Arbitrary Waveform Generator

Moku:Pro User Manual

Moku:Pro's Arbitrary Waveform Generator can generate custom waveforms with up to 65,536 points at update rates of up to 1.25 GS/s. Waveforms can be loaded from a file, or input as a piece-wise mathematical function with up to 32 segments, enabling you to generate truly arbitrary waveforms. In pulsed mode, waveforms can be output with more than 250,000 cycles of dead time between pulses, allowing you to excite your system with an arbitrary waveform at regular intervals over extended periods of time.

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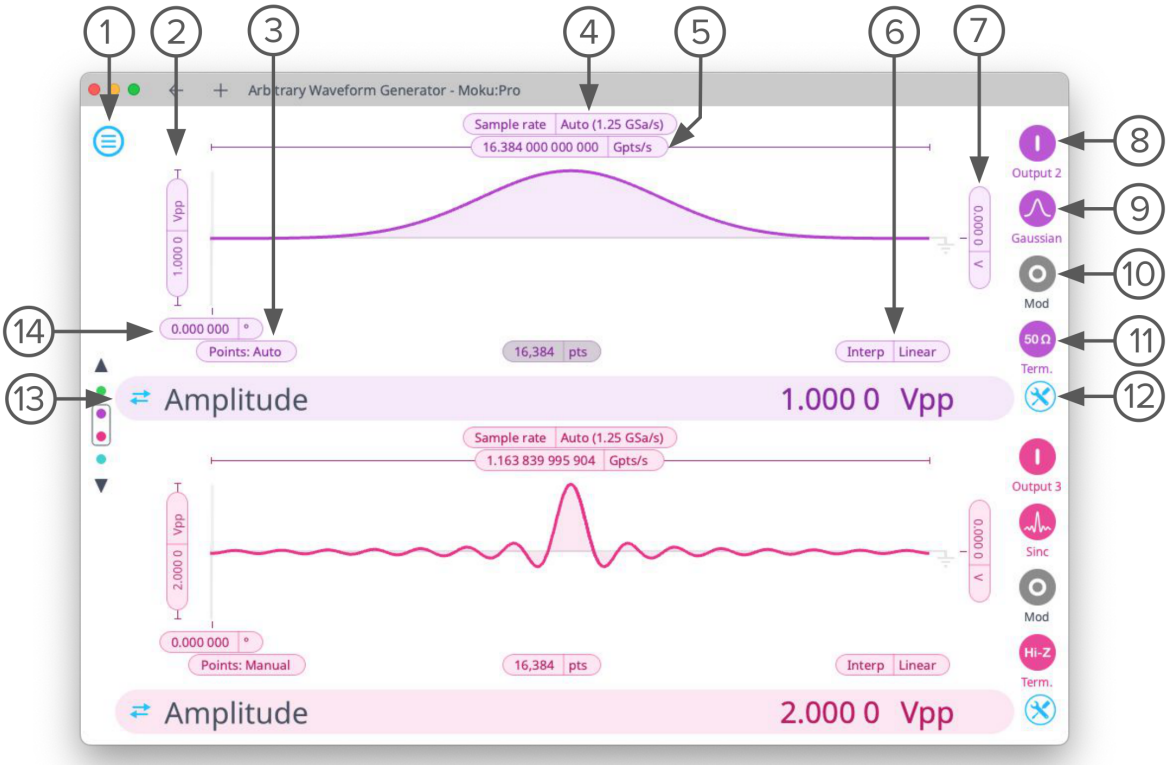
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User Interface

Moku:Pro is equipped with four outputs channels. You can tap the or icons to navigate between channels.



ID	Description	ID	Description
1	Main menu	**8**	Enable/disable output
2	Configure amplitude / high and low levels	**9**	Configure waveform shape
3	Configure number of points	**10**	Enable/disable modulation
4	Configure sample rate	**11**	Configure the termination impedance
5	Configure frequency / period / update rate	**12**	Configuration options*
6	Turn linear interpolation on or off	**13**	Switch between representations**
7	Configure offset	**14**	Configure phase

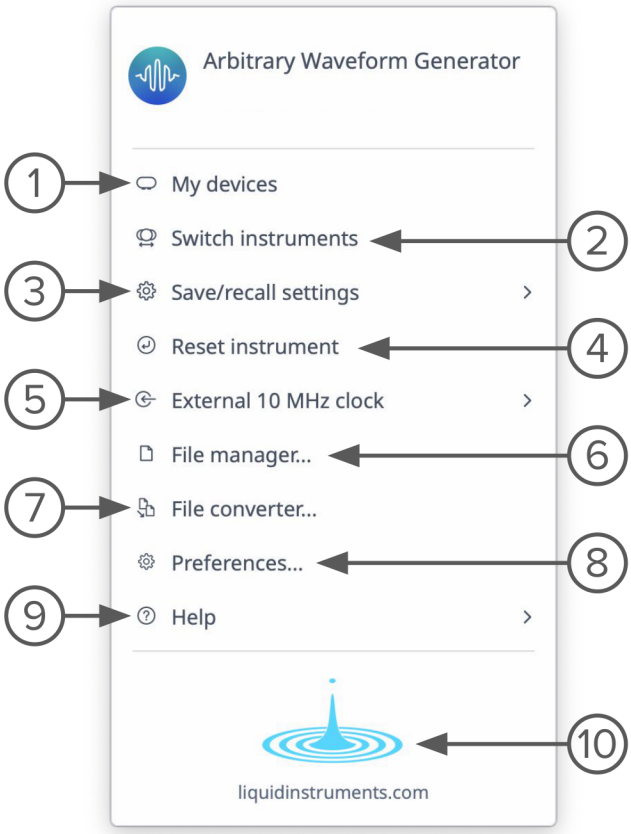
*Use this option to sync phase, copy settings from other outputs, load a waveform from file or clipboard.

**Click the amplitude, offset, frequency, or phase number to make it the active parameter. For amplitude and offset, click the swap button to switch between Vpp/offset or high/low level representations. For frequency, click the swap button to switch between frequency, period, or update rate representations.

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Main Menu

The **main menu** can be accessed by pressing the icon on the top-left corner.

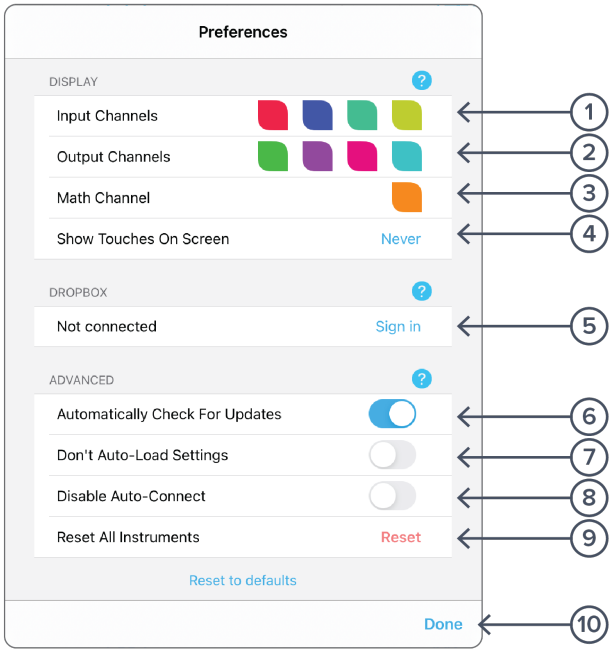


ID	Description
1	Select device or return to selection screen
2	Select instrument or return to instrument selection screen
3	Save and load instrument settings
4	Reset the instrument to its default state (cannot be undone)
5	Enable or disable external 10 MHz reference clock
6	Open File manager to access saved data files
7	Open File converter to convert ".li" data files to other formats
8	Access settings for app theme and channel colors
9	Help • Access the Liquid Instruments website • Show the Moku Shortcuts list • Access the Instrument Manual • Report a bug to Liquid Instruments • About – show app version, check update, or licence information
10	Launch the liquidinstruments.com website

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Preferences

The preferences panel can be accessed via the main menu. In here, you can reassign the color representations for each channel, connect to Dropbox, etc. Throughout the manual, the default colors (shown in the figure below) are used to present instrument features.



ID	Description
1	Tap to change the color associated with input channels.
2	Tap to change the color associated with output channels.
3	Tap to change the color associated with math channel.
4	Indicate touch points on the screen with circles. This can be useful for demonstrations.
5	Change the currently linked Dropbox account to which data can be uploaded.
6	Notify when a new version of the app is available.
7	Moku:Pro automatically saves instrument settings when exiting the app, and restores them again at launch. When disabled, all settings will be reset to defaults on launch.
8	Moku:Pro can remember the last used instrument and automatically reconnect to it at launch. When disabled, you will need to manually connect every time.
9	Reset all instruments to their default state.
10	Save and apply settings.

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Output Configuration

Enable / Disable Outputs

Enable the output of the selected channel by pressing the  icon.

Disable the output of the selected channel by pressing the  icon.

Termination

Select between 50 Ω and Hi-Z termination impedance.

Selecting the correct termination

Moku:Pro's outputs have an impedance of 50 Ω. As such, voltages supplied to a 50 Ω load will be reduced by a factor of two due to the voltage divider formed by the closed circuit. Moku:Pro compensates for this voltage division into 50 Ω loads by doubling the output voltage that is displayed on the interface. A consequence of this is that the voltage measured across a high-impedance load will be *twice* the value displayed on the interface since the voltage division of the high-impedance circuit is comparably small.

Selecting a termination of Hi-Z does not double the amplitude of the generated signal.

Phase Synchronization

The phase of the two outputs can be synchronised by selecting the Configuration options button and then tapping **Sync phase**.

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Output Modes

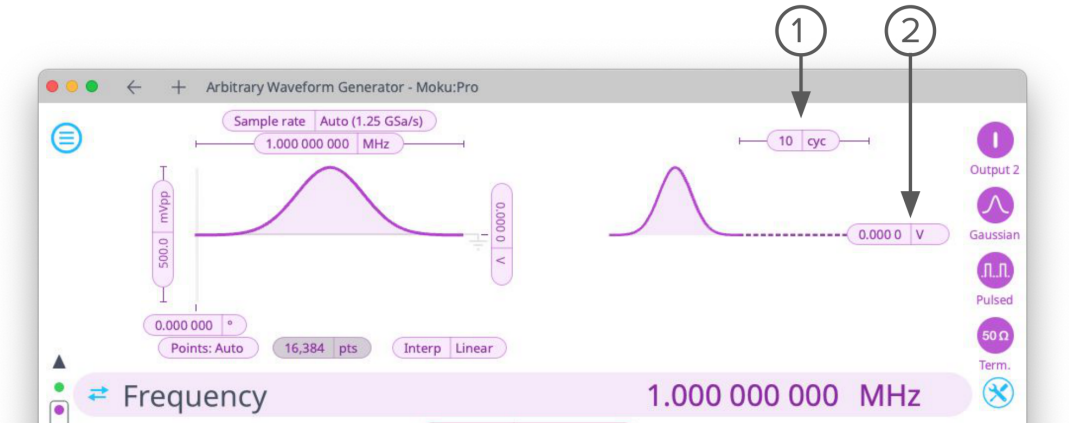
Moku:Pro's Arbitrary Waveform Generator supports three output modes: Normal, Pulsed and Burst.

Normal

In normal mode, the output waveform is repeated continuously with no dead time between cycles.

Pulsed

In pulsed mode, the output waveform can be configured to have up to 2^{18} = 262,144 cycles of dead time between each repetition of the arbitrary waveform.

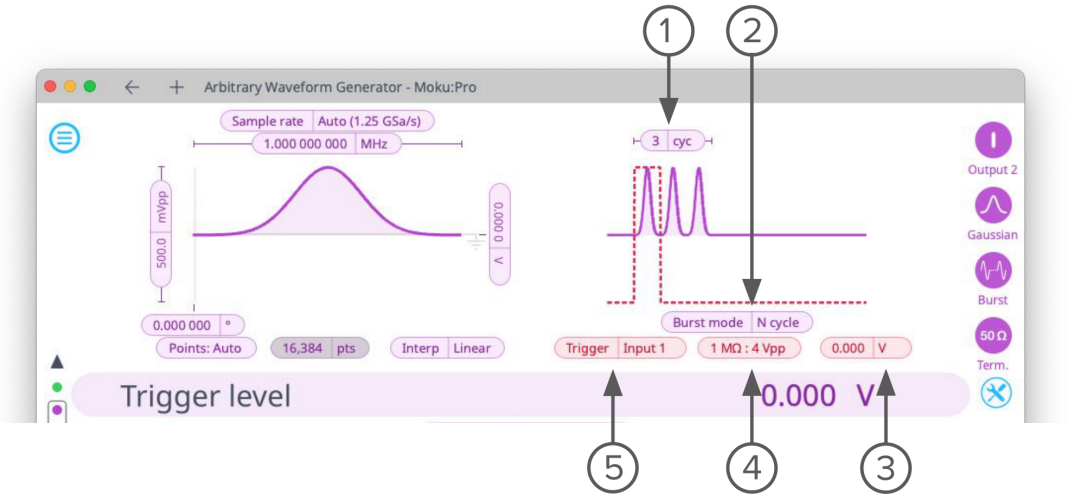


ID	Parameter	Description
1	Dead cycles	Dead time between each repetition of the arbitrary waveform. The period of each cycle of dead time is equal to the selected period of the waveform.
2	Dead voltage	The dead time voltage can be configured to equal any DC value between the waveform's minimum and maximum voltages.

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Burst

In burst mode, the output waveform can be triggered from another signal source. The output, once triggered, varies according to the trigger mode.

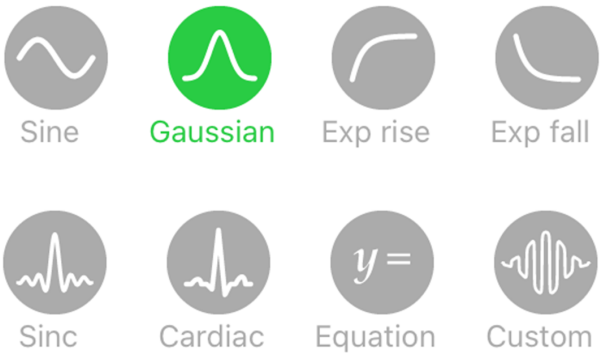


ID	Parameter	Description
1	Burst cycle count	N-Cycle mode only. The number of cycles to generate before re-arming.
2	Burst mode	N-Cycle or Start. The Start mode generates infinite loops of the waveform after the trigger event.
3	Trigger level	Set the voltage level to trigger at.
4	Input range	Set the input channel range.
5	Trigger source	Select between Input 1, Input 2, or Ext. trig.

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Waveform Types

Generate one of six pre-set waveforms, a custom waveform from a file, or a waveform defined by a series of piece-wise mathematical equations.

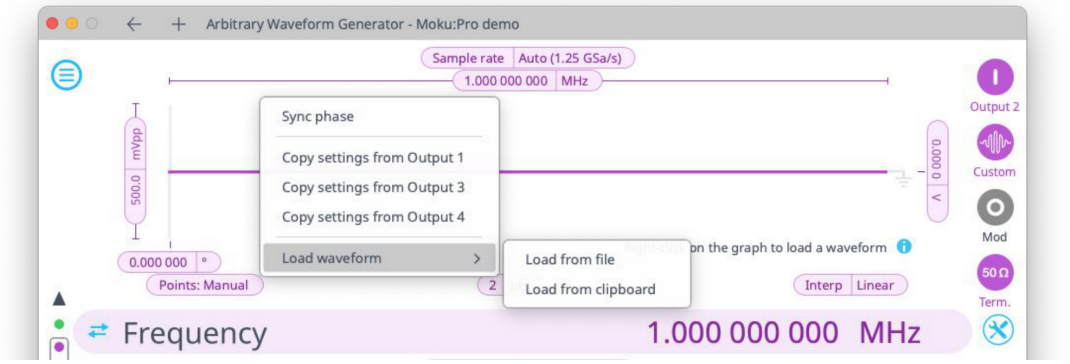


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Custom

Uploading custom waveforms

- Tap the waveform preview to load the waveform.
- Upload custom waveforms from comma- or newline-delimited text from a file or clipboard.
- Up to 16,384 points can be output at an update rate of 1.25 GS/s, up to 32,768 points at 625 MS/s, and up to 65,536 points at 312.5 MS/s.



Maximum recommended sampling rate

- The maximum safe frequency of the generated waveform is equal to the sampling rate divided by the number of points in the custom waveform
    - For example, the maximum safe frequency of a 1000-point waveform is 1 GS/s ÷ 1000 Samples = 1 MHz.
- Exceeding the maximum recommended frequency will result in some points being skipped.

Amplitude scaling and interpolation

- The amplitude of custom waveforms will be normalized to the range [-1, +1] and then scaled to the desired amplitude and offset.
- Select between linear and no interpolation.

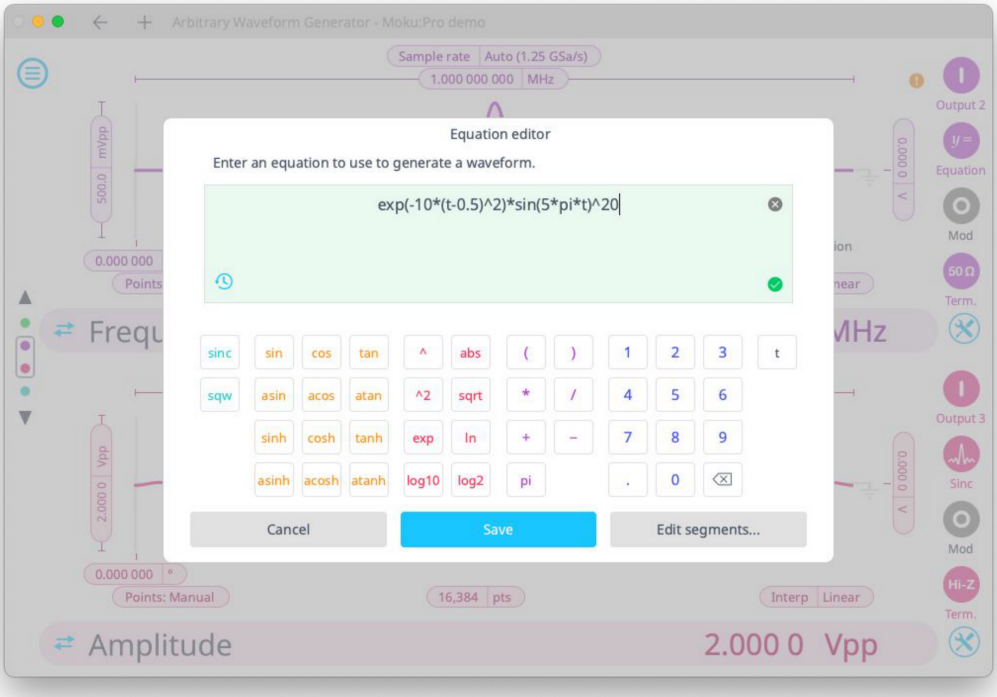
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Equation

The **equation waveform type** enables you to design arbitrary waveforms using up to 32 piece-wise mathematical functions.

Equation editor

- The equation editor allows you to define arbitrary mathematical functions for each segment in the waveform.
- Select from a range of common mathematical expressions including trigonometric, quadratic, exponential and logarithmic functions.
- The variable **t** represents time in the range from 0 to 1 periods of the total waveform
- Access recently entered equations by pressing the icon.
- The validity of the entered equation is indicated by the and icons that appear to the right of the equation box.



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Waveform segments

- Add up to 32 waveform segments and define their fractional time periods within a single period of the total waveform.
- To add or remove segments, press the Add / Remove label and tap the ⊕ and ⊖ icons that appear to the left of the equations.
- To modify the period of an individual segment, tap its **time segment** label and type in the desired end time for that period. The starting time for each segment is the end time for the previous segment.



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