TELEDYNE TEST TOOLS

Everywhereyoulook™

Operator's Manual

T3AWG2152

Simple AFG

Rev. 2.1

Summary

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 T3AWG2152 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 T3AWG2152 offers premium signal integrity thanks to the 16-bit resolution DAC. The output signal can reach up to 6Volts pk-pk into 50 Ohm single ended. The T3AWG2152can generate signals up to 150MHz.
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 T3AWG2152 package includes the following:

- T3AWG2152 Arbitrary Waveform Generator equipment
- Power Cord
- Performance/Calibration Certificate
- CE certificate

Recommended Accessories T3AWG2152 and T3AWG2152-D

Item	Description
T3AWG3K-RACKMOUNT	Rack Mount Kit

Recommended Accessories T3AWG2152-D only

Item	Description
T3AWG3-8DIG-SMA	LVDS to SMA digital adapter cable

Mechanical Characteristics

Net Weight	6.5kg
Net Weight with Package	7 kg

Overall Dimensions	Height: 143 mm Width: 362 mm Depth: 258 mm

Key features

The following list describes some of the key features of the T3AWG2152:

- High resolution, high sampling rate: 16 Bits, 600MS/s
- Best output frequency vs amplitude trade off: up to 150MHz, up to 6V voltage window
- 2 operating modes in the same instruments: Function Generator and Arbitrary Waveform Generator
- Very long memory: up to 128MSample per channel
- Mixed signal generation: 2 analog outputs + 8 digital outputs (T3AWG2152-D model only)
- Simple touch screen user interface to create complex waveforms scenarios just in few screen touches
- Large 7", 1024x600 capacitive touch LCD
- Touchscreen or Keypad data entering
- Windows 10 operating system
- USB and LAN interfaces
- Compact case size with the possibility of rack mounting in 3U

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 240VAC ±10% @ 45-66 Hz
Power Consumption	Maximum: 100W

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 if at the previous power off the instrument was working in AFG mode.

  Alternatively push the AFG icon  to launch the application from the desktop or push the Switch To button  to switch in AFG mode from another application.

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 ±15Vpk to Trigger Input connector. The instrument may be damaged.

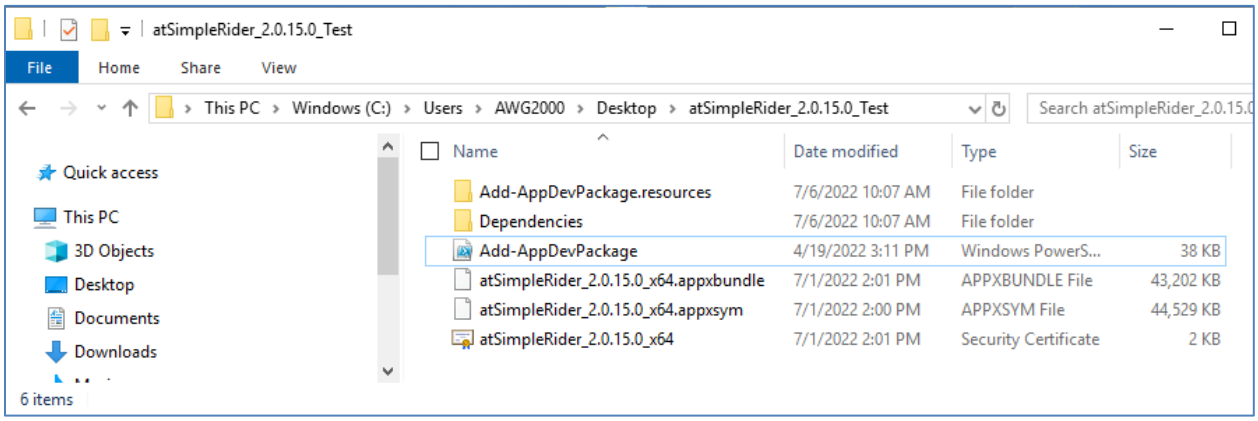
Obtaining the Latest Version Releases

The latest release of the software may not be installed on your instrument. The latest version could be found on Teledyne LeCroy website (www.teledynelecroy.com) in the support area.

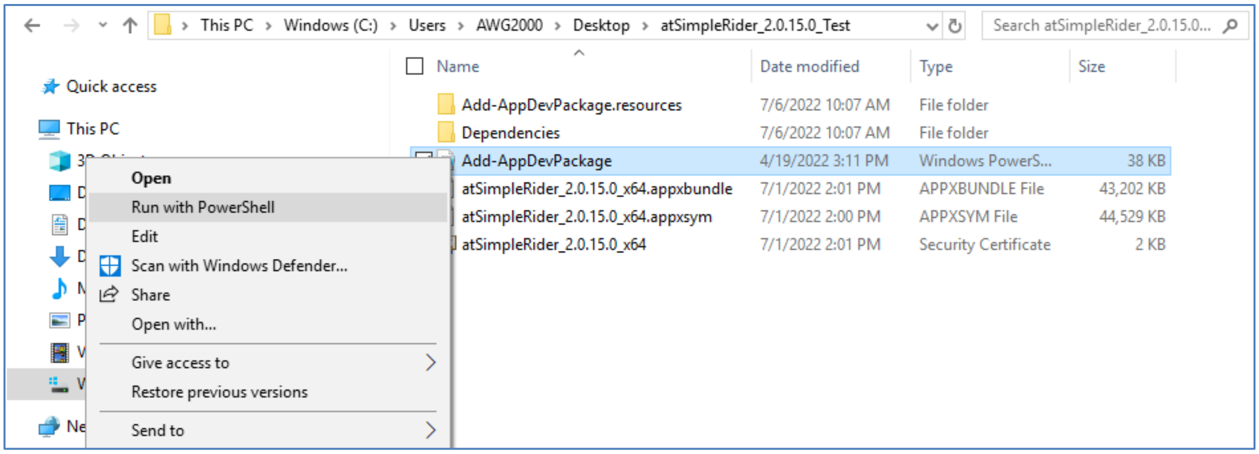
Install Simple AFG Application

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

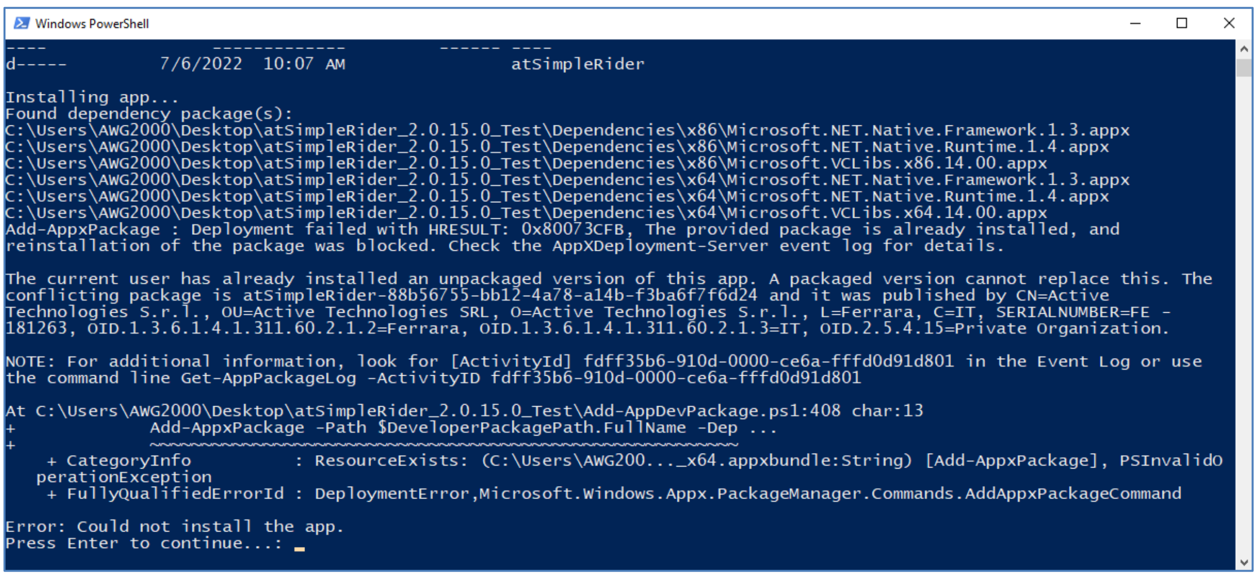
1. Download the atSimpleRider setup package from Teledyne LeCroy website and decompress it to instrument's local disk.



2. Right click on the "Add-AppDevPackage.ps1" file and select **Run with PowerShell** to start the installation.

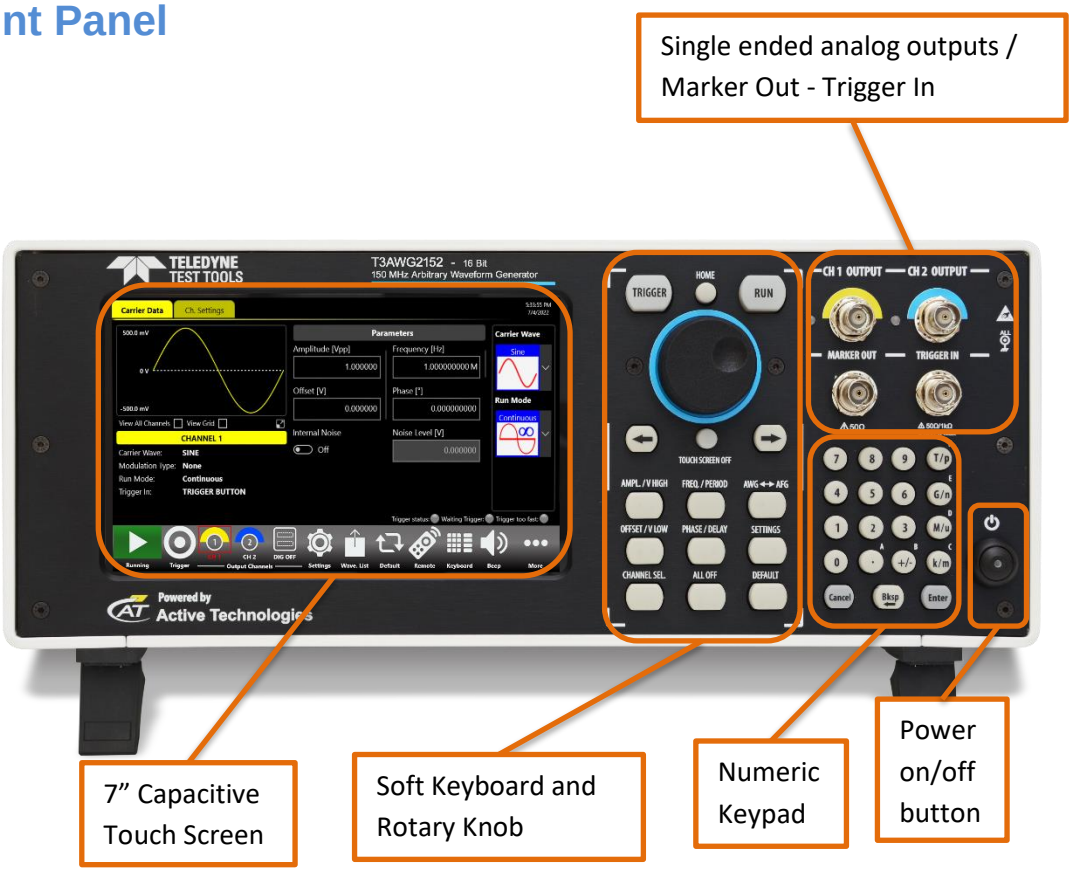


3. When the application has been installed, press the “Enter” button to continue.



Instrument Overview

Front Panel



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

Analog Outputs

The T3AWG2152 instrument has two analog output channels, each one is single-ended and the connector type is a standard BNC.

Marker Output Connector

The Marker Out BNC connector is located on the front panel in the T3AWG2152. See "Auxiliary Channels" section form more information.

Trigger In Connector

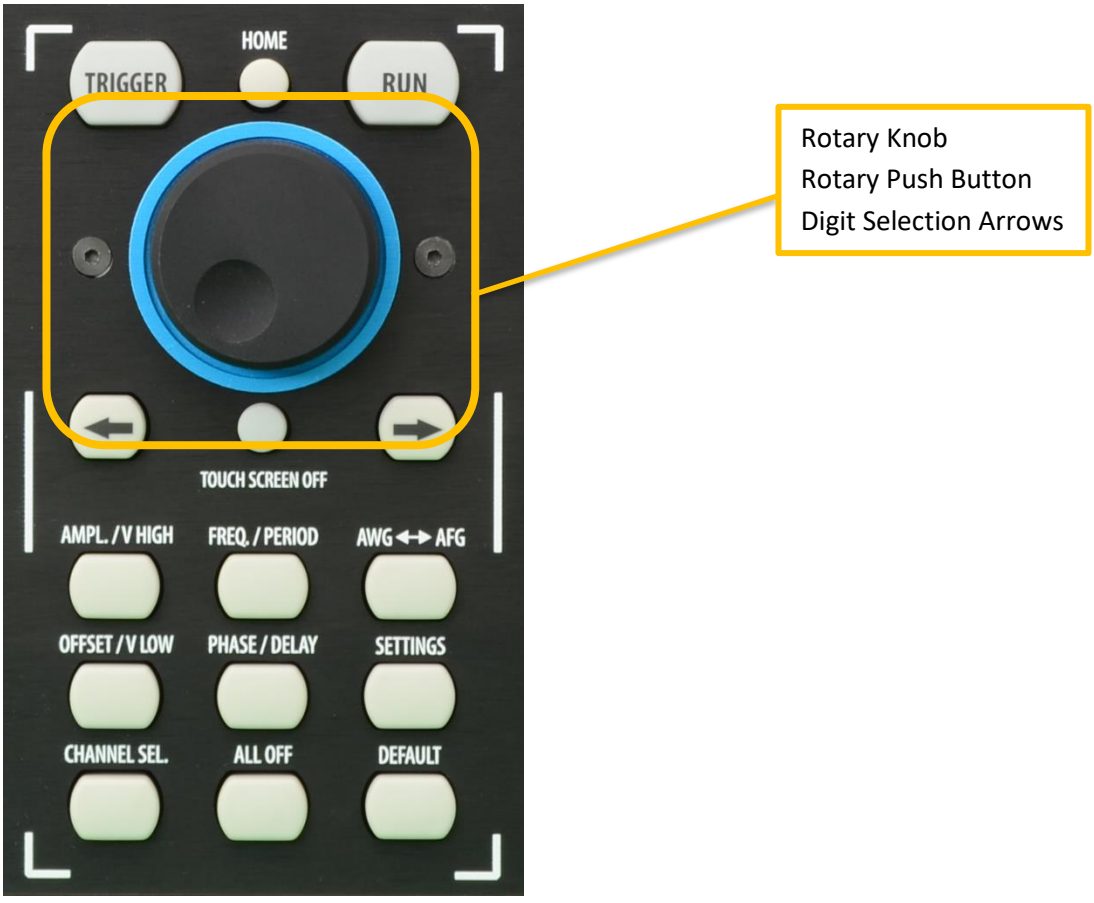
The Trigger In BNC connector is located on the front panel in the T3AWG2152. See "Auxiliary Channels" section form more information.

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 left. 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 shown 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.

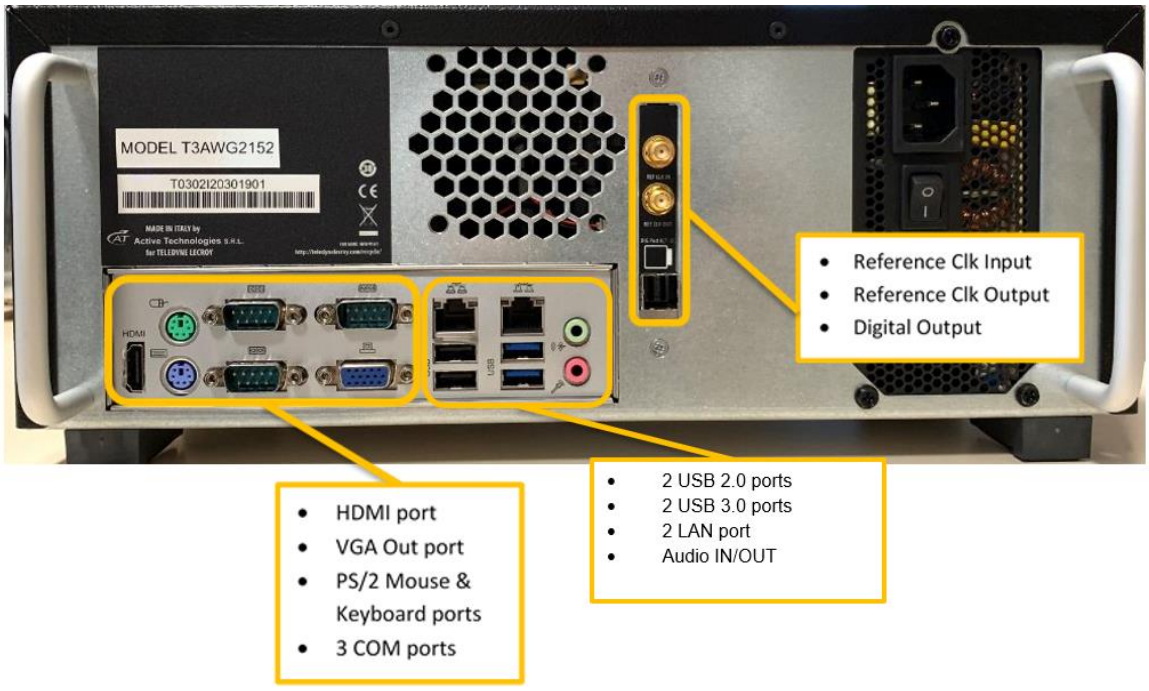
When you select a parameter on the user interface, if you press a Unit Measure Range button it will automatically update the available range allowed for that parameter.

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

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



Reference Clock Input Connector

The T3AWG2152 instrument can use an external clock source to generate the sampling clock frequency. The connector type is a SMA. See "Auxiliary Channels" section form more information.

Reference Clock Output Connector

This connector outputs the internal 10MHz reference clock used to synthesize the DAC sampling clock. The connector type is a SMA. See "Auxiliary Channels" section form more information.

Digital Output connector

This connector is not used by AFG application.

Introduction

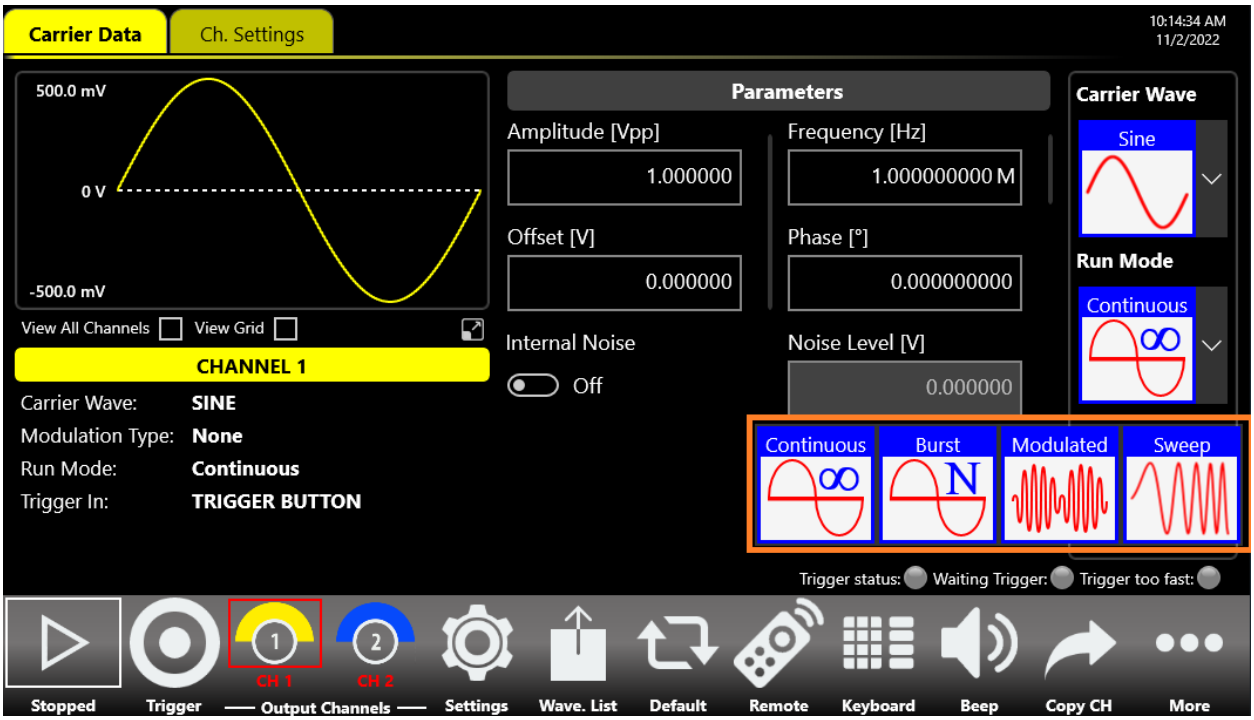
The T3AWG2152 instrument, when used in Arbitrary Function Generator mode, has two independent analog channels. Each channel can generate a predefined waveform, or a user defined waveform loaded from a file.

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.

Run Mode

The instrument can be used in different run modes, each one providing different characteristics:

- **Continuous:** the selected waveform is generated continuously until the RUN/STOP button is pressed.
- **Modulation:** allows to select among different type of modulation. The modulating source can be a predefined waveform or a user defined waveform loaded from a file.
- **Sweep:** changes the frequency during time following a defined profile. It is possible to choose different sweep profiles: linear, logarithmic, upstairs and user defined.
- **Burst:** generates a defined or infinite number of waveform periods starting after the reception of a trigger signal. The gated mode runs the selected waveform only when the trigger is true.



Simple AFG Software

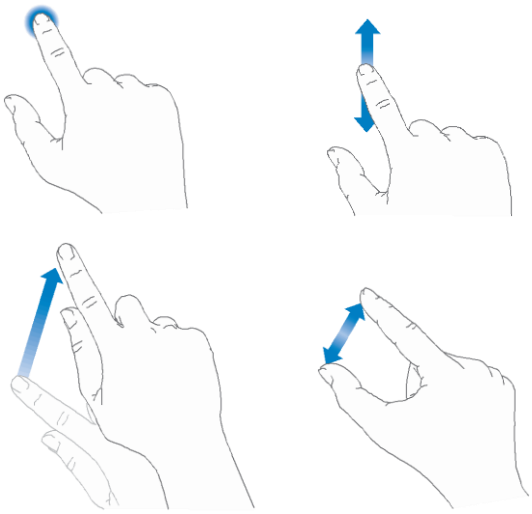
The T3AWG2152 instrument includes a 7" capacitive touch screen and an easy touch user interface based on a Microsoft Windows 10 platform.
You can control instrument operations using one or all of the following entering methods:

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

Simple AFG Touch UI

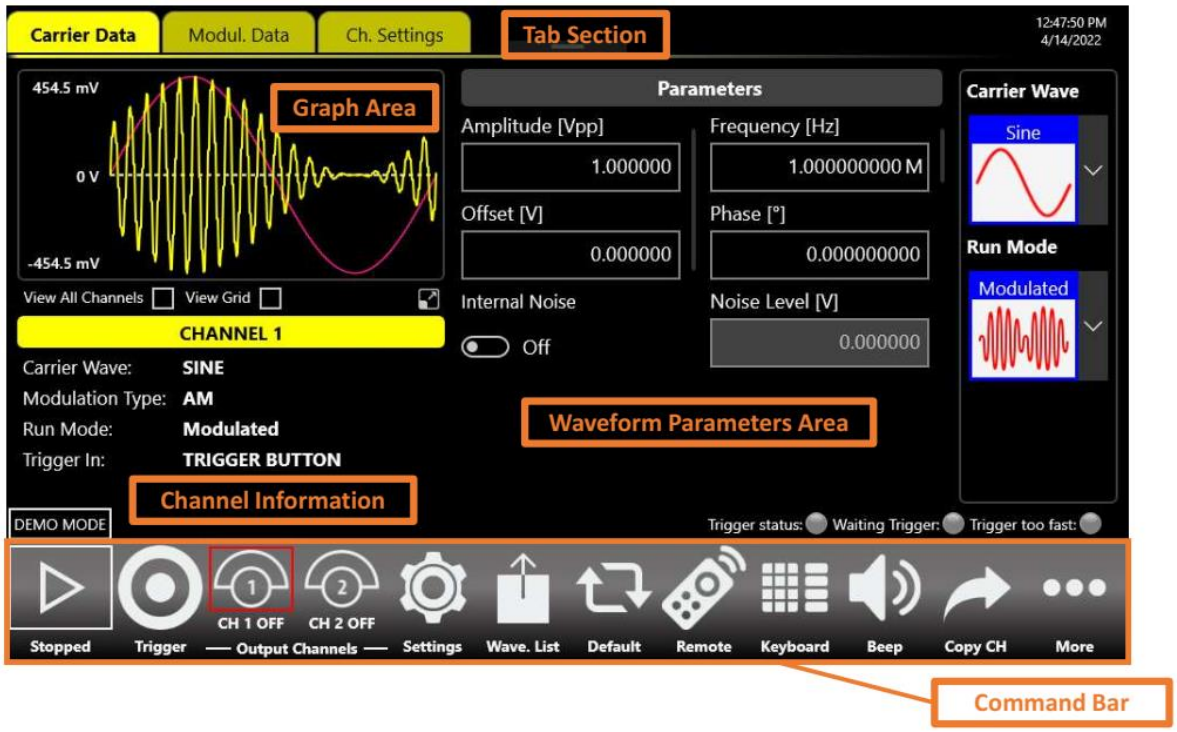
Simple AFG UI is designed for touch to drive simplicity in operating with an Arbitrary Waveform Generator, by using the today's modern technique, used on Tablet or smart phones, available in capacitive touch-screen displays.
All the important instrument controls and settings are always one touch away:

- 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.

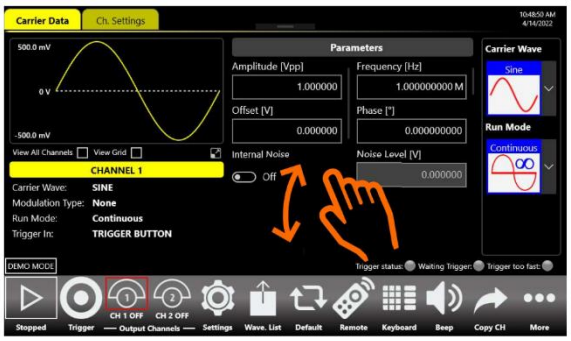


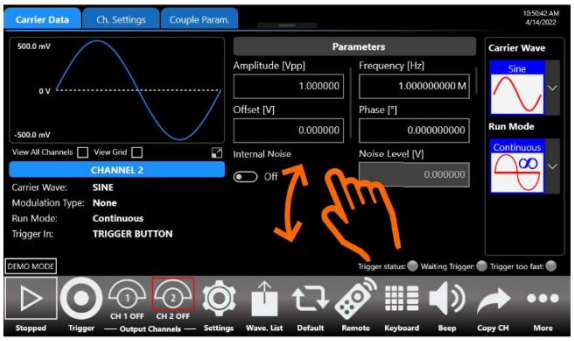
AFG user interface consists of four main elements:

- **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 summarizes 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.

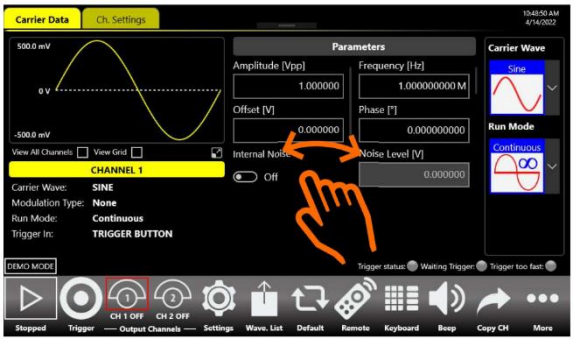
As mentioned, the display is 7" capacitive touch screen display and you can use the gestures like in a mobile phone:

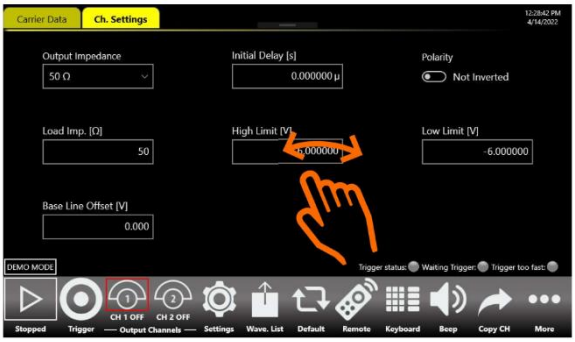
If you use the Swipe Up or Down gesture over the Command Bar Area you can switch between the adjacent channels.





If you use the Swipe Left or Right gesture over the Command Bar Area you can switch between the Tab Section.

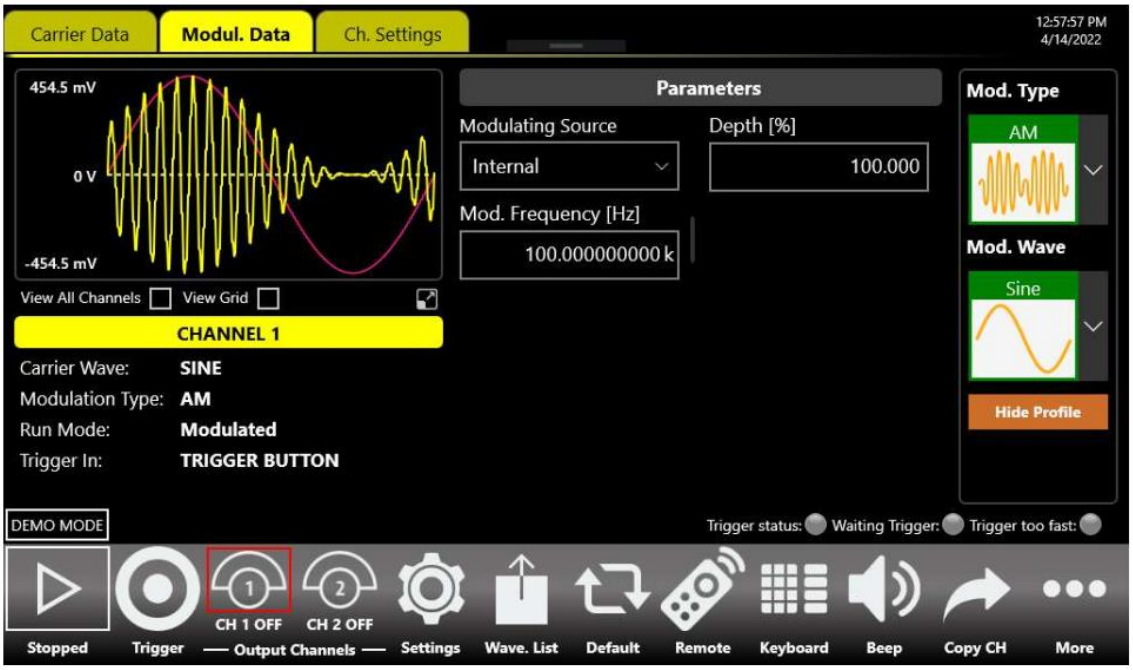




Waveform Parameters Area

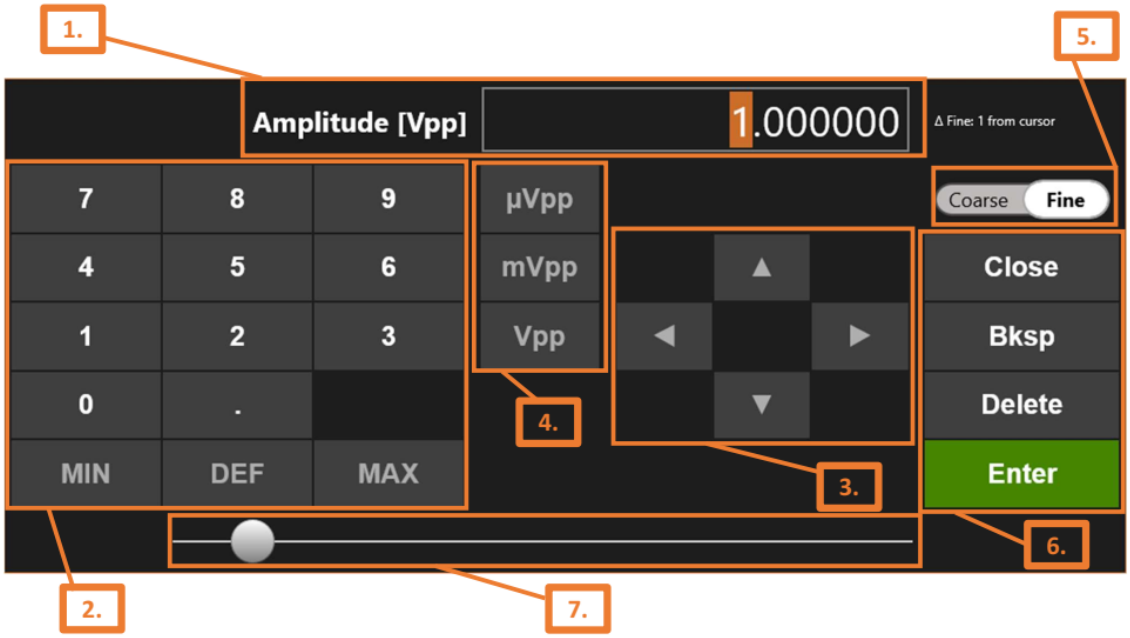
This section is composed by two tabs: the **Carrier** tab and the **Secondary** tab.

- 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.

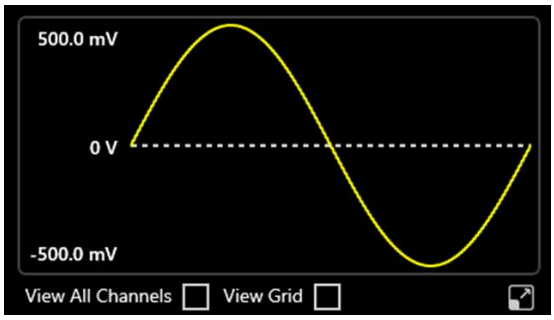
Below there is a description of the keypad items:



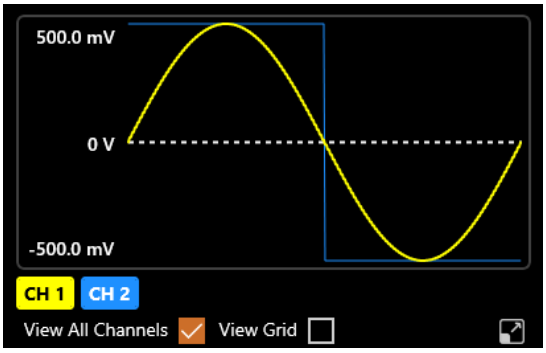
1. **Parameter Name and Value:** This area of the virtual keyboard displays the parameter name, value and unit of measure.
2. **Numeric Keypad:** this area contains the keys to edit the number that will be displayed in the area 1. The [+/-] key will toggle the sign of the number being entered and can 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

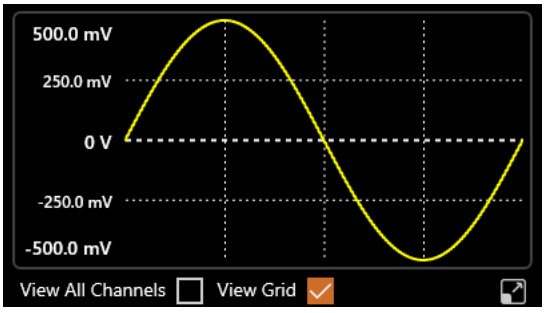
The graph area displays the Output channel waveform with a vertical legend that shows the minimum and maximum voltage levels and the offset.



When **View All Channels** is checked the graph shows all channels graphs overlapped. The vertical scale is referred to the most amplitude from the channels. Furthermore, you can decide to View only the channels that you want tapping on coloured buttons under the graph.

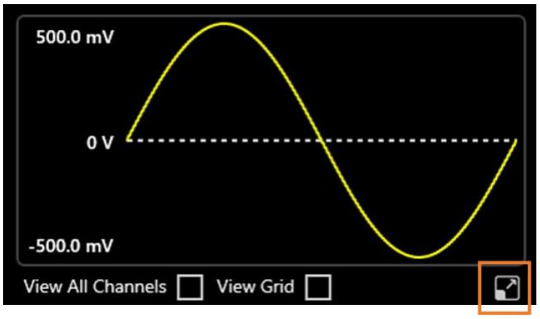


Checking **View Grid**, you can view further horizontal e vertical line with an others value of amplitude.

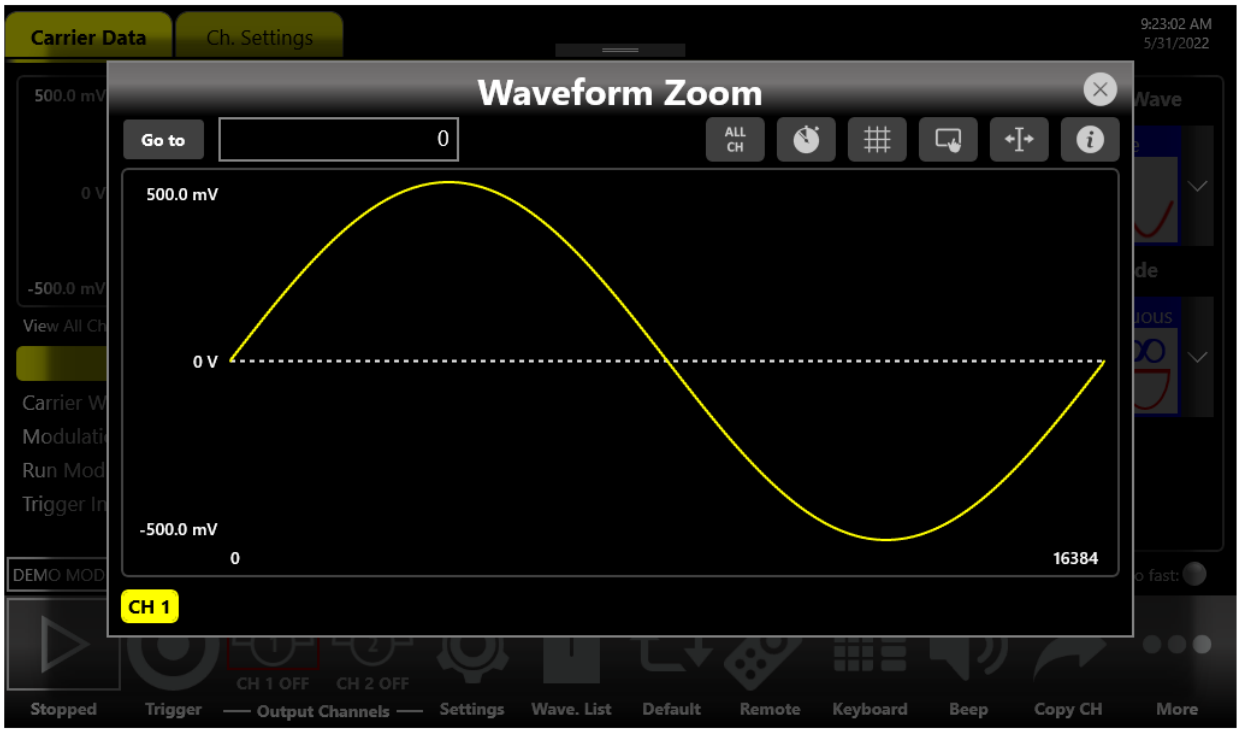


Zoom graph

Tapping on the highlighted button below, you can open another panel with more functions that expands the functionality of the graph.

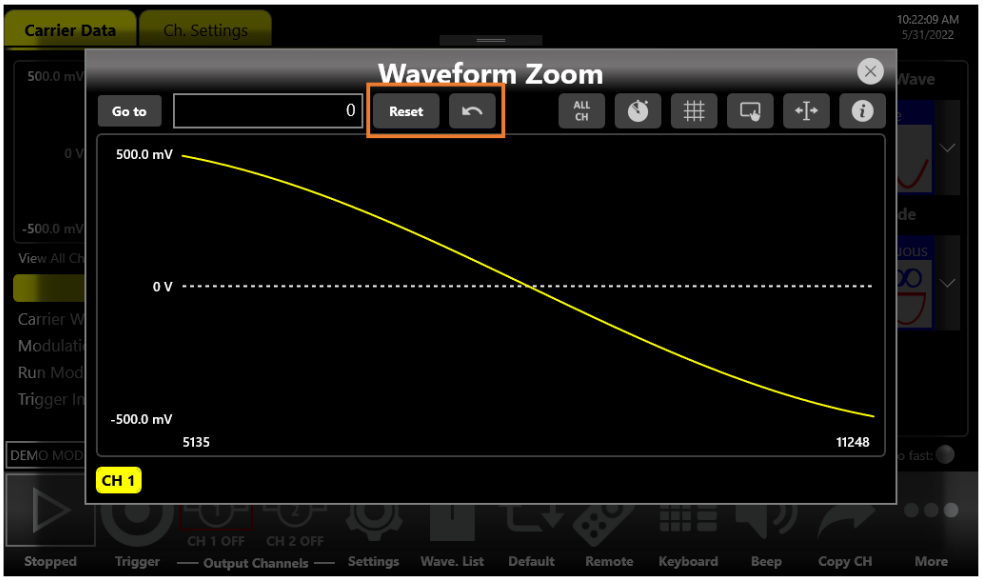


In particular, this new panel give you the possibility to Zoom into area of the graph with different modality.

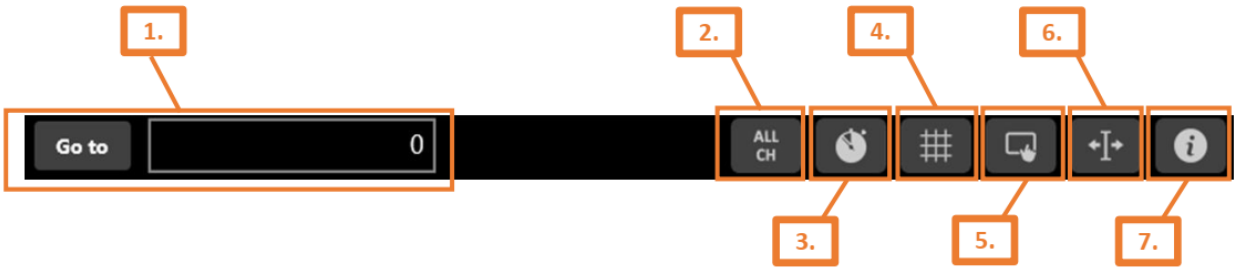


As you can see in the previous figure, the panel is divided in two areas, on top there is the command bar while the rest of the area is employed by the graph. The Waveforms on the graph can be represented with Samples Scale or Times Scale, you can zoom into area using two fingers as multitouch to zoom in e

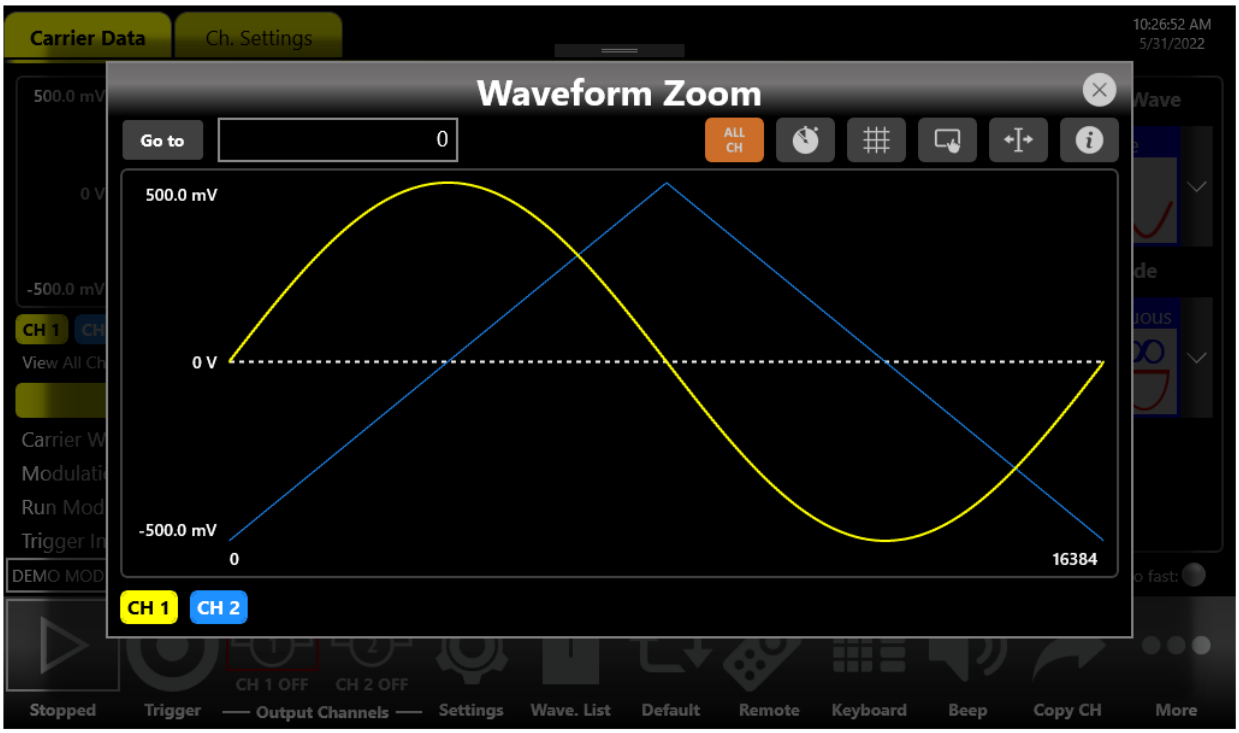
out, one finger to translate window zoom left or right, otherwise you can select a rectangle area if the correct button is enabled. Every time that you Zoom In, will be add to a stack the previous value of Zoom and will be show two buttons, "Reset" and "Back" in the command bar, these buttons permit you to come back the previous values or set the default value state of the waveform with zoom at 100%.



Below the description of the command bar:

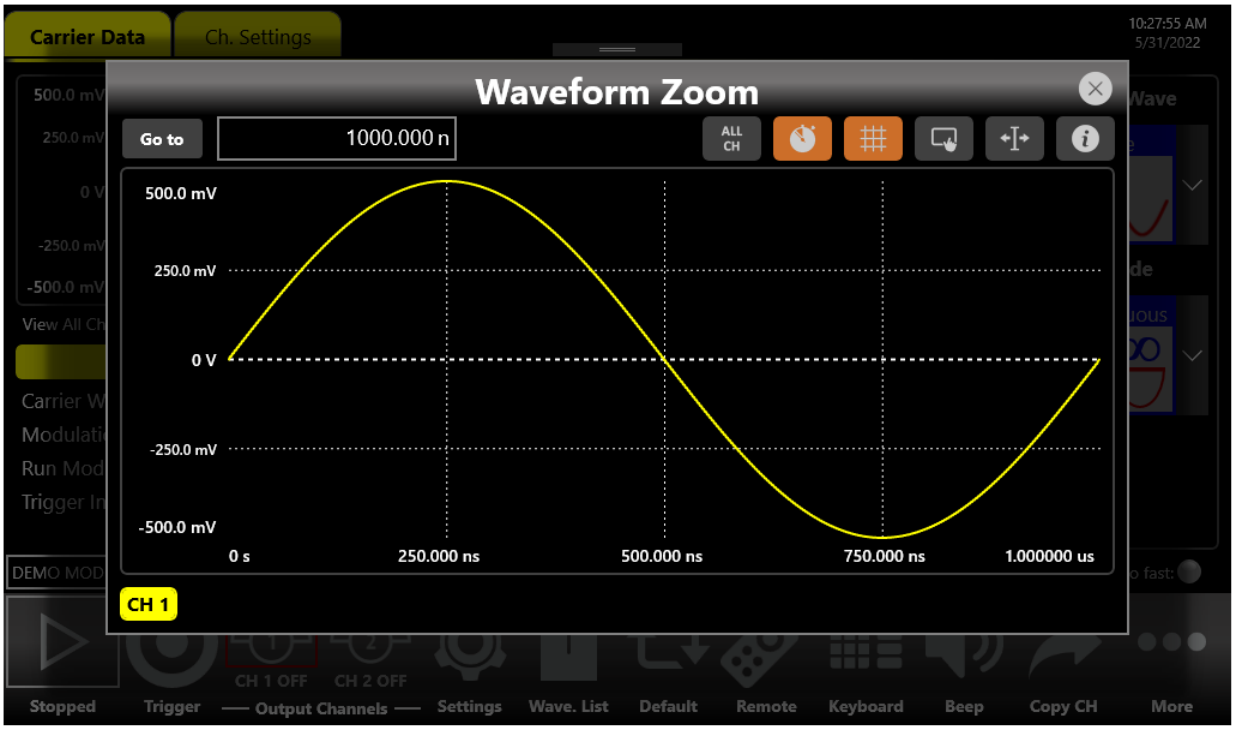


1. **Go To**: If you are in Samples Scale, you can insert in the textbox the sample that you want to go and the graph will move the actual window zoom to that sample, at same way if you are in Times Scale, but you must insert a time value. The range of the Samples Scale is 0 to 16384, while the Time Range depends of the values set on the Channel Data.
2. **ALL CH**: enable or disable the View All Channels.

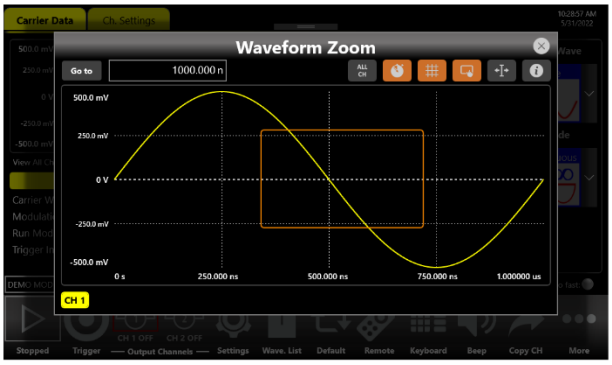


You can decide to View only the channels that you want tapping on coloured buttons under the graph.

3. **Times Scale**: if enabled the Times Scale is visible, otherwise Samples Scale by default.
4. **View Grid**: if enabled, you can view further horizontal e vertical line with an others value of amplitude and Samples/Times.

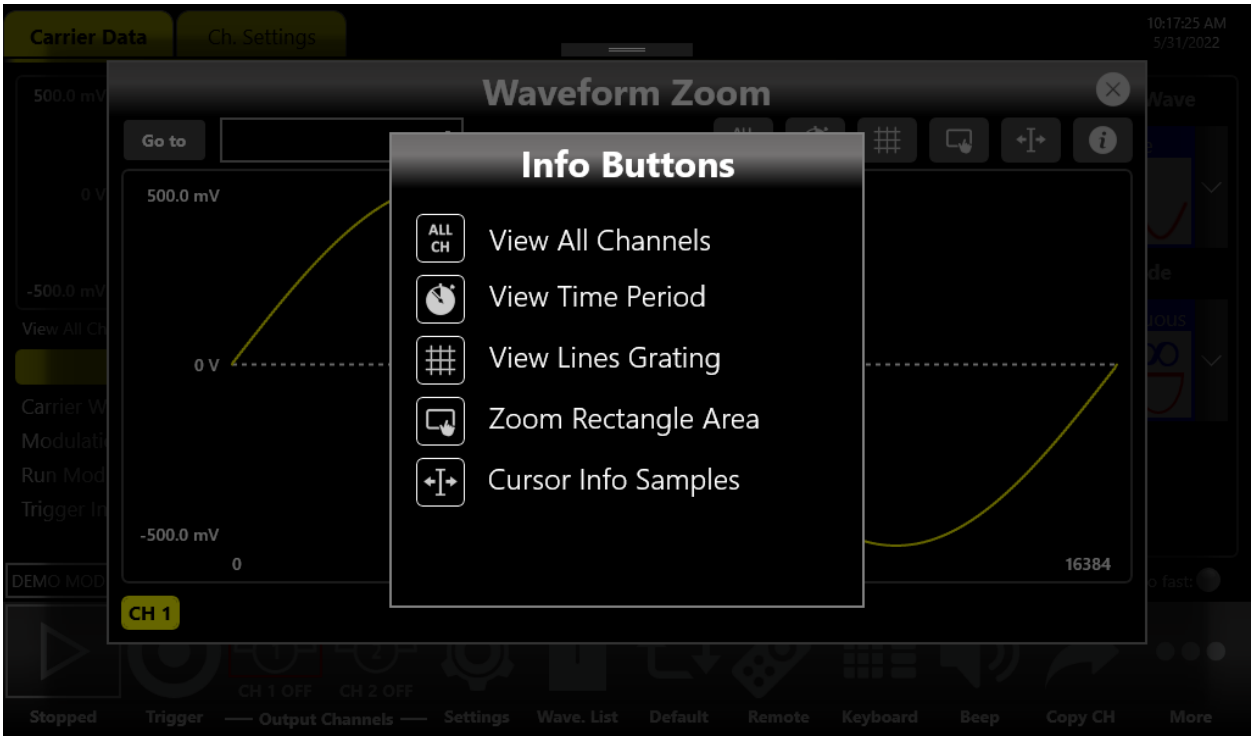


5. **Zoom Rect Area**: if enabled, the multitouch and the translation left/right will be disabled, you can holding down and then release to select an area to Zoom.



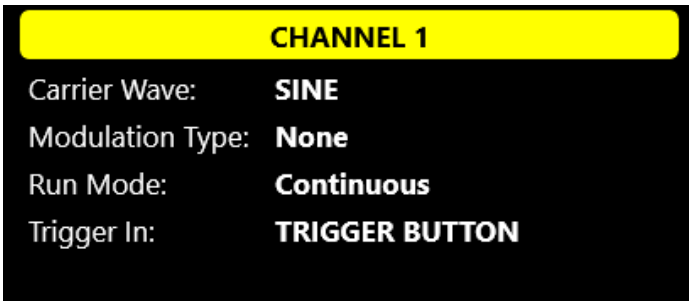
6. **Cursor**: enable this button if you want to see a cursor on the graph that visualize the values (Sample/Time and Amplitude) of the waveforms in the position set.

7. **Info Buttons**: tap to open a panel where they are indicated a lite description of the buttons just listed.



Channel Information

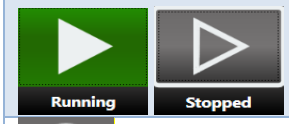
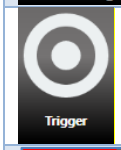
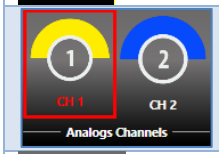
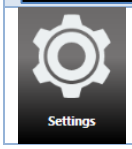
This area displays the channel name and a list of all the main current channel settings: the selected waveform type, the Modulation / Sweep / Burst mode, the Generation mode, the channel status and the Trigger Source.

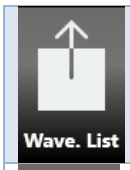
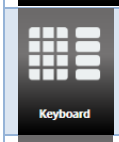


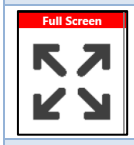
Command Bar Area

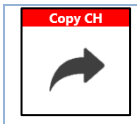
The command bar contains several touch buttons to control the instrument. Below a detailed description of this bar is provided.

Please note that the position of the buttons described below may change due to instrument different model.

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 or CH2 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.
	**Settings Button** – Use this button to open the output channel Settings and device Settings. (For more information, please refer to the relative section).

	**Wave. List 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).
	**Default** – Use this button to restore the default value of all parameters of the instrument.
	**Numeric Keyboard Button** – Use this button to enable or disable the virtual numeric keyboard.
	**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.
	**Full/Float Button** – press this button to maximize or reduce the application screen; in this way you can access to Windows OS.
	**Load From Button** – Use this button to load a configuration file. (For more information, please refer to the relative section).
	**Save As** – Use this button to Save the Current configuration into an existing one or create a new one. (For more information, please refer to the relative section).
	**Export –** Use this button to export the current configuration. (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.
	**Change Application** – Use this button to switch from AFG to TrueArb application.

	**Copy Ch1** (Ch2) **Button** –This button copies all the channel settings to the other channel. When you press the button a dialogue window appears to Confirm or Cancel the operation. You can copy the channel 1 into channel 2 or channel 2 into channel 1 depending on the current selecting one.
	**About Button** – Use this button to check the credits, the software and firmware release number and the instrument serial number.
	**Help Button –** Use this button to open the User Manual.
	**Calibration button –** Use this button to enter the Calibration and Diagnostic page. (For more information, please refer to the relative section).
	**Waveform Editor –** Use this button to open the Waveform Editor software. (For more information, please refer to the Waveform Editor User Manual).
	**License button –** Use this button to enter the License setup page. (For more information, please refer to the relative section).

Input / Output Channels

The T3AWG2152 instrument has two independent analog channels. Each channel is a single-ended output and it is provided on a BNC connector located on the front instrument panel (CH 1 OUTPUT, CH 2 OUTPUT).
The Marker Out is a digital output signal provided on a BNC connector located on the front instrument panel (MARKER OUT). It is possible to choose in the software the channel it is related.
The Trigger In is an input signal provided on a BNC connector located on the front instrument panel (TRIGGER IN). The Trigger In is a common input source for all the 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.

Main 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]** or in the format **Amplitude [Vrms] / Offset[V]** or in the format **Amplitude[dBm] / Offset[V]**.
The output signal levels displayed by the Simple AFG UI text are calculated for the specified source and load impedances that by default are 50Ohm. To change the expected load and source impedance please refer to the Channel Settings.

Amplitude

The amplitude can be represented in three different formats that can be selected by opening the menu beside the amplitude label:

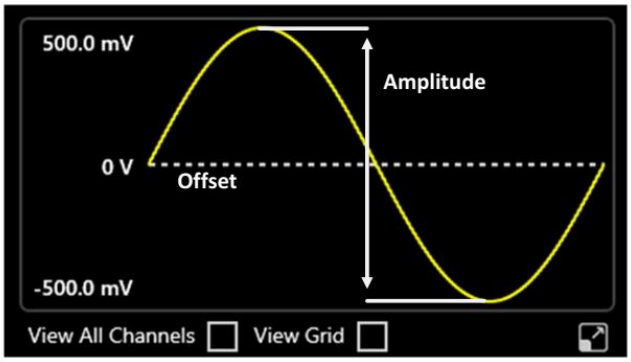
- **Vpp (Peak to Peak Voltage):** it is the difference between the highest and lowest level of the waveform.
- **Vrms (Root Mean Square Voltage):** it is the rms value of the waveform.
- **dBm:** it is the power transferred to the load expressed in dBmW (this representation is available only for sine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

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

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

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

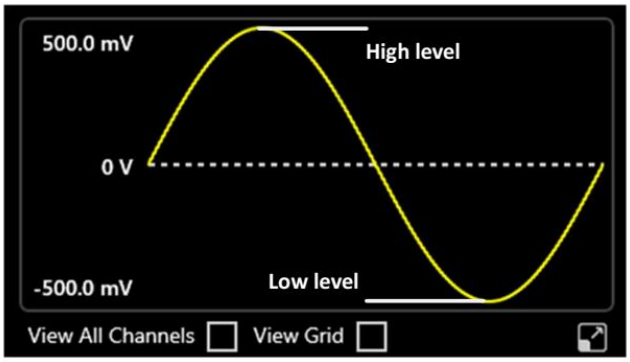


High Level [V]

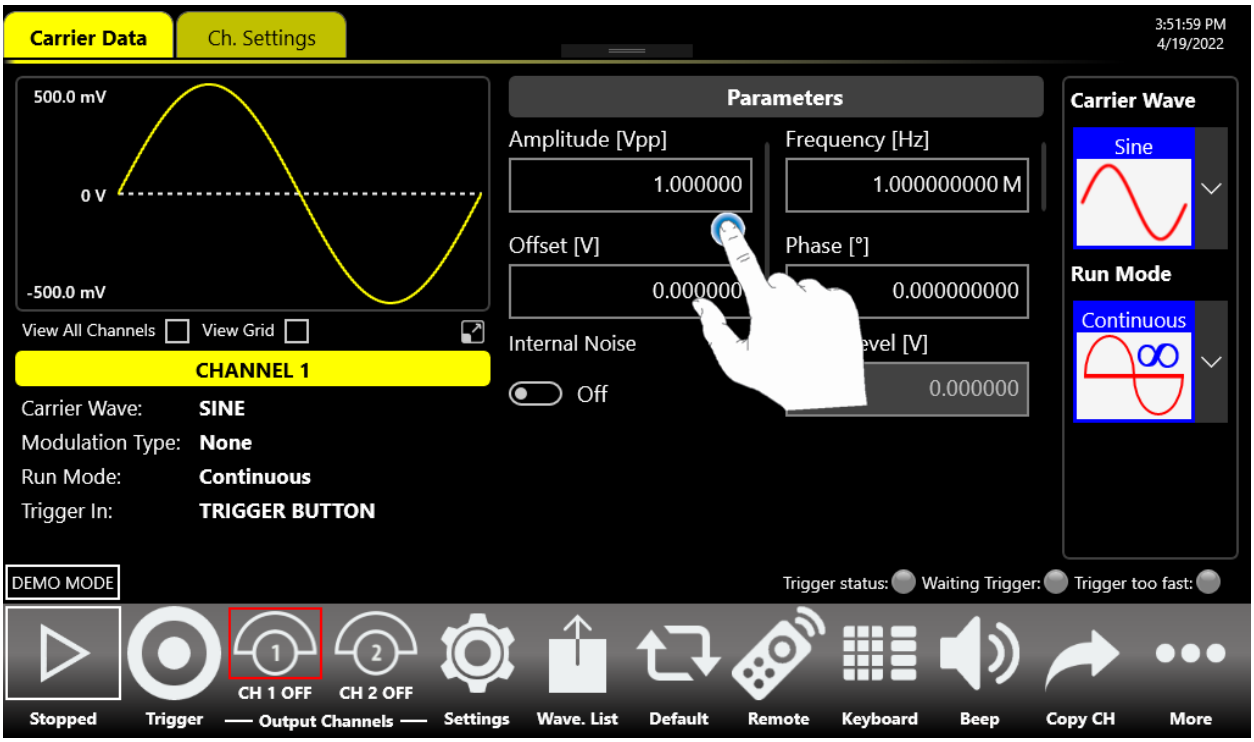
It defines the maximum level of the waveform expressed in Volts

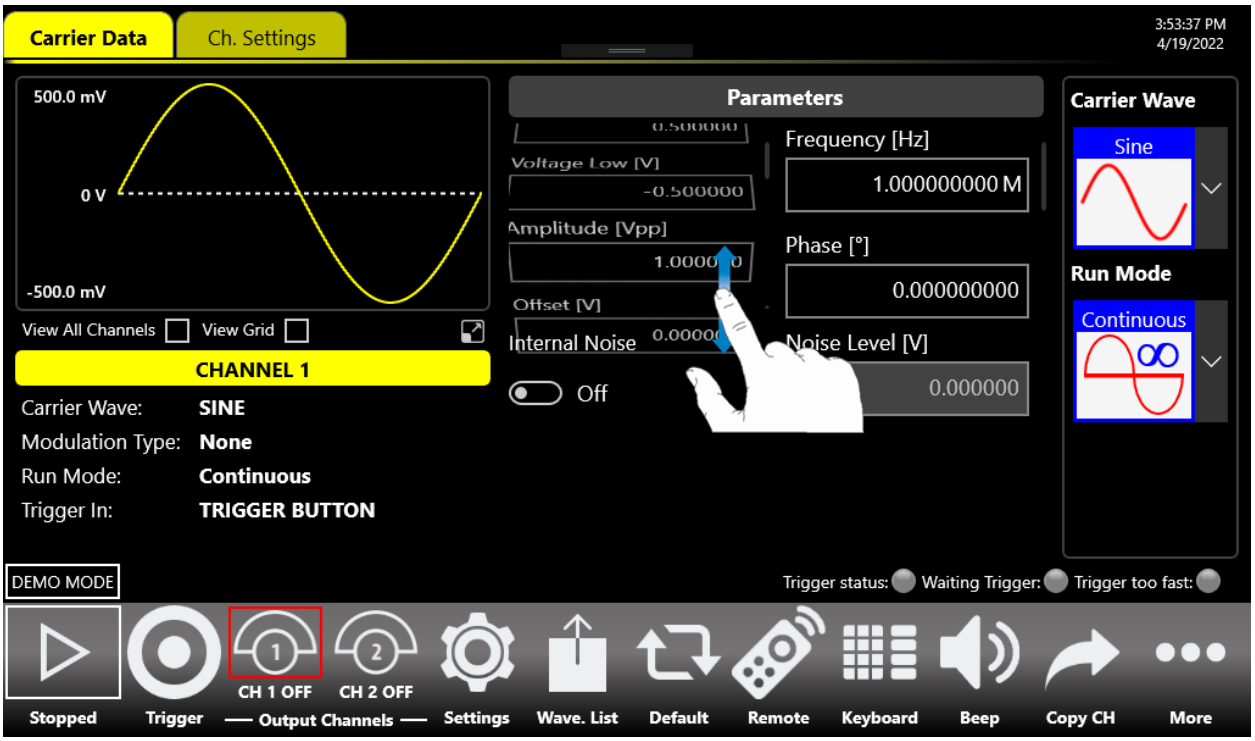
Low Level [V]

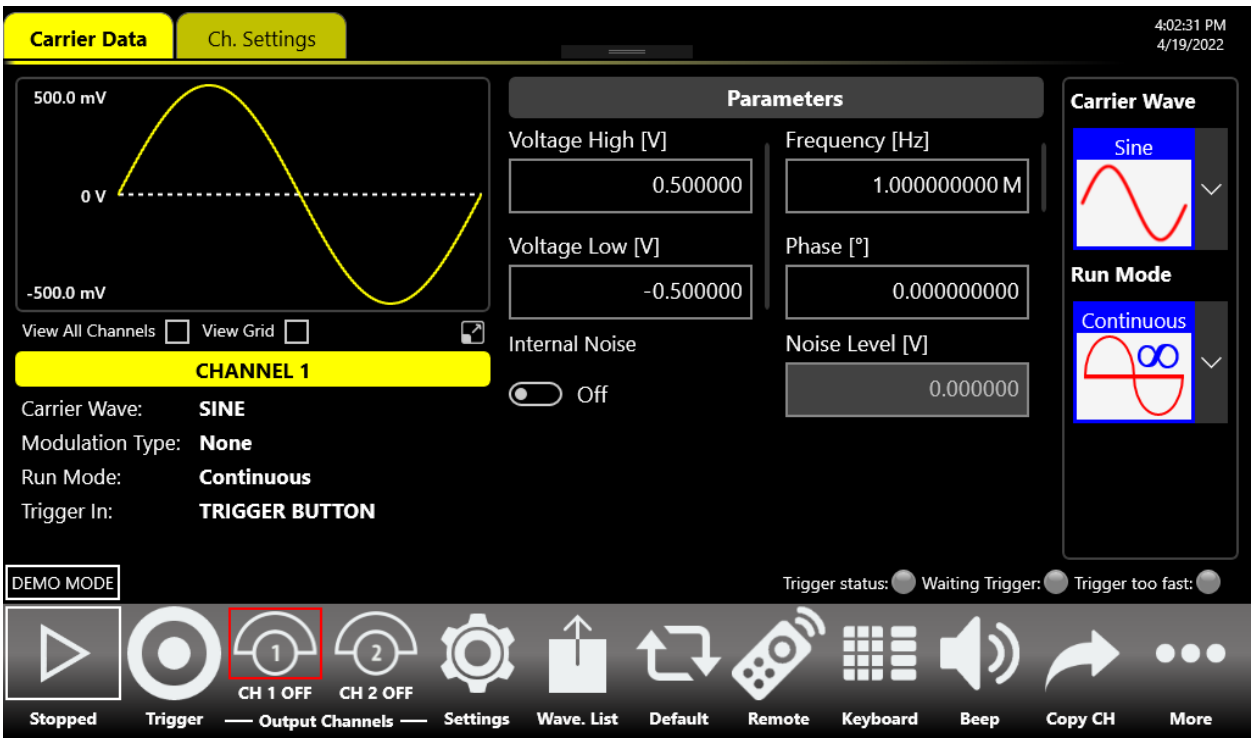
It defines the minimum level of the waveform expressed in Volts



The amplitude and the offset can be represented in four different formats, as listed before, that can be selected by rotate the 3D cube as below:




Carrier Data
Ch. Settings
3:53:37 PM
4/19/2022
500.0 mV
0 V
-500.0 mV
View All Channels
View Grid
CHANNEL 1
Carrier Wave: SINE
Modulation Type: None
Run Mode: Continuous
Trigger In: TRIGGER BUTTON
Parameters
Voltage Low [V]
-0.500000
Amplitude [Vpp]
Offset [V]
Internal Noise
Off
Frequency [Hz]
1.000000000 M
Phase [°]
0.000000000
Noise Level [V]
0.000000
Carrier Wave
Sine
Run Mode
Continuous
DEMO MODE
Trigger status:
Waiting Trigger:
Trigger too fast:
Stopped
Trigger
CH 1 OFF
CH 2 OFF
Output Channels
Settings
Wave. List
Default
Remote
Keyboard
Beep
Copy CH
More


Carrier Data
Ch. Settings
4:02:31 PM
4/19/2022
500.0 mV
0 V
-500.0 mV
View All Channels
View Grid
CHANNEL 1
Carrier Wave: SINE
Modulation Type: None
Run Mode: Continuous
Trigger In: TRIGGER BUTTON
Parameters
Voltage High [V]
0.500000
Voltage Low [V]
-0.500000
Internal Noise
Off
Frequency [Hz]
1.000000000 M
Phase [°]
0.000000000
Noise Level [V]
0.000000
Carrier Wave
Sine
Run Mode
Continuous
DEMO MODE
Trigger status:
Waiting Trigger:
Trigger too fast:
Stopped
Trigger
CH 1 OFF
CH 2 OFF
Output Channels
Settings
Wave. List
Default
Remote
Keyboard
Beep
Copy CH
More

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.
Rotating the parameter (in the same way as amplitude parameter) 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.

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 Vpp. 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 6 Vpp.

Internal Noise

Use this control to enable or disable the noise added to the output signal.

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.
Rotating the parameter (in the same way as amplitude parameter), you can change the format between the Width (absolute) and Duty Cycle.

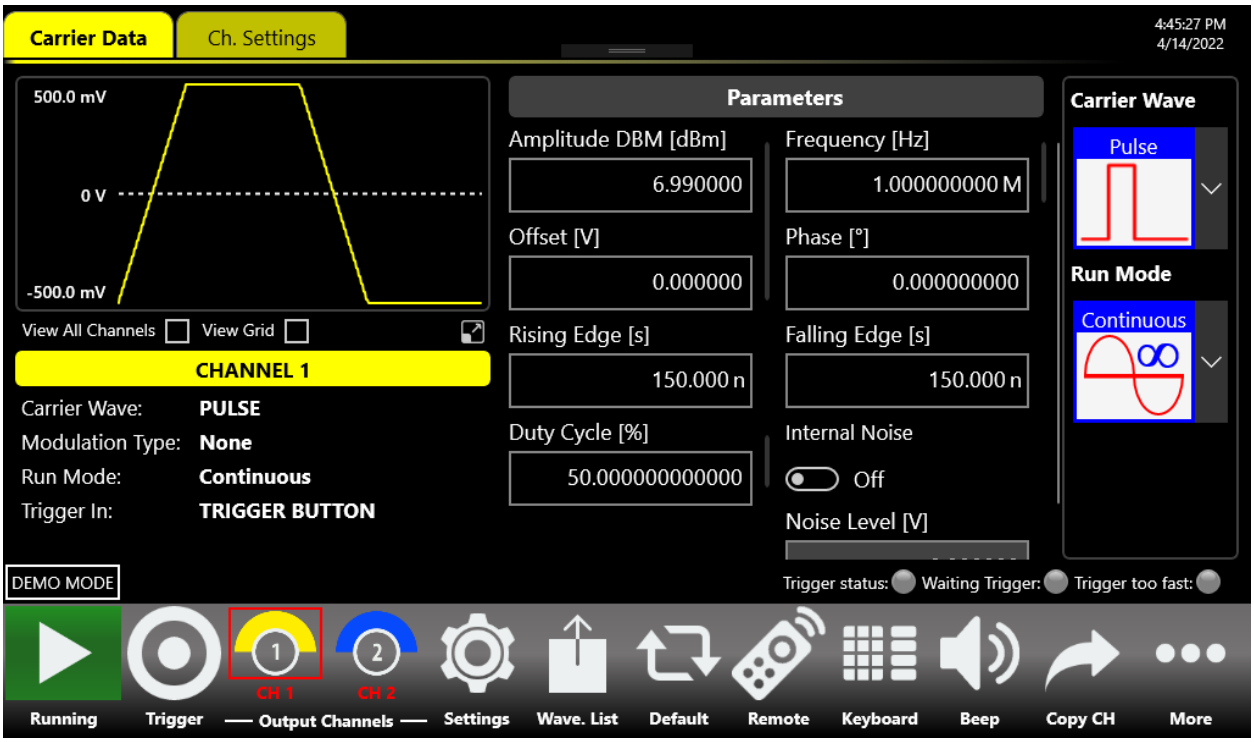
Rising – Falling Edge [s]

In the Pulse function, it defines the transition time between Low level and High level for the Rising/Leading Edge and between High level and Low level for the Falling/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:

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

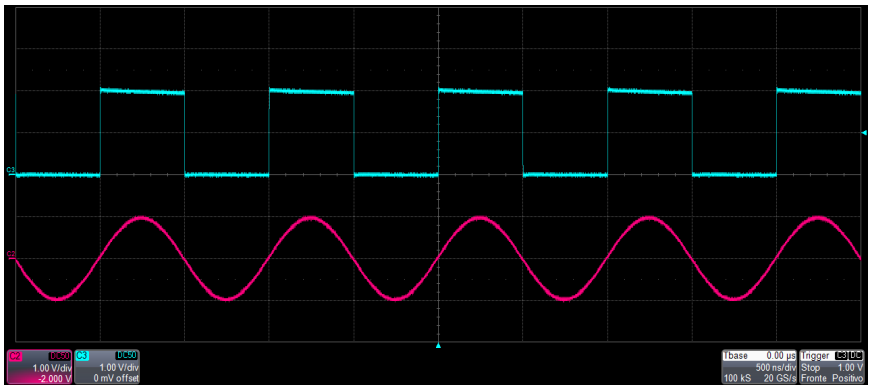


Auxiliary Channels

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 on the Front Panel
Output impedance	50Ω
Output level (into 50 Ω)	1V to 2.5V

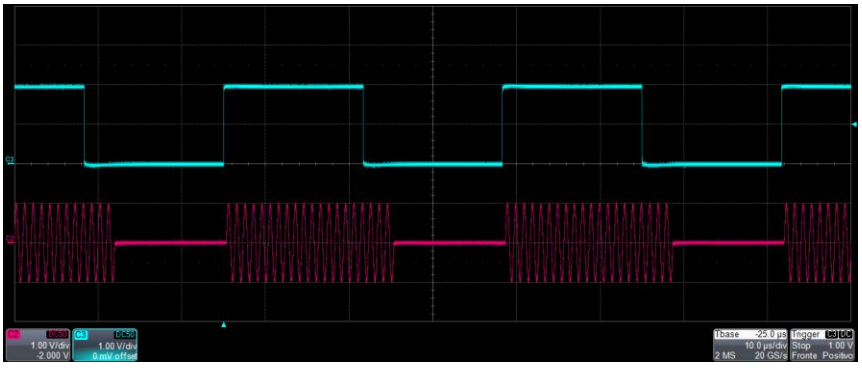


Marker out (blue, top) synchronous with the analog signal (red, bottom)

Trigger In

The TRIGGER IN connector 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	1kΩ or 50Ohm selectable
Slope/Polarity	Positive or negative selectable



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

Reference Clock Input

The T3AWG2152 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.
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

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	SMA on the Rear Panel
Number of connectors	1
Output impedance	50 Ohm, AC coupled

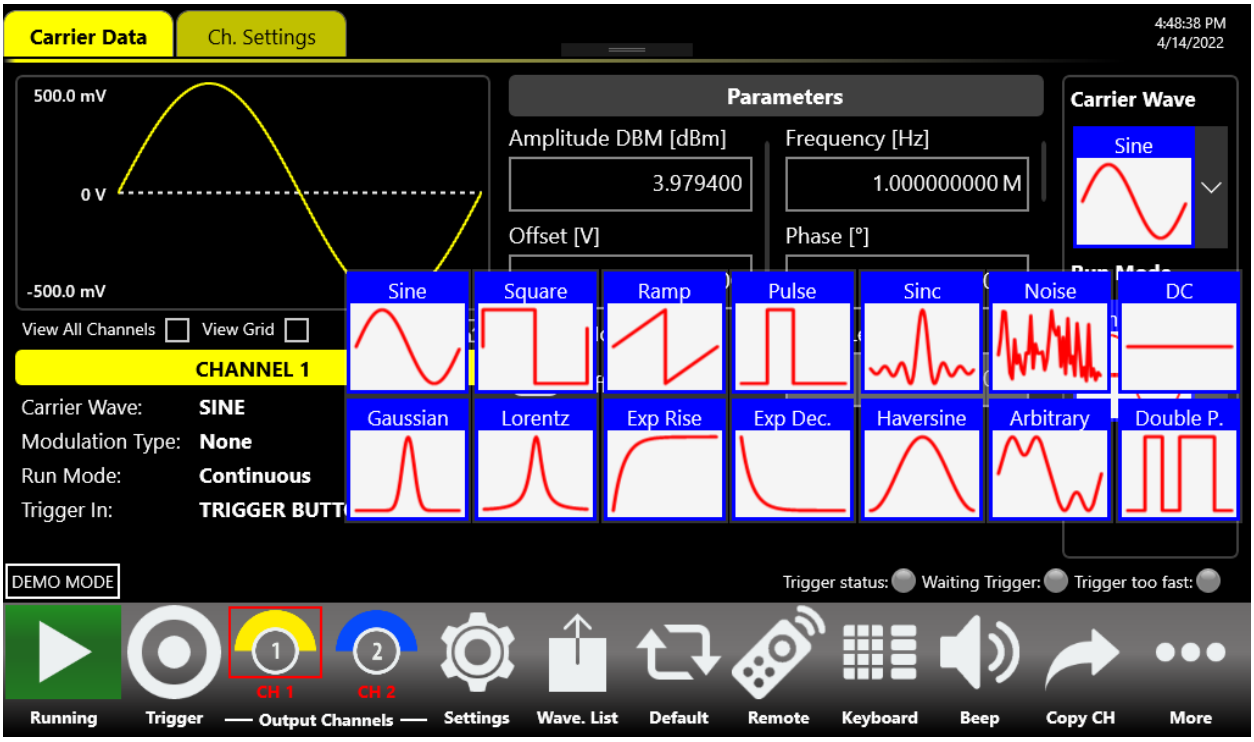
Digital Output connector

This connector is not used by AFG application.

Predefined Waveforms

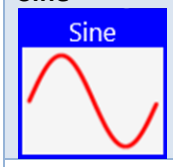
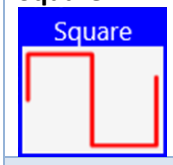
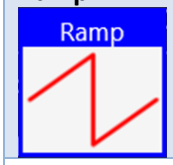
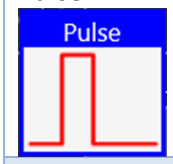
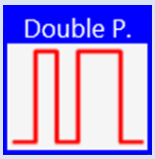
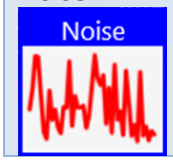
The Simple AFG application provides 13 predefined functions each of them described by its own set of parameters. It is also available the **Arbitrary** waveform that allow to load a waveform from a file or from remote.

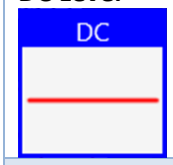
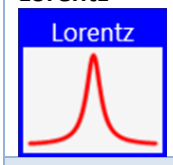
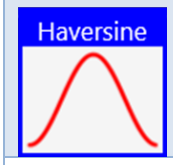
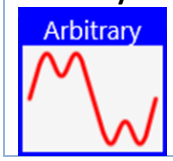
Touching the "Waveform" button on the "Carrier" a dropdown menu opens where it is possible to select a waveform to use as carrier.



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.

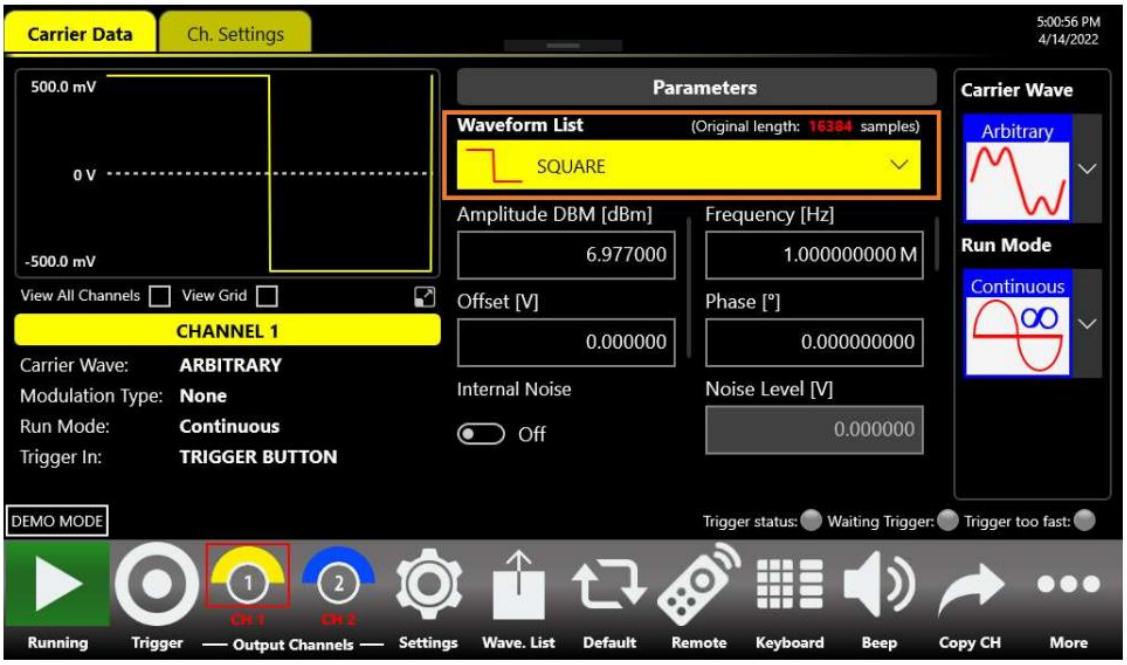
Waveform	Frequency Range	Parameters	AM, FM, PM, PSK, FSK	PWM	Sweep	Burst
Sine 	1 uHz÷150 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Square 	1 uHz÷60 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Ramp 	1 uHz÷5 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase, Symmetry	√		√	√
Pulse 	1 uHz÷60 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase, Duty Cycle, Leading Edge, Trailing Edge		√		√
Double Pulse 	1 uHz÷3 MHz ≤ 12Vpp 3 MHz÷50 MHz ≤ 6 Vpp where Vpp=|Vpp1|+|Vpp2|	**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 	1 uHz÷10 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Noise 		Amplitude (Noise Level), Offset				√

Waveform	Frequency Range	Parameters	AM, FM, PM, PSK, FSK	PWM	Sweep	Burst
DC Level 		Offset				
Gaussian 	1 uHz÷10 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Lorentz 	1 uHz÷10 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Exponential Rise 	1 uHz÷5 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Exponential Decrease 	1 uHz÷5 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Haversine 	1 uHz÷10 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√
Arbitrary 	1 uHz÷60 MHz ≤ 6Vpp	Amplitude, Offset, Frequency, Phase	√		√	√

Note: Please consult the updated datasheet to check the right frequency limit specification of your instrument model.

Note: Pulse and Double Pulse maximum frequency can be reached only by setting the leading and trailing edge duration and the pulse width to the minimum allowed.

You can assign the "**Arbitrary**" waveform using the combo box highlighted in figure below (refer to "Waveform List" description paragraph):



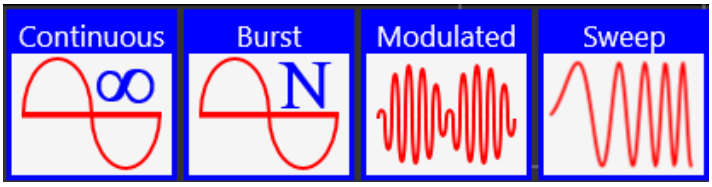
Note: When Arbitrary waveform is selected the amplitude and offset of the original waveform are lost because the waveform in normalized. Anyway, the amplitude and offset of the normalized waveform can be modified as for any predefined waveforms.

Note: In Stopped State the instrument stops at zero voltage level 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.

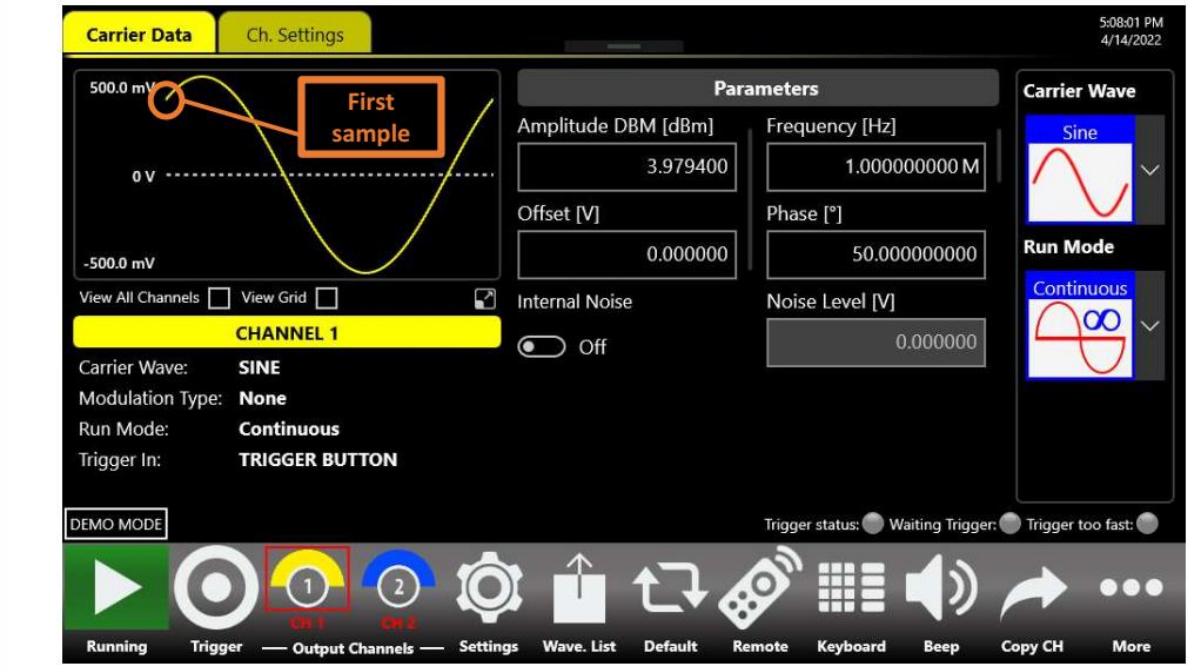
Run Mode

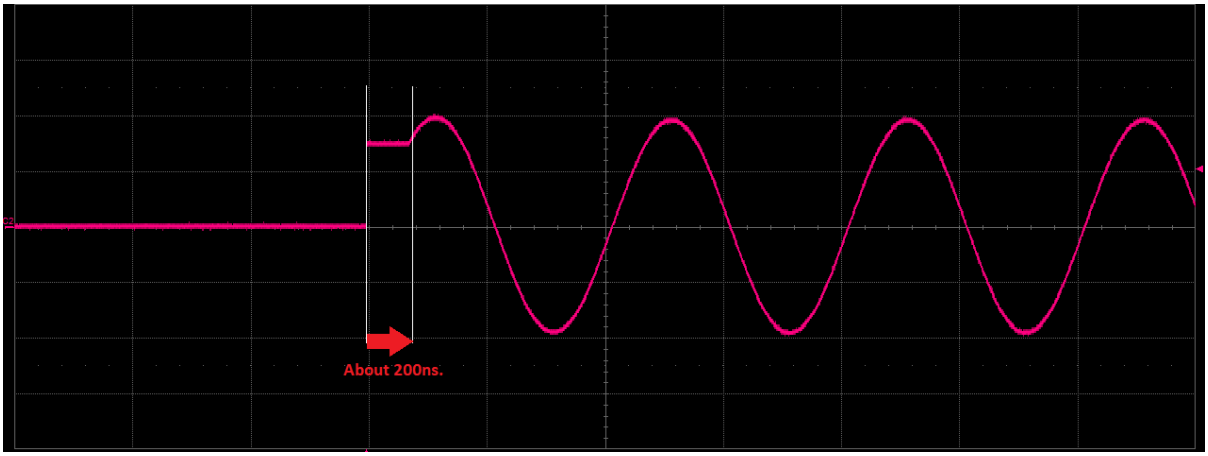
On the Carrier tab pressing the "Run Mode" button a menu opens showing all possible choices for the Run Mode. If "Modulation", "Sweep" or "Burst" is selected the software moves directly on the secondary tab that takes the name of the selected Run Mode.



Note: after enabling a channel and pressing the Running button (see Command Tool Area section), the generation of the corresponding waveform will start keeping the first sample of the waveform constant for about 200ns.

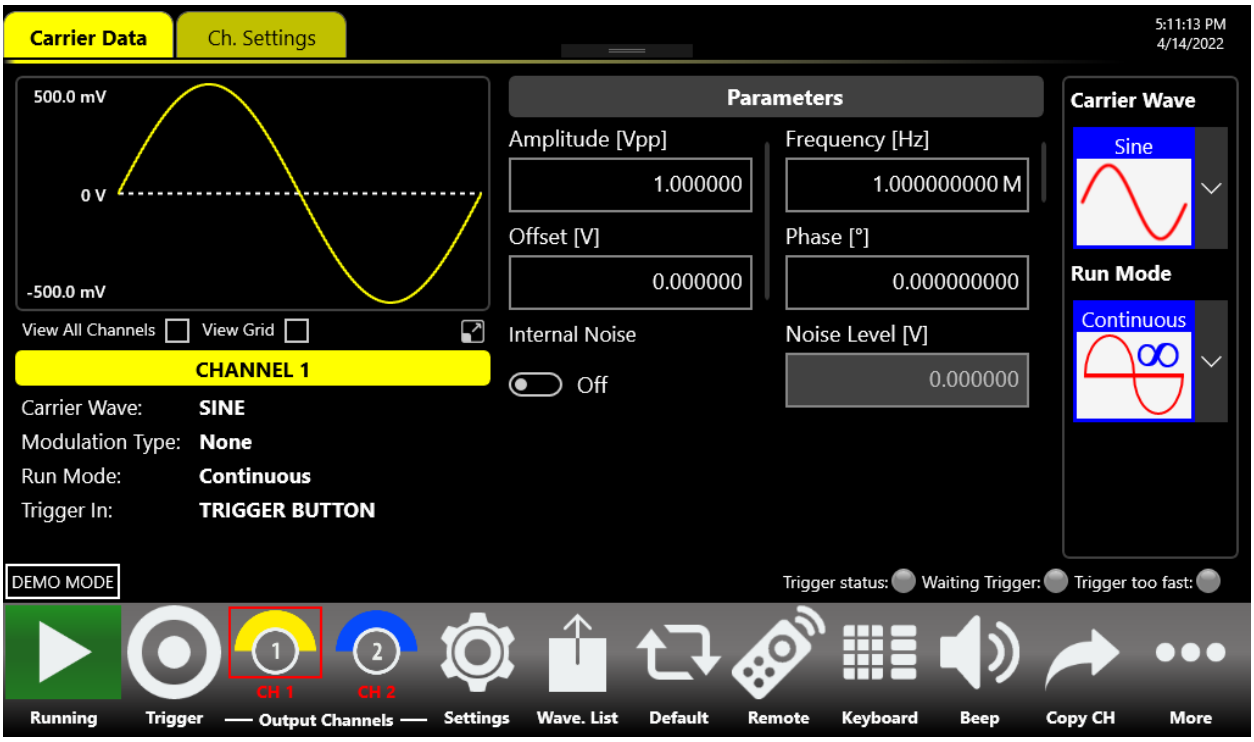
For example, in the picture below is represented the initial part of the generation of a sine wave with 50 deg of phase in continuous mode.





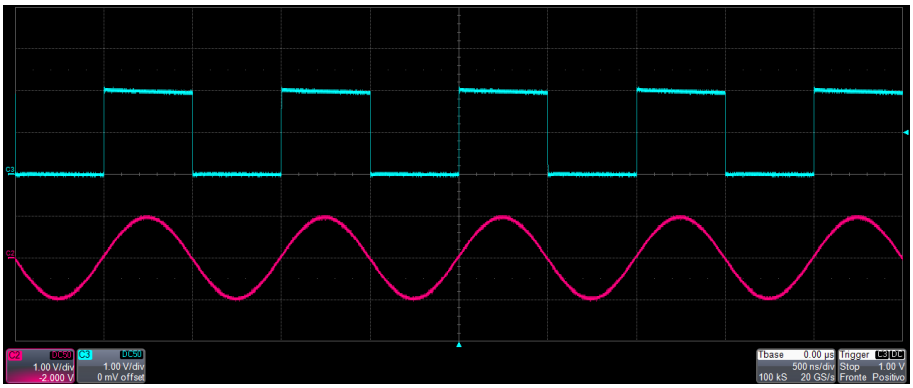
Continuous

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 75MHz. Over 75MHz the Marker Out frequency is divided by 2 from 75MHz up to 150MHz.



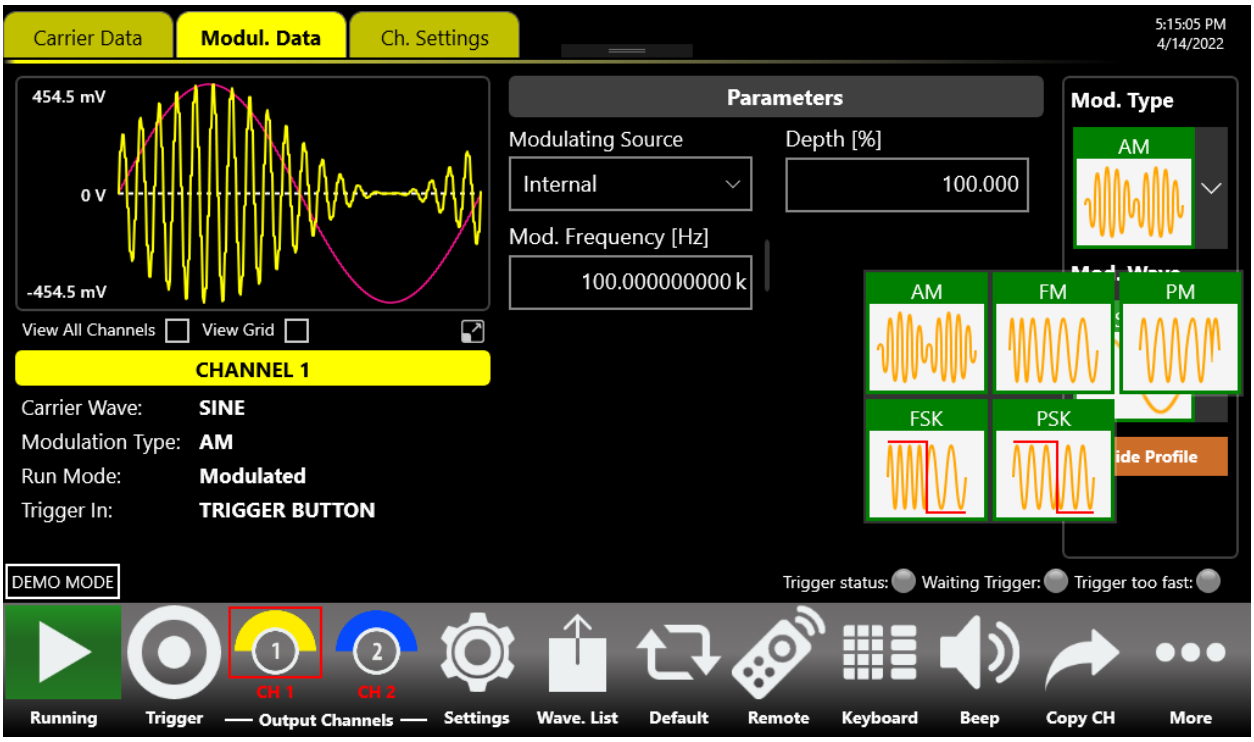
Marker out (blue, top) synchronous with the analog signal (red, bottom)

Note: for the Noise and DC waveforms, the **Marker Out** is unavailable in continuous mode.

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 "Mod.Type" button the modulation type menu opens as shown in the picture below.



With the button **Hide Profile** you can view and hide the waveform modulation profile on the graph

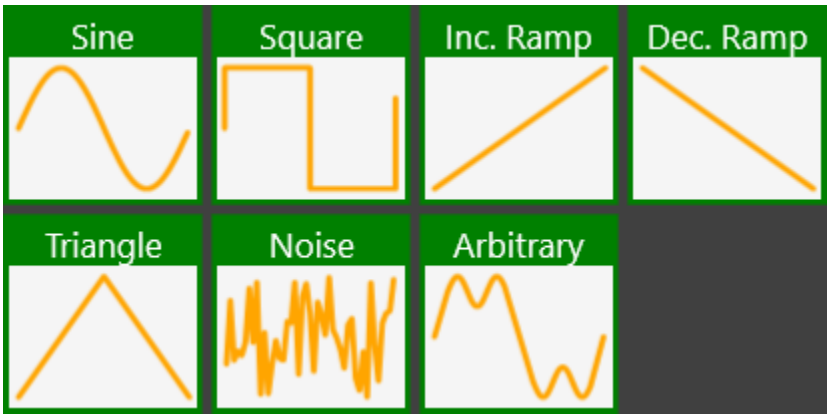
The modulation types are:

- **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 "Mod.Wave" button the modulation type menu opens. The possibility to choose the shape is only available for AM, FM, PM and PWM modulations.

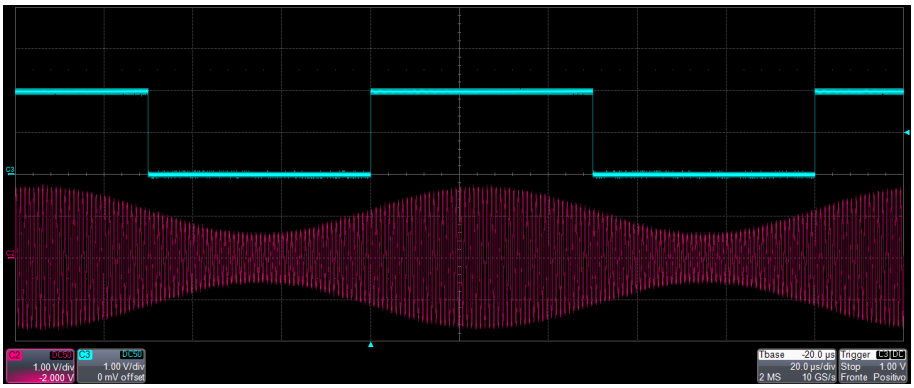


The modulation *Shapes* (when available) can be:

- **Sine**
- **Square**
- **Triangle**
- **Increase Ramp**
- **Decrease Ramp**
- **Noise**
- **Arbitrary:** it allows to load a Modulating Waveform from file. By default, the "Arbitrary" waveform is a cosine function. As Carrier Arbitrary you can select the waveform by combo box Waveform List.

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.



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 500uHz and 48MHz.

Modulation Types and associated parameters

- **Amplitude Modulation (AM):** the amplitude of the carrier waveform is modulated following the modulating shape. It is available except for the Noise, DC Level, Pulse and Double Pulse function. 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 except for the Noise, DC Level, Pulse and Double Pulse function. The parameter **Freq. 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. To know the maximum allowed frequency for each function, please refer to the Predefined Waveforms chapter.

  For example, for a sine function with an amplitude of 1Vpp at 91 MHz the Deviation must be below 59 MHz.
- **Phase Modulation (PM):** the phase of the carrier waveform is modulated following the modulating shape. It is available except for the Noise, DC Level, Pulse and Double Pulse function. The parameter **Phase 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 except for the Noise, DC Level, Pulse and Double Pulse function.

  Note that the Hop Frequency can be negative and it must satisfy the following conditions:
  - $Carrier\ Frequency - \text{Hop Frequency} > 0\ Hz$
  - $Carrier\ Frequency + \text{Hop Frequency} \leq Maximum\ Frequency$

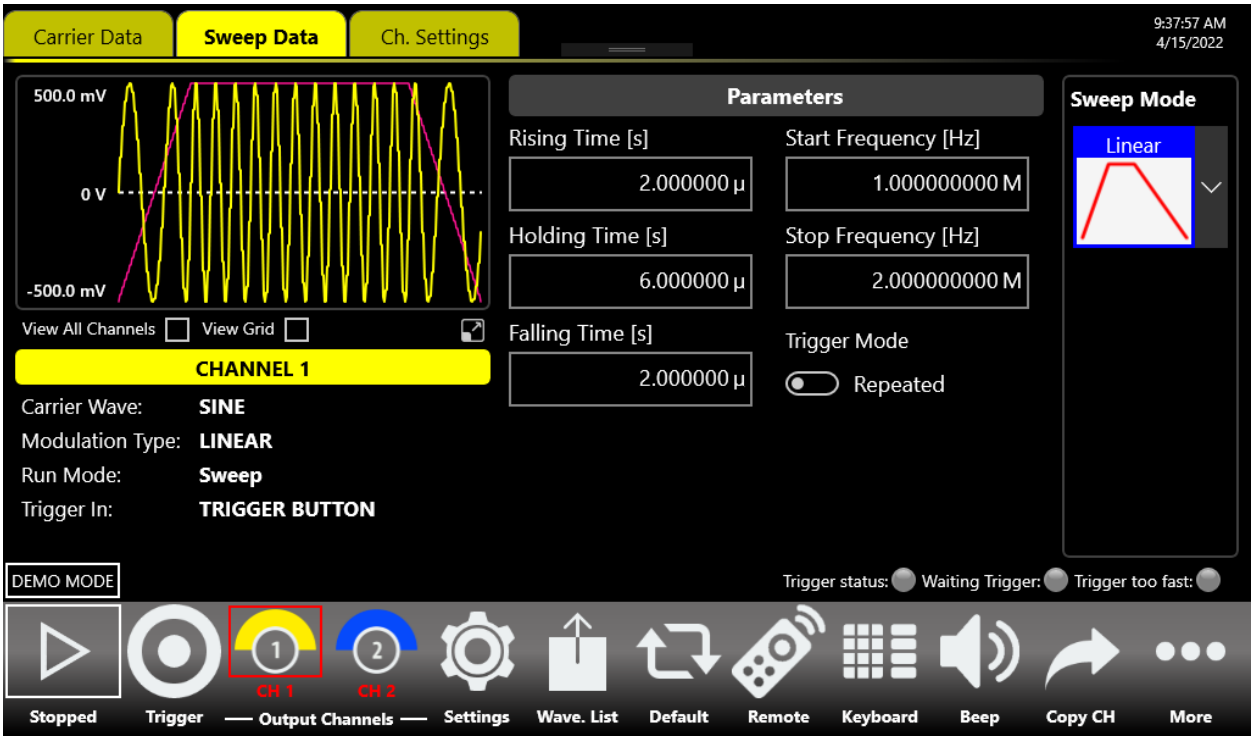
Where the Maximum Frequency depends on the selected carrier. To know the maximum allowed frequency for each function, please refer to the Predefined Waveforms chapter.

- **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 except for the Noise, DC Level, Pulse and Double Pulse function. 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 **PWM 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%.

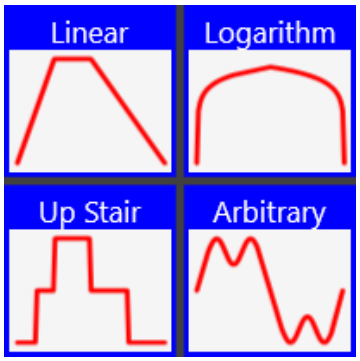
Sweep

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.



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.
- **Arbitrary:** allows to load a sweep profile from a file. By default, the "Arbitrary" waveform is a cosine function. As Carrier Arbitrary you can select the waveform by combo box Waveform List. ***Note*** the time to execute the sweep is the sum of Rising, Holding and Falling Time. When the Arbitrary mode is selected these 3 parameters are not meaningful.

Parameters

- **Rising Time [s]:** it controls the time to increase the frequency from the Start Frequency up to the Stop Frequency.
- **Holding Time [s]:** it is the time that the frequency keeps the Stop Frequency.
- **Falling 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:

$$Rising\ Time + Holding\ Time + Falling\ Time \leq 2000\ s$$

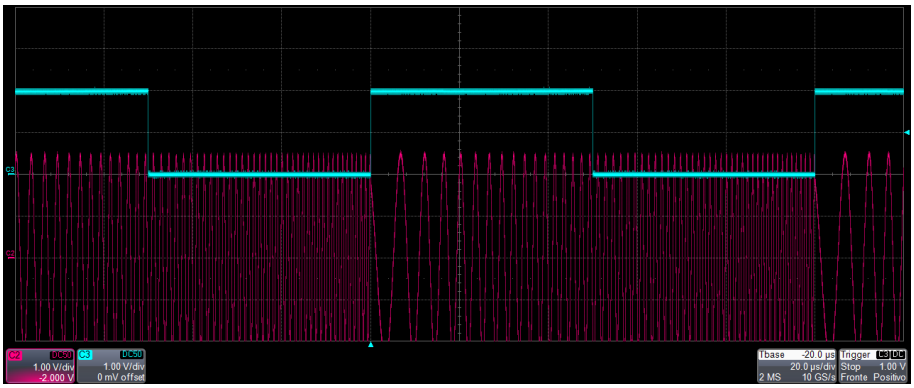
- **Step Number [N]:** it selects the number of frequency steps of the Upstair Sweep mode.
- **Start Frequency [Hz]:** it selects the initial sweep frequency.
- **Stop Frequency [Hz]:** it selects the final sweep frequency.

Sweep Trigger Mode

- **Repeated:** the instrument starts when the Run/Stop button is pressed and repeats the sweep continuously.
- **Triggered:** 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 instrument generates the waveform with its frequency equal to the start frequency.

Marker Out behaviour in Sweep Run Mode

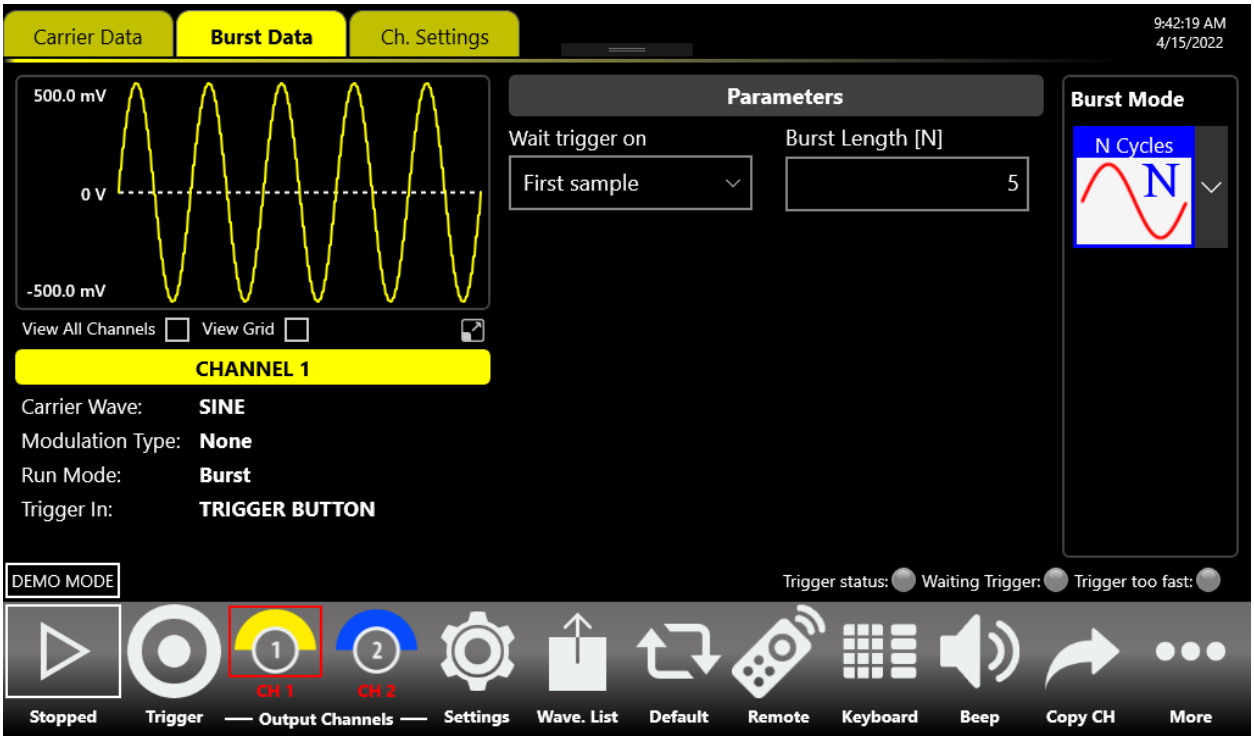
In this Run Mode the **Marker Out** generates a square wave with the rising edge placed at the beginning of each sweep and the marker's period is equal to the sum of Rising Time, Holding Time and Falling Time parameters.



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

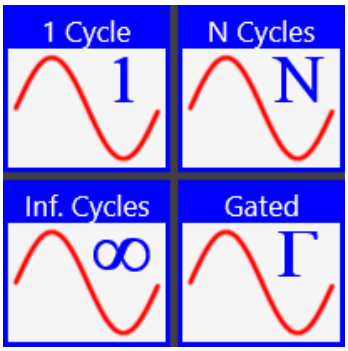
Burst

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.



Burst Mode

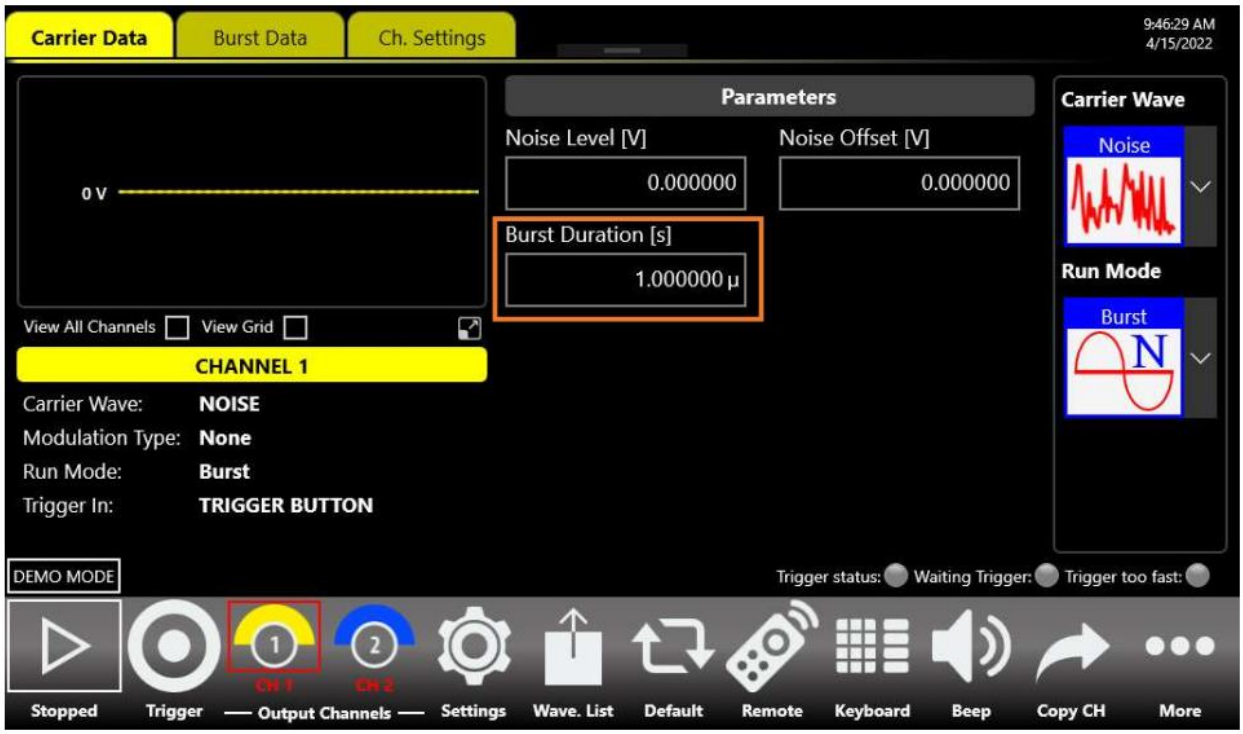
The burst mode allows to define the behaviour of the instrument after the Trigger reception. Touching the "Mode" button the following menu opens and it is possible to select the burst type.



- **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.

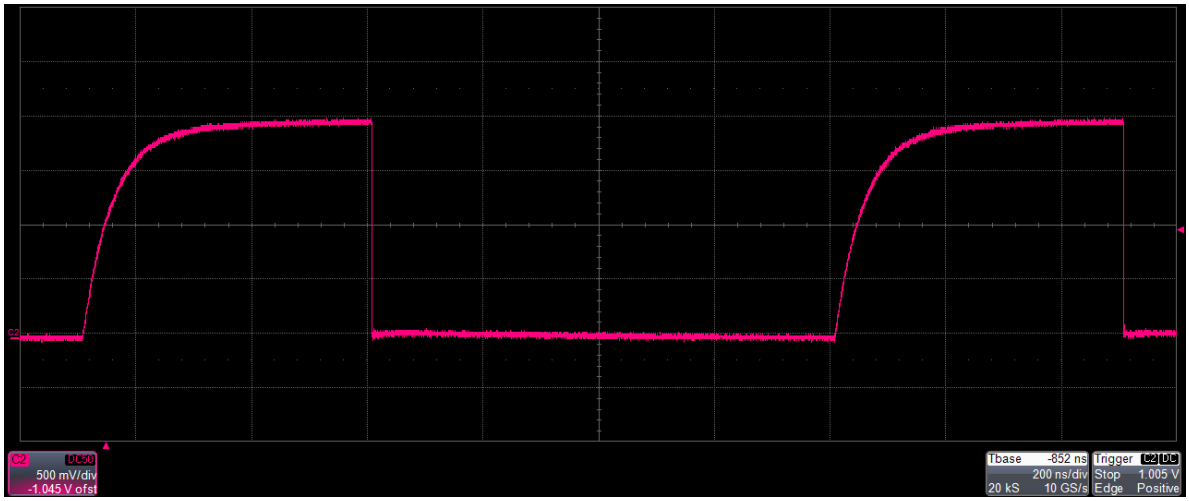
- **N-Cycles:** the instrument waits for a Trigger. When the trigger is detected, it generates N times the carrier waveform then it stops and waits for the next Trigger. The number of N cycles to generate is defined by the **Burst Length** parameter.
- **Inf-Cycles:** this mode is similar to the previous 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.
  In Gated mode, if the source of trigger is external (from connector BNC Trigger In), a trigger condition is "true" when it crosses the selected Threshold with the selected Edge, otherwise it's "false" when it crosses the selected Threshold with the opposite Edge; the 'Both' option for the Edge parameter is meaningless in this modality and it will be disabled.
  For more information about previous parameters see the Trigger In section.
  If the source of trigger is Button, a trigger condition is "true" when the Trigger button is held press, otherwise it is "false" when you release it.

Note: if the Noise is selected as carrier and the channel is in 1-Cycle Burst or N-Cycles Burst mode, the **Duration Burst [s]** control will appear in Carrier Setting and the user can specify the duration of a single burst generation.

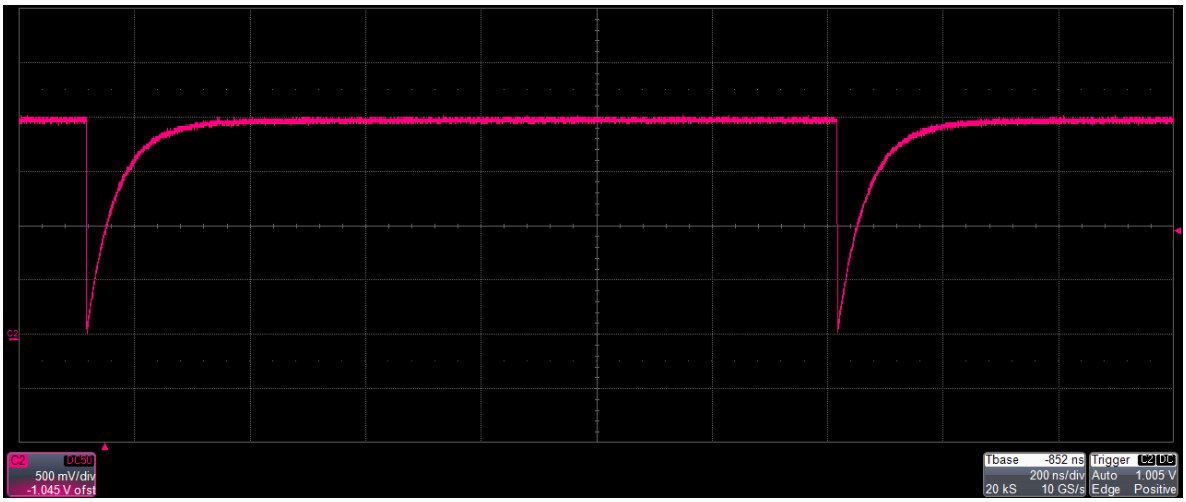


Note: after the execution of the each burst the Output voltage level keeps the Last Sample voltage (equal to the First sample) of the carrier waveform. This is true except for Exponential Rise, Exponential Decrease and Arbitrary Carrier where the **Wait Trigger On** parameter is enabled:

In this case the user can set which voltage level will be generated between one burst and another: the carrier's first or last sample.



Exponential Rise Carrier, 1-Cycle Burst Mode, Wait Trigger On **First** *Sample*



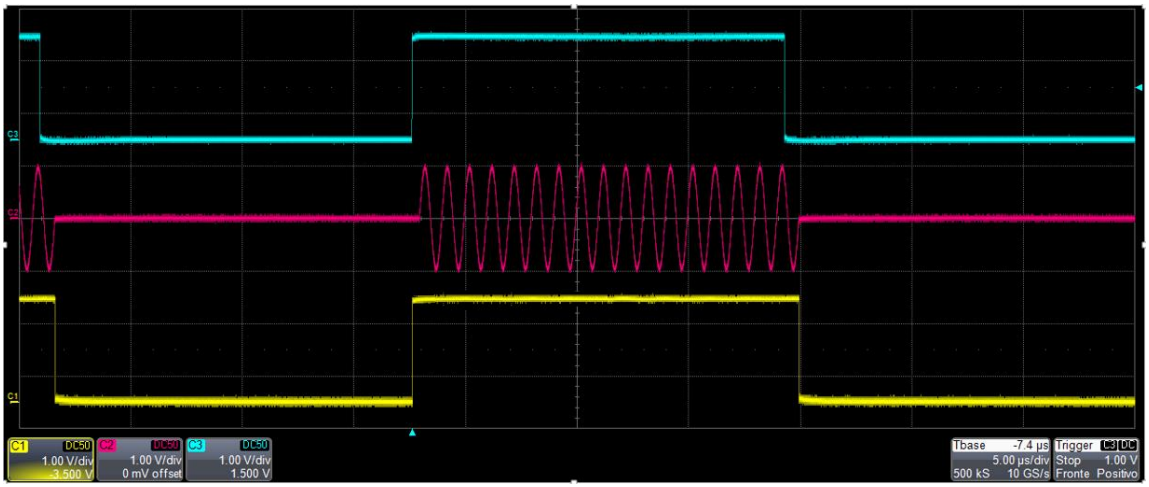
Exponential Rise Carrier, 1-Cycle Burst Mode, Wait Trigger On **Last** *Sample*

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).

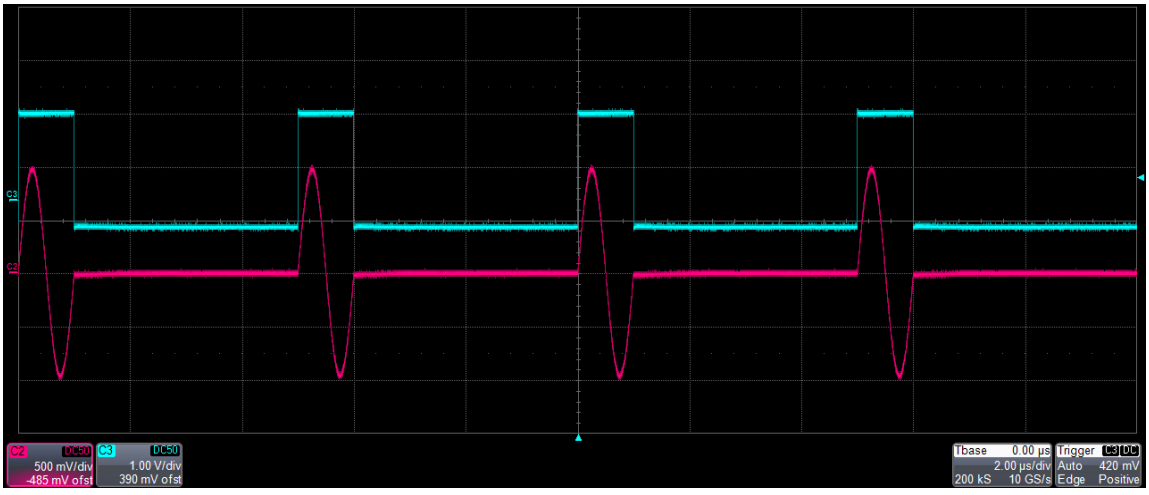
Es.1: in the following picture the gated mode operation is shown. From top to bottom there are:

- C3 (blue trace) is the Trigger signal source from the external Trigger In 1 connector.
- C2 (red trace) is the generated signal.
- C1 (yellow trace) is the marker out.



Burst Gated with Trigger from external Trigger In 1

Es.2: in the following picture the 1-Cycle Burst mode operation is shown. A sine wave carrier (frequency = 1Mhz) is generated using the internal timer (interval = 5 us).

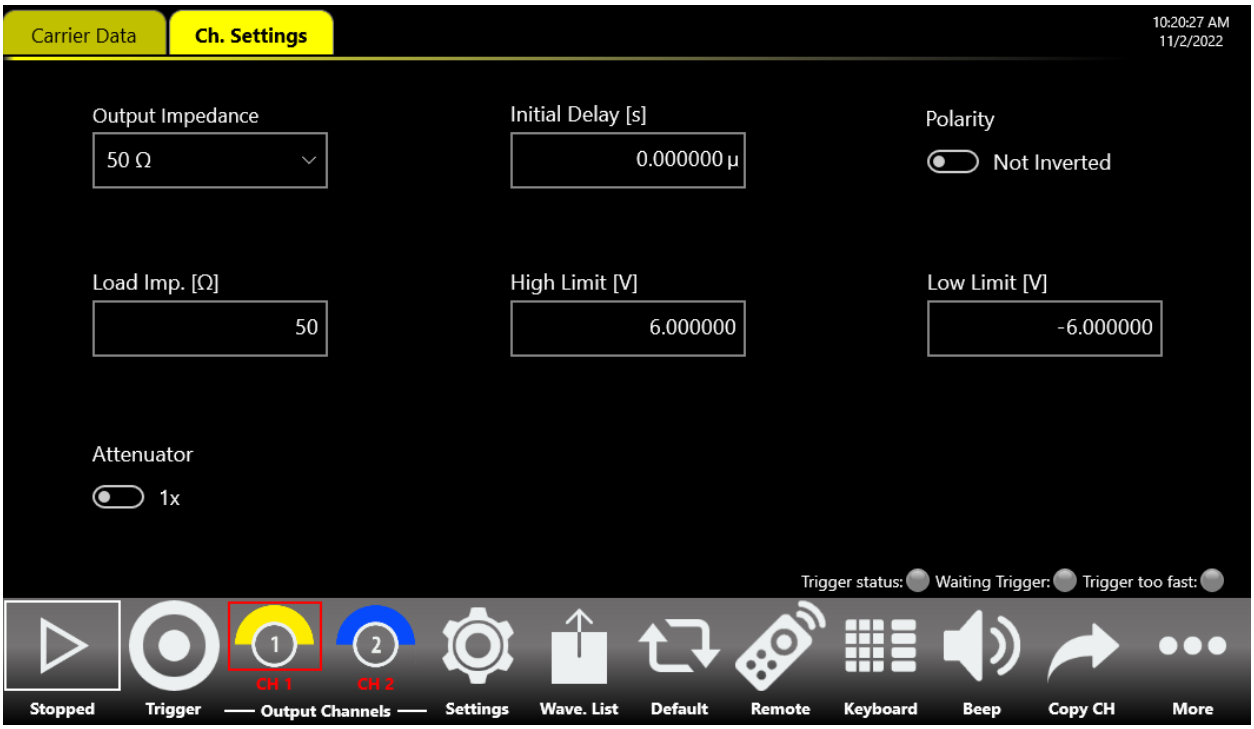


Marker out (blue, top) synchronous with 1-Cycle Burst (red, bottom)

Channels and Device Setting

Channels Settings

Touching the Setting Tab **Ch. Settings** or slide left right until you reach the setting page.



The parameters present in Channel settings are descripted in the table below:

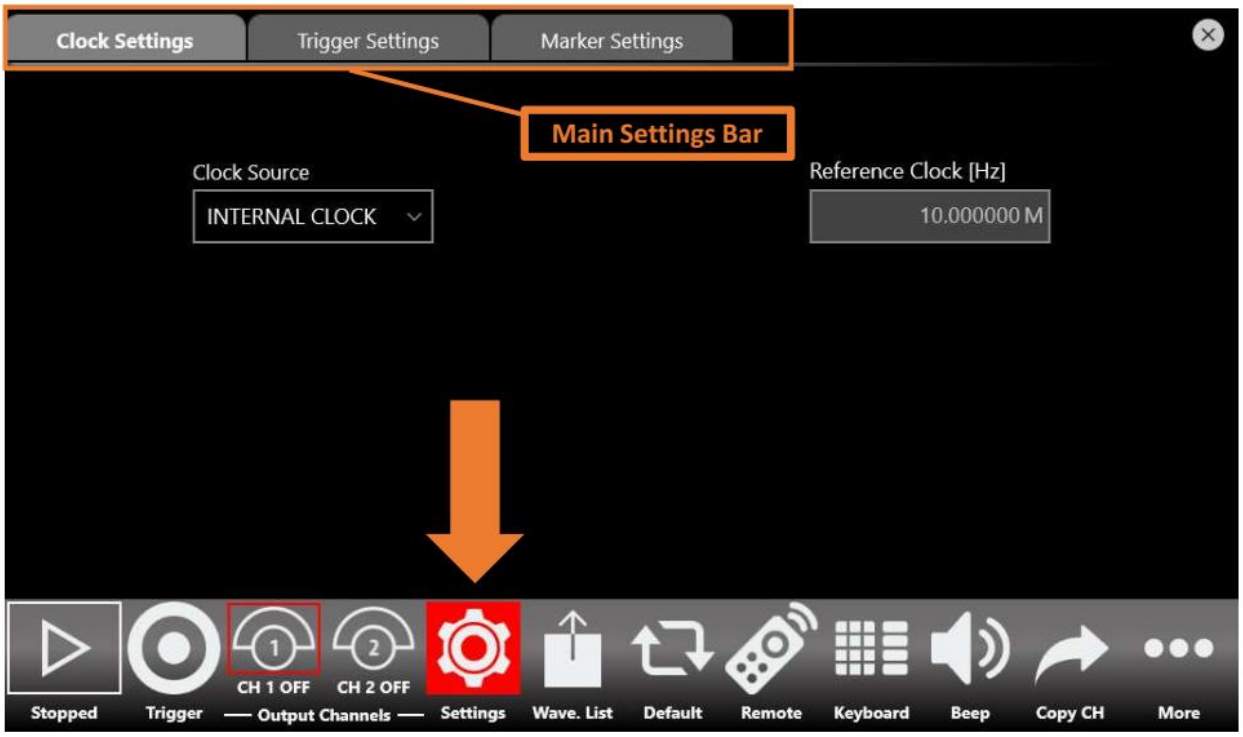
Channel Setting	Description
Initial Delay [s]	Set the Initial Delay of the selected channel. The delay range is 0s to 14 s.
Load Impedance [Ohm]	The instrument applies the appropriate scaling to the output waveform to get the right amplitude on the defined Load expressed in Ohm. The impedance range is 1 Ohm to 1 MOhm.
Attenuator	Use this control to change the full-scale range of the channel. On the instrument are available two full scale ranges that are selectable by means of an internal 10X attenuator. You can set the attenuator ON (10x) to improve the output signal quality with low level signals.
Polarity	This control allows you to invert the polarity of the output signal relative to its offset.
High Limit [V]	Sets the maximum voltage that the channel generates. This limit is verified during the generation.

	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 [V]	Sets the minimum voltage that the channel generates. This limit is verified during the generation. 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.
Output Impedance [Ohm]	Sets the output instrument impedance to low (5 Ohm) or to 50 Ohm.

Settings button

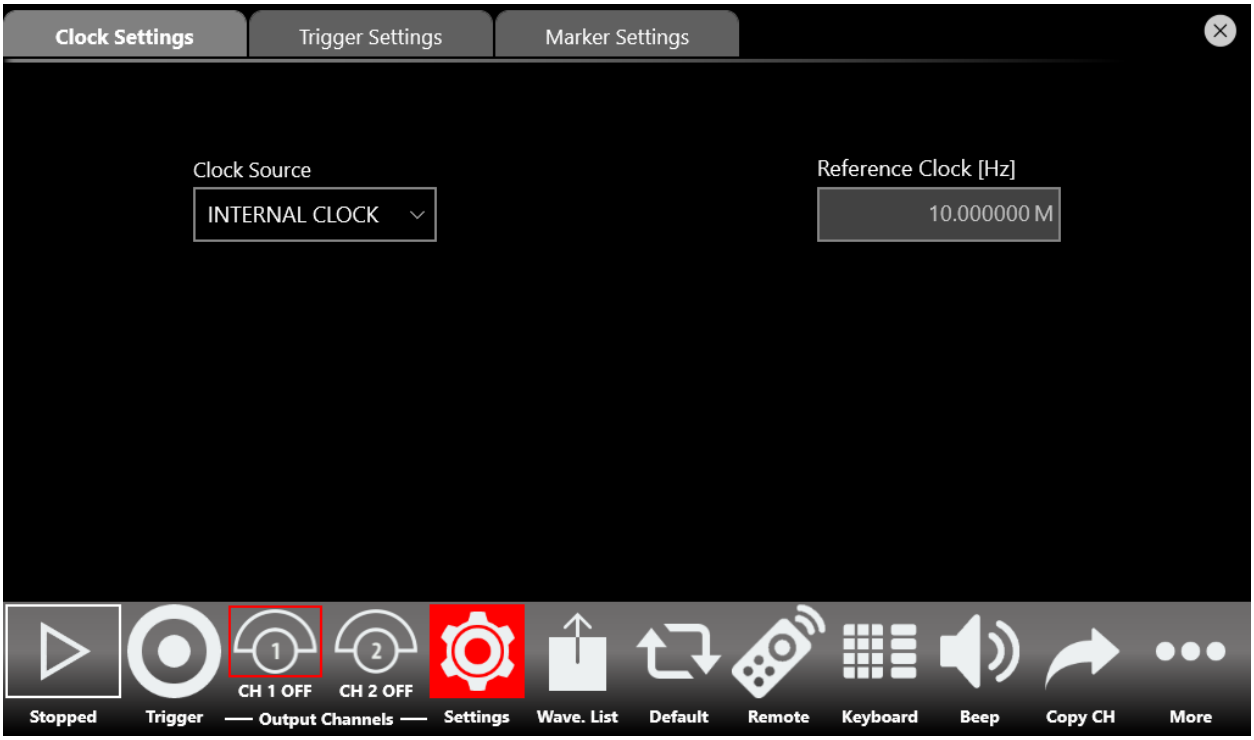
Touch the "Settings" 

button to open the dedicated **Main Setting Tabs** page relative to the, **Clock Settings**, **Trigger Settings** and **Marker Settings** tab.



Clock Settings tab

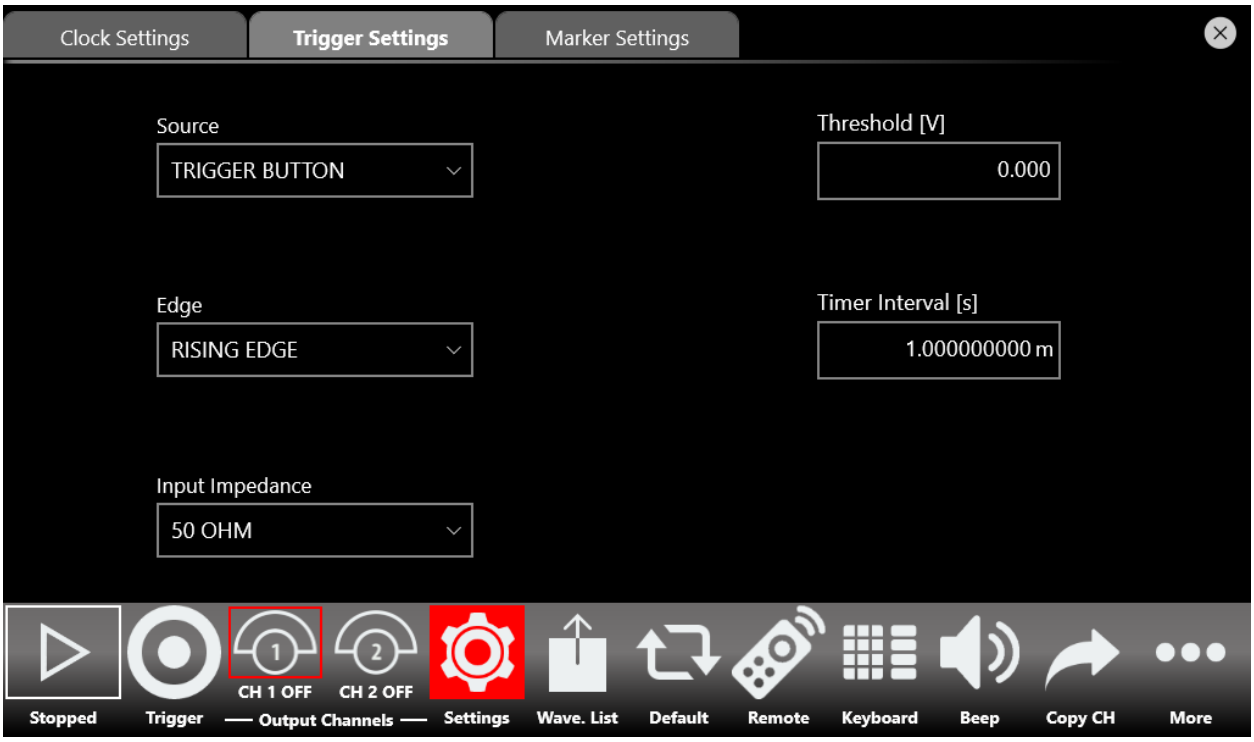
The Timing settings parameters are located in the Clock Settings tabs.



Timing Setting	Description
Clock Source	If **Internal Clock** is selected, the internal DAC sampling clock is synthesized using a 10Mhz reference clock generated internally. If the external **Reference Clock In** (**External Clock**) is selected, the DAC sampling clock is synthesized using the clock provided externally to the Ref.Clock In SMA connector on the rear pannel of the instrument. In this case the **Ref Clk Frequency** control will appear and the user must specify the Reference Clock frequency [Hz]**.** The frequency range of this clock is: 5 Mhz to 100Mhz.

Trigger Settings tab

The Trigger In settings parameters are located in the **Trigger Settings Tab**. These parameters are shared by all channels of the instrument.

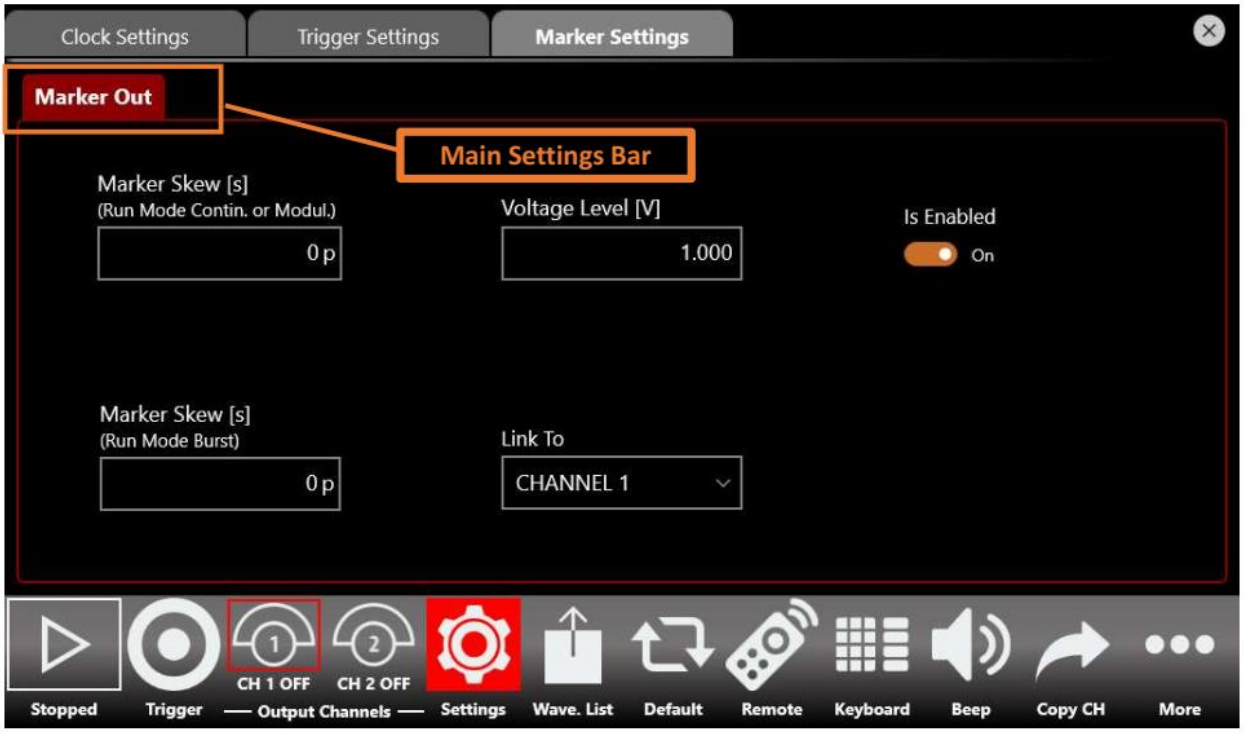


Trigger In Setting	Description
Source	**Trigger Button:** the Trigger event is provided to the instrument by pressing the Trigger button on the keyboard or the Trigger button on the menu toolbar or by issuing a trigger by Remote Command. **Timer:** the Trigger is internally generated by a Timer. The Timer count interval is set by Timer Interval [s] textbox. **Trigger In Connector:** a Trigger event is generated by the signal applied externally to the "Trigger In" BNC connector when it crosses the selected Threshold. ***Note:*** the Trigger buttons and the Trigger from remote command are always active, independently from the selected Trigger Source.
Timer Interval [s]	Set the timer count interval. It has effect only when the selecting trigger Source is *Timer*. The Interval range is from 13.4ns to 100s. The edited value is automatically rounded to the closest value that the hardware can implement.
Threshold [V]	It is the threshold that the external signal applied to the "Trigger In" BNC connector must cross to issue a Trigger event to the instrument. It has effect only when the selected Source is *Trigger In Connector*.

Edge	When *Rising Edge* is selected the trigger is detected when the signal on the "Trigger In" BNC connector crosses the threshold from low to high. The *Falling Edge* option is the opposite. "*Both Edges*" means that Trigger is sensitive to both edges of the signals. It has effect only when the selecting Source is *Trigger In Connector*.
Impedance	It selects the Trigger In connector impedance: 1 kOhm or terminated into 50 Ohm.

Marker Settings

The Marker Out settings parameters are located in the **Marker Settings** tab. The MARKER OUT BNC connector is shared by each channel of the instrument but it's possible to link the marker signal coming out of it to a predetermined one.



The available parameters for the markers out are:

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).
Is Enabled	It enables or disables the Marker Out. When the Marker Out is disabled, it is forced to 0 V.

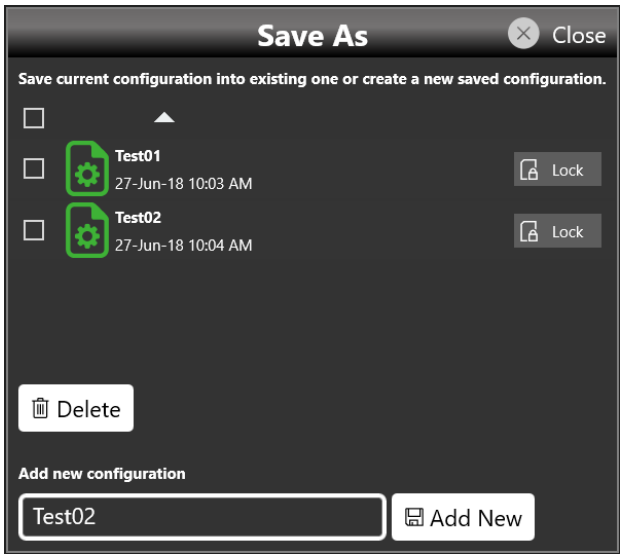
Marker Skew [s] (**Run Mode Contin. or Modul**)	It sets the delay between the marker and the analog channel. This parameter is valid only if the run **Continuous Mode** or **Modulated Mode** or **Sweep Repeated Mode** is been selected for the associated channel to the Marker out. The skew range is **0s** to **14s**.
Marker Skew [s] (**Run Mode Burst or Sweep Trig.**)	It sets the delay between the marker and the analog channel. This parameter is valid only if the run **Sweep Triggered Mode** or **Burst Mode** is been selected for the associated channel to the Marker out. The skew range is **0s** to **3us**.
Link To	The Marker Out frequency is related to the analogic channel frequency. Since there is a unique Marker Out signal while there are two analogic channels it is possible, by means of this parameter, to define the analogic channel that is related to the Marker Out signal.

Main Command Button Description

Save As...

A configuration can be saved by means of the 

"Save As" button that will open the following dialog box. The configuration will be saved in the configuration list that can be accessed by the "Load From" dialog box:



In this page you can add a new configuration entry or overwrite an existing one. To create a new configuration entry, it is necessary to write a name in the text box in the bottom of the page and click on "Add_New".

Export Configuration

If you touch the Export Configuration button 

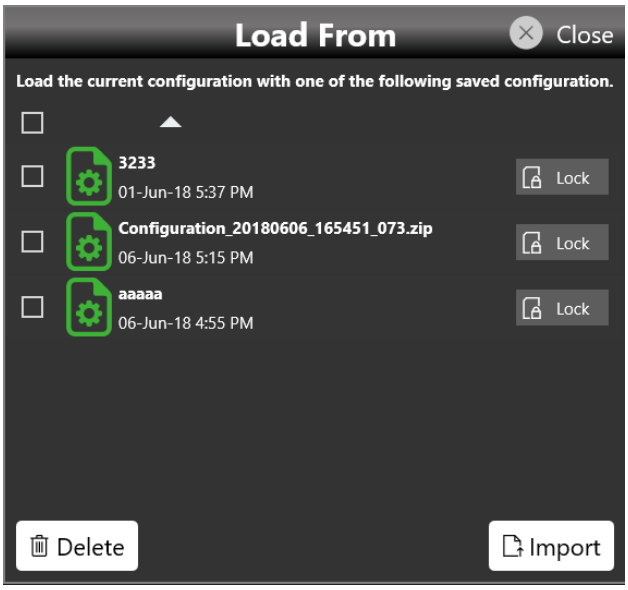
a proprietary binary .zip file relative to the current configuration will be exported. The exported file can be used to share configurations between different users or instruments.

Load From…

Touching the "Load From" 

button in the "More" menu, a page will be opened that shows the list of all the saved and imported configurations. If you select an existing Configuration, you will load all the settings into the instrument.

In the "Load From" page it is also possible to manage the configuration list: you can delete, import or lock a configuration. When a configuration is locked it can't be deleted or overwrited.

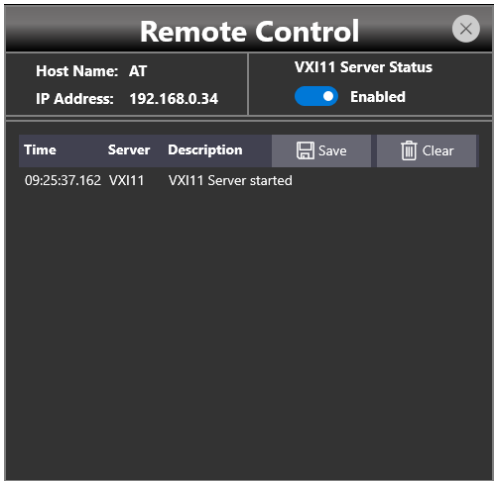


If you touch the Import Configuration button you can import the configuration file that comes from a different machine or from a different user. The imported configuration will be inserted in the "Load From" list.

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. It is enabled by default.

Remote Desktop Connection

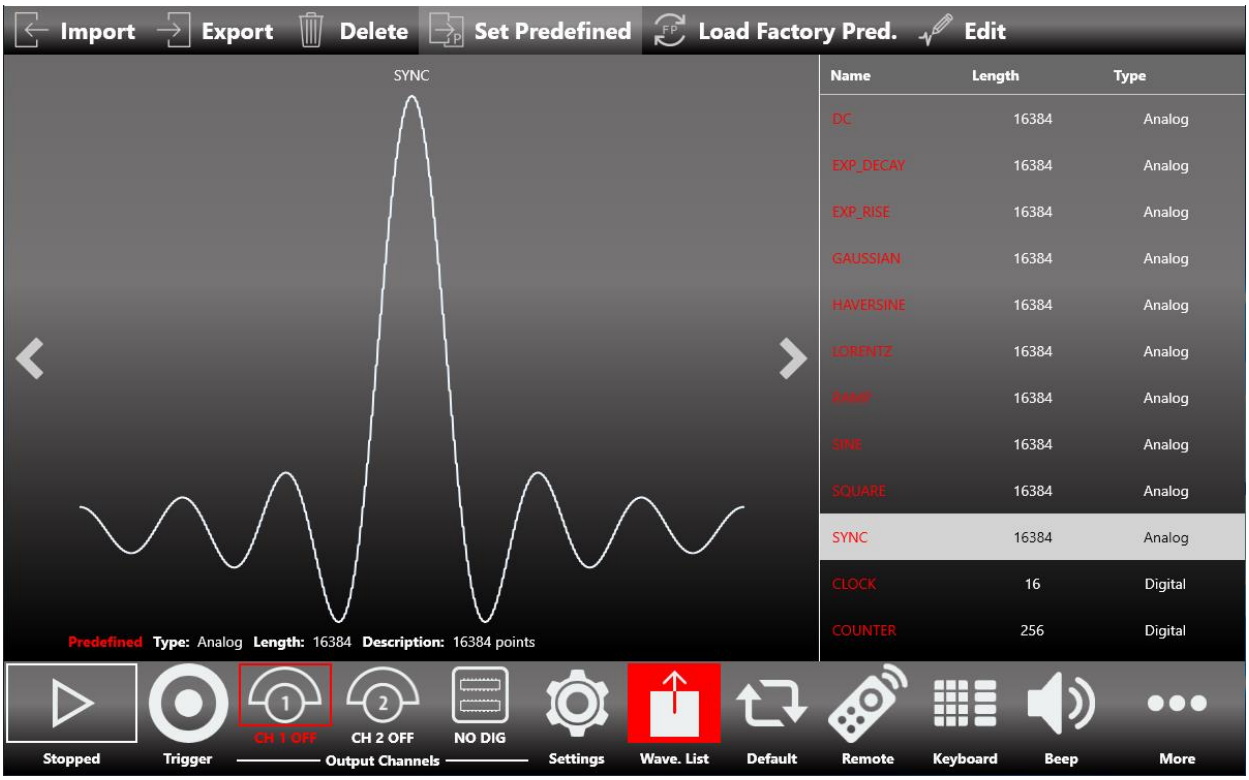
The following credentials must be used when connecting to the instrument by a remote desktop connection:

Computer Name: AT
User Name: AT
Password: 1234

Waveform List

By pressing the 

button the Waveform List page will open showing all the waveforms available in the current configuration.



The T3AWG2152 series contains by default a set of Factory Predefined Waveforms.
The Predefined Waveforms are the ones in red color on the list, the imported waveforms are the ones in gray.

Please note that:

- You can create your own set of Predefined Waveform by promoting waveforms in the list to Predefined ones.
- You can delete a Predefined waveform with the exception of SINE and DC waveforms.
- It is possible to restore the Factory Predefined waveforms by pressing the 

button. All the waveforms previously imported will not be deleted.

How to import a waveform from a file

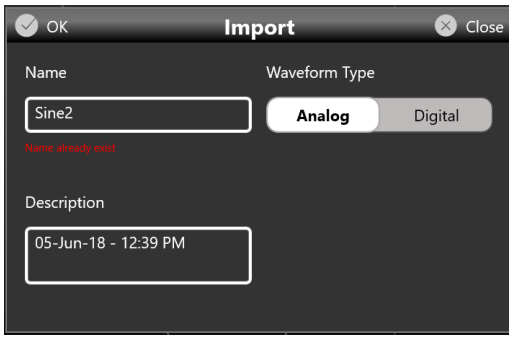
Import button 

allow you to import data from a file to create a new waveform.

The supported file formats are:

- .txt – New line (\n) separated text file (one column only with no header)
- .zip – Compressed file in binary proprietary format
- .trc – LeCroy oscilloscope binary file format
- .bin – Binary file. The software will use two bytes for each sample (little endian format)

1. Press the import button and the Windows File Browser will open, select the file you would like to import. The Import page will open.
2. In the Import dialog, the Name and Description fields will be automatically filled with default values. The imported waveform is normalized.
3. Press OK to confirm or Close to cancel the operation.



How to export a waveform to a file

- Select a waveform on the waveform list.
- Press the 

button.
- The exported waveform will be stored in a proprietary binary .zip file format that can be shared with other instruments running the same application.
- You can export also the Predefined waveforms.
  Please note this special case: if you export a Predefined waveform and then you try to import it again on the list, it will be imported as a standard waveform.

How to promote a waveform to a Predefined

Please note that when a configuration is loaded only all Predefined waveforms and those directly used at the time of saving will appear in the Waveform list.

Before saving a configuration it's necessary to promote an imported waveform as Predefined if the user want to keep it in the Waveform List.

- Select an imported waveform on the waveform list.
- Press the 

button.
- The waveform will appear on the list in red color to show that it has been promoted to Predefined.

How to edit a Waveform

- Prerequisites: "Waveform Editor" software installed.
- Select a waveform on the waveform list.
- Press the 

button to launch the "Waveform Editor".
- Please refer to the "Waveform Editor" user manual for a complete explanation about editing and creating waveforms.

How to create a new Waveform

- Prerequisites: "Waveform Editor" software installed.
- Press the 

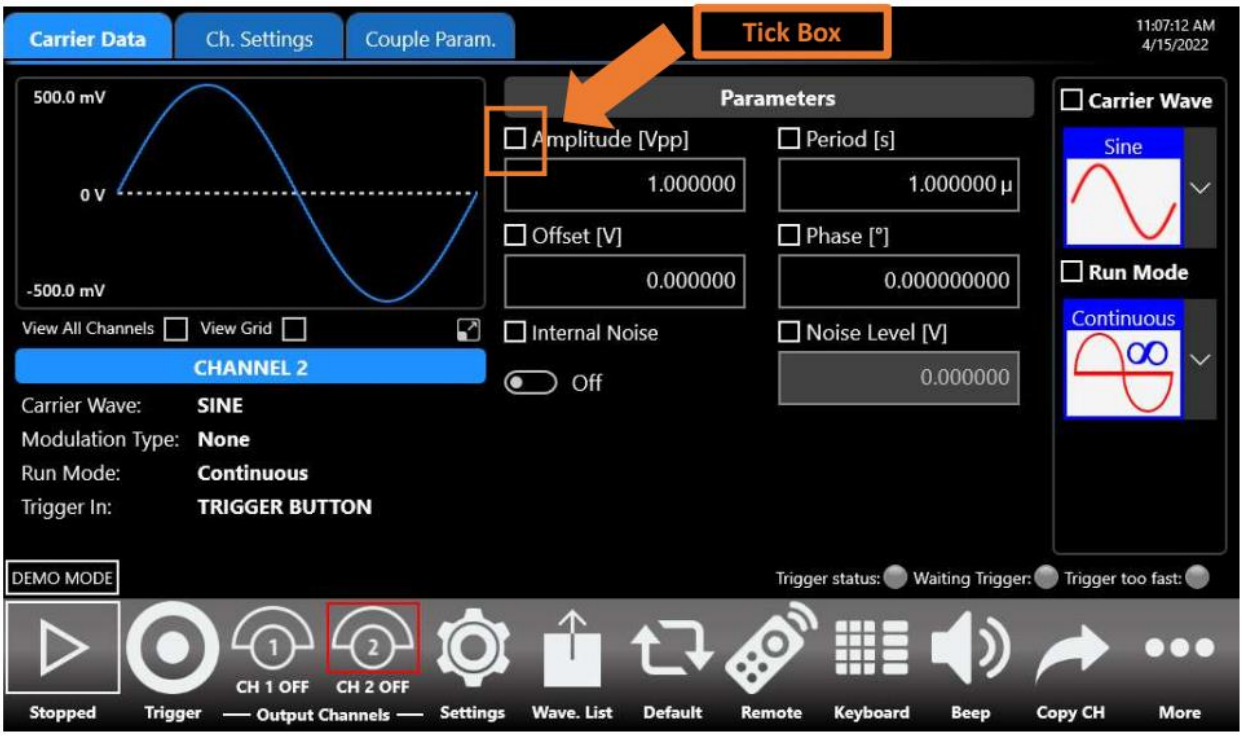
button in the **More**… menu to launch the "Waveform Editor".
- Please refer to the "Waveform Editor" user manual for a complete explanation about editing and creating waveforms.

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.

In **Decoupled** mode the behavior of the signal generated by a specific channel depends only on the parameters set on the channel itself, while it is independent of any parameter set on the other channels of the instrument.

In **Coupled** mode the user can choose which Channel 2 parameters are related to the respective Channel 1 (reference channel) parameters. If this modality is enabled, near all Channel 2 parameters will appear a tick box, where the user can choose whether this should be coupled or not to the corresponding Channel 1 (CH1) parameter.
The coupled parameters will change in real time following the changes of Channel 1 parameters.
Some parameters are already coupled by default when this mode is selected.
The Operating Mode "Coupled" is not allowed between channels with different Output Format. (e.g: the Symmetry parameter of channel CH2, where a Ramp is selected as carrier, cannot be coupled if the carrier of CH1 is a Sine waveform, because for this one the parameter doesn't exist).

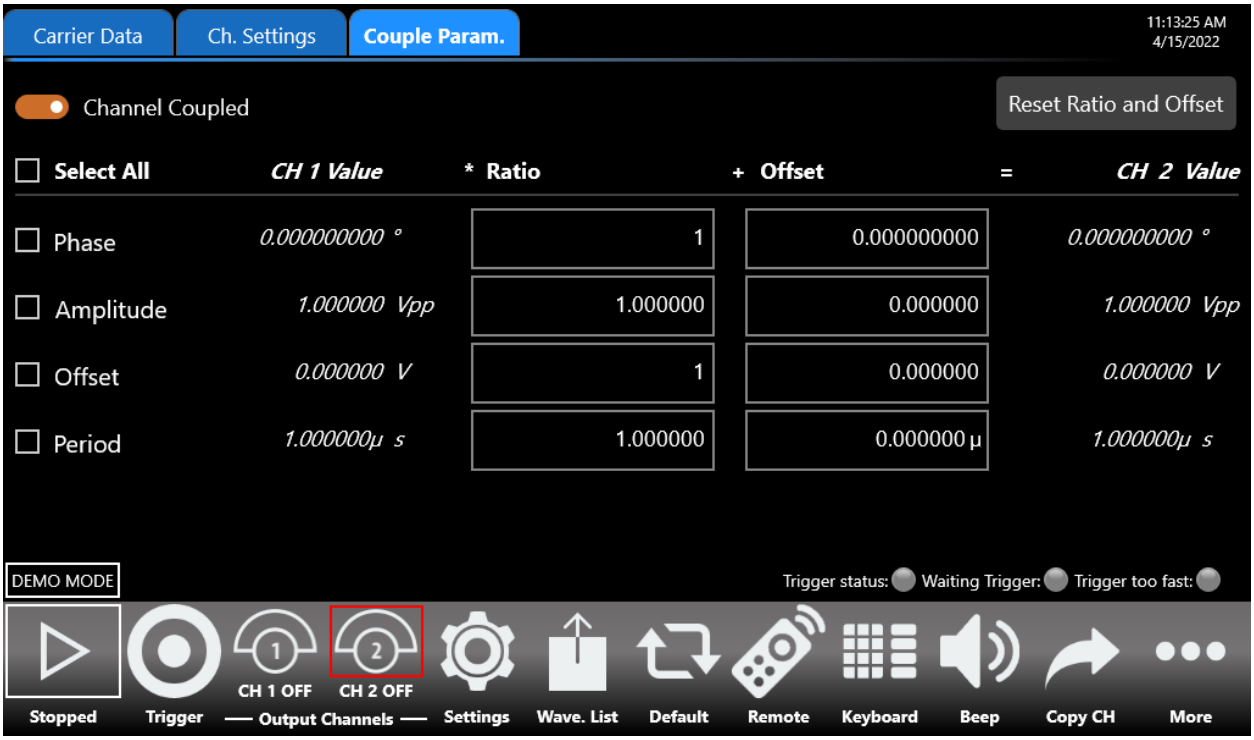


The Channel Coupling section allows you to specify that Channel 2 parameter like frequency, amplitude, offset etc. is related to Channel 1 parameter by a ratio (multiplying) and an offset (adding).

The equation that specifies the relation between the Channel 2 parameter to the Channel 1 parameter is the following:

Ch[2] 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.



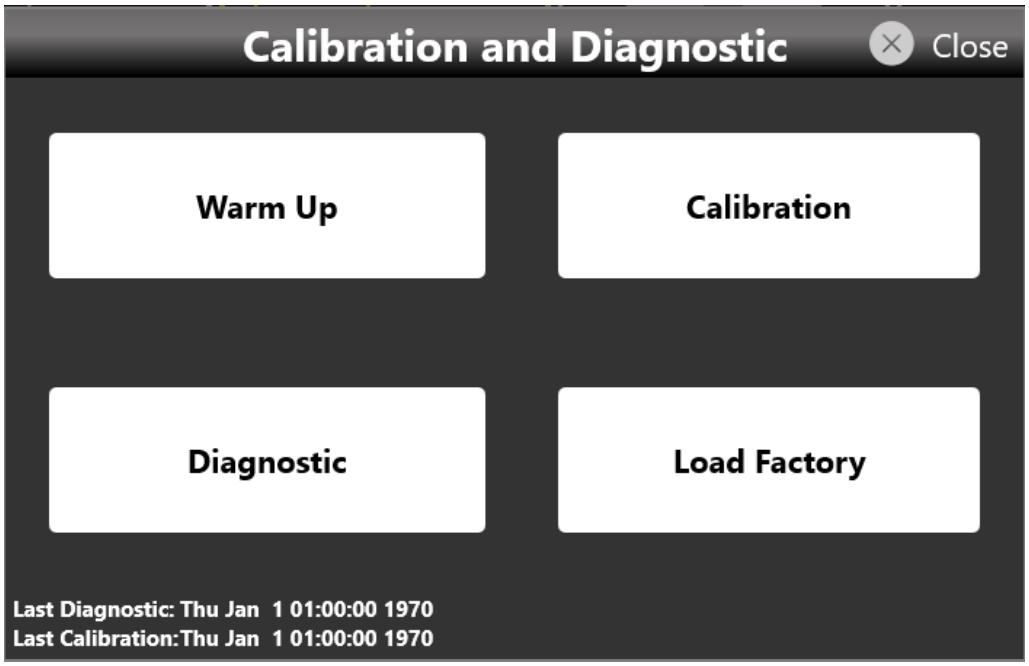
- Swipe up or down to select which parameters to couple to the Channel 1.
- **Toggle Channel Coupled**: enables or disables the channel coupling.
- **Reset Ratio and Offset**: resets the Ratio and Offset parameters to their default values (1 and 0).
- **Select All**: selects/deselects all the available coupling parameters on the selected channel.
- 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.
- Ratio or Offset auto limit their ranges in base of the linked parameter value set.

Calibration and Diagnostic

The calibration button 

in the More... menu 

opens the Calibration and Diagnostic page.



Below a description of the actions executed by pressing the buttons located in the page:

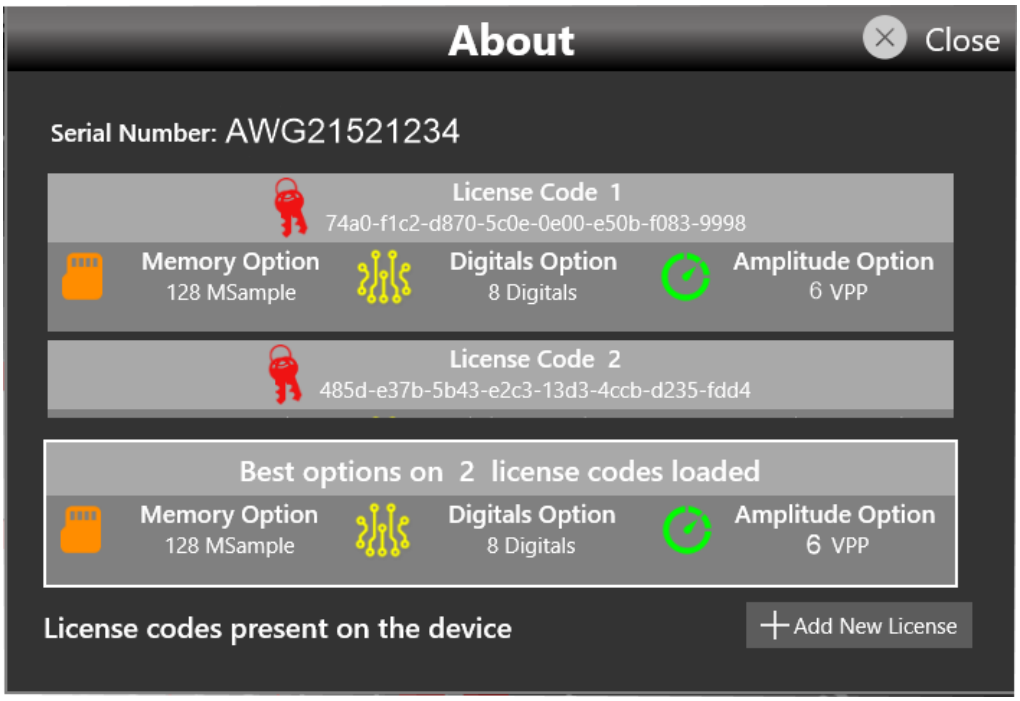
- *Warm up* button: touching this button will start the warm up instrument procedure that will take 30 minutes. The elapsed time is shown. The procedure can be stopped by touching the Stop button located at the bottom right of the Warm Up page
- *Calibration button*: touching this button will start the self-calibration of the instrument. The logs of the procedure are displayed in a text box that can be saved at the end of the procedure for further analysis.
- *Diagnostic* button: touching this button will start the self-diagnostic of the instrument. The logs of the procedure are displayed in a text box that can be saved at the end of the procedure for further analysis.
- *Load Factory* button: touching this button will load the factory calibration parameters.

License

The license button 

in the More... menu 

opens the License page that serves to manage the license options.



T3AWG2152-D includes the licence for operating with 8 Digital Channels in addition to the 2 analog channels.

Additional items included within the T3AWG2152-D

Item	Description
T3AWG3-8DIG-TTL	LVDS to LVTTL digital adapter probe
T3AWG3-8DIG-MSCAB	Cable mini SAS HD 1 m for 8-DIG

To get the licence key please contact your distributor sales representative.

Certifications

Teledyne LeCroy 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, 4kV contact, 8 kV air, 4 kV vertical/horizontal coupling planes [4]

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

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

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

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

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.