where  
NR1 indicates an integer number,  
NR2 indicates a fixed point real number, and  
NR3 indicates a floating point real number.

iv) Numeric value program data

This data type defines numeric values, as well as special cases of Character Data. Numeric values may be specified in any of Integer, Fixed Point or Floating Point format. All parameters which have associated units accept a suffix, which may be specified using upper or lower-case characters. When the suffix is not specified, the numeric value is accepted in the default units, which are Hertz for frequency, Seconds for time, and Volts for voltage. To set the frequency to 1KHz we can send one of the following commands:

```
FREQ 1000  
FREQ 1E3
```

The special forms of character data accepted as numbers are

```
MAXimum: sets the parameter to its maximum value.  
MINimum: sets the parameter to its minimum value.
```

For example, to set the frequency to its maximum value we can send the command

```
FREQ MAX
```

Some Program Message Units either require, or can accept, more than one data element. Program data elements are separated from each other by the Program Data Separator. It is defined as optional white space characters followed by a comma (','), which in turn is followed by optional white space characters.

There are two types of Program Message Units: Command Message Units and Query Message Units. A Query differs from a Command in that the Program Header is terminated with a question mark ('?'). For example, the frequency might be queried with the following query:

```
FREQ?
```

Some Query Message Units accept data, giving the device more specific information about what is

being queried. In many cases the Query Message Unit may optionally be supplied with the MIN or MAX mnemonics as data. This tells the device to return the minimum or maximum value to which the parameter may currently be set. For example,

FREQ? MAX

will return the maximum value to which the frequency may currently be set.

Not all Program Message units have query forms (for example, SAV), and some Program Message Units might have only the query form (for example IDN?).

The instrument puts the response to the query into the output queue, from where it may be read by the controller.

**NOTE: All commands should be terminated with a <CR> carriage return or <LF> line feed character. Any response string from a query command has both <CR> and <LF> characters appended. For example, an amplitude query command will return 1.23<CR><LF>.**

## 4.7 Status Reporting

The instrument is capable of reporting status events and errors to the controller.

### 4.7.1 *The Error Queue*

The error queue is used to store codes of errors detected in the device. It is implemented as a cyclic buffer of length 10. The error queue is read with the following query:

ERR?

The first error in the queue is returned, and the queue is advanced.

### 4.7.2 *Error Codes*

The negative error codes are defined by SCPI. Positive codes are specific to the instrument.

The error message is returned in the form

<error number>,"<error description>"

A table of error numbers and their descriptions is presented here.

No error reported

0 - No error

## Command Errors

A command error is in the range -199 to -100, and indicates that a syntax error was detected. This includes the case of an unrecognized header.

-100	Command Error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-108	Parameter not allowed
	More parameters than allowed were received
-109	Missing parameter
	Fewer parameters than necessary were received
-110	Command header error
-111	Header separator error
-112	Program mnemonic too long
	The mnemonic must contain no more than 12 characters.
-113	Undefined header
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-128	Numeric data not allowed
	A different data type was expected
-131	Invalid suffix
-134	Suffix too long
-138	Suffix not allowed
-140	Character data error.
-141	Invalid character data.
	Incorrect character data were received.
-144	Character data too long
	Character data may contain no more than 12 characters.
-148	Character data not allowed
-158	String data not allowed
-161	Invalid block data
	An error was found in the block data
-168	Block data not allowed
-178	Expression data not allowed

## Execution Errors

An execution error indicates that the device could not execute a syntactically correct command, either since the data were out of the instrument's range, or due to a device condition.

-200	Execution error An attempt was made to RECALL the contents of an uninitialized stored setting buffer.
-211	Trigger ignored. The *TRG common command was ignored due to the device not being in the correct state to execute the trigger.
-220	Parameter error. A parameter is in the correct range, but conflicts with other parameters.
-221	Settings conflict. The parameter is out of range due to the current instrument state.
-222	Data out of range.
-223	Too much data. The arbitrary waveform memory limit has been exceeded.
-224	Illegal parameter value. The parameter value must be selected from a finite list of possibilities.

## Device-Specific Errors

An error specific to the device occurred.

-315	Configuration memory lost. Device memory has been lost.
-330	Self-test failed.
-350	Queue overflow. Error codes have been lost due to more than 10 errors being reported without being read.

## Query Errors

A query error indicates that the output queue control has detected a problem. This could occur if either an attempt was made to read data from the instrument if none was available, or when data were lost. Data could be lost when a query causes data to be formatted for the controller to be read,

and the controller sends more commands without reading the data.

- 410 Query INTERRUPTED.  
Data were sent before the entire response of a previous query was read.
- 420 Query UNTERMINATED.  
An attempt was made to read a response before the complete program message meant to generate that response was sent.

## Warnings

The execution of some commands might cause an undesirable instrument state. The commands are executed, but a warning is issued.

- 500 Trigger rate short
- 510 Output overload

"Trigger rate short" means that the period of the waveform is larger than the value of the internal trigger rate. Thus not every trigger will generate a cycle (or burst) of the waveform.

## 4.8 Common Commands

### 4.8.1 System Data Commands

#### \*IDN? - Identification query

The identification query enables unique identification of the device over the GPIB. This query should always be the last in a program message. It returns a string with four fields:

- Manufacturer name
- Model name
- Serial number (0 if not relevant)
- Version number

Command

Type: Common Query

Syntax: \*IDN?

Response: BK, MODEL 4047B,0,V1.1

## 4.8.2 Internal Operation Commands

### **\*RST - Reset command**

The Reset command performs a device reset. It causes the device to return to the factory default power up state.

Type: Common Command  
Syntax: \*RST

## 4.8.3 Device Trigger Commands

### **\*TRG - Trigger command**

This command is analogous to the IEEE 488.1 Group Execute Trigger interface message, and has the same effect. It is used to trigger the device to output a wave, and is accepted only when the trigger mode is set to Trigger, Gate or Burst, and the trigger source is set to BUS.

Type: Common Command  
Syntax: \*TRG

## 4.8.4 Stored Settings Commands

### **\*RCL - Recall instrument state**

This command is used to restore the state of the device to that stored in the specified memory location.

#### Arguments

Type <NRf>  
Range 0 to 19 (4047B). Non integer values are rounded before execution

Type: Common Command  
Syntax: \*RCL<ws><NRf>  
Example: \*RCL 0 (Recall default state)  
\*RCL 9

### **\*SAV - Save instrument state**

This command is used to store the current instrument state in the specified memory location.

#### Arguments

Type: <NRf>  
Range: 0 to 9. Non integer values are rounded before execution  
Type: Common Command  
Syntax: \*SAV<ws><NRf>  
Example: \*SAV 2

Stored setting location 0 stores the factory defaults, and is a read-only location.

## 4.9 Instrument Control Commands

Instrument control commands are grouped into logical subsystems according to the SCPI instrument model. The commands are comprised of mnemonics indicating the subsystem to which the command belongs, and the hierarchy within that subsystem. When the command is to be referred to the Root node, it should be prefixed with a colon (:). Mnemonics appearing in square brackets [...] are optional. The '|' character is used to denote a choice of specifications. The '<ws>' is used to denote a white space character.

The selection of which channel to use is achieved through the use of a numeric suffix indicating the channel, attached to the root level mnemonic. When the channel is not specified, channel 1 is assumed. Program message units that are referred back to a specific root level mnemonic operate on the channel specified in that mnemonic.

Examples:

a) `FREQ 5KHZ;AMPL 3V`

Sets the frequency and amplitude of the first channel (default).

b) `FREQ2 5KHZ;AMPL 3V`

Sets the frequency and amplitude of channel 2.

c) `ARB2:START 100;LENGTH 50`

Sets the start address and length of the waveform being output on channel 2.

**Note:** *When controlling the instrument remotely, do not interrupt the instrument with front panel interactions. Although the instrument will be automatically changed back to LOCS (local) mode, subsequent remote commands may cause errors during communication, in which will require a need of restarting the instrument before continuing again with remote operations.*



### 4.9.1 Default Subsystem

The Source Subsystem controls the frequency, voltage, amplitude modulation and clock source. The command structure is as follows:

FUNCTION	SINusoid SQUare TRIangle
FREQuency	<numeric value>
AMPLitude	<numeric value>
OFFSet	<numeric value>
DCYCLE	<numeric value>
OUTPUT	ON/OFF
MODULation	OFF/AM/FM/INT/EXT
DEPTH	<numeric value>
MODFRequency	<numeric value>
MODSHape	SIN/TRI/SQU
DEVIation	<numeric value>
SWEEp	ON/OFF/LIN/LOG
SWRAte	<numeric value>
SWSTArt	<numeric value>
SWSTOp	<numeric value>
MODE	CONT/TRIG/GATE/BRST
TRIG	INT/EXT
TRAtE	<numeric value>
BURSt	<numeric value>

#### **FREQuency <frequency>**

The frequency command controls the frequency of the output waveform.

#### Arguments

Type:	Numeric
Units:	MHz, KHz, Hz (default)
Range:	For SIN and SQU – 0.1 Hz to 20 MHz, For TRI – 0.1 Hz to 2 MHz, For ARB - Dependent on the Point Rate and Wavelength. $F_{max} = 1/(8ns * Wavelength)$ $F_{min} = 1/(100s * Wavelength)$
Rounding:	The value is rounded to 8 digits or 100 mHz (DDS) or 4 digits (ARB)
Command Type:	Setting or Query
Setting	

Syntax:           FREQUency<ws><frequency>[units]  
                  FREQUency<ws>MINimum | MAXimum  
Examples:         FREQ 5KHZ  
                  FREQ 5E3  
                  FREQ MAXIMUM  
                  FREQ MIN

#### Query

Syntax:           FREQUency? [<ws>MAXimum | MINimum]  
Examples:         FREQ?  
                  FREQ? MAX  
Response:         NR3

#### Considerations:

- 1) The MIN and MAX arguments refer to currently settable minimum or maximum.
- 2) FIXEd is alias for CW.

### Point Rate

RATE <point rate>

This command is used to set the point rate. It is coupled with the frequency of the waveform by the relation:

$$\text{Frequency} = 1/(\text{Point Rate} * \text{Wavelength})$$

Thus changing the point rate will result in a change in frequency.

#### Arguments

Type:            Numeric  
Units:           s, ms, us, ns  
Range:           8ns to 100s  
Rounding:       to 4 digits  
Command Type:   Setting or Query

#### Setting

Syntax:           RATE<ws><point rate>[units]  
                  RATE<ws>MINimum | MAXimum

Examples:         RATE 100NS

#### Query

Syntax:           RATE? [<ws>MINimum | MAXimum]  
Response:         NR3

Note: You can alternately use the :ARB:PRATe command.

### AMPLitude <p-p amplitude>

The amplitude command is used to set the peak-to-peak amplitude of the output waveform. Note that the amplitude and the offset are limited by the relation:

$$\text{Peak Amplitude} + |\text{Offset}| \leq 5V$$

#### Arguments

Type: Numeric  
Units: V, mV, VPP, mVPP  
Range: 10mV to 10V  
Rounding: 1mV for 10mV to 999mV. 10mV for 1V to 10V.  
Command Type: Setting or Query

#### Setting

Syntax: AMPLitude<ws><amplitude>[units]  
AMPLitude<ws>MINimum | MAXimum

Examples: AMPL 2.5  
AMPL 2.5V  
AMPL MAX

#### Query

Syntax: AMPLitude? <ws>MINimum | MAXimum]

Examples: AMPL?  
AMPL? MAX

Response: NR2

#### Considerations:

- 1) The MAXimum amplitude is dependent on the offset.
- 2) The MAX and MIN arguments should not be used in a program message containing an OFFSET command, since these values are evaluated during parsing, based on the current value of the offset.

### **OFFSet <offset>**

The offset command is used to set the DC offset of the output waveform. Note that the amplitude and the offset are limited by the relation:

$$\text{Peak Amplitude} + |\text{Offset}| \leq 5V$$

#### Arguments

Type: Numeric  
Units: V, mV  
Range: 10mV to 5V  
Rounding: To 10mV  
Command Type: Setting or Query

#### Setting

Syntax: OFFSet<ws><offset>[units]

Examples:           OFFSet<ws>MINimum | MAXimum  
                       OFFS 2.5  
                       OFFS 2.5V  
                       OFFS MAX

Query

Syntax:            OFFSet? [<ws>MINimum | MAXimum]

Examples:         OFFS?  
                       OFFS? MAX

Response:         NR2

Considerations:

- 1) The MAXimum offset is dependent on the amplitude.
- 2) The MAX and MIN arguments should not be used in a program message containing an AMPLitude command, since these values are evaluated during parsing, based on the current value of the amplitude.

## **FUNCTION**

The function command is used to set the type of waveform to be generated by the instrument.

Command Type:     Setting or Query

Setting Syntax:    FUNCTION<ws><SIN | SQU | TRI>

Examples:          FUNC SIN  
                       FUNC TRI  
                       FUNC ARB

Query Syntax:     FUNCTION?

Examples:          FUNC?

Response:          SIN | TRI | SQU | ARB

## **DCYCLE <duty cycle value>**

This command is used to set the duty-cycle of the square wave or the symmetry of triangular wave. The value is given in percent.

Arguments Type:    Numeric

Units:             None (percent implied)

Range:             1 to 99

Rounding:          To integer

Command Type:     Setting or Query

Syntax:            DCYCLE <ws><duty cycle value>  
                       DCYCLE <ws>MINimum | MAXimum

Query Syntax:     DCYCLE? [<ws>MINimum | MAXimum]

Response:          NR3

## OUT <state>

This command controls whether the output is ON or OFF.

### Arguments

Type: Boolean  
Command Type: Setting or Query  
Setting  
Syntax: OUT<ws>ON|1|OFF|0  
Examples: OUT ON  
OUT 1  
Query  
Syntax: OUT?  
Response: 0|1

## MODULation

This command activates or deactivates modulation:

Command Type: Setting or Query  
Setting  
Syntax: MODULation OFF|AM|FM|PM|FSK|PWM|INT|EXT  
Examples: MODULation FM  
MODULation OFF  
MODULation EXT  
Query  
Syntax: MODULation?  
Response: OFF |  
AM INT |  
AM EXT |  
FM INT |  
FM EXT |  
PM INT |  
PM EXT |  
FSK INT |  
FSK EXT |  
PWM INT |  
PWM EXT |

## DEPT<sub>h</sub>

This command sets the AM modulation depth in %

## Arguments

Type: Numeric  
Units: none (implied %)  
Range: 0 to 100  
Rounding: To integer  
Command Type: Setting or Query

### Setting

Syntax: DEPT<sub>h</sub><ws><percent depth>  
DEPT<sub>h</sub><ws>MINimum | MAXimum

Examples: DEPT<sub>h</sub> 50

### Query

Syntax: DEPT<sub>h</sub>?[<ws>MINimum | MAXimum]  
Response: NR3

## MODFRequency

This command sets the AM and FM modulating waveform frequency

## Arguments

Type: Numeric  
Units: MHz, KHz, Hz (default)  
Range: Fmax = 20 KHz  
Fmin = 0.01 Hz  
Command Type: Setting or Query

### Setting

Syntax: MODFR<ws><frequency>[units]  
MODFR<ws>MINimum | MAXimum

Examples: MODFR 5KHZ  
MODFR 5E3  
MODFR MAXIMUM  
MODFR MIN

### Query

Syntax: MODFR? [<ws>MAXimum | MINimum]  
Examples: MODFR?  
MODFR? MAX  
Response: NR3

## MODSHape

This command selects the modulating waveform shape.

## Arguments

Type: Character  
Options: SINusoid, TRIangle, SQUare  
Command Type: Setting or Query  
Setting  
Syntax: MODSHape<ws><SIN|TRI|SQU>  
Examples: MODSHape SIN  
MODSHape TRI

Query  
Syntax: MODSHape?  
Response: SIN|TRI|SQU

## DEVIation

This command sets the FM modulation deviation.

### Arguments

Type: Numeric  
Units: MHz, KHz, Hz (default)  
Range:  
Fmax = carrier frequency  
Fmin = 0.01 Hz

Command Type: Setting or Query  
Setting  
Syntax: DEVIation<ws><frequency>[units]  
DEVIation<ws>MINimum|MAXimum  
Examples: DEV 5KHZ  
DEV 5E3  
DEV MAXIMUM  
DEV MIN

Query  
Syntax: DEVIation? [<ws>MAXimum|MINimum]  
Examples: DEV?  
DEV? MAX  
Response: NR3

## SWEep

This command activates or deactivates sweep:

### Arguments

Type: Boolean  
Command Type: Setting or Query  
Setting

Syntax: SWE<ws>ON|OFF|LIN|LOG

Examples: SWE ON  
SWE LIN

#### Query

Syntax: SWE?

Response: OFF|LIN ON|LIN OFF|LOG ON|LOG OFF

Note: Sweep will automatically be active if set to Linear or Logarithmic.

## SWRAte

This command sets the time for one complete sweep:

#### Arguments

Type: Numeric  
Units: S, mS, uS, nS  
Range: 10mS to 100S  
Command Type: Setting or Query

#### Setting

Syntax: SWRAte<ws><time>[units]  
SWRAte<ws>MINimum|MAXimum

Examples: SWRAte 50MS

#### Query

Syntax: SWRAte? [<ws>MINimum|MAXimum]

Response: NR3

## SWSTArt

This command sets the start frequency of the sweep:

#### Arguments

Type: Numeric.  
Units: MHz, KHz, Hz (default)  
Range: Dependent on the frequency range of the current function.  
Command Type: Setting or Query

#### Setting

Syntax: SWSTArt<ws><frequency>[units]  
SWSTArt<ws>MINimum|MAXimum

Examples: SWSTArt 5KHZ  
SWSTArt 5E3  
SWSTArt MAXIMUM



SWStArt MIN

Query

Syntax: SWStArt? [<ws>MAXimum | MINimum]

Examples: SWStArt ?

SWStArt ? MAX

Response: NR3

## SWStOp

This command sets the stop frequency of the sweep:

### Arguments

Type: Numeric.

Units: MHz, KHz, Hz (default)

Range: Dependent on the frequency range of the current function.

Command Type: Setting or Query

### Setting

Syntax: SWStOp<ws><frequency>[units]  
SWStOp<ws>MINimum | MAXimum

Examples: SWStOp 5KHZ  
SWStOp 5E3  
SWStOp MAXIMUM  
SWStOp MIN

### Query

Syntax: SWStOp? [<ws>MAXimum | MINimum]

Examples: SWStOp ?

SWStOp ? MAX

Response: NR3

## MODE <trigger mode>

This command is used to set the trigger mode.

### Arguments

Type: Character

Options: CONTinuous  
TRIGger  
GATE  
BURSt

Command Type: Setting or Query

### Setting

Syntax: MODE<ws><CONT | TRIG | GATE | BURSt>

Examples:           MODE CONT  
                   MODE BURS

Query

Syntax:            MODE?

Response:         CONT|TRIG|GATE|BURS

### **TRIGger <trigger source>**

This command is used to select the trigger source, for use in the Trigger, Gate and Burst trigger modes.

#### Arguments

Type:             Character

Command Type:   Setting or Query

Setting

Syntax:           TRIGger<ws><INT|EXT>

Examples:         TRIG EXT  
                   TRIG INT

Query

Syntax:           TRIGger?

Response:         INT|EXT

### **BURSt <burst count>**

This command is used to set the number of cycles to be output in the BURST mode. It is not a standard SCPI command.

#### Arguments

Type:             Numeric

Range:            1 to 65535

Rounding:         To integer value

Command Type:   Setting or Query

Setting

Syntax:           BURSt<ws><value>

Examples:         BURS 100  
                   BURS MAXIMUM

Query

Syntax:           BURSt? [<ws>MAXimum|MINimum]

Response:         NR1

Examples:         BURST?

BURS? MAX

### **TRAtE <trigger rate>**

Sets the rate of the internal trigger.

#### Arguments

Type: Numeric  
Units: S, mS, uS, nS  
Range: 1 uS to 10S  
Rounding: to 4 digits  
Command Type: Setting or Query  
Setting  
Syntax: TRAtE<ws><value>[units]  
TRAtE<ws>MINimum | MAXimum  
Examples: TRAtE 10E-6  
TRAtE MIN

#### Query

Syntax: TRAtE? [<ws>MINimum | MAXimum]  
Response: NR3  
Examples: TRAtE?  
TRAtE? MIN

### **ERRor?**

This query returns the first entry in the error queue, and removes that entry from the queue.

Command Type: Query only  
Query  
Syntax: ERRor?  
Response: <Error number>, "<error description>"

## **4.9.2 Arbitrary Subsystem**

The Arbitrary subsystem is not part of the SCPI standard. It was developed to suit the needs of the instrument. Within this subsystem are found commands to:

- 1) control the point rate, start address, wavelength, and synchronization pulse address;
- 2) set values of the arbitrary waveform, either discretely or using predefined, copy or draw functions;

- 3) protect an area of waveform memory;
- 4) set the state of the automatic update and increment features;
- 5) update the waveform.

The following shows the structure of the ARbitrary subsystem:

```
:ARbitrary
    :PRATe <numeric value>
    :ADDRess <numeric value>
    :DATA <numeric value>|<arbitrary block>
    :DRAW <numeric value>,<numeric value>
:PREDefined <shape>,<start>,<address>,<length>,<scale>
    :START <numeric value>
    :LENGth <numeric value>
    :SAVE
```

### Point Rate

```
ARbitrary:PRATe <point rate>
```

This command is used to set the point rate. It is coupled with the frequency of the waveform by the relation:

$$\text{Frequency} = 1/(\text{Point Rate} * \text{Wavelength})$$

Thus changing the point rate will result in a change in frequency.

#### Arguments

Type:	Numeric
Units:	s, ms, us, ns
Range:	8ns to 100s
Rounding:	to 4 digits
Command Type:	Setting or Query
Setting	
Syntax:	:ARbitrary:PRATe<ws><point rate>[units] :ARbitrary:PRATe<ws>MINimum MAXimum
Examples:	:ARB:PRAT 100NS
Query	
Syntax:	:ARbitrary:PRATe? [<ws>MINimum MAXimum]
Response:	NR3

Note: You can alternately use the RATE command.

### Address

```
:ARbitrary:ADDRess <address>
```

This command sets the current address of the waveform. It is used to determine to where arbitrary data are to be written.

## Arguments

Type: Numeric  
Range: 1 to 16,382  
Rounding: to integer value  
Command Type: Setting or Query  
Setting  
Syntax: :ARbitrary:ADDRess<ws><address>  
:ARbitrary:ADDRess<ws>MINimum | MAXimum  
Examples: :ARB:ADDR 100  
Query  
Syntax: :ARbitrary:ADDRess? [<ws>MINimum | MAXimum]  
Response: NR1

## Data

:ARbitrary:DATA <data>

This command is used to set the values of the waveform.

## Arguments

Type: Numeric. Definite form arbitrary block. Indefinite form arbitrary block  
Numeric Range: -8191 to 8191 ASCII  
Rounding: to integer value  
Command Type: Setting or Query  
Setting Syntax  
Numeric:

:ARbitrary:DATA<ws><numeric>{[,<numeric>]}  
Example :ARB:DATA 100,200,1000,2000,-2000  
Query  
Syntax: :ARbitrary:DATA?<ws><number of points>,AScii  
Response: Data are returned in the decimal numeric form.  
Considerations:

## Line Draw

:ARbitrary:DRAW <start address>,<end address>

This command is used to generate a straight line between two points in the arbitrary waveform memory.

## Arguments

Type: Numeric.  
Range: 1 to 500,000  
Rounding: to integer value  
Command Type: Setting only  
Setting  
Syntax: :ARbitrary:DRAW<ws><start address>,<end address>

Example: :ARB:DRAW 1,1000

Considerations:

- 1) The value of the data at the start and end points must first be set by the user, using the :ARB:DATA command.
- 2) The range of the straight line cannot overlap with protected memory.
- 3) The end address must be greater than the start address.

### Predefined waveforms

:ARB:PRED <shape>,<start address>,<length>,<scale>

This command is used to load the waveform memory with a specific type of waveform.

Arguments

Shape

Type: Character

Options: SINusoid

SQUare

TRIangle

NOISe (Pseudo-Random Noise)

ANOise (Noise added to the current waveform)

Start Address

Type: Numeric. The MIN and MAX forms both set the address to 1

Range: 1 to 16382

Rounding: to integer value

Length

Type: Numeric

Range

SIN: 16 to 16,382; divisible by 4

SQU: 2 to 16,382; divisible by 2

TRI: 16 to 16,382; divisible by 4

NOIS: 16 to 16,382

ANO: 16 to 16,382

Rounding: to integer value

Scale

Type: Numeric. MIN sets the scale to 1; MAX sets the scale to 100

Range: 1 to 100 (See considerations)

Rounding: to integer value.

Command Type: Setting only

Setting

Syntax: :ARbitrary:PREDefined<ws> <shape>, <start>, <length>,<scale>

Examples: :ARB:PRED SIN,1,1e3,100

Considerations:

- 1) The start address and the length must meet the specification that. Start address + Length - 1 <= 16,382

2) The 'scale' refers to the scaling of the waveform as a percentage of full scale. A scale of 100% will, under the correct conditions, generate a waveform whose data values range from -8191 to +8191. These 'correct conditions' are set by the 'offset' value. This offset is the value of the data at the start address, and determines the maximum scale settable. The following table shows the data values required in order to achieve maximum scale.

SHAPE	DATA
SIN	100
SQU	100
TRI	100
NOIS	100

## Start Address

:ARbitrary:STARt <start address>

This command sets the start address of the waveform to be run.

### Arguments

Type: Numeric  
 Range: 1 to 16381  
 Rounding: to integer value  
 Command Type: Setting or Query

### Setting

Syntax: :ARbitrary:STARt<ws><start address>  
 :ARbitrary:STARt<ws>MINimum | MAXimum

Example: :ARB:STAR 100

### Query

Syntax: :ARbitrary:STARt? [<ws>MINimum | MAXimum]

Examples: :ARB:STAR?  
 :ARB:STAR? MIN

Response: NR1

Considerations: The start address and length must meet the condition:  
 Start Address + Length - 1 <= 16382

## Wavelength

:ARbitrary:LENGth <length>

This command sets the length of the waveform being run.

### Arguments

Type: Numeric  
 Range: 2 to 16382  
 Rounding: to integer value  
 Command Type: Setting or Query

### Setting

Syntax: :ARbitrary:LENGth<ws><length>  
 :ARbitrary:LENGth<ws>MINimum | MAXimum

Example: :ARB:LENG 1E3  
Query  
Syntax: :ARbitrary:LENGth? [<ws>MINimum | MAXimum]  
Example: :ARB:LENG?  
Response: NR1  
Considerations: 1) Changing the wavelength will change either the frequency.  
2) The minimum wavelength is 2.

## Save

:ARbitrary:SAVe

This command is used to save all unsaved arbitrary waveform data into non-volatile memory.

Arguments  
Type: Numeric  
Range: 1 to 5  
Command Type: Setting only  
Setting  
Syntax: :ARbitrary:SAVe <location>

## 5 Troubleshooting Guide

Below are some frequently asked questions and answers. Please check if any apply to your instrument before contacting B&K Precision.

### **Q: I cannot power up the generator**

- Check that the power cord is securely connected to the AC input and there is live power from your electrical AC outlet.
- Verify that the AC power coming from the mains is the correct voltage. The generator can accept a specific range of AC input voltages. Refer to section "2.1 Input Power and Fuse Requirements".

### **Q: I do not get any output from the output terminals**

- Make sure that the **On** button(s) above channel 1 and/or channel 2 BNC connectors are lit. If not, press it once to toggle the output option **ON**. The backlight of these output channel buttons indicates that the respective channel's output is enabled.

### **Q: I have connected my signal to an oscilloscope, but the amplitude is double of what I set**

- This is often because the impedance of the generator is not matched with the oscilloscope. When the generator is set to 50  $\Omega$  impedance, connecting it directly to an oscilloscope with a 1 M $\Omega$  input impedance will cause this to happen. To eliminate this issue, connect a 50  $\Omega$  terminator to the input of the oscilloscope, then connect a BNC cable between the generator and the terminator to have matching impedance. Refer to section "2.3 Output Connections".



**Q: My two signals are out of phase even after I press the sync phase button.**

- Check that the two cables being used are the same impedances. At higher frequencies, impedances of the cables play a factor in the signal integrity.
- Check that the two cables being used are the same exact lengths. At higher frequencies, different length cables will cause phase delay issues between the two channels.

## 6 Specifications

**Note:** All specifications apply to the unit after a temperature stabilization time of 15 minutes over an ambient temperature range of 23 °C ± 5 °C. Specifications are subject to change without notice.

<b>Model</b>	<b>4047B</b>
Channels	2
<b>Frequency Characteristics</b>	
Sine	0.01 Hz – 20 MHz
Square	0.01 Hz – 20 MHz
Triangle	0.01 Hz – 2 MHz
Pulse	0.01 Hz – 20 MHz
Accuracy	0.001% (10 ppm) at < 500 Hz: 0.001% + 0.006 Hz
Resolution	Up to 8 digits
<b>Output Characteristics</b>	
Amplitude Range	10 mV <sub>p-p</sub> to 10 V <sub>p-p</sub> (into 50 Ω) 20 mV <sub>p-p</sub> to 20 V <sub>p-p</sub> (open circuit)
Resolution	3 digits (1000 counts)
Amplitude Accuracy	± 2 % ± 20 mV of programmed output from 1.01 V – 10 V
Flatness	± 0.5 dB to 1 MHz ± 1 dB to 20 MHz
Offset Range	- 4.99 V to 4.99 V (into 50 Ω)
Offset Resolution	10 mV, 3 digits
Offset Accuracy	± 2 % ± 10 mV (into 50 Ω)
Output Impedance	50 Ω ± 2 %
Output Protection	Protected against short circuit or accidental voltage practically available in electronic laboratories, applied to the main output connector
<b>Waveform Characteristics</b>	
Harmonic Distortion*	0 – 1 MHz, < - 60 dBc 1 MHz – 5 MHz, < -50 dBc 5 MHz – 12 MHz, < -45 dBc 12 MHz – 20 MHz, < -50 dBc
Rise/Fall Time (square, pulse)	< 20 ns (10% to 90% at full amplitude into 50 Ω)
Variable Duty Cycle/Symmetry	Square: 20% to 80 %, up to 2 MHz Triangle: 1 % to 99 % in 1% steps, up to 200 kHz
Symmetry Accuracy at 50%	± 1 %
Pulse Width (period 100 s - 50 ns)	10 ns to <(Period – 10 ns), 10 ns resolution
Variable Edge Time	100 ns to Width/0.625 (50 % duty cycle) 10 ns resolution
Jitter (square)	<50 ps (cycle-to-cycle, typical)

<b>Arbitrary Waveform Characteristics</b>	
Sampling Rate	8 ns to 100 s
Vertical Resolution	14 bits
Accuracy	0.001%
Resolution	4 digits
Waveform Length	2 – 16,382 points
<b>Operating Modes</b>	
Continuous	Output continuous at programmed parameters
Triggered	Output quiescent until triggered by an internal or external trigger, at which time one waveform cycle is generated to programmed parameters. Frequency of waveform cycle is limited to 1 MHz.
Gate	Same as triggered mode, except waveform is executed for the duration of the gate signal. The last cycle started is completed.
Burst	2 – 65535 cycles
Trigger Source	Trigger source may be internal, external, or manual. Internal trigger rate 0.1 Hz – 1 MHz (1 $\mu$ s – 10 s)
<b>Modulation Characteristics</b>	
<b>Amplitude Modulation (AM)</b>	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Internal Modulation	0.1 Hz – 20 kHz
Depth	0% to 100%
<b>Frequency Modulation (FM)</b>	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Internal Modulation	0.1 Hz – 20 kHz
Deviation	1 $\mu$ Hz to max frequency/2
<b>Frequency Shift Keying (FSK)</b>	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Rate	$\leq$ 100 kHz
<b>Phase Modulation (PM)</b>	
Carrier	Sine, Square, or Triangle
Source	Internal, External
Internal Modulation	0.01 Hz – 20 kHz
Deviation	0 – 360 $^{\circ}$ , 0.1 $^{\circ}$ resolution
<b>Pulse Width Modulation (PWM)</b>	
Source	Internal, External
Width	1% to 99%
Internal Modulation	0.01 Hz – 100 kHz
<b>Sweep Characteristics</b>	
Sweep Shape	Linear or Logarithmic, up or down

Sweep Time	10 ms to 100 s
<b>Input and Output</b>	
Trigger IN	TTL compatible Maximum rate 1 MHz Minimum width > 50 ns Input impedance 1 k $\Omega$
Sync OUT	TTL pulse at programmed frequency 50 $\Omega$ source impedance
Modulation IN	5 V <sub>p-p</sub> for 100% modulation 10 k $\Omega$ input impedance DC to > 20 kHz minimum bandwidth
<b>Counter Characteristics</b>	
Range	50 Hz to 50 MHz
Resolution	Auto ranging, up to 8 digits
Accuracy	$\pm 0.02\% \pm 2$ digits
Sensitivity	25 mV <sub>rms</sub> typical
<b>General</b>	
Memory Storage	Store up to 20 instrument settings
Arbitrary memory	16,382 points in flash memory
Power Requirements	100 V – 240 V AC $\pm 10\%$ (90 V – 264 VAC), 47 – 63 Hz
Max. Power Consumption	< 30 VA
Operating Temperature	0 °C – 50 °C
Storage Temperature	-10 °C – 70 °C
Humidity	95% RH, 0 °C – 30 °C
Dimensions	213 mm x 88 mm x 210 mm (WxHxD)
Weight	Approx. 2.5 kg
Safety Standards	EN55011 for radiated and conducted emissions EN55082 EN61010

\*3 V<sub>p-p</sub> into 50  $\Omega$ .

**Note:** All specifications apply to the unit after a temperature stabilization time of 15 minutes over an ambient temperature range of 23 °C  $\pm$  5 °C. Specifications are subject to change without notice.