Model 675

High Performance AWG

Simple AFG User Manual

Rev 1.7.4, July 2020

Summary

Contacting Berkeley Nucleonics Corporation

Berkeley Nucleonics Corporation
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USA
For product information, sales, service, and technical support:
Call: 800-234-7858
Visit: https://www.berkeleynucleonics.com/

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Cord

Use only the power cord specified for this product and certified for the country of use.

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings

To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Power Disconnect

The power cord provides Mains disconnect.

Do Not Operate Without Covers

Do not operate this product with covers or panels removed.

Do Not Operate With Suspected Failures

If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid Exposed Circuitry

Do not touch exposed connections and components when power is present.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation

Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Safety Requirements

This section contains information and warnings that must be observed to keep the instrument operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the safety precautions specified in this section.

Safety Symbols

Where the following symbols appear on the instrument's front or rear panels, or in this manual, they alert you to important safety considerations.

	This symbol is used where caution is required. Refer to the accompanying information or documents in order to protect against personal injury or damage to the instrument.
	This symbol warns of a potential risk of shock hazard.
	This symbol is used to denote the measurement ground connection.
	This symbol is used to denote a frame or chassis connection.
	This symbol is used to denote a safety ground connection.
	On (Supply). This is the DC power connect/disconnect switch at the back of the instrument.
	Off (Supply). This is the DC power connect/disconnect switch at the back of the instrument.
	This symbol is used to denote Power. It is located on the front panel and denotes Power On/Off status of the instrument.
	This symbol is used to denote Direct Current.
	This symbol is used to denote that the device connectors are sensitive to electrostatic discharge

CAUTION

The **CAUTION** sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause damage to equipment. If a **CAUTION** is indicated, do not proceed until its conditions are fully understood and met.

WARNING

The **WARNING** sign indicates a potential hazard. It calls attention to a procedure, practice or condition which, if not followed, could possibly cause bodily injury or death. If a **WARNING** is indicated, do not proceed until its conditions are fully understood and met.

CAT I

Installation (Overvoltage) Category rating per EN 61010-1 safety standard and is applicable for the instrument front panel measuring terminals. CAT I rated terminals must only be connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level.

Environmental considerations

Product End-of-life Handling

Observe the following guidelines when recycling an instrument or component.

Equipment Recycling

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

The symbol shown to the left indicates that this product complies with the European Union's requirements according to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).

Preface

This manual describes the installation and operation of Model 675 High Performance AWG using the Simple AFG software. Basic operations and concepts are presented in this manual.
The easiest touch screen display interface allows to create waveforms scenarios, only in few screen touches.
The Model 675 High Performance AWG series offers premium signal integrity thanks to the 14 bit resolution DAC. The output signal can reach up to 12 Volts pk-pk into 50 Ohm single ended. In addition, it is possible to move the offset voltage in a range of ±6 V thus providing an output voltage window of 24 Volts into 50 Ohm load or 48 Volts into open load. The Model 675 High Performance AWG can generate signals up to 300 MHz.
The software architecture provides the possibility to easily generate predefined waveforms and modulated signals or to load an arbitrary waveform from a user defined file.

Package Contents

The standard AWG Series package includes the following:

- Model 675-2C/4C/8C Arbitrary Waveform Generator equipment
- Power Cord
- Performance/Calibration Certificate
- CE certificate

Models

Item	Description
Model 675-2C-2M	2 Ch - 1.2GS/s AWG-2MS memory
Model 675-2C-64M	2 Ch - 1.2GS/s AWG-64MS memory
Model 675-2C-128M	2 Ch - 1.2GS/s AWG-128MS memory
Model 675-4C-2M	4 Ch - 1.2GS/s AWG-2MS memory
Model 675-4C-64M	4 Ch - 1.2GS/s AWG-64MS memory
Model 675-4C-128M	4 Ch - 1.2GS/s AWG-128MS memory
Model 675-8C-2M	8 Ch - 1.2GS/s AWG-2MS memory
Model 675-8C-64M	8 Ch - 1.2GS/s AWG-64MS memory
Model 675-8C-128M	8 Ch - 1.2GS/s AWG-128MS memory

Recommended Accessories

Item	Description
Model 675-DIG8	8 channel Digital license (Mini SAS cable included, not used with Simple AFG application)
AT-DTTL8	LVDS to LVTTL digital adapter probe (not used with Simple AFG application)
AT-LVDS-SMA8	LVDS to SMA digital adapter cable (not used with Simple AFG application)
Model 675-2C-WAR	3 years warranty extension for Model 675-2C
Model 675-4C-WAR	3 years warranty extension for Model 675-4C
Model 675-8C-WAR	3 years warranty extension for Model 675-8C
Model 675-2C-HV	High voltage output (12Vpp on 50 Ohm) for Model 675-2C
Model 675-4C-HV	High voltage output (12Vpp on 50 Ohm) for Model 675-4C
Model 675-8C-HV	High voltage output (12Vpp on 50 Ohm) for Model 675-8C
RIDER-AWG-SYNC	Synchronization cable for Model 675-8C (not used with Simple AFG application)
Model 675-2C-PAT	Data Pattern Generator (DPG) for Model 675-2C
Model 675-4C-PAT	Data Pattern Generator (DPG) for Model 675-4C
Model 675-8C-PAT	Data Pattern Generator (DPG) for Model 675-8C

Mechanical Characteristics

Model 675-2C

Net Weight	9.5 kg
Net Weight with Package	10 kg
Overall Dimensions	Height: 160 mm Width: 450 mm Depth: 340 mm

Model 675-4C

Net Weight	10 kg
Net Weight with Package	10.5 kg
Overall Dimensions	Height: 160 mm Width: 450 mm Depth: 340 mm

Model 675-8C

Net Weight	10.8 kg
Net Weight with Package	11.3 kg
Overall Dimensions	Height: 160 mm Width: 450 mm Depth: 340 mm

Key features

The following list describes some of the key features of the Model 675 series

- High resolution, high sampling rate: 14 Bits, 1.2GS/s
- Best output frequency vs amplitude trade off: 300MHz, 48V voltage window
- 3 operating modes in the same instruments: Function Generator, Arbitrary Waveform Generator or Digital Pattern Generator
- Very long memory: up to 128 MSample per channel
- Mixed signal generation: 2 analog outputs + 8 digital outputs (with Model 675-DIG8 option)
- Simple touch screen user interface to create complex waveforms scenarios just in few screen touches
- Large 7 inch, 1024x600 capacitive touch LCD
- Touchscreen or Keypad data entering
- Windows 10 operating system
- USB and LAN interfaces
- 3U case size with the possibility of rack mounting

Installing your instrument

Unpack the instrument and check that you received all items listed in the Package Content paragraph.

NOTE. The instrument does not ship with a product software CD. To reinstall the product software, follow the instructions in the paragraph “Obtaining the latest version releases” to get the latest software release and the instructions in the paragraph “Install Simple AFG Application” to install the application

Operating Requirements

CAUTION. *To ensure proper cooling, keep sides of the instrument clear of obstructions.*

Place the instrument on a cart or bench, observing clearance requirements:

- Top: 20 mm (0.8 in)
- Left and right side: 150 mm (5.9 in)
- Bottom: 20 mm (0.8 in)
- Rear: 75 mm (3 in)

CAUTION. *Ensure that the equipment is positioned in a way that the disconnecting device can be readily accessible.*

The instrument is intended for indoor use and should be operated in a clean, dry, nonconductive environment. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.

Environmental requirements

Before using this product, ensure that its operating environment is maintained within these parameters:

Temperature	Operating +5 °C to +40 °C (+41 °F to 104 °F) Non-operating -20 °C to +60 °C (-4 °F to 140 °F)
Humidity	Operating 5% to 80% relative humidity with a maximum wet bulk temperature of 29 °C at or below +40 °C, non-condensing. Non-operating 5% to 95% relative humidity with a maximum wet bulb temperature of 40 °C at or below +60 °C, non- condensing.
Altitude	Operating 3,000 m (9,843 feet) Non-operating 12,000 m (39,370 feet)

Power supply requirements

WARNING. To reduce the risk of fire and shock, ensure that the mains supply voltage fluctuations do not exceed 10% of the operating voltage range.

No manual voltage selection is required because the AC Adapter automatically adapts to line voltage.

Source Voltage and Frequency	100 to 240 VAC ±10% @ 45-66 Hz
Power Consumption	Model 675-2C Maximum: 100W Model 675-4C Maximum: 130W Model 675-8C Maximum: 150W

WARNING - Electrical Shock Hazard
Only use the power cord provided with your instrument

Cleaning

WARNING. To avoid personal injury, power off the instrument and disconnect it from line voltage before performing any other following procedures.

Inspect the arbitrary waveform generator as often as operating conditions require. To clean the exterior surface, perform the following steps:

- Remove loose dust on the outside the instrument with a lint-free cloth. Use care to avoid scratching the front panel display.
- Use a soft cloth dampened with water to clean the instrument. Use a 75% isopropyl alcohol solution as a cleaner.

CAUTION. To avoid damage to the surface of the arbitrary waveform generator, do not use any abrasive or chemical cleaning agents.

Calibration

The recommended calibration interval is one year. Calibration should be performed by qualified personnel only.

Abnormal Conditions

Operate the instrument only as intended by the manufacturer.
If you suspect the instrument's protection has been impaired, disconnect the power cord and secure the instrument against any unintended operation.
The instrument's protection is likely to be impaired if, for example, the instrument shows visible damage or has been subjected to severe transport stresses.
Proper use of the instrument depends on careful reading of all instructions and labels.

WARNING. Any use of the instrument in a manner not specified by the manufacturer may impair the instrument's safety protection.

Power the Instrument On and Off

Power On

- Insert the AC power cord into the power receptacle on the rear panel.
- Use the front-panel power button to power on the instrument.
- Wait until the system shows windows desktop.
- The Simple AFG software will start automatically

Power Off

- Close the application in use. 

- Press the front-panel power button  to power off the instrument.

Protect Your Instrument from Misuse

Check Input and Output Connectors

When connecting a cable, be sure to distinguish the input connector from the output connectors to avoid making the wrong connection.

CAUTION. Do not short output pins or apply external voltages to Output connectors. The instrument may be damaged.

CAUTION. Do not apply excessive inputs over ±15 Vpk to Trigger Input connector. The instrument may be damaged.

Obtaining the Latest Version Releases

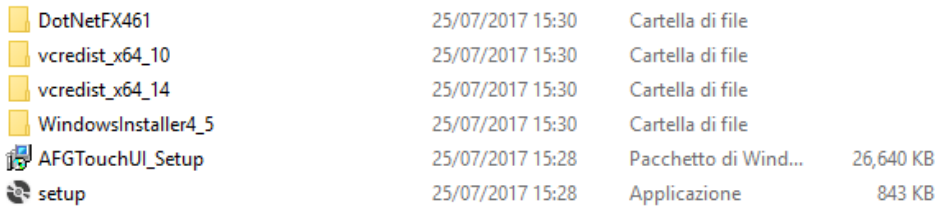
The latest version of an optional application that you ordered with your instrument may not be installed on your instrument. The following download location is a fast and easy way to get the latest software version.

To download the latest version of software, register on the website; go to the home page of the Berkeley Nucleonics website (www.berkeleynucleonics.com), press the Register button in the upper right of your screen.

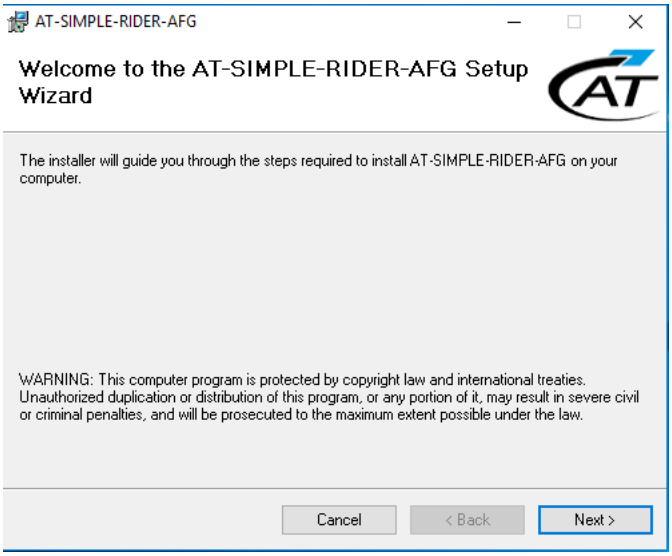
Install Simple AFG Application

If your instrument has already installed another version of the Simple AFG application, you must first uninstall it.

1. Download the Simple AFGTouchUI setup package from Berkeley Nucleonics Corporation website and decompress it to instrument's local disk.



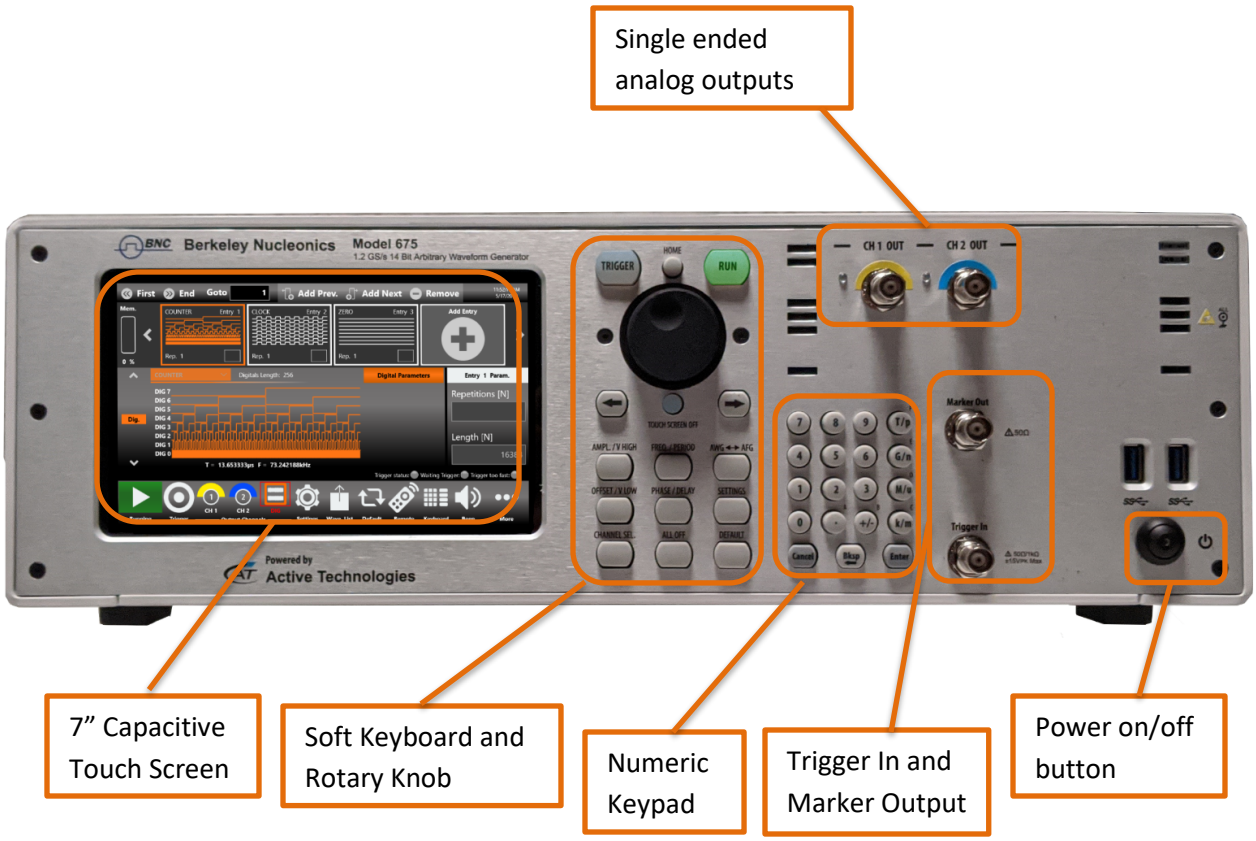
2. Double click on the "setup.exe" to start the installation.
3. Follow the steps and click next to continue the procedure.



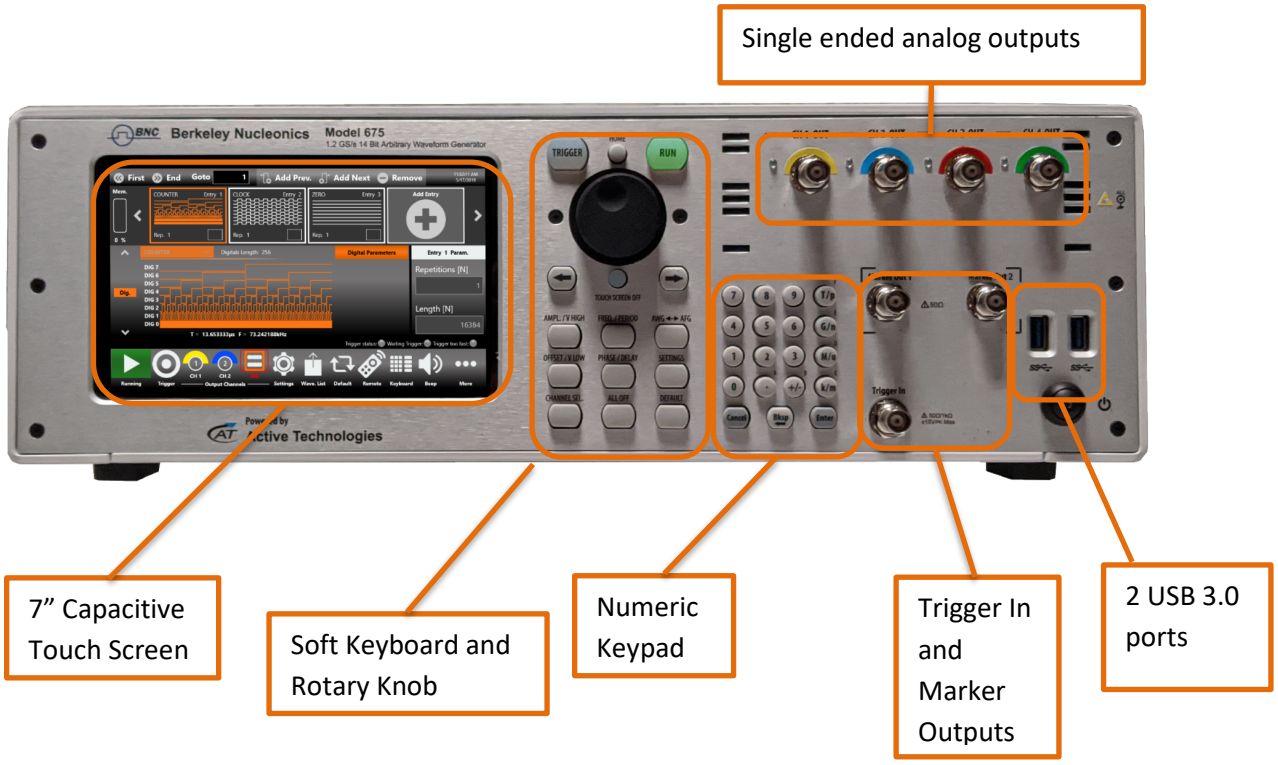
4. When the application has been installed, press the "Close" button to continue.

Instrument Overview

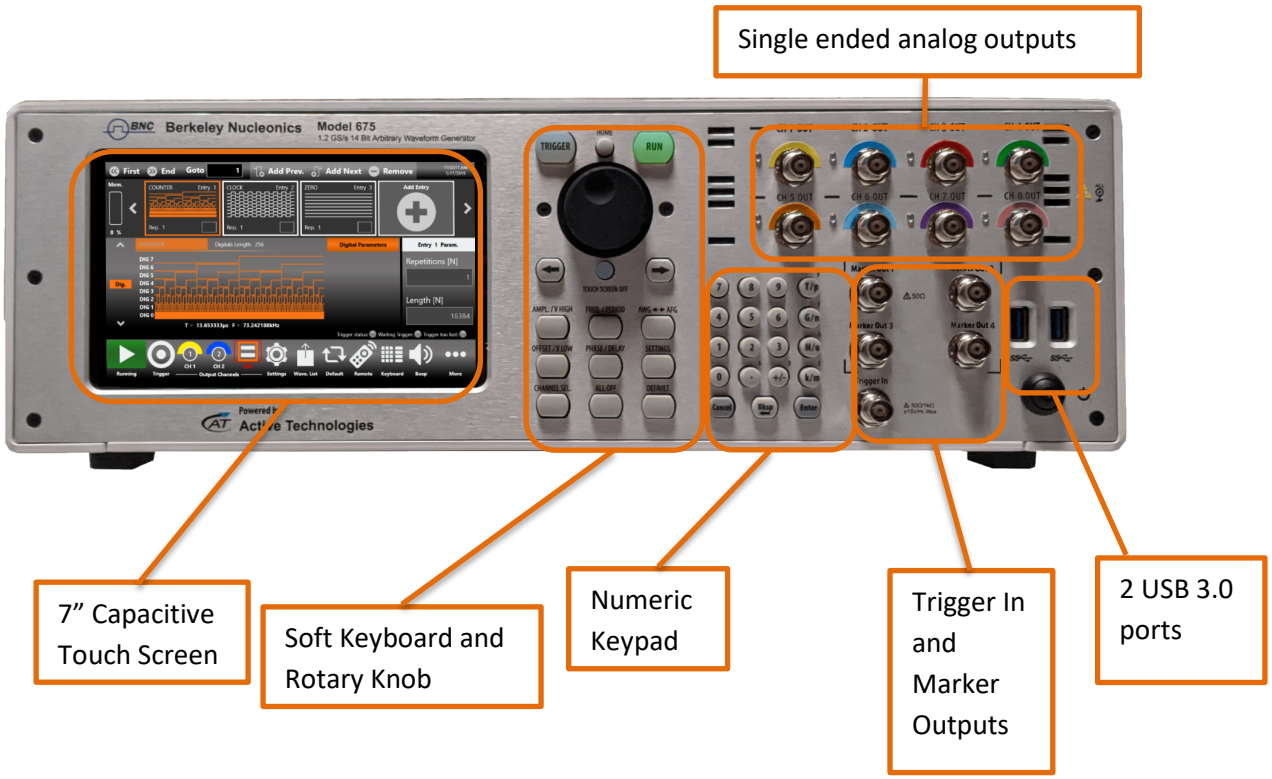
Front Panel Model 675-2C



Front Panel Model 675-4C



Front Panel Model 675-8C



The Touch screen functionalities and features are described in the Simple AFG Application paragraph.

Analog Outputs

The Model 675 High Performance AWG series instrument has 2/4/8 analog output channels, each one is single-ended and the connector type is a standard BNC.

Marker Output

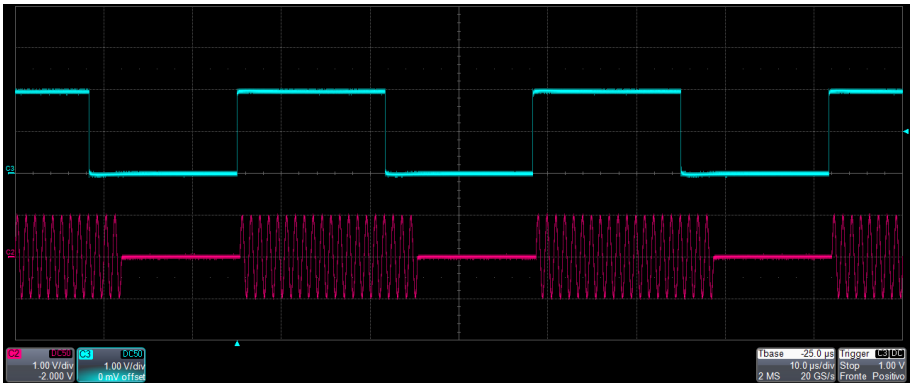
The Marker Out is a digital output channel that generates a pulse related to the analog waveform. Its impedance is 50 Ohm and the output voltage amplitude ranges from 1 V to 2.5 V into 50 Ohm load.
The Marker Out generates a digital pulse synchronous with the waveform depending on the Run Mode.
To set the Marker Out parameters refer to the Marker Out Settings.
The connector type is a standard BNC.

Marker Out Specification	Value
Connector	1 BNC for each pair of channels on the Front Panel
Output impedance	50 Ω
Output level (into 50 Ω)	1 V to 2.5 V

Trigger In

The Trigger In (Trigger In connector on the front panel) allows to control the generation by an external signal source. It has a selectable impedance of 1 kOhm or 50 Ohm. To know how to set the trigger parameters or the Run Mode refer to the paragraph “Trigger In Settings”. In Continuous mode the Trigger In doesn’t have any effect.

Trigger In Specification	Value
Connector	BNC on the Front Panel
Number of connectors	1
Input impedance	1 kΩ or 50Ω selectable
Slope/Polarity	Positive or negative selectable



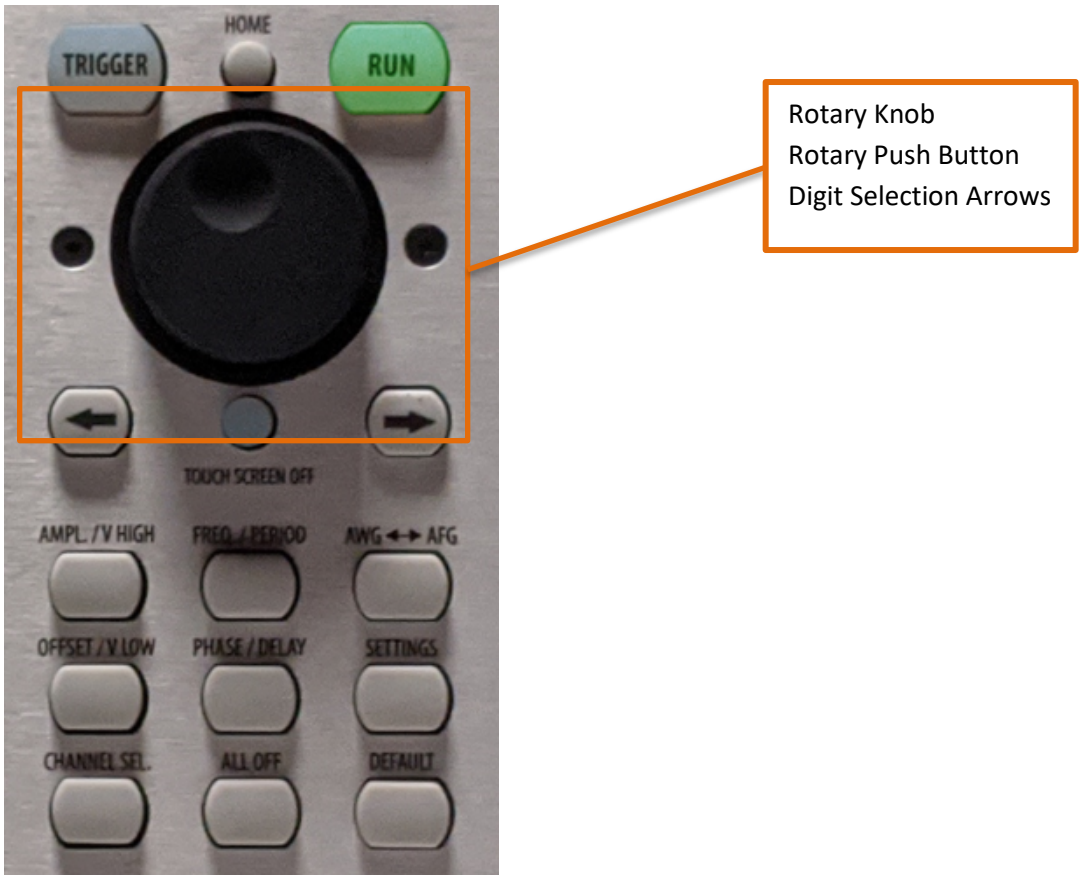
Trigger In signal (blue, top) that starts a burst of sine waveform (red, bottom)

Soft keyboard and rotary knob

Most of the buttons you use with Simple AFG application are virtual ones on the touchscreen, but a few physical buttons control basic functions, such as the setting of amplitude, offset, frequency, etc.

A physical numeric keypad is available on the front-panel and it can be used instead of the virtual numeric pad.

A useful central knob is available for fine-tuning and adjustments during the on the fly set up operation. The rotary knob will change the value in continuous, analog fashion. The push button rotary knob lets you to change the value increment between Coarse and Fine adjustment.
The → key will move the selected digit to the right and the ← key will move the selected digit to right. You can keep pressed the rotating knob and rotate it on the right or on the left to change the Delta increment.



Button	Description
HOME	If you are in a sub-menu page, use this button to return to the main page.
TRIGGER	Use this button to send an internal trigger to the instrument.
RUN	Use this button to start and stop the signal generation. If the button is on and **green** the instrument is running while if it is off the instrument is stopped. Bushing the button will change the instrument state.
LEFT ARROW	Once the virtual numeric keypad will be opened, use this button to move to the left the digit selection cursor.
RIGHT ARROW	Once the virtual numeric keypad will be opened, use this button to move to the right the digit selection cursor.
TOUCH SCREEN OFF	Use this button to disable the touch screen.
AMPL./V HIGH	Use this button to set the high voltage level or the amplitude of the waveform.
FREQ/PERIOD	Use this button to set the period or the frequency of the waveform.
AWG <-> AFG	Use this button to switch between AFG mode and AWG operating mode.
OFFSET/V LOW	Use this button to set the low voltage level or the offset of the waveform.
PHASE/DELAY	N.A.
SETTINGS	Use this button to open the Settings page
CHANNEL SEL.	Use this button to change the output selection in the user interface
ALL OFF	Use this button to turn off all the outputs.
DEFAULT	Use this button to restore the default settings.

Numeric Keypad

The physical numeric keypad lets you to set the parameter value and their measure unit.
Once a parameter to be edited is selected by using the touch panel or the soft keyboard, each number pressed in the keypad will be displayed in the display. The Bksp key is provided for deleting erroneous key presses. The [+/-] key will toggle the sign of the number being entered and may be pressed after terminating the entry. After the sign and the numeric portion of the desired value have been entered, the pressing of the multiplier button applies the parameter. The Enter button closes the virtual keyboard and will apply the entered value.

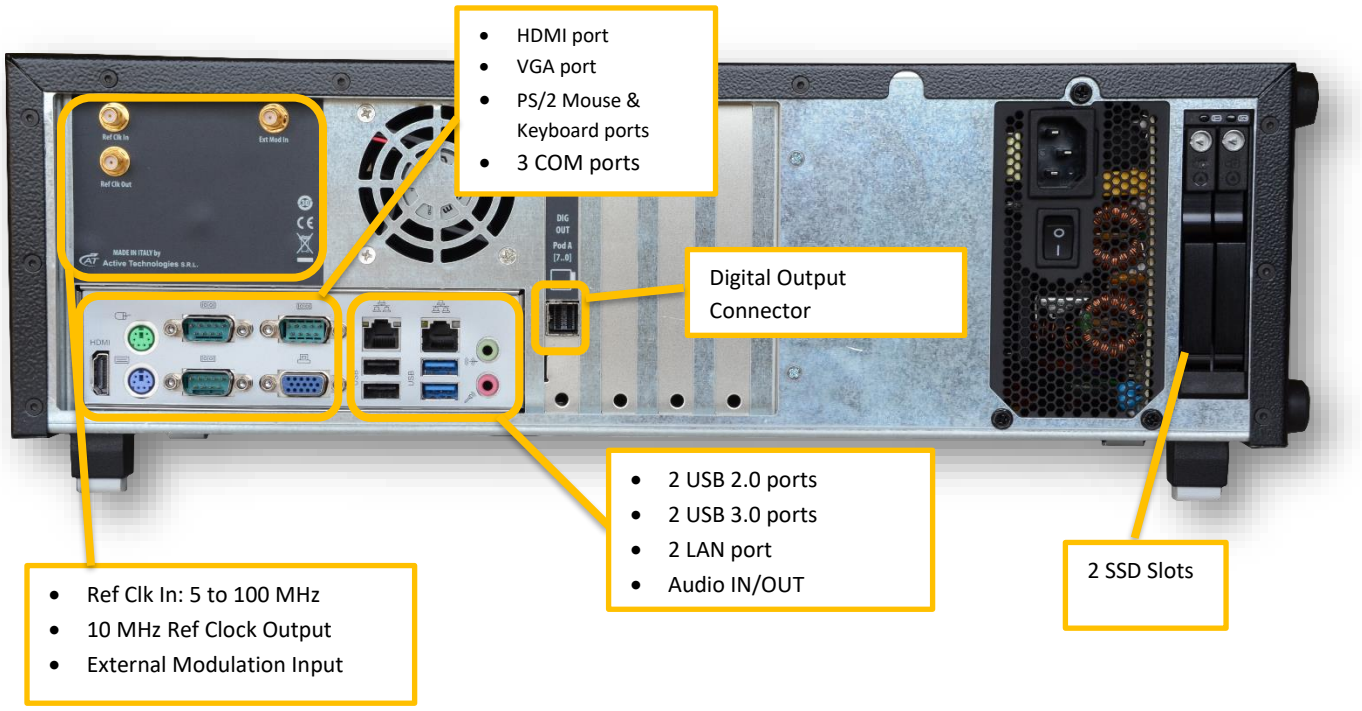
When you select a parameter on the user interface, if you press a Unit Measure Range button it will automatically update the available range allowed for that parameter.

Unit Measure Range Button	Unit Measure Range
T/p	Tera / pico
G/n	Giga / nano
M/u	Mega / micro
k/m	kilo / milli

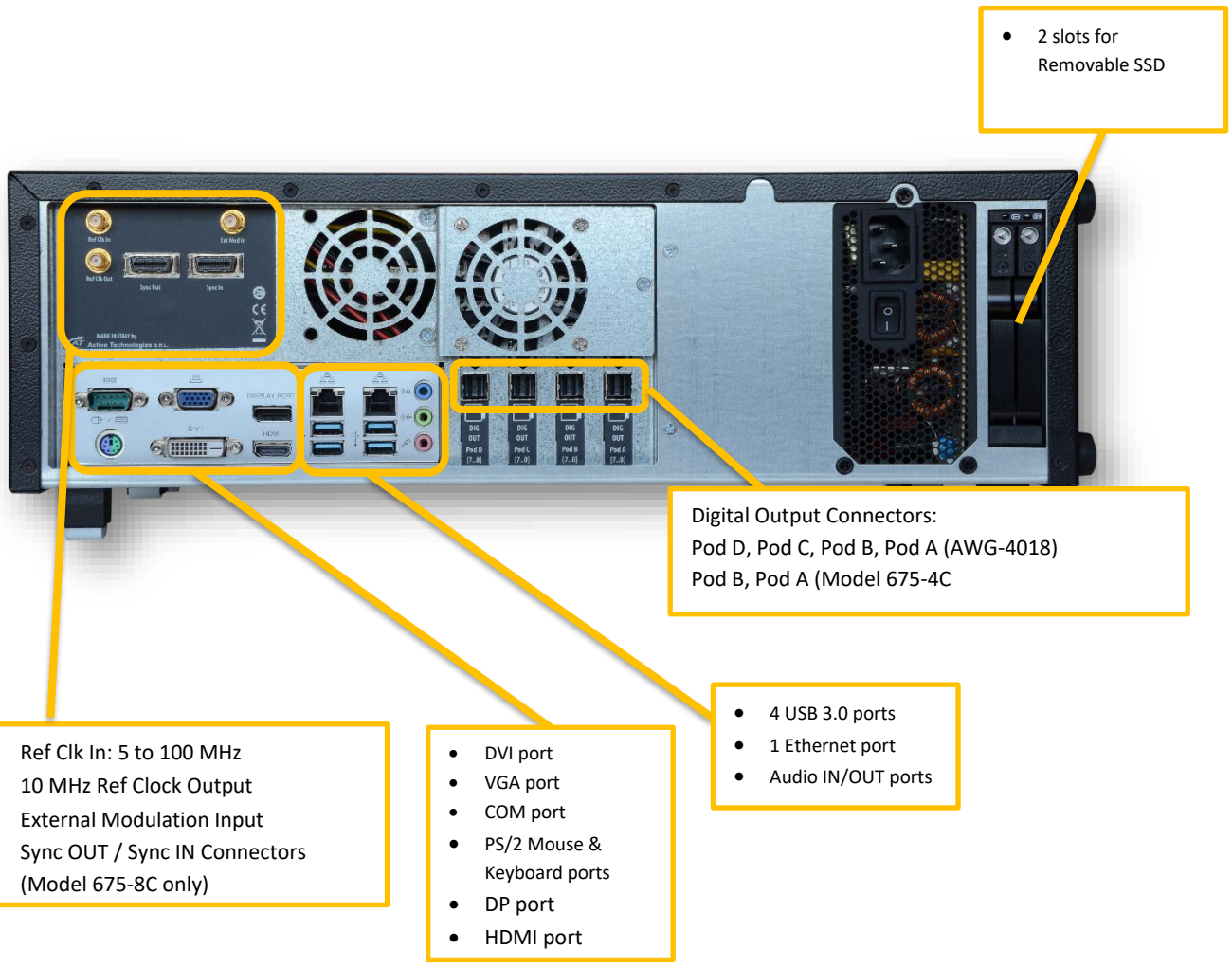
For example if you select the Frequency parameter and you press k/m the unit measure range will be kHz, if you press M/u it will be MHz, if you press G/n it will be GHz, if you press T/p nothing will happen because that range is not available for the selected parameter.
If both the two unit of measure of a Unit Measure Range button are available for the selected parameter (i.e. Mega and Micro), if you press the range button **M/u**, the range will switch accordingly between Mega and Micro.

Rear Panel Model 675-2C

The callouts on this image gives the description of the corresponding connectors:



Rear Panel Model 675-4C and Model 675-8C



External Modulation Input Connector

The Model 675 High Performance AWG series instrument has an input connector to receive an external analog signal that is used as modulating source. When the selected Run Mode is “Modulation” and the source is

“External” the instrument will use this signal to modulate the carrier waveform.

For the specification please refer to the Auxiliary Channels section.

The connector type is a SMA.

Reference Clock Input Connector

The Model 675 High Performance AWG series instrument can use an external clock source to generate the sampling clock frequency.

This feature allows to synchronize the generator with an external clock.

The connector type is a SMA.

Reference Clock Output Connector

This connector outputs the internal 10MHz reference clock used to synthesize the DAC sampling clock. If the clock source is internal it produces a signal at 10 MHz, if the source is external it is disabled.
The connector type is a SMA.

Digital Output connector

Important Note: this connector is not used by AFG application.

Sync In / Sync Out Connectors (Model 675-8C model only)

The purpose of those connectors is to connect and synchronize together multiple instruments: up to 4 instruments can be linked together.
Those connectors are available on Model 675-8C model only.

Important Note: this connector is not used by AFG application.

Introduction

The Model 675 High Performance AWG series instrument, when used in Arbitrary Function Generator mode, has two independent analog channels. Each channel can generate a predefined waveform or a user defined waveform loaded from a file.
Any characteristic parameter of the selected waveform can be modified at runtime. For example, if a pulse waveform is selected it is possible to define at runtime its amplitude, offset, frequency, duty cycle and the duration of leading and trailing edge.

Simple AFG Software

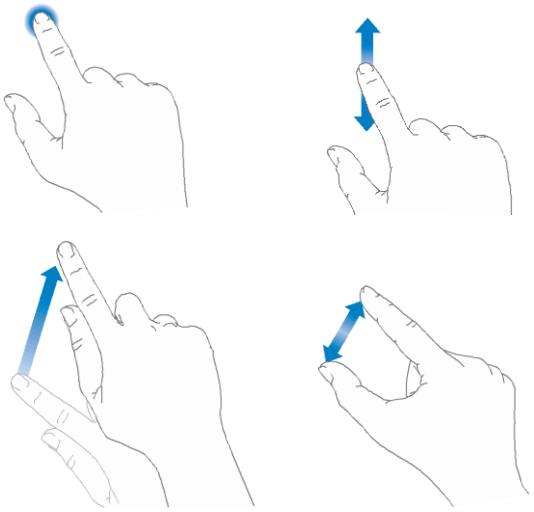
The Model 675 High Performance AWG series instrument includes a 7” capacitive touch screen and an easy touch user interface based on a Microsoft Windows 10 platform.
You can control instrument operations using one or all of the following entering methods:

- Touch Screen and Front-panel soft key controls
- Keyboard and mouse

Simple AFG Touch UI

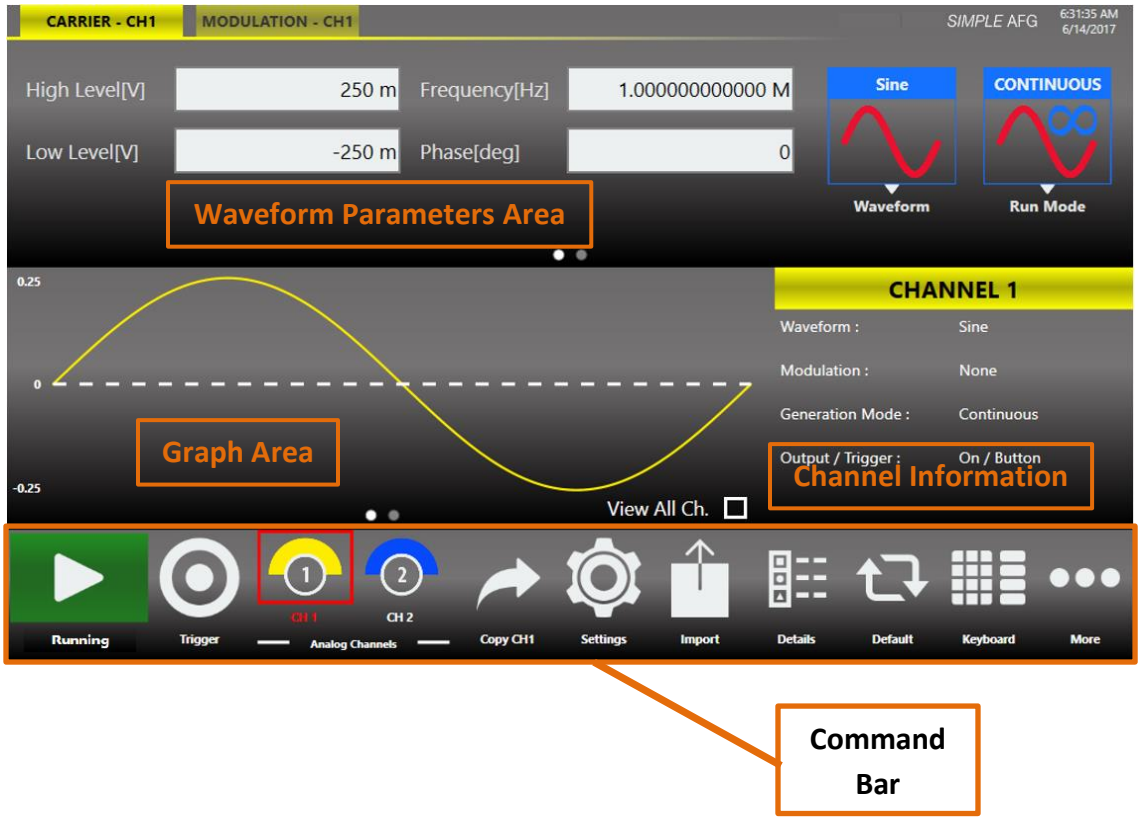
Simple AFG UI is designed for touch to drive simplicity in operating with an Arbitrary Waveform Generator, by using the today’s modern technique, used on Tablet or smart phones, available in capacitive touch-screen displays.
All the important instrument controls and settings are always one touch away:

- swipe down gesture to change the output channel
- swipe left or right to navigate through the sequencer entries
- pinch in-out to zoom the waveform graph
- use the touch-friendly virtual numeric keyboard to modify the parameters and to entry new values on the fly



User Interface Description

The Simple AFG software environment provides an easy access to all instrument functionalities and parameters.

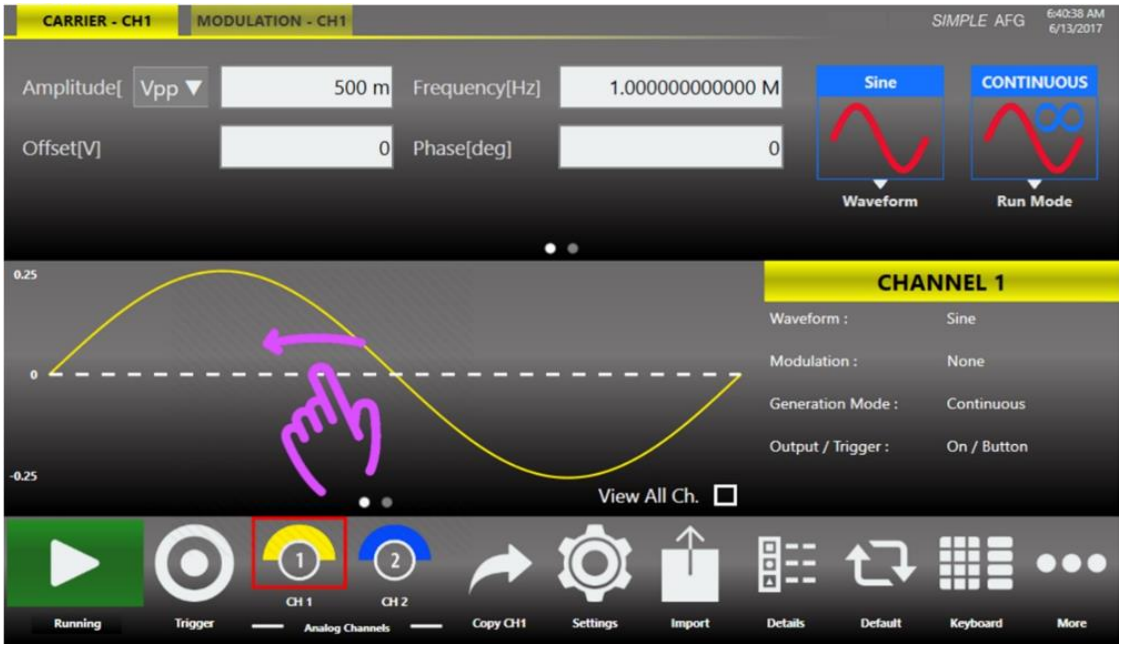


AFG user interface consists of four main elements:

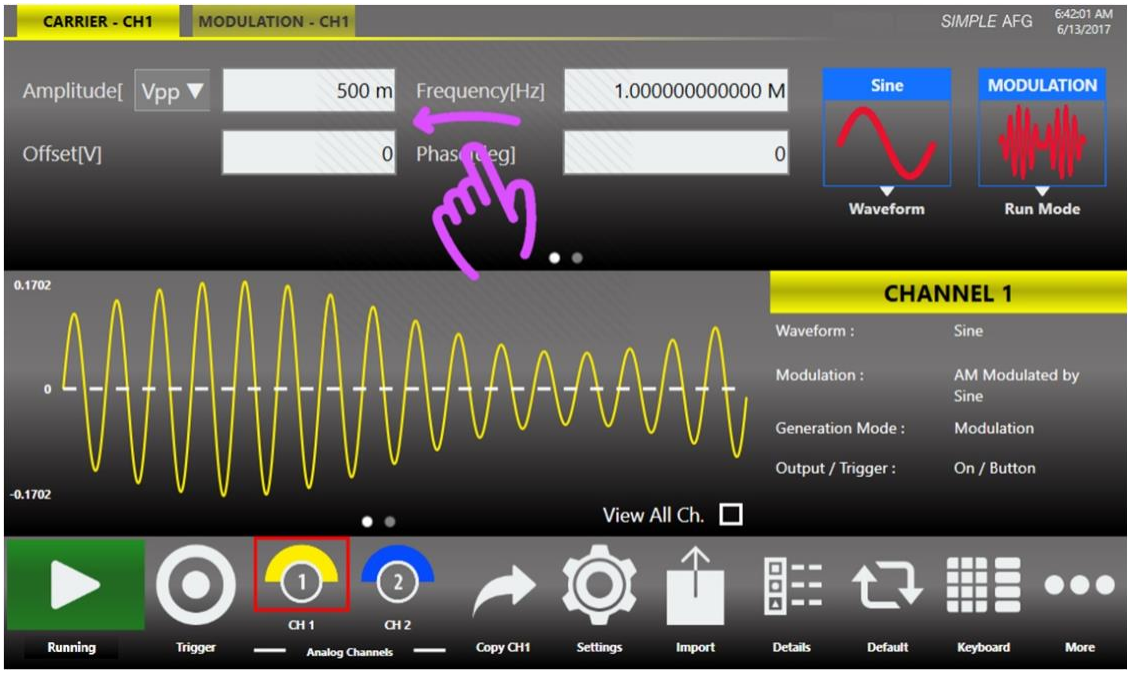
- **Waveform Parameters Area:** it contains all the waveform settings. It is composed by the **Carrier** tab and the **Secondary** tab.
  The **Carrier** tab allows to choose the Run Mode and the Waveform type and to set its parameters.
  The **Secondary** tab is used to define the **Modulation, Sweep** or **Burst** parameters depending on the selected Run Mode.
- **Graph Area:** it shows a qualitative graphical representation of the generated waveform.
- **Channel Information:** it summarize the channel settings.
- **Command Bar:** in this bar there are elements to control the instrument operations, to modify the instrument settings and to manipulate waveforms.

As mentioned, the display is 7” capacitive touch screen display and you can use the gestures like in a mobile phone:

If you use the Swipe left or right gesture on the Graph Area you can switch between the Output Channel 1 and Output Channel 2 page.



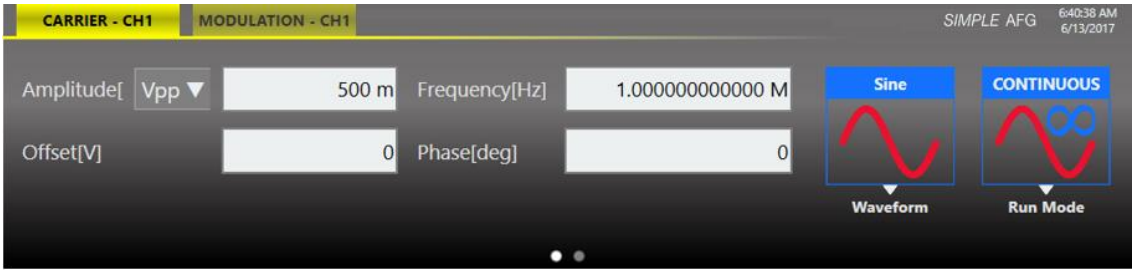
If you use the Swipe left or right gesture on the Waveform Parameter Area you can switch the page between Carrier tab and the Secondary tab. The Secondary tab can be Modulation, Sweep or Burst depending on the selected Run Mode.



Waveform Parameters Area

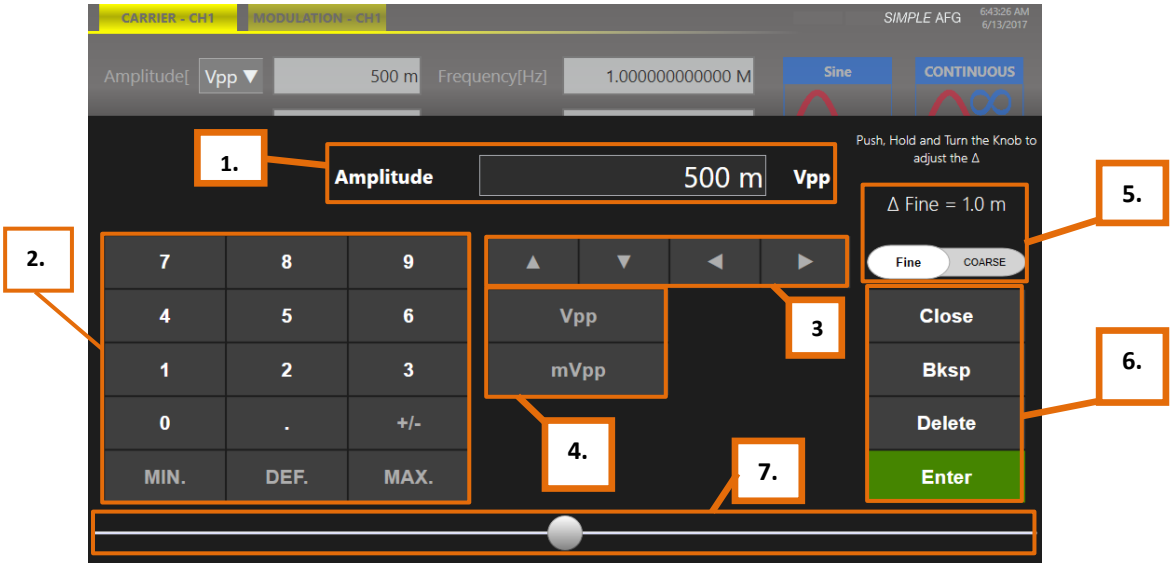
This section is composed by two tabs: the **Carrier** tab and the **Secondary** tab.

- In the **Carrier** tab it is possible to define the Run Mode, of the Carrier Waveform and its parameters as explained in the relative chapter.
- In the **Secondary** tab it is possible to define the parameters that describe the **Modulation, Sweep** and **Burst**. This tab changes title name and functionality depending on the selected Run Mode. For example if the Run Mode is Sweep the Secondary tab will take the title name "Sweep" and the tab page will show the Sweep parameters. The same will happen for Modulation and Burst modes. In Continuous Run Mode the Secondary tab is not active.



You can touch the parameter area to open the Virtual numeric keypad, edit the parameter value and its measure unit.

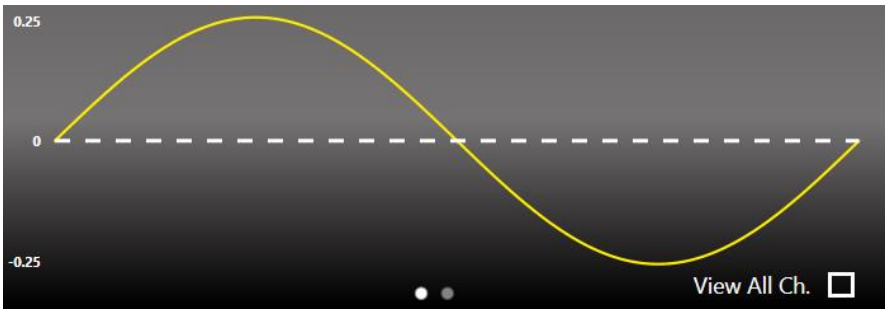
Below there is a description of the keypad items:



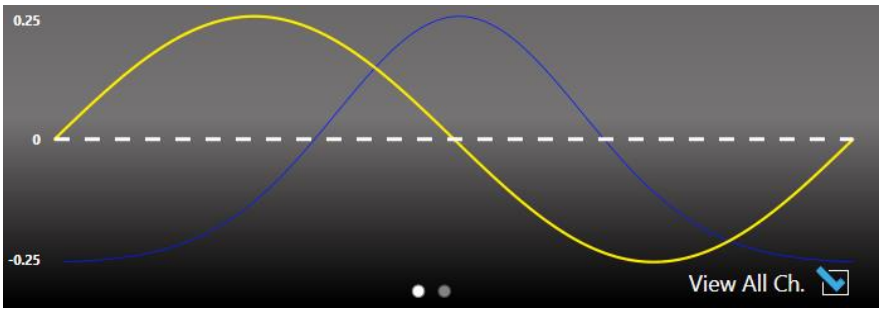
1. **Parameter Name and Value:** This area of the virtual keyboard displays the parameter name, value and unit of measure.
2. **Numeric Keypad:** this area contains the keys to edit the number that will be displayed in the area 1. The [+/-] key will toggle the sign of the number being entered and can be pressed at the end of the number editing.
   Touch the “MIN” and “MAX” buttons to set the minimum and maximum allowed value for the selected parameter. Use the “DEF” button to set the default value.
3. **Arrows:** The left/right arrows allow to move the cursor or select the different digit position as the arrows on the front panel. The up/down arrows allow to modify the value.
4. **Measurement Unit:** After typing the numeric value these buttons can apply a different multiplier of the measurement unit. When a measurement unit is pressed, the value is applied on the fly.
5. **Coarse / Fine:** the coarse/fine button let you to modify the granularity of the increment.
   You can increment or decrement the selected parameter using the UP/DOWN arrows button or rotating knob on the front panel.
   When Fine is selected, the increment is of 1 unit at the current cursor position.
   When Coarse is pressed, the Delta increment is displayed in the parameter area and the parameter value changes in steps of the selected increment.
   You can keep pressed the knob and rotate it on the right or on the left to change the Delta Coarse increment.
6. **Control Buttons:** The “Close” button closes the virtual keypad without applying any changes on the instrument while the “Enter” button confirms the changes and it applies them on the instrument.
   “Bksp” (backspace) button is provided for deleting erroneous key presses, “Delete” button deletes all digit of the textbox.
7. The **horizontal scrollbar** allows to change quickly the selected value. The position specifies the value between the allowed minimum and the maximum.
   The increment/decrement value entered by the rotary knob or by the scrollbar are applied to the instrument on the fly.

Graph Area

The graph area displays the Output channel waveform with a vertical legend that shows the minimum and maximum voltage levels and the offset.

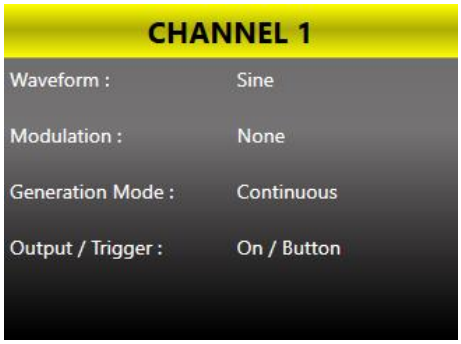


Note: When **View All Ch.** is checked the graph shows all channels graphs overlapped. The vertical scale is that of the selected channel.



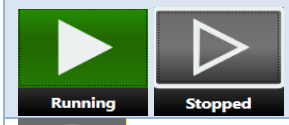
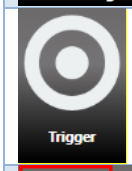
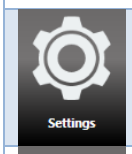
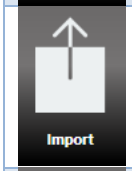
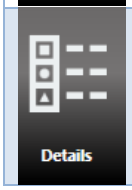
Channel Information

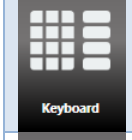
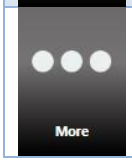
This area displays the channel name and a list of all the main current channel settings: the selected waveform type, the Modulation / Sweep / Burst mode, the Generation mode, the channel status and the Trigger Source.

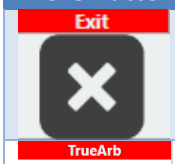
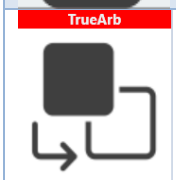
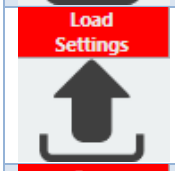
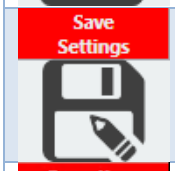
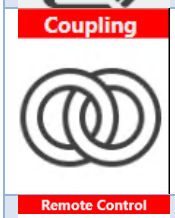
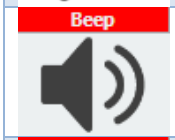
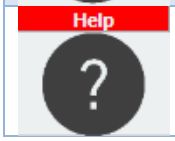


Command Bar Area

The command bar contains several touch buttons to control the instrument. Below a detailed description of this bar is provided.

Command Bar Buttons	Description
	**Running/Stopped Button** – Use this button to set the instrument in Running state (or Ready to receive a Trigger) or in the Stopped state. If the button is green the instrument is running while if it is grey the instrument is stopped. Bushing the button will change the instrument state.
	**Trigger Button** – Use this button to send an internal software trigger to the instrument. Independently from the setting this trigger is always received.
	**Output Channels Buttons -** Press CH1, CH2, …, CHN to change the Output channel page. If you press again the selected Channel, you can turn OFF/ON . When a channel is OFF, it is mechanically disconnected from the output.
	**Copy Ch1** (Ch N) **Button** –This button copies all the channel settings to the other channels. When you press the button a dialogue window appears to Confirm or Cancel the operation. As example on four channel models, you can copy the channel 1 into channel 2,3,4 or the channel 2 into channel 1,3,4 depending on the current selected one. Note: this button is in the More menu on four/eight channel model.
	**Settings Button** – Use this button to open the output channel Settings and device Settings. (For more information, please refer to the relative section).
	**Import Button** – Use this button to open the page where you can import a waveform from a file and use it as Carrier Waveform, Modulation Law or Sweep Profile. (For more information, please refer to the relative section). Note: this button is in the More menu on the four/eight channel model.
	**Details Button** – Use this button to open a page that summarize all channel settings. Note: this button is in the More menu on the four/eight channel model.

	**Default** – Use this button to restore the default value of all parameters of the instrument. Note: this button is in the More menu on the four/eight channel model.
	**Numeric Keyboard Button** – Use this button to enable or disable the virtual numeric keyboard. Note: this button is in the More menu on the four/eight channel model.
	**More Button** – Use this button to have access to other instrument features. These buttons are explained in the following table.

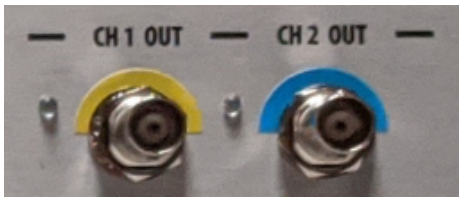
More Button Menu Items	Description
	**Exit Button** – Press this button to close the application.
	**Change Application** – Use this button to switch from AFG to TrueARB application.
	**Minimize Button** – press this button to minimize the application screen; in this way you can access to Windows OS.
	**Load Setting Button** – Use this button to load user instrument settings from a file (called Memory). (For more information, please refer to the relative section).
	**Save Setting Button** – Use this button to store the instrument settings to a file (called Memory). (For more information, please refer to the relative section).
	**Coupling Button –** Use this button to open the channel Coupling page. (For more information, please refer to the relative section).
	**Remote Control Button** – Use this button to open the SCPI server page. In that page you can enable or disable the SCPI server and see the sequence of commands sent to the instrument and its response.
	**Beep Button** – Use this button to enable or disable the beep audio signal when the user touches a button.
	**About Button** – Use this button to check the credits, the software, the firmware release number and the instrument serial number.
	**Help Button –** Use this button to open the User Manual.

Input / Output Channels

The Model 675 High Performance AWG has 2/4/8 independent analog channels. Each channel is a single-ended output and it is provided on a BNC connector located on the front instrument panel (CH1 OUTPUT to CH*N* OUTPUT).
The Marker Out is a digital output signal provided on a BNC connector located on the front instrument panel (MARKER OUT *N*).
It is available one marker out BNC for each couple of channels on the front panel.
Depending on the instrument model, it is possible to choose in the software the channel it is related to (CH1/CH2), (CH3/CH4), (CH5/CH6), (CH7/CH8).
The Trigger In is an input signal provided on a BNC connector located on the front instrument panel (TRIGGER IN).
The External Modulation Input is an input signal provided on a SMA connector located on the rear instrument panel (Ext. Mod. In).
The Trigger In and the External Modulation Input signals are common input sources for every instrument channels.

Analog Output Channel

The term Output Channel, as used in this user manual, refers to the analog signal provided on the BNC output connector located on the front instrument panel.
For some parameters the Simple AFG application supports different input formats. For example it is possible to specify the frequency of a waveform or alternatively it is possible to specify the corresponding time period. It is possible to switch between two different parameter formats by just touching the parameter label.
Note that the input format is the same for all channels, so if the High/ Low Level format is selected for channel 1, the channel 2,…. the channel N, will use that format as well.



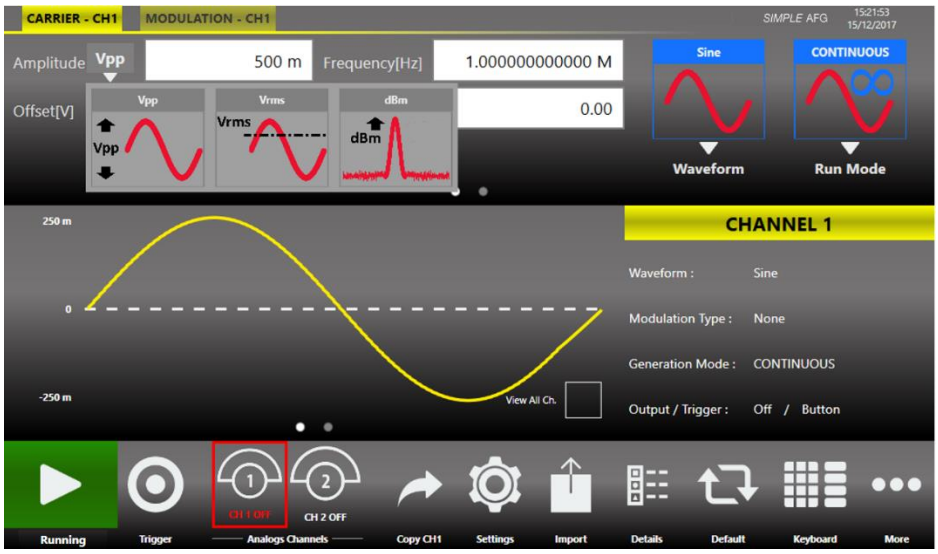
Main Channel Vertical Parameters

The Simple AFG application provides the control of the vertical (voltage) parameters of the Output channel in the format **Amplitude[Vpp] / Offset[V]** or in the format **Voltage High[V] / Voltage Low[V]**. By touching the labels, you can switch between the two formats.

The output signal levels displayed by the Simple AFG UI text are calculated for the specified source and load impedances that by default are 50 Ohm. To change the expected load and source impedance please refer to the Channel Settings.

Amplitude

It defines the difference between the maximum value and the minimum value of the waveform expressed in Volts except for functions non-symmetrical with respect to 0 V, such as Sinc and Gaussian, where the amplitude may have a different meaning depending on the waveform type.
The amplitude can be represented in three different formats that can be selected by opening the menu beside the amplitude label:

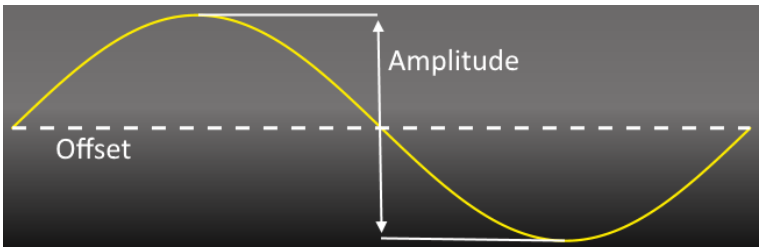


- **Vpp (Peak to Peak Voltage):** it is the difference between the highest and lowest level of the waveform.
- **Vrms (Root Mean Square Voltage):** it is the rms value of the waveform.
- **dBm:** it is the power transferred to the load expressed in dBmW (this representation is available only for sine wave). Its value takes in account the Load set in Channel Settings.

Note: The Vrms and the dBm set in the textbox are referred only to the waveforms amplitude. They don't take into consideration the Offset of the waveform.

Offset[V]

It defines the voltage of (Vmax+Vmin)/2 expressed in Volts where Vmax is the maximum level of the waveform and Vmin is the minimum level of the waveform

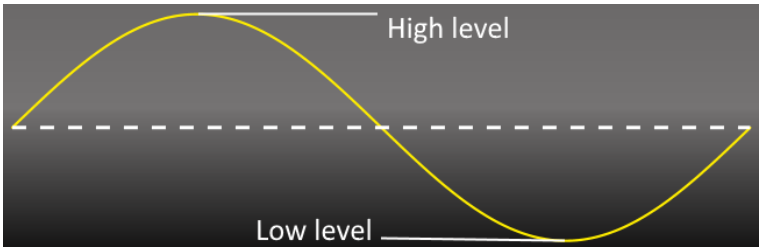


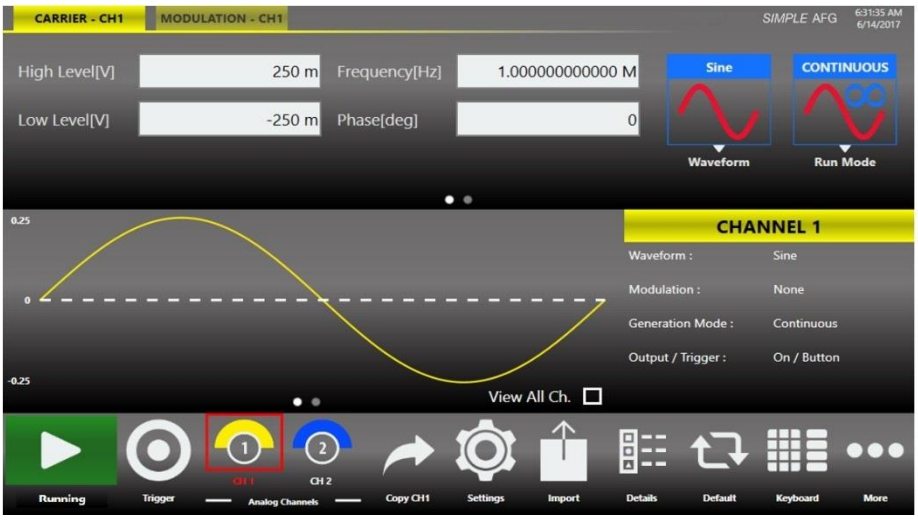
High Level [V]

It defines the maximum level of the waveform expressed in Volts

Low Level [V]

It defines the minimum level of the waveform expressed in Volts





These parameters are available for all function excepts the DC level that is identified only by the Offset parameter.

Main Channels Horizontal parameter

The horizontal parameters control the frequency, the phase and the shape of the waveform. The set of available parameters depends on the selected waveform.

Frequency [Hz] / Period [s]

This parameter defines the frequency or the period of the generated waveform. This parameter is available for all the functions except DC Level and Noise.
In sweep run mode it is replaced by the Phase[deg] or Start Freq./Stop Freq.[Hz] parameters .
Touching the parameter label the format switches between Frequency and Period.

Phase [deg]

It controls the initial phase of the waveform. This control is available for all function except DC Level and Noise.

Symmetry [%]

This parameter is defined only for the Ramp function. It represents the percentage of the cycle in which the ramp function is rising.

Width [s] / Duty Cycle [%]

It defines the duration of the High-level part of the Pulse function. The width is defined as Full Width at Half Maximum (FWHM) that means the time from the medium of the leading edge to the medium of the trailing edge. The duty cycle is the percentage value of the width compared to the period.
Touching the label, you can change the format between the Width (absolute) and Duty Cycle.

Leading – Trailing Edge [s]

In the Pulse function, it defines the transition time between Low level and High level for the Leading Edge and between High level and Low level for the Trailing Edge.
Note: the values refer to the rise and fall time between the 10% and the 90% of the pulse amplitude. The 0% to 100% transitions will be longer than the set values anyway the graph represents the entered value as the 0% to 100% transition time.

Note: Using the Pulse Waveform the following constraints must be met:

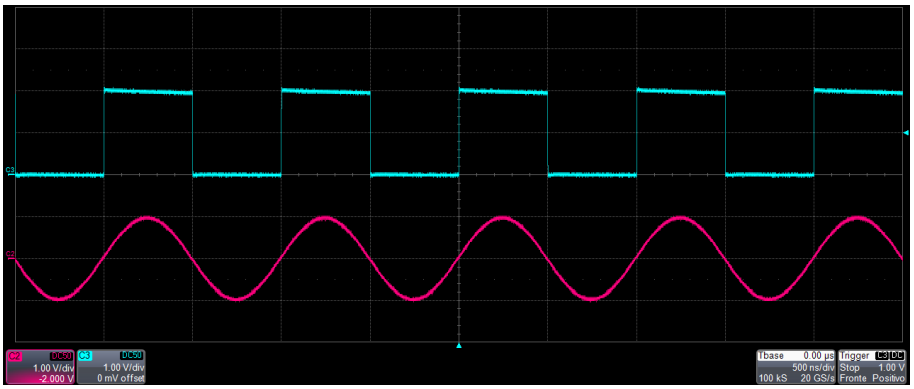
- $Leading\ Edge + Trailing\ Edge < Period$
- $Width < Period$

Auxiliary Channels

Marker Out

The Marker Out generates a digital pulse synchronous with the waveform or with the modulating function depending on the Run Mode. To set the Marker Out parameters refer to the Channel Settings.

Marker Out Specification	Value
Connector	1 BNC per pair of channels on the Front Panel
Output impedance	50 Ω
Output level (into 50 Ω)	1 V to 2.5 V

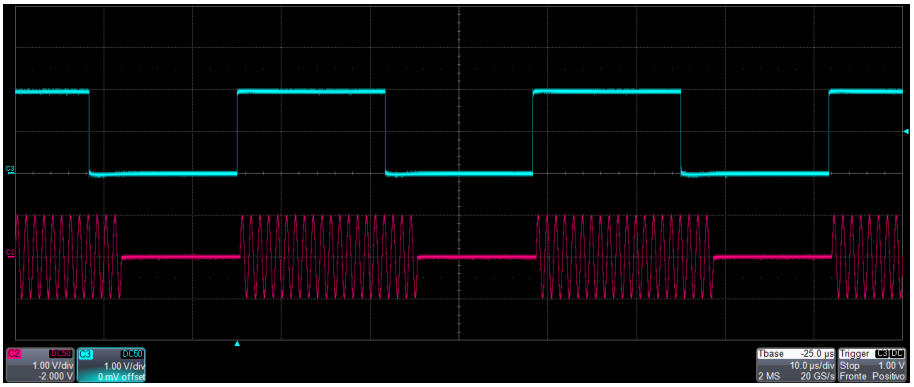


Marker out (blue, top) synchronous with the analog signal (red, bottom)

Trigger In

The TRIGGER IN (Trigger In connector on the front panel) allows to control the signal generation when a channel is in Burst Run Mode or in Sweep Run Mode. Refer to the chapters about the Device Settings to know how to define the trigger parameters or the Run Mode. In Continuous and Modulation Run Modes the Trigger In doesn't have any effects.

Trigger In Specification	Value
Connector	1 BNC on the Front Panel
Input impedance	1 kΩ or 50 Ohm selectable
Slope/Polarity	Positive or negative selectable



Trigger In signal (blue, top) that starts a burst of sine waveform (red, bottom)

Reference Clock Input

When the “Clock Source” is set on “External” in the “Device Settings” page, the internal clock synthesizer uses the signal from “Reference Clock Input” SMA connector to generate the DAC sampling clock signal.

Reference Clock Input	Value
Connector type	1 SMA on the Rear Panel
Input impedance	50 Ohm, AC coupled
Input Frequency range	5 MHz to 100 MHz

External Modulation Input

The Model 675 High Performance AWG series instrument can accept the modulating signal from an external source, through the External Modulation Input SMA connectors located on the Rear Panel.

External Modulating Input	Description
Connector Type	1 SMA on Rear Panel for all channels
Input Impedance	10 kOhm
Input Voltage Range	±0.5 V for all modulations

Reference Clock Output

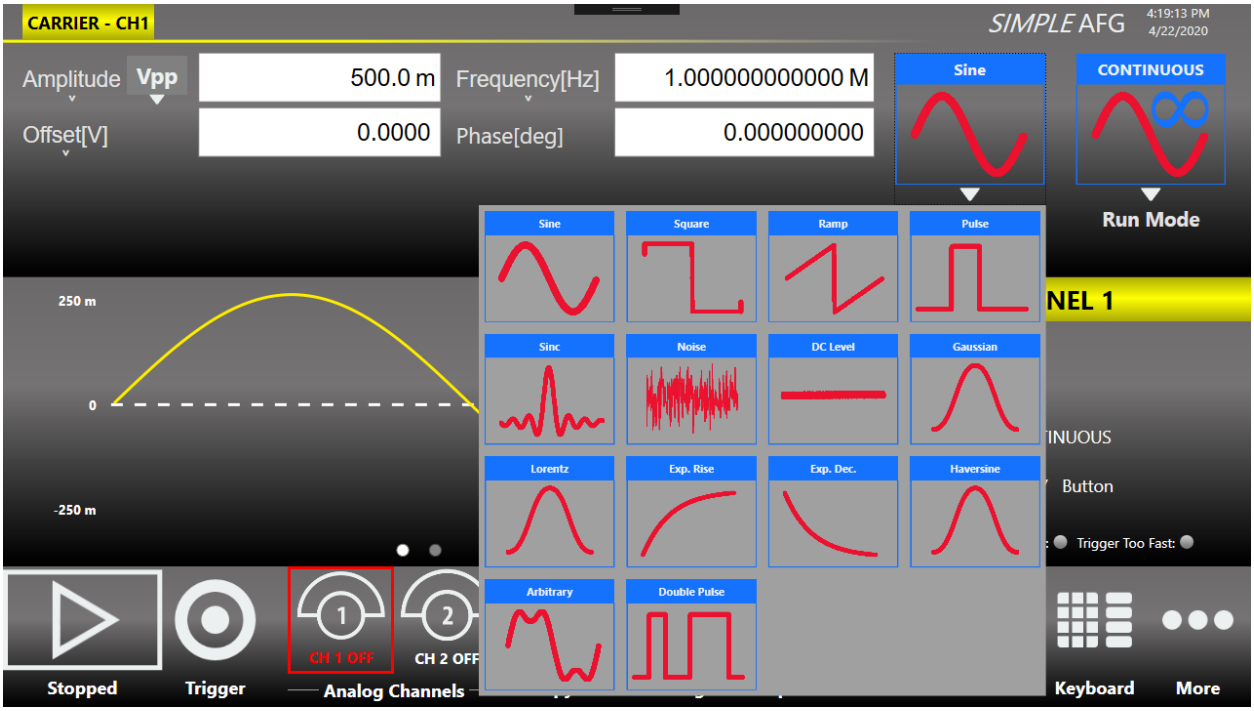
This connector outputs the internal 10MHz reference clock used to synthesize the DAC sampling clock. If the clock source is internal it produces a signal at 10 MHz, if the source is external it is disabled.
The connector type is a SMA.

Reference Clock Input	Value
Connector	1 SMA on the Rear Panel
Output impedance	50Ω, AC coupled

Predefined Waveforms

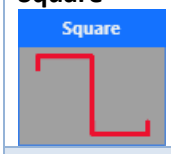
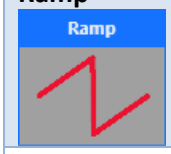
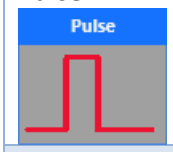
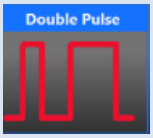
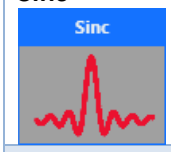
The Simple AFG application provides 13 predefined functions each of them described by its own set of parameters. It is also available the **Arbitrary** waveform that allow to load a waveform from a file or from remote.

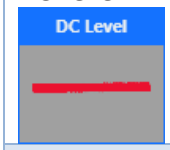
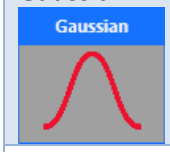
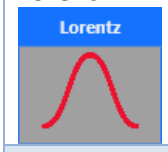
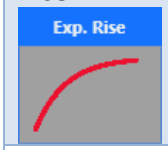
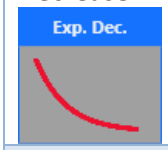
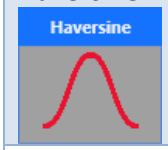
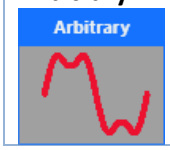
Touching the “Waveform” button on the “Carrier” a dropdown menu opens where it is possible to select a waveform to use as carrier.



List and parameters of predefined waveforms

The following table shows the available waveforms, the parameters that you can change for each one and the possible combination of run mode and waveforms. The Continuous Run Mode has been omitted from the table because it is available for all waveforms.

Waveform	Parameters	AM, FM, PM, PSK, FSK	PWM	Sweep	Burst
Sine 	Amplitude, Offset, Frequency, Phase	√		√	√
Square 	Amplitude, Offset, Frequency, Phase	√		√	√
Ramp 	Amplitude, Offset, Frequency, Phase, Symmetry	√		√	√
Pulse 	Amplitude, Offset, Frequency, Phase, Duty Cycle, Leading Edge, Trailing Edge		√		√
Double Pulse 	**Common:** Offset, Frequency, Phase. **Pulse 1 / Pulse 2:** Amplitude1/2, Offset1/2, Leading Edge1/2, Trailing Edge1/2, Width1/2, Delay1/2 **Note**: Delay2 is a delta delay relative to the end of the first pulse				√
Sinc 	Amplitude, Offset, Frequency, Phase	√		√	√
Noise 	Noise level (Amplitude), Offset				√

Waveform	Parameters	AM, FM, PM, PSK, FSK	PWM	Sweep	Burst
DC Level 	Offset				
Gaussian 	Amplitude, Offset, Frequency, Phase	√		√	√
Lorentz 	Amplitude, Offset, Frequency, Phase	√		√	√
Exponential Rise 	Amplitude, Offset, Frequency, Phase	√		√	√
Exponential Decrease 	Amplitude, Offset, Frequency, Phase	√		√	√
Haversine 	Amplitude, Offset, Frequency, Phase	√		√	√
Arbitrary 	Amplitude, Offset, Frequency, Phase	√		√	√

Note: Consult the instrument datasheet to find out the specifications of frequency range for each waveform.

You can assign the "**Arbitrary**" waveform using the "**Import**" button 

of the command bar. For more information refer to the "Import from File" section. By default, the "Arbitrary" waveform is a cosine function.

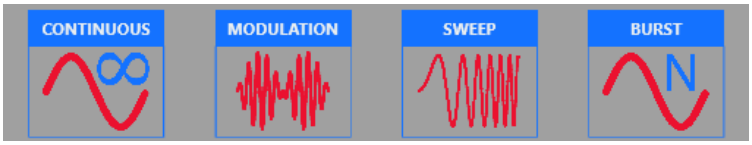
Note: When Arbitrary waveform is selected the amplitude and offset of the original waveform are lost because the waveform in normalized. Anyway, the amplitude and offset of the normalized waveform can be modified as for any predefined waveforms.

Note: In Stopped State the instrument stops at the Common Mode Voltage (Vocm) of the selected channel for all the waveforms except for:

- Pulse Waveform – Stopped State: Low Level[V] if the polarity is positive or High Level[V] if the polarity is negative.
- Double Pulse Waveform – The stopped state is the Offset[V] parameter.

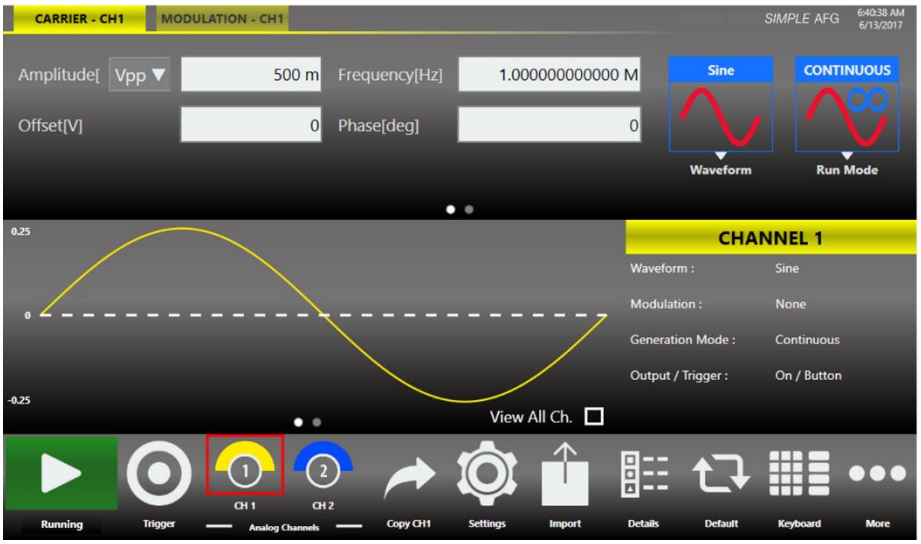
Run Mode

On the Carrier tab pressing the "Run Mode" button a menu opens showing all possible choices for the Run Mode. If "Modulation", "Sweep" or "Burst" is selected the software moves directly on the secondary tab that takes the name of the selected Run Mode.



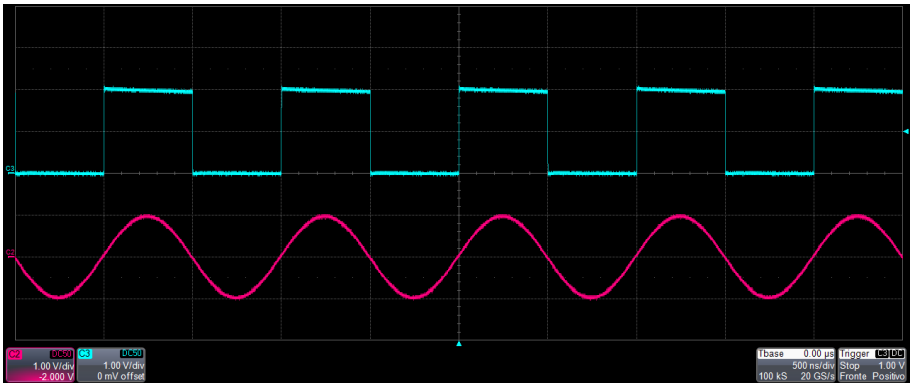
Continuous

In the Continuous mode when the Run/Stop button is pressed the waveform is reproduced continuously until the Run/Stop button is pressed again or Waveform / Run Mode is changed.



Marker Out behaviour in Continuous Run Mode

In Continuous mode, the **Marker Out** generate a pulse with a duty cycle of 50% at the beginning of each period. The Marker have the same frequency of the carrier waveform until it is below 75 MHz. Over 75MHz the Marker Out frequency is divided by 2 from 75MHz up to 150MHz, by 4 from 150MHz up to 300MHz.

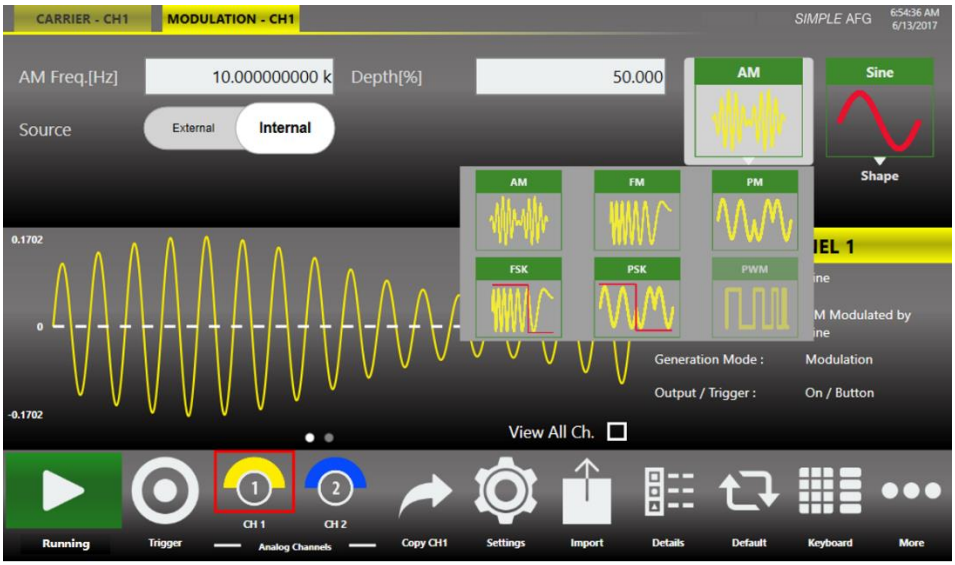


Marker out (blue, top) synchronous with the analog signal (red, bottom)

Modulation

In this Run Mode, it is possible to modulate a carrier waveform with a modulation law that can be another waveform or an external signal. All waveforms except Noise and DC level support the Modulation Run Mode.

Touching the “Type” button the modulation type menu opens as shown in the picture below.

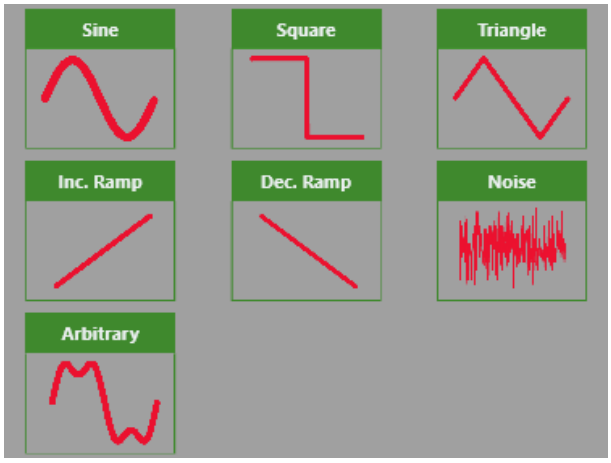


The modulation types are:

- **Amplitude Modulation (AM)**
- **Frequency Modulation (FM)**
- **Phase Modulation (PM)**
- **Frequency Shift Keying (FSK)**
- **Phase Shift Keying (PSK)**
- **Pulse Width Modulation (PWM)**

The PWM modulation is the only modulation supported by the Pulse waveform.
The types of modulation are explained in detail in the following sections of this chapter.

Touching the “Shape” button the modulation type menu opens. The possibility to choose the shape is only available for AM, FM, PM and PWM modulations.



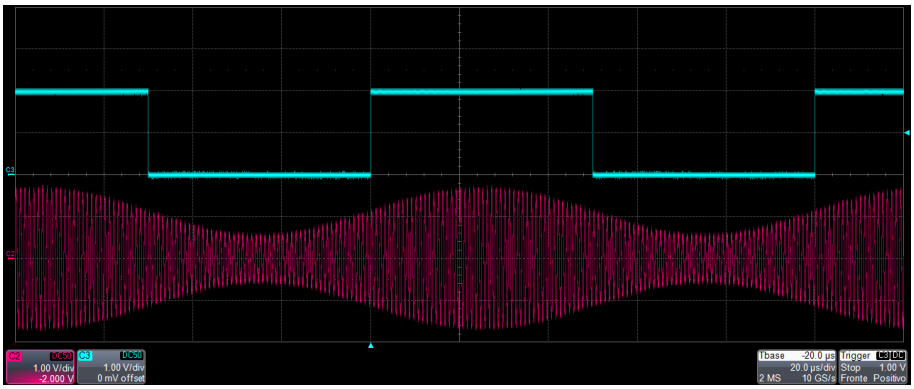
The modulation **Shapes** (when available) can be:

- **Sine**

- **Square**
- **Triangle**
- **Increase Ramp**
- **Decrease Ramp**
- **Noise**
- **Arbitrary:** it allows to load a Modulating Waveform from file. For the file specification please refer to the “Import from File” section. By default, the “Arbitrary” waveform is a cosine function.

Marker Out behaviour in Modulation Run Mode

If the modulating source is **Internal**, the **Marker Out** generates a square wave synchronous with the modulating waveform. The leading edge of this pulse is positioned at the beginning of the modulating waveform.
If the modulating source is **External**, the **Marker Out** is disabled.



Marker out (blue, top) synchronous with the modulating waveform of the AM (red, bottom)

Modulation General Parameter

- **Frequency [Hz]:** it defines the modulating frequency. It can vary between 500 uHz and 48 MHz.
- **Source:** the source can be **Internal** or **External**. If **Internal** is selected it is possible to select a Shape. If **External** is selected the instrument accepts a modulating signal from the **Ext. Mod.** SMA connector.

Modulation Types and associated parameters

- **Amplitude Modulation (AM):** the amplitude of the carrier waveform is modulated following the modulating shape. It is available for all functions except for the Pulse, Double Pulse, DC level and Noise.
  The parameter **Depth [%]** controls the modulation depth between 0% and 120%.

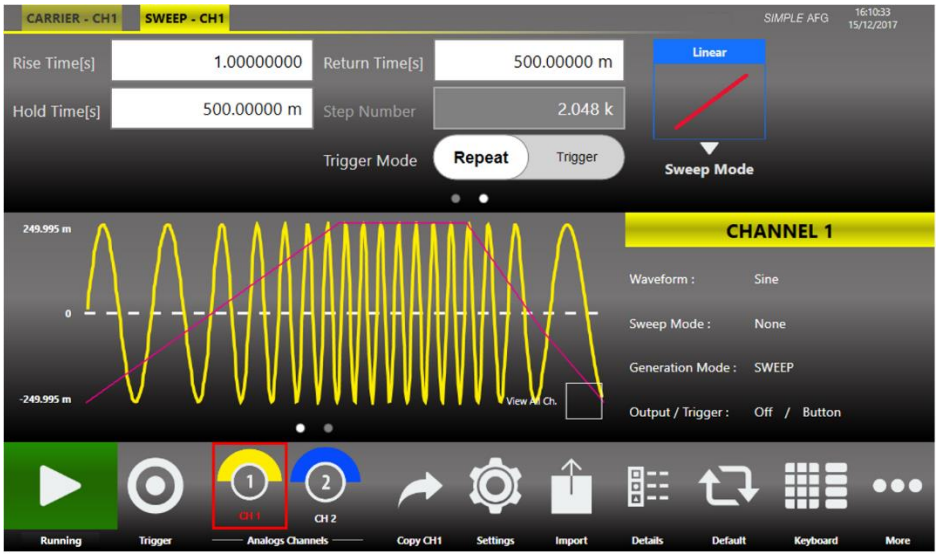
- **Frequency Modulation (FM):** the frequency of the carrier waveform is modulated following the modulating shape, it is available for all functions except for the Pulse, Double Pulse, DC level and Noise.
  The parameter **Deviation [Hz]** defines the deviation of frequency with respect to the carrier frequency. The Deviation is between 0 Hz and the maximum frequency that satisfies the following 2 relationships:
  - $Carrier\ Frequency - Deviation\ >\ 0\ Hz$
  - $Carrier\ Frequency + Deviation \leq Maximum\ Frequency$
    Where the Maximum Frequency depends on the selected carrier.

  For example, for a sine function at 200 MHz the Deviation must be below 200 MHz.
- **Phase Modulation (PM):** the phase of the carrier waveform is modulated following the modulating shape. It is available for all functions except for the Pulse, Double Pulse, DC level and Noise.
  The parameter **Deviation [deg]** set the maximum phase deviation of the carrier waveform. It can vary in the range 0 to 360 degrees.
- **Frequency Shift Keying (FSK):** this modulation is a 2 level FSK. The carrier frequency switches between the initial carrier frequency and the initial carrier frequency + **Hop Frequency [Hz]**. It is available for all functions except for the Pulse, Double Pulse, DC level and Noise.
  Note that the Hop Frequency can be negative and it must satisfy the following conditions:
  - $Carrier\ Frequency - \text{Hop Frequency} > 0\ Hz$
  - $Carrier\ Frequency + \text{Hop Frequency} \leq Maximum\ Frequency$
    Where the Maximum Frequency depends on the selected carrier.
- **Phase Shift Keying (PSK):** this type of modulation is a 2 level PSK. The carrier phase is shifted by the value of **Hop Phase [deg]**. It is available for all functions except for the Pulse, Double Pulse, DC level and Noise.
  The hop phase is between 0 and 360 deg.
- **Pulse Width Modulation (PWM):** this modulation is available only for the Pulse waveform. It modulates the width of the Pulse of the quantity defined in the **Deviation [%]** parameter that defines the maximum increase and decrease of the Duty Cycle percentage. The deviation has to meet the following conditions:
  - $deviation\ [\%] \leq duty\ cycle\ [\%] - \frac{Leading\ Edge[s]}{0.8} * \frac{100[\%]}{Period\ [s]} - \varepsilon$
  - $deviation\ [\%] \leq 100[\%] - duty\ cycle\ [\%] - \frac{Trailing\ Edge[s]}{0.8} * \frac{100[\%]}{Period\ [s]} - \varepsilon$

  Where ε is a small margin to avoid that the duty cycle reaches the 0 % or the 100 % and the factor “0.8” take in account that the edges are defined as 10-90%.

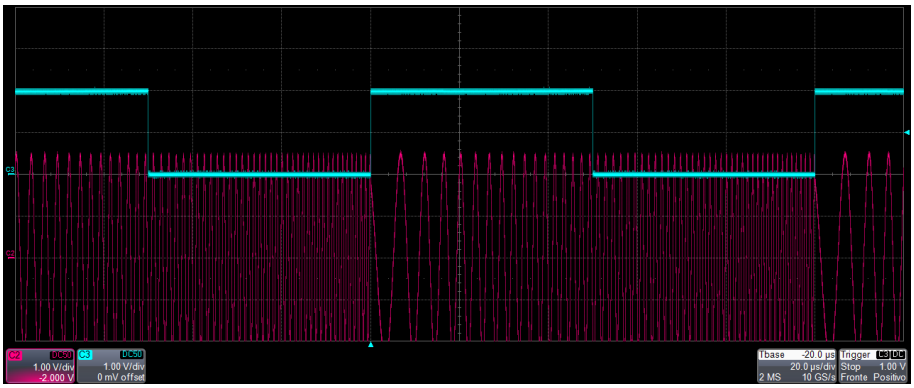
Sweep

The Sweep mode varies the waveform frequency following a law that can be **Linear, Logarithm, Upstair** or **User Defined.** The **User Defined** selection gives the possibility to load the sweep profile from a file. The Sweep is available for all function except for Pulse, Double Pulse, Noise and DC level.



Marker Out behaviour in Sweep Run Mode

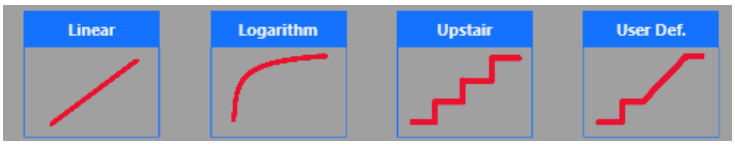
In this Run Mode the **Marker Out** generates a square wave with the rising edge placed at the beginning of each sweep.



Marker out (blue, top) synchronous with the sweep (red, bottom)

Sweep Mode

Touching the Sweep Mode button a menu opens that gives the possibility to choose a sweep profile among the following:



- **Linear:** the frequency increases and decreases linearly.
- **Logarithm:** the frequency increases and decreases following a logarithmic function.
- **Upstair:** the frequency varies step by step. The number of steps is selectable through the **Step Number** parameter.
- **User Defined:** allows to load a sweep profile from a file. For the file specification please refer to the "Import from File" section. By default, the "Arbitrary" waveform is a cosine function.
  Note: the time to execute the sweep is the sum of Rise, Hold and Return Time. When the User Defined mode is selected these 3 parameters are not meaningful.

Parameters

- **Rise Time [s]:** it controls the time to increase the frequency from the Start Frequency up to the Stop Frequency.
- **Hold Time [s]:** it is the time that the frequency keeps the Stop Frequency.
- **Return Time [s]:** it controls the time to decrease the frequency from the Stop Frequency back to the Start Frequency.

Note: the time parameters must meet the following conditions:

$$Rise\ Time + Hold\ Time + Return\ Time \leq 2000\ s$$

- **Step Number:** it selects the number of frequency steps of the Upstair Sweep mode.
- **Start Frequency [Hz]:** it selects the initial sweep frequency.
- **Stop Frequency [Hz]:** it selects the final sweep frequency.

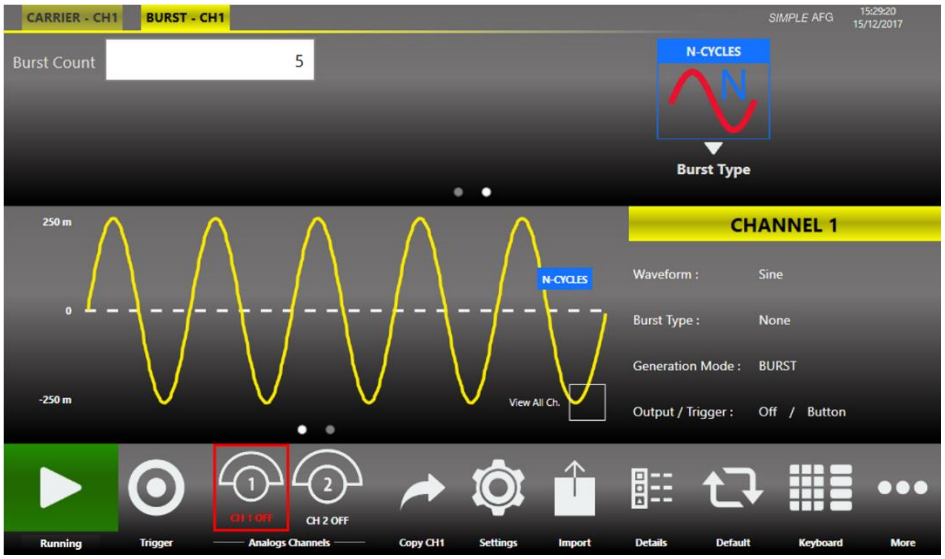
Note: The **Start Frequency [Hz]** and the **Stop Frequency [Hz]** are defined in the Carrier tab.

Sweep Trigger Mode

- **Repeat:** the instrument starts when the Run/Stop button is pressed and repeats the sweep continuously.
- **Trigger:** When the Run/Stop button is pressed the instrument waits for a Trigger signal. When the trigger is detected it generates the sweep profile then stops waiting for a new Trigger. During the wait for a Trigger the instruments generates the waveform with its frequency equal to the start frequency.

Burst

In Burst mode a waveform is repeated a predefined number of times or until the Trigger signal is at High Level depending on the selected Burst Type. This Run Mode is available for all waveforms except the DC level.

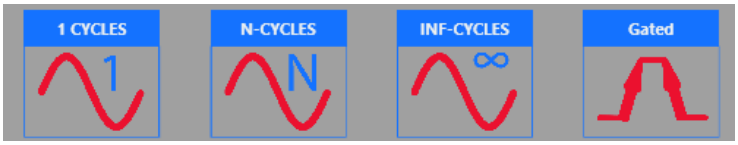


Marker Out behaviour in Burst Run Mode

In this Run Mode, the **Marker Out** generates a pulse with a duration equal to the duration of the burst sequence or to the gate time duration (time when the Trigger signal is at High level).

Burst Mode

The burst mode allows to define the behaviour of the instrument after the Trigger reception. Touching the “Mode” button the following menu opens and it is possible to select the burst type.



- **1 Cycles:** the instrument waits for a Trigger. When the trigger is detected it generates one time the carrier waveform then it stops and waits for the next Trigger.
- **N-Cycles:** the instrument waits for a Trigger. When the trigger is detected it generates N times the carrier waveform then it stops and waits for the next Trigger. The number of N cycles to generate is defined by the **Number of Cycles** parameter.

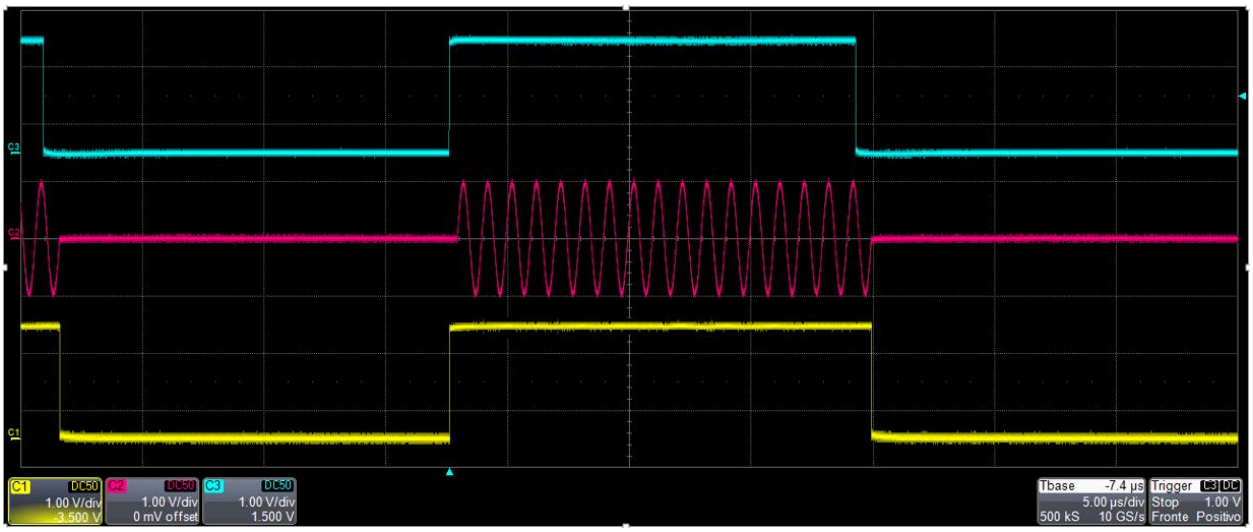
- **Inf-Cycles:** this mode is similar to the previous one, but after the Trigger the generation starts until the Run/Stop Button is pressed.
- **Gated:** the waveform is generated only when the Trigger is “true”. When the trigger returns to “false” the instrument terminates the current burst sequence then it returns waiting for the next trigger.

Note: If you select the Noise as carrier for the Burst mode, the frequency/period associated to the Noise is the last used one. It doesn’t affect the generated noise, but affects the duration of the burst.

Note: when the instrument is waiting for the first Trigger the Output voltage level keeps the Offset voltage but during the wait state after the first execution the Output voltage level keep the last sample of the carrier waveform.

In the following picture, you can see the gated mode operation. From top to bottom there are:

- C3 (blue trace) is the Trigger signal source from the external Trigger In connector.
- C2 (red trace) is the generated signal.
- C1 (yellow trace) is the marker out.



Burst Gated with Trigger from external

Main Command Button Description

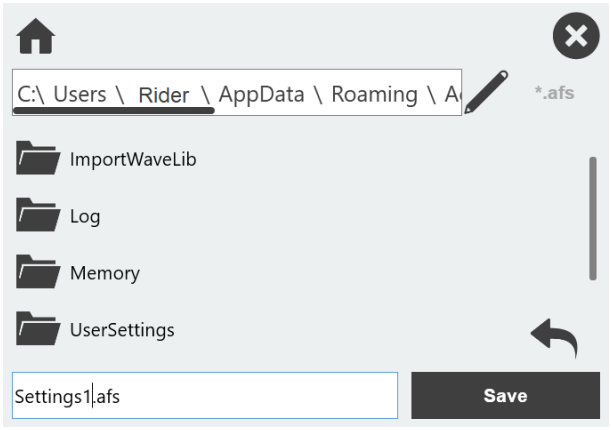
Save Settings

The button “Save Settings” 

in the “More” menu allows to save the current instrument settings called “*memory*”. In the relative dialogue box, you can save a new *memory* entry or overwrite an existing one. If you try to overwrite an existing *memory* entry, a dialogue box appears to ask confirmation.
The file extension for the *memory* file is “.afs”.

In the bottom textbox you can type a new name then pressing the “Save” button 

the *memory* will be saved.



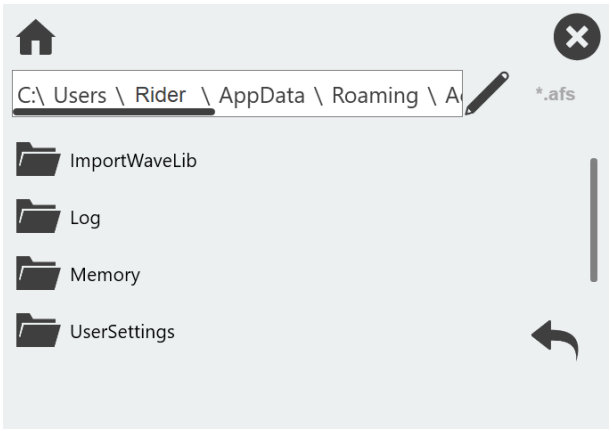
In this page it is possible to choose to destination folder to save the current settings. The “pencil” 
activates the textbox to specify a path. The “house button” 
on the top left sets the path to home path and the “left arrow” 
restores the path to the previous one.

Note: Some file names are reserved for the “Memory State” accessible by Remote Commands. The reserved names are: Memory0.afs, Memory1.afs, …, Memory4.afs,… It is possible to use that names but they will be deleted or overwritten by remote commands without confirmation. Take also care that the “Memory0.afs” saves the last settings before the instrument is power off. Therefor this file is overwritten every time that the instrument is powered off.

Load Settings

Touching the “Load Settings” button 

in the “More” menu, a page will open showing the list of all the saved *memories*. Selecting a *memory* entry the current instrument settings will be immediately updated with those of the *memory* entry.



The buttons  have the same functions they have in the “Save Settings” page.

Note: at the power on of the instrument the file “Memory0.afs”, containing the last setting before the power off, is used to update the current instrument settings.

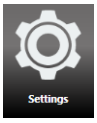
Remote Control

The “Remote” button 

located in the Command Bar opens the page of the SCPI server. In that page there is the list of all the commands received by the SCPI server and its replies. If the text of the command is displayed in **green** it means that the command is correct and it has been accepted by the server. If the text of the command is displayed in **red** it means that the command is wrong and it hasn’t been accepted by the server.

In the top of the page the Host Name and the IP Address of the instrument are shown. The slider on the right side of the page allows to enable or disable the SCPI server. By default it is enabled.

Channels and Device Setting

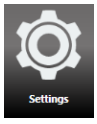
Press this button 

to open the settings page composed by by N +1 number of tabs, N for each Channel of the instrument and one for the Device. You can swipe left or right to switch among the tabs.

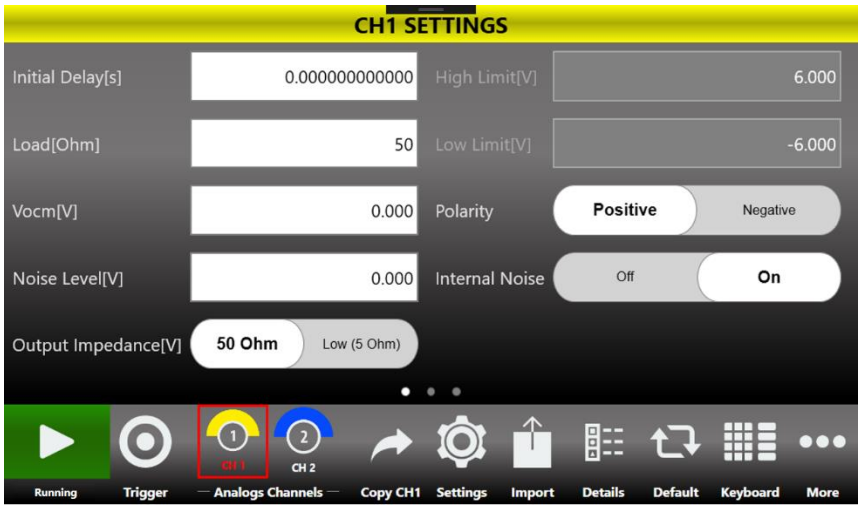
Touching a channel button 

or pressing the “CHANNEL SEL.” button on keypad the settings page will switch between the channels tabs.

Channels Settings

Touching the Setting button 

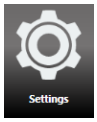
or the “SETTINGS” button on keyboard, the setting page opens.



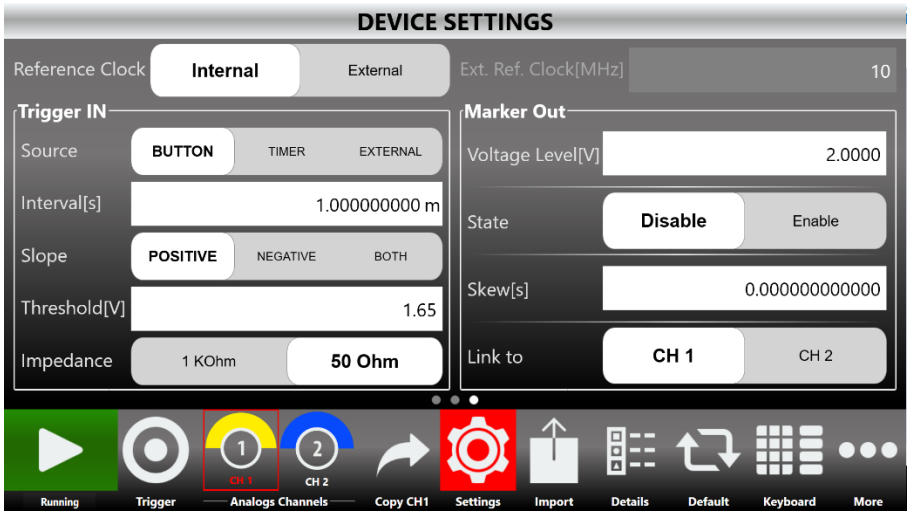
Channel Setting	Description
Initial Delay	Set the Initial Delay of the selected channel. The delay range is 0s to 14 s.
Load [Ohm]	The instrument applies the appropriate scaling to the output waveform to get the right amplitude on the defined Load expressed in Ohm. The impedance range is 1 Ohm to 1 MOhm.
Vocm[V]	Controls the common mode voltage of the channel. The range is between -6 V to 6 V on 50 Ohm load and it depends on the selected load impedance (i.e. -12V to 12V into open load)
Noise Level [V]	Use this setting to add noise to the output signal. The voltage shown in the textbox defines the peak voltage of the noise level. The range is 0V to 6 Vpk (i.e. 0 to 12Vpp). The Noise is hardware generated using a pseudo random algorithm. ***Note:*** When you set the Noise amplitude please pay attention that Signal + Noise does not exceed the amplitude of 12 Vpp.
Internal Noise	Use this control to enable or disable the noise added to the output signal.
Polarity	This control allows you to invert the polarity of the output signal.
High Limit	Sets the maximum voltage that the channel generates. This limit is verified during the generation, but it doesn't take care about the Common Voltage Level (Vocm). The constraint High Limit > Low Limit must be met. This feature can be used to ensure the load is not damaged. ***Note:*** The High Limit doesn't force setting voltages under the limit, but during the generation the part of the waveform that exceeds the limit will be cut at the High Limit.
Low Limit	Sets the minimum voltage that the channel generates. This limit is verified during the generation, but it doesn't take care about the Common Voltage Level (Vocm). The constraint Low Limit < High Limit must be met. This feature can be used to ensure the load is not damaged. ***Note:*** The Low Limit doesn't force setting voltages under the limit, but during the generation the part of the waveform that exceeds the limit will be cut at the Low Limit.

Device Settings

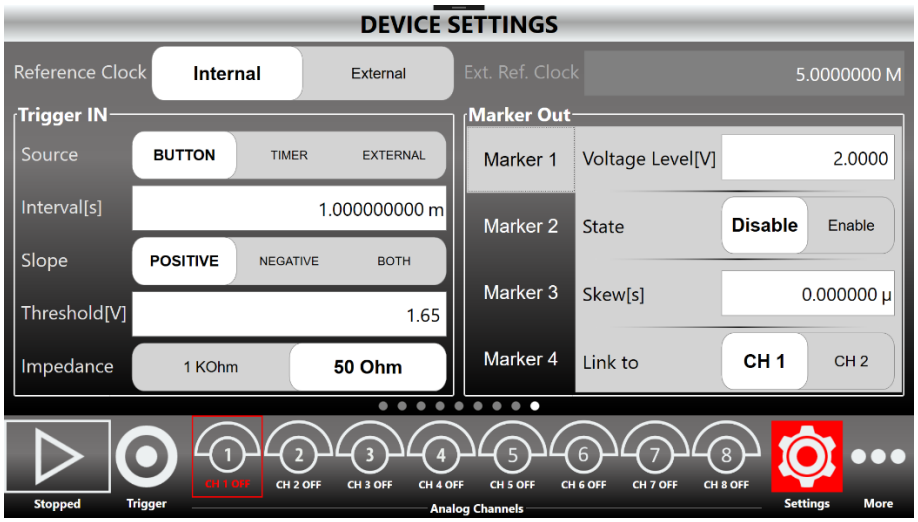
The “Device Settings” page contains the general setting of the instrument, such as the clock source and the Marker Out setting.

Touching the “Settings” button 

in the menu bar or the “SETTINGS” button on the keyboard the channel settings page open. Slicing the page from right to left or touching the last point on the bottom of the page the Device Setting page is displayed.



Device Settings: Two Channels Model

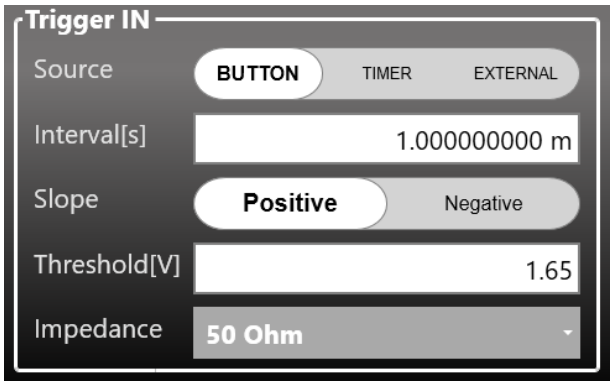


Device Settings: Eight Channels Model

Device Setting	Description
Reference Clock	It can be **Internal** or **External**. If it is Internal the DAC sampling clock is generated internally. If it is External the DAC sampling clock is synthesized starting from the external clock source provided to the External Reference SMA connector located in the rear panel. The external reference clock frequency must me specified in the Ext. Ref. Clock[MHz] parameter.
Ext. Ref. Clock[MHz]	This textbox defines the External Reference Clock frequency in MHz. This parameter has effect only if the Reference Clock is set on External.
Trigger IN	Use this group of parameters to define the Trigger In behaviour (see the table below).
Marker Out	Use this group of parameters to define the Marker Out behaviour (see the table below).

Trigger In Settings

The Trigger In settings parameters are located in the Device Setting page. These parameters are shared by both the instrument channels.



Trigger In Setting	Description
Source	**Button:** The Trigger event is provided to the instrument by the Trigger button on the keyboard or Trigger button on the menu bar or from a Remote Command. **Timer:** The Trigger is internally generated by a Timer. The Timer count is set by Interval [s] textbox. **External:** The Trigger event is generated by the signal applied externally on the BNC connector when it crosses the selected Threshold with the selected Slope. You can select Threshold value and Slope using the relative textbox and slider. ***Note:*** The Trigger buttons and the Trigger from remote command are always active, independently from the selecting Trigger Source.
Interval [s]	Set the timer count. It has effect only when the selecting Source is Timer. The Interval range is from 13.4 us to over 100 s.

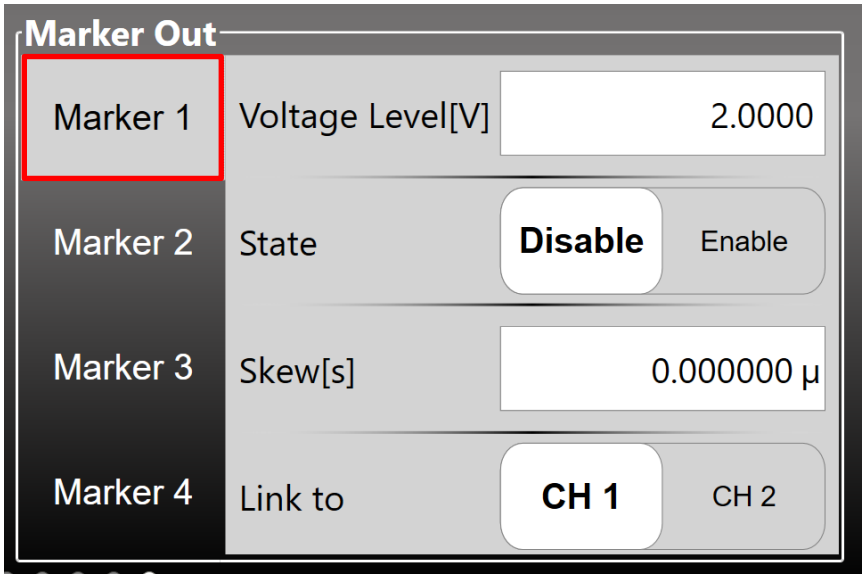
Slope	The Slope can be positive or negative. When positive is selected the trigger detected when the signal on the Trigger In connector crosses the threshold from low to high. The negative option is the opposite. It has effect only when the selecting Source is External.
Threshold [V]	It is the threshold that the external signal applied to the Trigger In connector must cross to issue a Trigger event to the instrument. It has effect only when the selected Source is External.
Impedance	It selects if the Trigger In connector impedance: 1 kOhm or terminated into 50 Ohm.

Marker Out Settings

The Marker Out settings parameters are located in the Device Setting page.

There is a Marker Out BNC connector for each pair of analog outputs; in the figure below you can see the Marker Out settings relative to the eight channels model.

Press the Marker N tab to have access to the Marker Out N parameters.

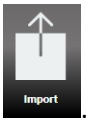


Marker Out Settings: 8 Channels Model

Marker Out Setting	Description
Voltage Level [V]	it sets the Marker high level Voltage. The Low level is fixed to 0V. The Voltage Level range is 1 V to 2.5 V on 50 Ohm load (twice on open load).
State	It enables or disables the Marker Out. When the Marker Out is disabled it is forced to 0 V.
Skew [s]	It sets the delay between the marker and the analog channels. The skew range depends on the Run Mode: in Gated (Burst) it is 0s to 3us; for all others modes it is 0s to 14s.

Link To	The Marker Out frequency is related to the analog channel frequency. Since there is one Marker Out signal for each couple of analog channels, using this parameter it is possible to choose which analog channel is related to the Marker Out N signal. Please note that • Marker Out 1 can be linked to Channel 1 or Channel 2 • Marker Out 2 can be linked to Channel 3 or Channel 4 • Marker Out 3 can be linked to Channel 5 or Channel 6 • Marker Out 4 can be linked to Channel 7 or Channel 8

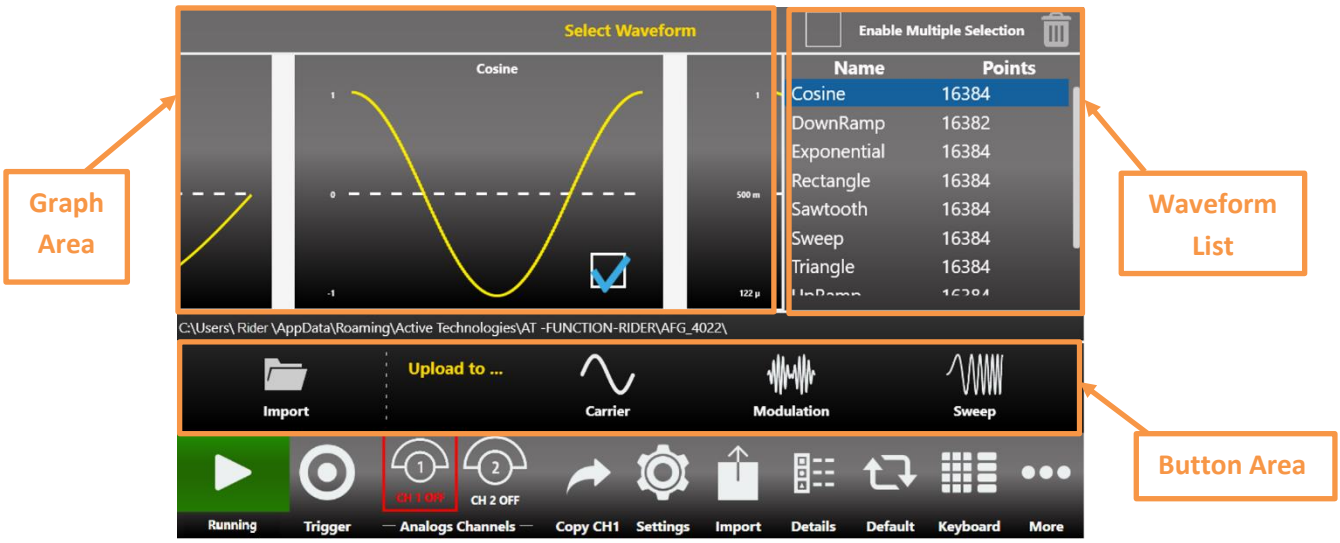
Import from File

The Import page allows to load a waveform from a file and assign it to the Carrier waveform or to the Modulation profile or to the Sweep profile. This page opens by touching the **Import** button 

. Once the waveform has been imported it will be available by choosing "Arbitrary" as waveform type for the Carrier/Modulating/Sweep of the channel. For example, if the "Cosine.txt" is imported and assigned as "Carrier Wave" for the channel 1 than the imported waveform can be selected by choosing "Arbitrary" as carrier waveform type of the channel 1.

To switch between channels, you can touch a channel button 

or press "CHANNEL SEL." button on the keyboard.



Import File Specifications	Description
Accepted Formats	.txt (Tab Separated text), .csv(Comma Separated Value), .trc (LeCroy Digital oscilloscope)
Length Range	Between 2 and 16384 samples. The instrument memory is limited at 16 k sample (16384) for each arbitrary waveform If a longer waveform is imported it will be resampled to match the maximum length.
Offset and Amplitude Range	When a waveform is imported from a file its original amplitude and offset are lost because the waveform in normalized during the importing process. Anyway the amplitude and offset of the normalized waveform can be redefined as for any predefined waveforms.

The Import page is divided into three areas: the **Graph Area**, the **Waveform List** and the **Button Area**. Below a detailed description of these areas is provided.

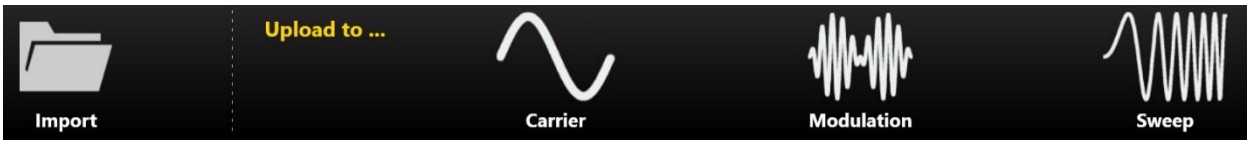
Graph Area: shows preview of the waveform. A waveform is selected by touching the checkbox in the graph. The selected waveform than can be assigned to the Carrier or Modulation Wave or Sweep Profile of the channel by touching one of the 3 buttons (**Carrier** button, **Modulation** button, **Sweep** button) in the Button Area located on the right side of the "Upload to…" label.

Waveform List: This section contains a list of all the predefined and imported waveforms.

- The **Trash Bin**  deletes the selected waveforms. It is not possible to delete a predefined waveform.
- The **Multiple Select Enable** 

checkbox enables the selection of multiple waveforms to be deleted. If multiple waveforms are selected for import only the first one is imported.

Button Area: It is composed by 4 buttons:



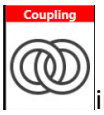
- **Import:** opens the file system browser to search and load a waveform. The loaded waveform is added to the Waveform List.
- **Carrier: a**ssigns the selected waveform to the "Arbitrary" Carrier of the current channel.
- **Modulation:** assigns the selected waveform to the "Arbitrary" Modulation of the current channel.
- **Sweep:** assigns the selected waveform to the "Arbitrary" Sweep profile of the current channel.

Example: how to modulate a carrier with an imported waveform in Burst Run Mode. Use the following steps:

1. Press the Import button, select the import waveform from predefined list or from preferred folder and upload it to Modulation
2. Set Run Mode to "Modulation"
3. In the Modulation tab press the Shape button and select "Arbitrary"
4. Set the Modulation parameters as preferred
5. Press Run/Stop button to start the generation.

Channel Coupling

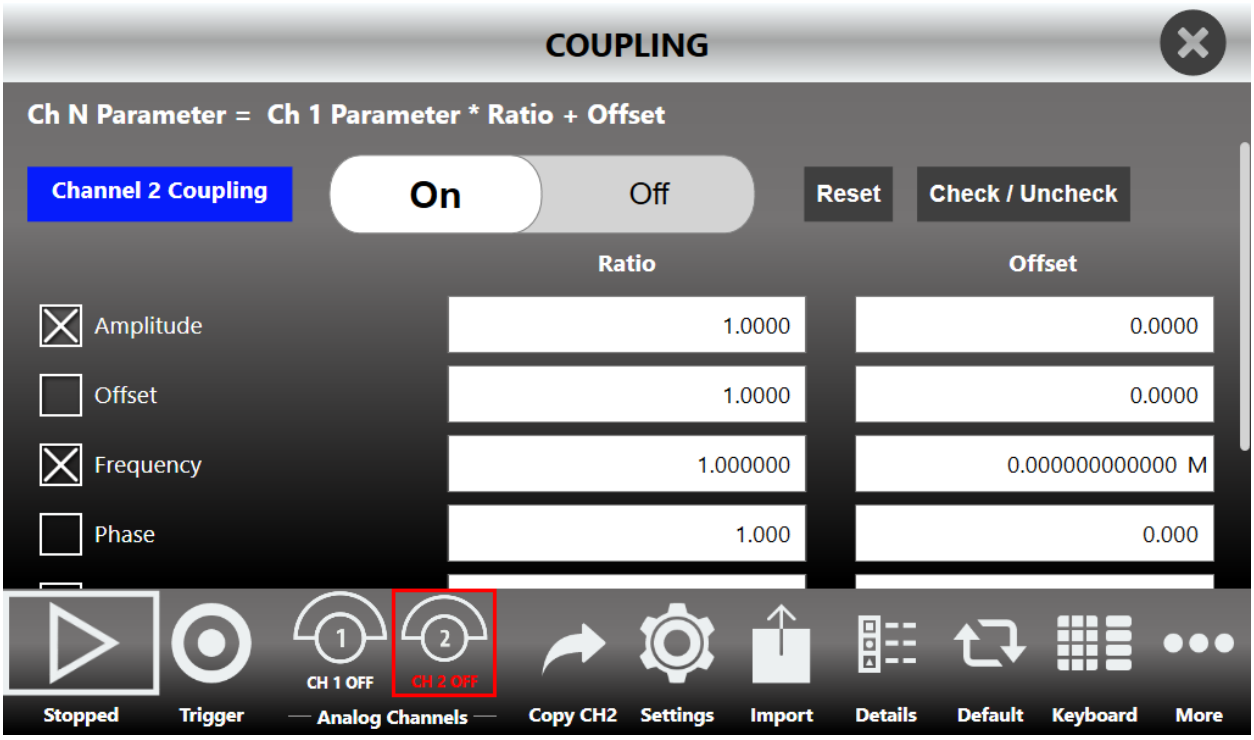
In electronics design and testing, you sometimes want to have two synchronized clock signals that are related by a frequency ratio; one clock needs to maintain a certain frequency ratio with the other clock. Or perhaps, you want to simulate an amplifier with an offset; the amplifier output needs to maintain a defined offset from the input amplitude.

Press this button 

in the More menu to open the Channel Coupling page.
Channel 1 parameters are the reference parameters.
The Channel Coupling section allows you to specify that Channel N parameter like frequency, amplitude, offset etc. is related to Channel 1 parameter by a ratio (multiplying) and an offset (adding).

The equation of the channel coupling is the following:
Ch[N] Parameter = CH1 Parameter*Ratio + Offset

The coupled parameters will change in real time following the changes of Channel 1 parameters to maintain the specified ratio **and** offset. You can couple multiple parameters together.



- Swipe up or down to select which channel to couple to the Channel 1.
- **ON/OFF button**: enables or disables the channel coupling.
- **Reset**: resets the Ratio and Offset parameters to their default values (1 and 0).
- **Check/Uncheck**: selects/deselects all the available coupling parameters on the selected channel.

- **Check All /Uncheck All**: selects/deselects all the available coupling parameters on all channels (4 channel and 8 channel models only).
- Press the parameter checkbox to select/deselect the single coupling parameter.
- When waveforms have different carrier shapes, only the common parameters will be available on this page.
- When a change of a parameter of Channel 1 causes an out of range error on the coupled channel, the application will limit the parameters value to the latest valid ones.
- When a change of the Ratio or Offset value causes an out of range in the coupled channels, the Ratio and Offset values will be set automatically to the previous valid one.
- The application may need to recalculate new parameter ranges due to a change in the user interface (such as carrier waveform type, other waveform parameters, run mode etc.).
  In these cases, if the parameter is coupled but the Ratio and the Offset no longer meet the coupling condition, the parameter coupling will be automatically disabled.

  For example, select a Sine Waveform on CH1 and CH2, set a frequency of 300 MHz on CH1 and coupling frequency with Ratio 1 and Offset 0. The result will be a Sine Waveform on CH2 with a frequency of 300 MHz.
  If you change on the CH2 the carrier waveform from Sine to Square, the Frequency range will be recalculated (the Square cannot reach 300 MHz of maximum frequency) and the frequency coupling will be disabled.

- If you press the **Copy Ch N Button** while the coupling channel is active, only the parameters that are not coupled will be copied to the other channels.

***Example**:* Frequency Coupling

1. Suppose that the channel 1 has a frequency of 1 MHz.
2. Set the Channel 2 coupling button to ON and the coupling parameters will appear
3. Check the Frequency parameter
4. Set Ratio to 2.5 and Offset to 0
5. The Channel 2 frequency will be 2.5 MHz

Now the channel 1 and the channel 2 frequency parameters are coupled and on the Channel 2 Carrier page, the Frequency parameter textbox will be disabled.
On the contrary, the Channel 1 frequency parameter will be enabled and if you then change the frequency to 5 MHz, the channel 2 frequency will automatically change to 12.5 MHz.

Now if you set the Offset to 1 MHz the coupling equation will be:

CH2 Frequency = Channel1 Frequency*2.5 + 1 MHz and changing channel 1's frequency will change

channel 2's frequency to maintain the specified ratio and offset in real time: if you set Channel 1 frequency to 1 MHz you will get 3.5 MHz on channel 2.

***Example**:* Amplitude & Offset Coupling

1. Set the Channel 2 coupling button to ON and the coupling parameters will appear
2. Check the Amplitude and the Offset parameter
3. Set Amplitude Ratio to 1 and Offset to 0
4. Set Offset Ratio to 1 and Offset to 0

This coupling configuration ensures that the amplitude and offset parameters on both channels are the same: if you move the amplitude or offset parameter on Channel 1 you will see that the amplitude and offset on Channel 2 will change at the same time of the same quantity.

Certifications

Berkeley Nucleonics Corporation certifies compliance to the following standards as of the time of publication. Please see the EC Declaration of Conformity document shipped with your product for current certifications.

EMC Compliance

EC DECLARATION OF CONFORMITY - EMC

The instrument meets intent of EC Directive 2014/30/EU for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications listed in the Official Journal of the European Communities:

EN 61326-1:2013, EN 61326-2-1:2013 EMC requirements for electrical equipment for measurement, control, and laboratory use. [1]

Electromagnetic Emissions:

EN 55011:2010, Radiated and Conducted Emissions Group 1, Class A [2] [3]

EN 61000-3-2/A2:2009 Harmonic Current Emissions, Class A

EN 61000-3-3:2008 Voltage Fluctuations and Flickers, Pst = 1

Electromagnetic Immunity:

EN 61000-4-2:2009 Electrostatic Discharge, 4 kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [4]

EN 61000-4-3/A2:2010 RF Radiated Electromagnetic Field, 3 V/m, 80-1000 MHz; 3 V/m, 1400 MHz - 2 GHz; 1 V/m, 2 GHz - 2.7 GHz

EN 61000-4-4/A1:2010 Electrical Fast Transient/Burst, 1 kV on power supply lines, 0.5 kV on I/O signal data and control lines [4]

EN 61000-4-5:2006 Power Line Surge, 1 kV AC Mains, L-N, L-PE, N-PE [4]

EN 61000-4-6:2009 RF Conducted Electromagnetic Field, 3 Vrms, 0.15 MHz - 80 MHz

EN 61000-4-11:2004 Mains Dips and Interruptions, 0%/1 cycle, 70%/25 cycles, 0%/250 cycles [4] [5]

[1] To ensure compliance with all applicable EMC standards, use high-quality shielded interface cables.

[2] Emissions which exceed the levels required by this standard may occur when the instrument is connected to a test object.

[3] This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

[4] Meets Performance Criteria “B” limits of the respective standard: during the disturbance, product undergoes a temporary degradation or loss of function or performance which is self-recoverable.

[5] Performance Criteria “C” applied for 70%/25

Safety Compliance

EC DECLARATION OF CONFORMITY – LOW VOLTAGE

The instrument meets intent of EC Directive 2014/35/EU for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

EN 61010-2:030:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits

The design of the instrument has been verified to conform to the following limits put forth by these standards:

• Mains Supply Connector: Overvoltage Category II, instrument intended to be supplied from the building wiring at utilization points (socket outlets and similar).
• Measuring Circuit Terminals: No rated measurement category. Terminals not intended to be connected directly to the mains supply.
• Unit: Pollution Degree 2, operating environment where normally only dry, non-conductive pollution occurs. Temporary conductivity caused by condensation should be expected.

Environmental Compliance

END-OF-LIFE HANDLING

The instrument is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2012/19/EU and 2013/56/EU on Waste Electrical and Electronic Equipment (WEEE) and Batteries.
The instrument is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles.

RESTRICTION OF HAZARDOUS SUBSTANCES (RoHS)

This instrument and its accessories conform to the 2011/65/EU RoHS2 Directive.