Synertronic Designs

Uragan-μ

Stepper motor driver with data acquisition

Features

- High power stepper motor driver
- Micro-stepping
- Backlash compensation
- Supply voltage up to 72 V
- 4 highly configurable input ports (channels)
- Solid state relay
- PWM output
- 5 V auxiliary supply
- USB interface
- Graphical user interface and Labview integration

Applications

- CNC translation stages
- Measurement stations
- Data acquisition
- Laboratory applications

Overview

Uragan-μ provides a powerful stepper motor driver and several acquisition functions in a small package. Together with the graphical user interface, *Uragan Studio*, the driver can be configured in a matter of minutes for many different applications via an USB interface. A usage diagram is shown in Figure 1.

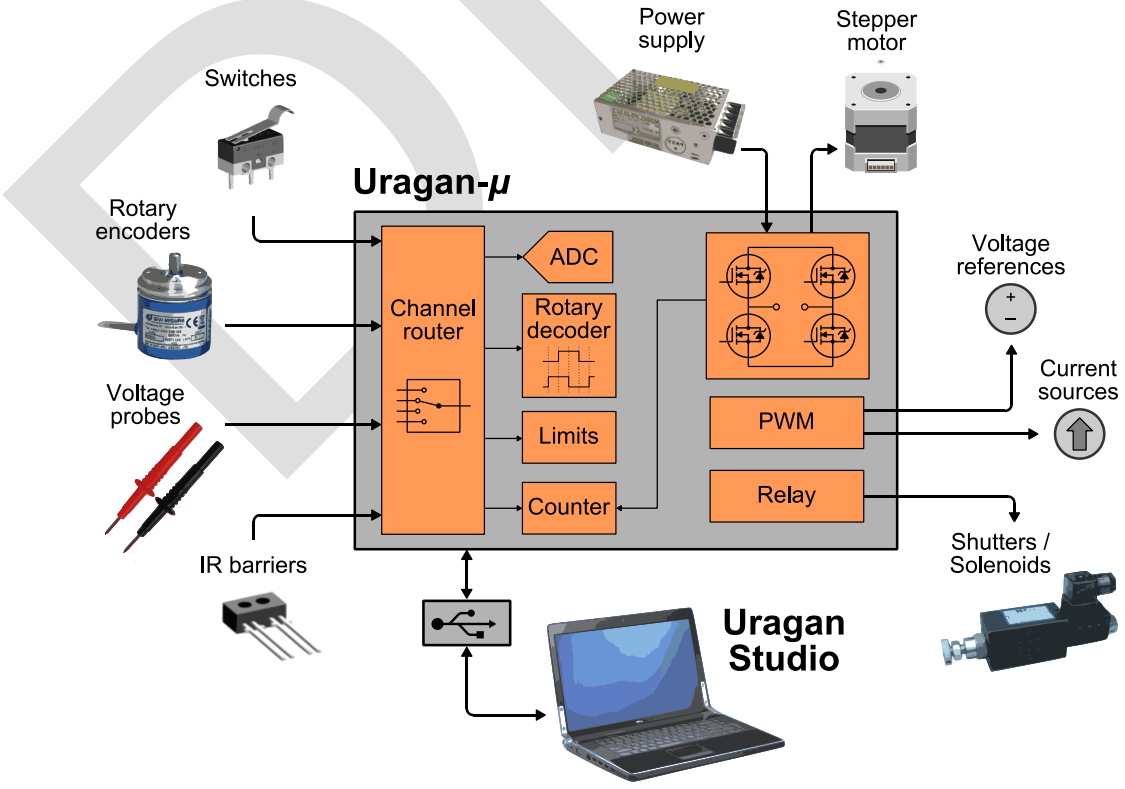


Figure 1 *Uragan-μ* usage diagram.

Specifications

Characteristic		Value	Unit
Stepper motor driver			
Driver type		2-phase, bipolar	
Supply voltage		24 - 72	V
Peak output current per phase		5	A
Micro-stepping		1, 2, 4, 8 and 16	
Maximum step frequency		20 000	steps/s
Acceleration profiles		step, trapezoidal	
Backlash compensation		yes	
Digital/Analogue inputs			
Absolute maximum input voltage		±15	V
Short-term overvoltage (<1 ms)		±100	V
Input current	@ V_i < 1V , no pull-up/down	< 0.1	µA
	@ V_i < 3V , no pull-up/down	< 20	µA
	@ V_i < 15V, no pull-up/down	< 5	mA
Input digital low level		<1.3	V
Input digital high level		>1.5	V
Effective pull-up/down resistance		24	kΩ
ADC			
Maximum measureable voltage		2.048	V
Minimum measureable voltage		-0.2	V
Maximum sample frequency		5	kHz
Minimum sample frequency		0.2	Hz
Voltage RMS noise (maximum over-sampling)		< 5	mV
Gain factors (single-ended mode)		1	
Gain factors (differential mode)		1, 2 ,4, 8, 16, 32, 64	
Low-pass filter cut-off frequency (channel 3 & 4)		150	kHz
PWM			
Signal type		5V-TTL	
PWM frequency		10	kHz
PWM duty cycle range		0 - 100	%
Maximum output current		±20	mA
Solid-state relay			
Operating voltage range		5 - 32	V
Maximum load current		2	A
5V Auxiliary supply			
Output voltage		4.85 - 5.15	V
Maximum output current (voltage > 4 V)		20	mA
PC Interface			
PC interface		USB 2.0 (full-speed)	
Data transfer rate		>1	MB/s
Maximum USB cable length		3	m
Minimum USB supply wire gauge		24	AWG

Table 1 Specifications.

Hardware description

Dimensions

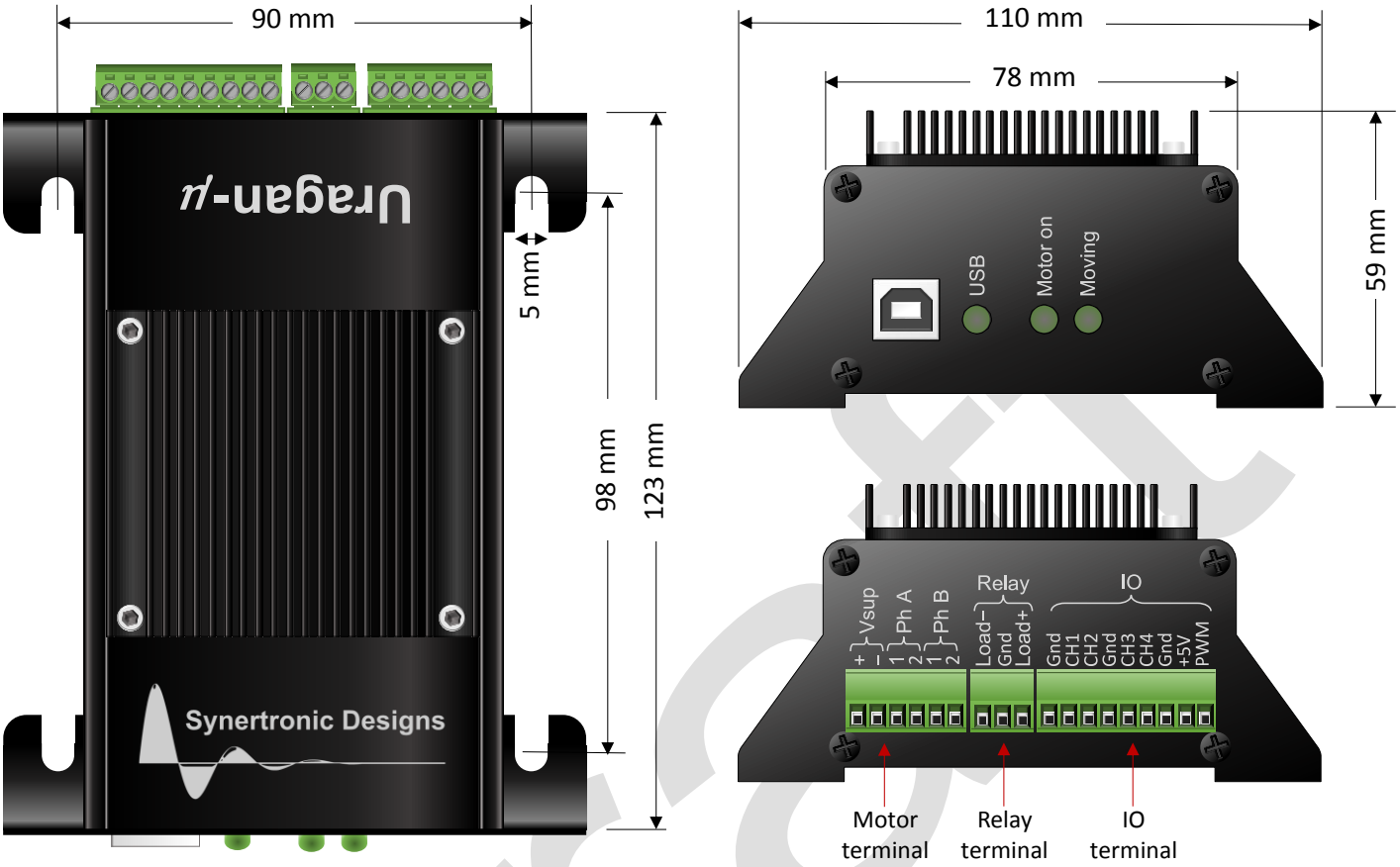


Figure 2 Mechanical dimensions and legend.

Motor terminal

Port	Function
Vsup	Supply voltage for motor driver (24 to 72 V)
Ph A	Phase A of stepper motor
Ph B	Phase B of stepper motor

Table 2 Motor terminal pins.

Relay terminal

Port	Function
Load+	Supply voltage (5 to 32 V) and positive side of load
Gnd	Relay ground (isolated from rest of device)
Load-	Switch and negative side of load

Table 3 Relay terminal pins.

IO terminal

Port	Function
Gnd	3x Ground pins (internally connected to -Vsup)
Ch1, Ch2	Configurable input pins (without low-pass filter)
Ch3, Ch4	Configurable input pins (with low-pass filter)
+5V	Auxiliary 5V output (maximum current: 20 mA)
PWM	PWM output (TTL signal)

Table 4 IO terminal pins.

LEDs

LED	States	
USB	Indicates USB data communication	
Motor on	off	motor power off
	on	motor power on
	blinking continuously	driver error
	blinking for 3 seconds	driver initialising
Moving	off	motor stationary
	on	motor moving

Table 5 LEDs.

Functional description

Connecting devices to a PC

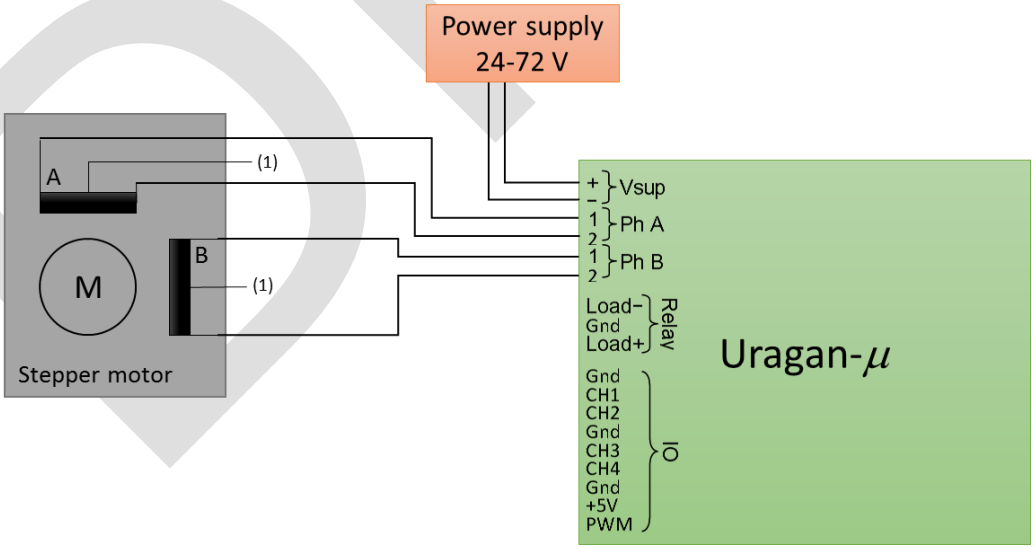
Uragan-μ devices are connected to a PC via USB interfaces. Both USB 2.0 high-speed and USB 1.1 interfaces are supported. Connecting a camera to a USB 1.1 interface will cause a reduction in the maximum data transfer rate to less than 0.5 MB/s. This will reduce the maximum scan rate of the camera.

If a PC has a limited number of USB ports, it is possible to use an external USB hub. Make sure to use a self-powered hub when connecting more than one device to the same USB hub. USB 2.0 bus-powered hubs are not able to source sufficient power to drive more than one device.

Connecting stepper motors

Any stepper motor with two separate phase windings can be connected to the *Uragan-μ*. The phase windings are driven in bi-polar mode. The wiring diagram is shown in Figure 3.

Connect an external supply to the *Vsup* ports. The voltage of the external supply must be between 24 V and 72 V. When the supply voltage is below 24 V, the driver is disabled.



(1) Some stepper motors may have centre taps for each phase winding. Leave these centre taps unconnected.

Figure 3 Stepper motor wiring diagram.

If the motor turns the wrong way, swap the two wires of one of the motor phases.
If the motor driver reports a phase error, swap one of the wires of phase A with a wire of phase B.

Connecting loads to the solid-state relay

The solid-state relay is electrically isolated from the rest of the device (stepper motor supply and control ground). It requires a separate external power supply, or it may also be connected to the motor power supply. The wiring diagram for the solid-state relay is shown in Figure 4.

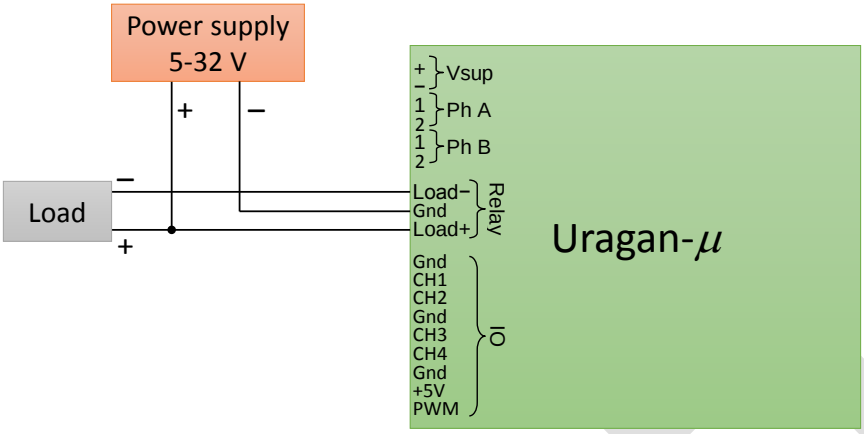


Figure 4 Solid-state relay wiring diagram.

The solid-state relay is able to drive inductive loads (for example: relays and shutters). It contains a protection diode and can safely turn off inductive loads.

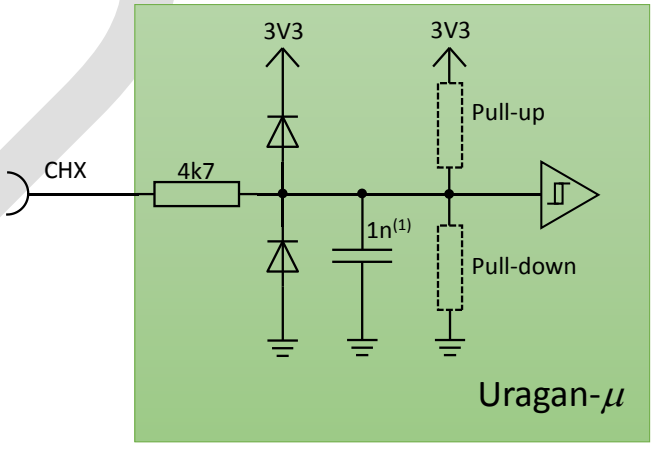
Using the input channels

The *Uragan-μ* provides four input channels. These channels can be configured to perform one of the following functions:

- Digital inputs
  - Limit switches
  - Event counting
  - Quadrature decoding
- Analogue inputs
  - High-impedance for single-ended or differential voltage measurements
- Special purpose control inputs
  - External control inputs for turning the motor power on/off and moving the motor

The input channel functions are configured with *Uragan Studio*. Alternatively, it is also possible to configure basic limit switch settings with the *Uragan* Labview libraries.

The equivalent input model for each input channel is shown in Figure 5.



(1) Only CH3 & CH4

Figure 5 Input channel model.

When using the input channels as digital inputs, additional settings are available:

- Input impedance
  - High-impedance
  - With internal pull-up resistor
  - With internal pull-down resistor
- Edge sense (for limit switches and event counting, only)
  - Rising edge trigger
  - Falling edge trigger

Connecting limit switches

There are two main limit switch categories: passive (mechanical) and active (optical, magnetic) limit switches. Passive limit switches do not require an auxiliary power source. Active limit switches require an auxiliary power source. In many cases, active limit switches can be powered by the auxiliary +5V source of the *Uragan-μ*. Older types of limit switches may draw more current. In these cases, an additional external voltage supply is required. Up to two limit switches can be connected:

- start limit switch
- end limit switch

The wiring diagrams for different limit switch types and configurations are shown in the figures below.

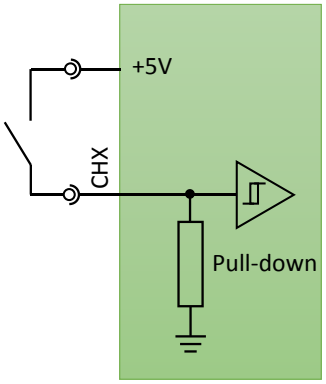


Figure 6 Passive limit switch with pull-down.

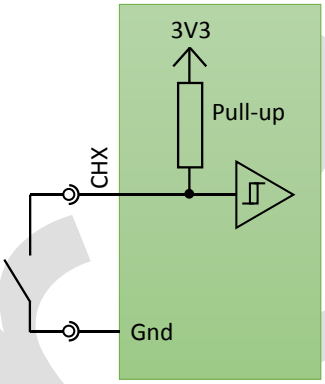


Figure 7 Passive limit switch with pull-up.

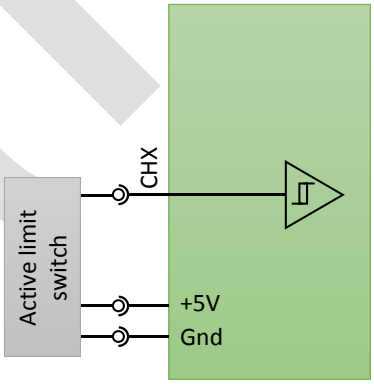


Figure 8 Active limit switch.

For each limit switch, the trigger edge must be specified. When a limit switch is active high, the rising edge must be selected as trigger. When a limit switch is active low, the falling edge must be selected as trigger.

The motor will only stop at the end limit switch, while moving in the positive direction. It will only stop at the start limit switch, while moving in the negative direction. It is important to define the correct end and start limit switches. If the start and end limit switches are reversed, the motor will not stop.

Connecting external motor control switches

The motor driver can also be controlled using external switches. The wiring diagram is depicted in Figure 9.

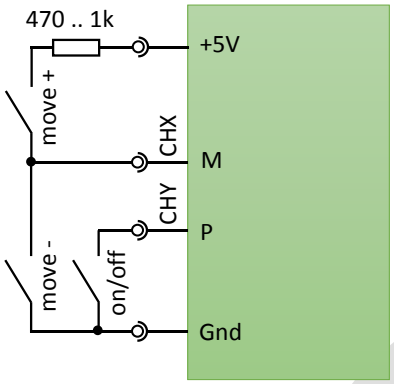


Figure 9 External motor control.

For this feature two input channels must be configured with *Uragan Studio*:

- M: Move motor
- P: Motor power on/off

The *P* channel connects to a single switch. When the switch is closed, the motor power is turned on. The *M* channel connects to two switches (e.g. push button or toggle switches). One switch will move the motor in the positive direction and the other will mote the motor in the negative direction.

Connecting quadrature encoders

There are two main quadrature encoder categories: passive (mechanical) and active (optical, magnetic) encoders. Passive encoders do not require an auxiliary power source, whereas active encoders require an auxiliary power source. In many cases, active encoders can be powered by the auxiliary +5V source of the *Uragan-μ*. Older types of encoders may draw more current. In these cases, an additional external voltage supply is required.

The wiring diagrams for different encoder types and configurations are shown in the figures below.

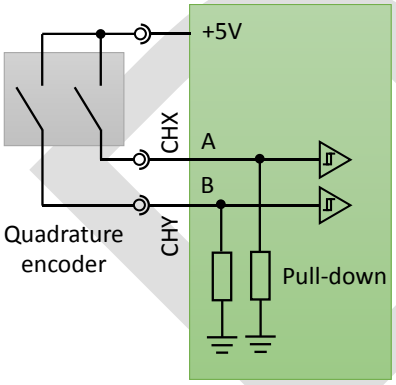


Figure 10 Passive quadrature encoder with pull-downs.

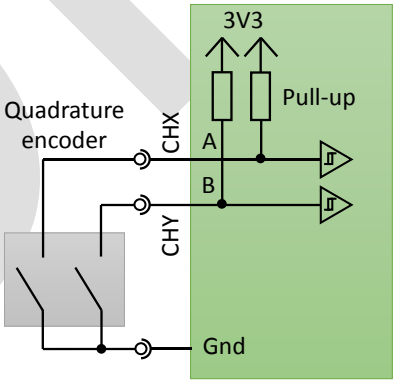


Figure 11 Passive quadrature encoder with pull-ups.

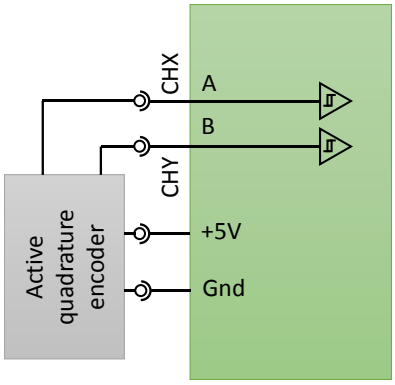


Figure 12 Active quadrature encoder.

Connecting voltage measurements

The *Uragan-μ* contains one analogue to digital converter (ADC) with internal gain stage. The ADC supports single-ended and differential measurements. Single-ended measurements support only a gain factor of X1. Differential measurements support gain factors X1, X2, X4, X8, X16, X32 and X64.

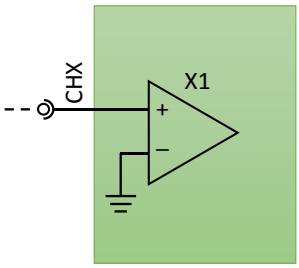


Figure 13 Single-ended ADC.

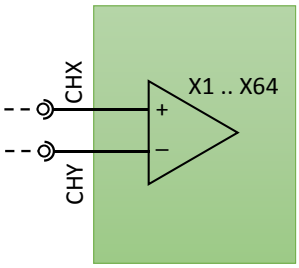


Figure 14 Differential ADC.

The voltage range, $V_{\text{range,se}}$, and resolution, $V_{\text{res,se}}$, for single ended measurements is given by:

$$V_{\text{range,se}} = -0.3\,..\,2.048\ \text{V}, \qquad V_{\text{res,se}} = 1\ \text{mV}.$$

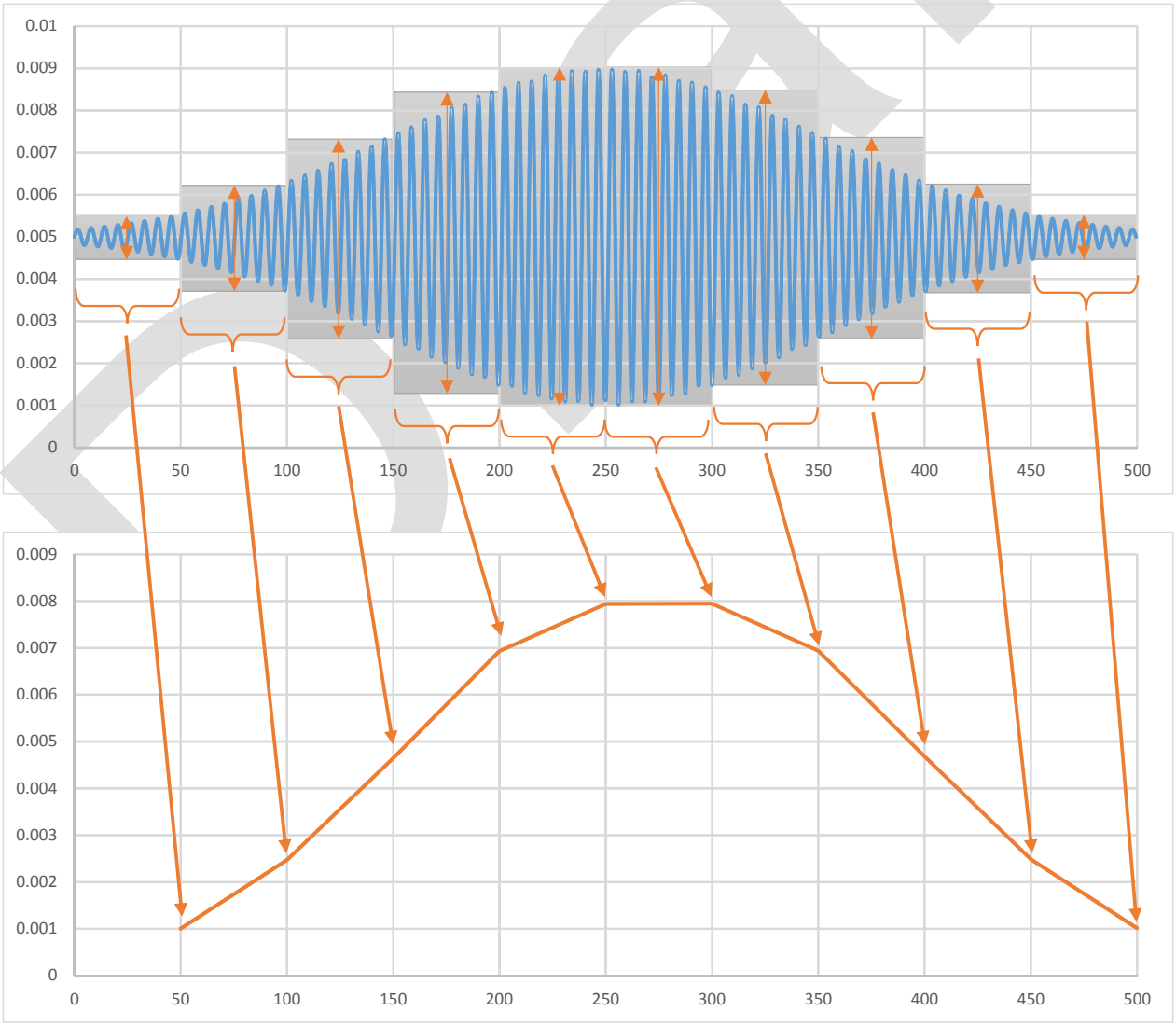
The voltage range, $V_{\text{range,se}}$, and resolution, $V_{\text{res,se}}$, for single ended measurements is given by:

$$V_{\text{range,dif}} = \frac{-0.3\,..2.048\ \text{V}}{\text{gain factor}}, \qquad V_{\text{res,dif}} = \frac{1\ \text{mV}}{\text{gain factor}}.$$

The ADC supports over-sampling. With over-sampling, several data points are measured and averaged for the same data point. This reduces noise and improves the resolution when measuring small signals.

Peak-peak voltage measurements

The ADC supports a peak-peak measurement mode. In this mode the peak-to-peak amplitude of an AC signal is measured over fixed intervals.



For example: In the diagrams above an AC signal is measured (top diagram). Over successive fixed time intervals, the ADC will measure the ADC waveform and determine the maximum and minimum. The difference between the maximum and minimum is calculated and returned as the peak-to-peak amplitude over the given interval. The resulting waveform is shown in the bottom diagram.

Peak-peak measurements are especially useful when measuring intensity, originating from 50 or 60 Hz light sources.

Uragan Studio

Uragan Studio is a stand-alone user interface to configure, control and take measurements with *Uragan* devices.

Installing Uragan Studio

The installer for *Uragan Studio* can be downloaded from the Synertronic Designs web page. Download and run the installer.

If the target PC is not connected to the internet, it is advisable to pre-install the USB device driver. The USB device driver can be downloaded from the Synertronic Designs web page.

Home page

When starting the application the *Home* page is displayed.

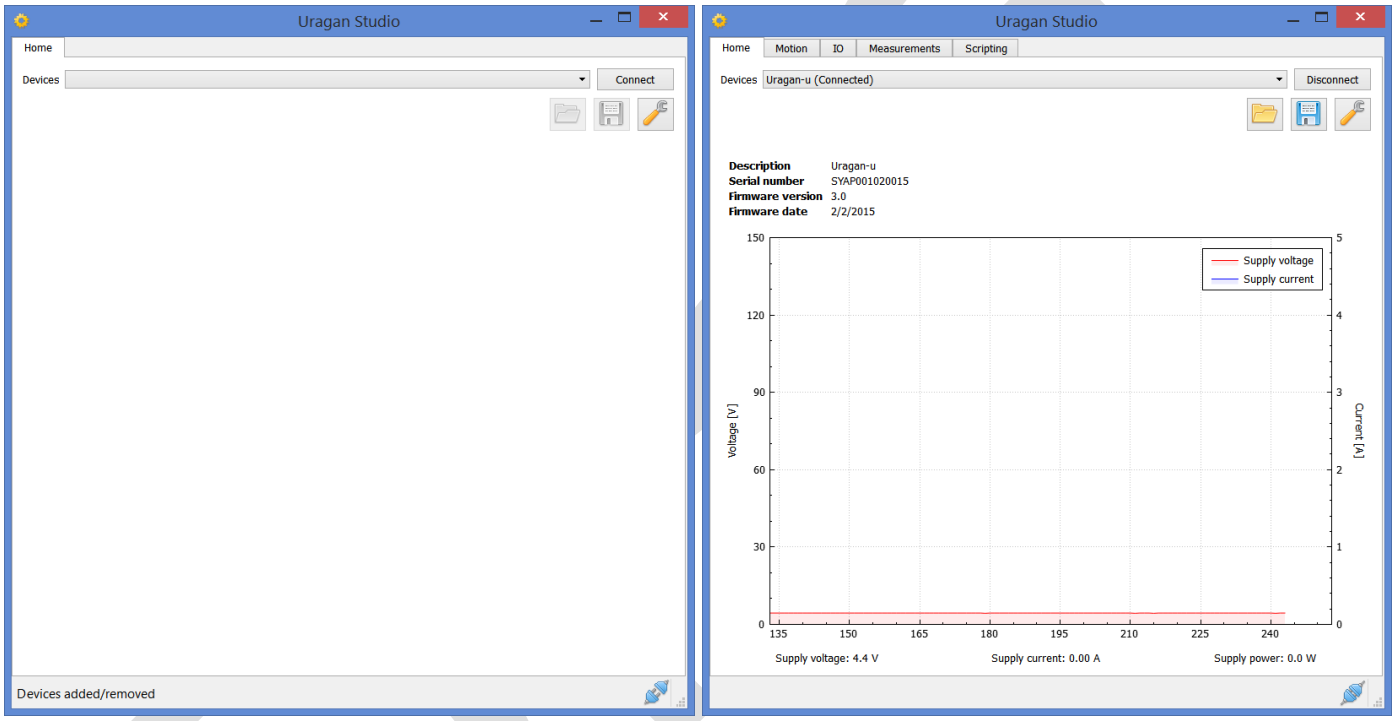
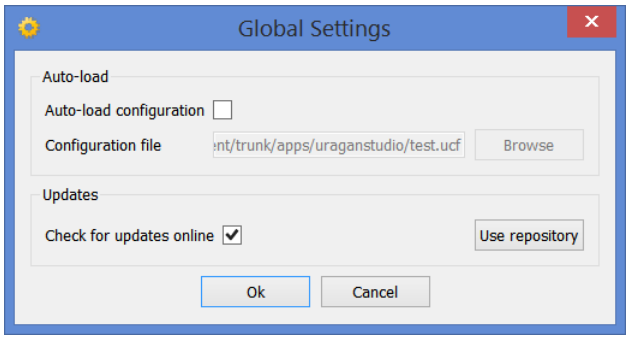


Figure 15 Home page in unconnected (left) and connected (right) state.

All available *Uragan* devices are listed under the *Devices* drop-down. Select one of the devices and click *Connect*. When a connection is established, information about the device is displayed. The information includes the devices description, serial number, firmware version and firmware date. A graph showing the motor supply voltage and current is also displayed. The following pages are added to the user interface:

- *Motion* Motor and motion settings.
- *IO* Connection diagram and settings for the available input channels and outputs.
- *Measurements* Measurement graphs and settings.
- *Scripting* Python scripting environment.



Click  to open the global settings dialog. The global settings dialog gives access to the update settings. In the *Updates* group, *Check for updates online* can be enabled or disabled. When enabled, *Uragan Studio* will try to connect to the online update repository and download any new software and firmware. For more information on updating software and firmware see “Software and firmware updates”.

The *Auto-load* group provides options to automatically load configuration files, when connecting to a device. To enable

this feature, the *Auto-load configuration* checkbox must be checked and a valid configuration file must be specified.

Configuration files are saved and loaded by clicking the or icon. This opens a file dialog and the relevant configuration file can be selected. When the auto-load feature is used, the relevant settings must first be configured and saved to a configuration file. This configuration file must then be specified in the global settings dialog.

Software and firmware updates

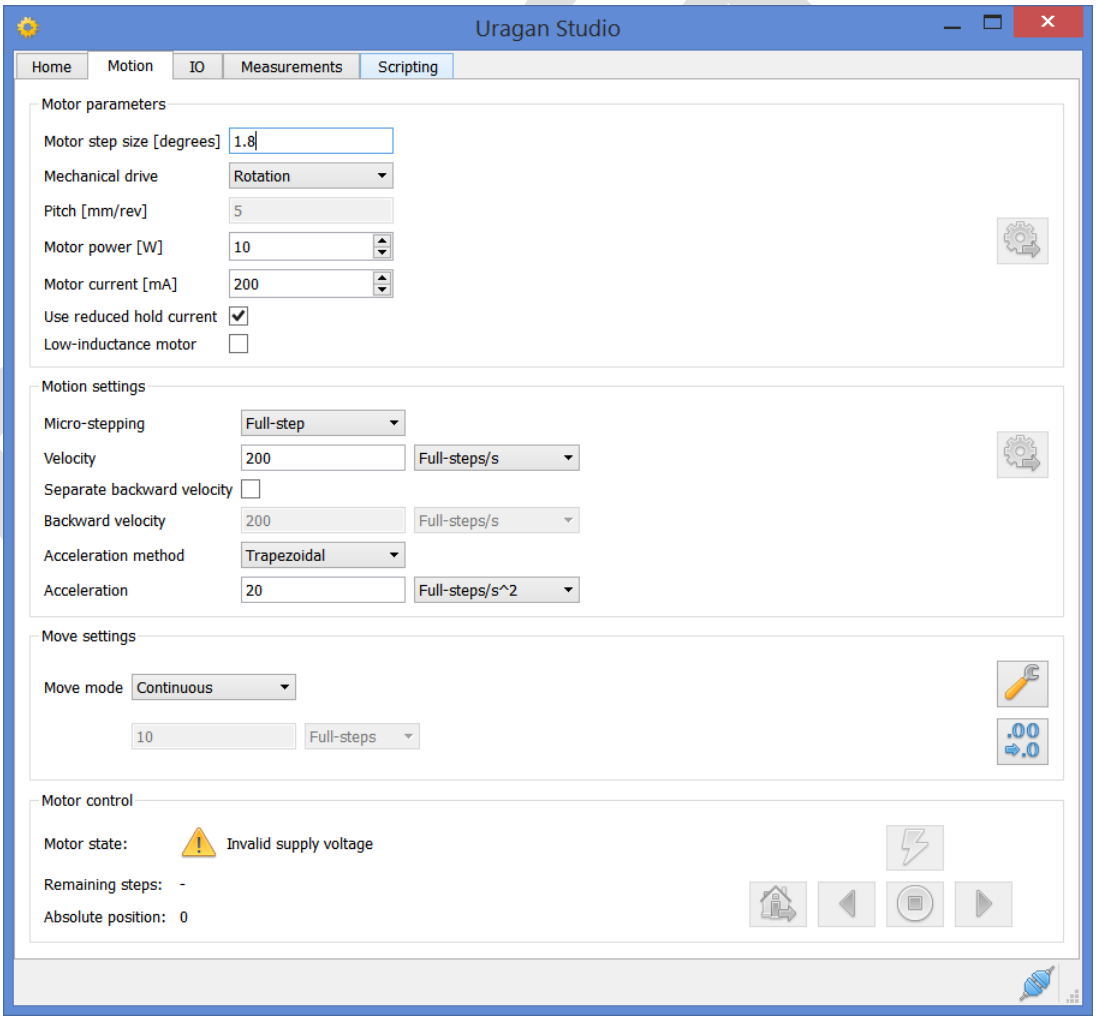
When check for online updates is enabled, *Uragan Studio* will try to download the latest software and firmware updates from the online repository of Synertronic Designs. If a new version of *Uragan Studio* is available, the user will be notified. When the application closes, the application will ask if the new version must be installed.

If new firmware is available, the user will be asked to update the firmware of the connected device. Firmware updates can take 1 to 3 seconds.

Under no circumstances, disconnect the device during a firmware update. If a firmware update fails due to a power failure or disconnecting the device, the device must be returned to Synertronic Designs for reprogramming.

Motion page

The motion page contains the motor parameters and motion and move settings. It also contains the controls for turning the motor power on and off and moving the motor forward and backward.



Motor parameters

Motor step size [degrees]	The full-step step size of the connected stepper motor. Often, this value is printed on the stepper motor. Alternatively, it can be obtained from datasheets. This value is used to perform unit conversion for settings specified in revolutions or revolutions/s. The value is also used to perform unit conversion for motor position measurements.
Mechanical drive	The mechanical drive is either rotational or linear (i.e. for linear translation stages).
Pitch [mm/rev]	When *linear translation* is selected for the mechanical drive, this value is used to specify the pitch of the linear translation screw. This parameter is used to perform unit conversions for settings specified in mm or mm/s. The value is also used to perform unit conversion for motor position measurements.
Motor power [W]	The rated maximum average power of the stepper motor.
Motor current [mA]	The maximum rated phase current of the stepper motor.
Use reduced hold current	When enabled, the motor current is reduced by 50% when in hold mode.
Low inductance motor	This option should be used with care. In most cases this option should be disabled. For stepper motors with a low voltage rating (<3V) this option can be enabled, to reduce the minimum obtainable motor phase current.
	Upload the new motor settings to the device.

Motion settings

Micro-stepping	Sets the micro-stepping step size. The options are: Full-step Half-step Micro-step 1/4 Micro-step 1/8 Micro-step 1/16 Smaller step sizes result in smoother motion and more accurate positioning. *Full-step* is recommended for high-speed motions, where accuracy is not important. *Micro-step 1/16* is recommended for slower motion with higher accuracy.
Velocity	The motor speed. It can be specified in: Full-steps/s Radial velocity Degrees/s Revolutions/s RPM The maximum motor speed is limited by the *Micro-stepping* setting. For the *Full-step* setting, the maximum velocity is 20 000 Full-steps/s. When using the *Radial velocity*, *Degrees/s*, *Revolutions/s* and *RPM* units, the correct *Motor step size [degrees]* parameter must be specified.
Separate backward velocity	When enabled, a different backward velocity can be specified. This is useful when operating in the *Back and forth* move mode.
Backward velocity	The backward motor speed.
Acceleration method	Acceleration can be either *Step* or *Trapezoidal*. For *Step* acceleration the motor speed will jump from hold to the specified velocity. For *Trapezoidal* acceleration the motor speed is increased linearly from zero to the specified velocity.
Acceleration	The time for the motor to reach the specified velocity is given by: *Acceleration time = Velocity / Acceleration*
	Upload the new motion settings to the device.

Move settings

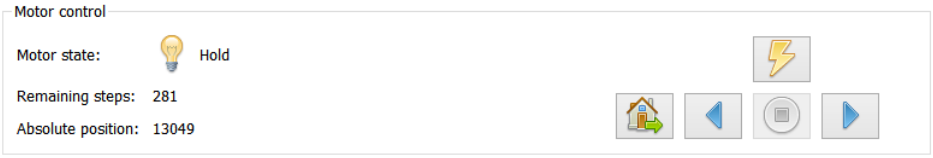
Step count or *Position*	The position or step count (i.e. distance) for the *Relative*, *Absolute* and *Back and forth* move modes. It can be specified in: Full-steps Micro-steps Revolutions mm When using *Revolutions* the correct *Motor step size [degrees]* parameter must be specified. In addition, when using *mm*, the correct *Pitch [mm/rev]* must be specified.
	Opens the *Advanced move settings* dialog. Open the dialog to specify backlash compensation and the home position settings.
	Manually set the current absolute position to zero.

Using absolute positions

When the *Absolute* move mode is selected, the motor is moved to absolute positions. It is important to define a home position. The home position can be configured to also be the absolute zero position. In most cases one of the limit switches (start or end) is used as the home position and is defined on the *Advanced move settings* dialog.

Motor control

The motor control section provides information about the current motor state and motor position and contains the motor control buttons.



Motor state	The current motor state:	
	Invalid supply voltage	The motor supply voltage is below 24 V.
	Off	A valid supply voltage is detected and the motor power is off. It is also indicated, when one of the limit switches is reached. For example: *Off (at start)*
	Hold	The motor power is on and in hold (not moving) state. It is also indicated, when one of the limit switches is reached. For example: *Off (at start)*
	Moving	The motor is busy moving.
	Error	An error was encountered. Click the *Clear error* button to clear the error and resume operation.
Remaining steps	Indicates the remaining steps to move, when in *Absolute* or *Relative* move mode.	
Absolute position	The absolute motor position in full-steps.	
	Turn the motor power on or off.	
	Move the motor in the positive direction using the current move mode. When *Back and forth* move mode is selected, this will start the back-and-forth movement. When *Absolute* move mode is selected, this will move the motor to the target position.	
	Move the motor in the negative direction. Only enabled in *Relative* and *Continuous* move modes.	
	Manually stop the motor. No deceleration is used.	
	Move the motor to the home position.	

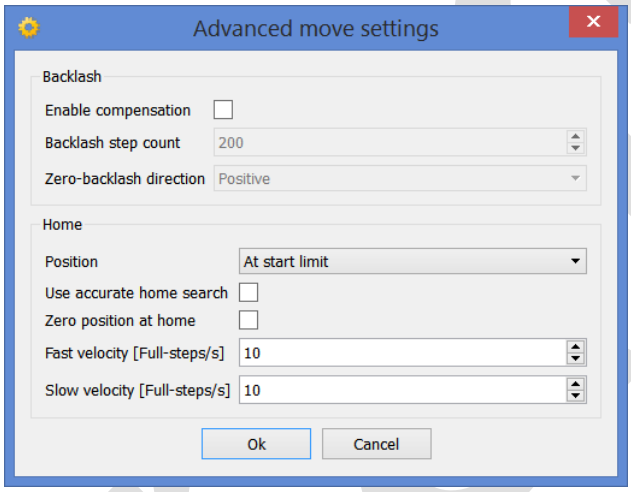
When stopping the motor manually by pressing the button, no deceleration is used. The motor will stop abruptly and no backlash compensation is performed.

When moving to the home position by pressing the button, the correct home position and limit switch settings must be defined.

When the motor state indicates that both limit switches have been reached (for example: *Hold (at start and end)*), it indicates, that the limit switches are configured incorrectly.

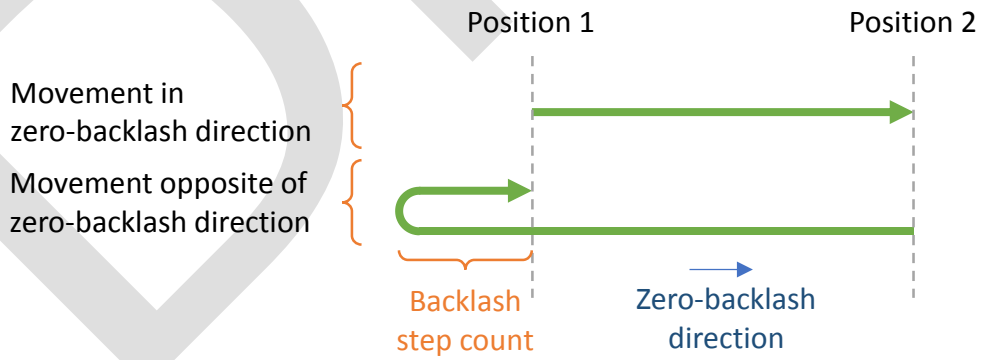
Advanced move settings

The *Advanced move settings* dialog gives access to the backlash compensation and home position settings. Open the dialog by clicking on the icon on the *Motion* page under *Backlash* .



Backlash compensation

Backlash compensation removes backlash in a given direction. An example is depicted in the diagram below. The zero-backlash direction is set to the right or positive direction.



When the motor is moved from position 1 to position 2 it will simply stop when it reaches the target position 2. When the motor is moved from position 2 to position 1 (opposite of the zero-backlash direction), it will move passed the target position 1 for the given number of backlash steps. After this, the motor moves back in the zero-backlash direction, until it reaches the target position 1.

Backlash settings

Enable compensation	When checked, backlash compensation is enabled.
Backlash step count	The number of full-steps used for backlash compensation.
Zero-backlash direction	The direction used for zero-backlash.

Home search and position

One of the configured limit switches can be used as the home position. When pressing the icon on the *Motion* page, the motor will move towards the home position and stops at the home limit switch. When the limit switch is reached, the motor driver can perform an additional accurate home search at a lower motor speed. When backlash compensation is enabled, the home search also takes backlash compensation into account.

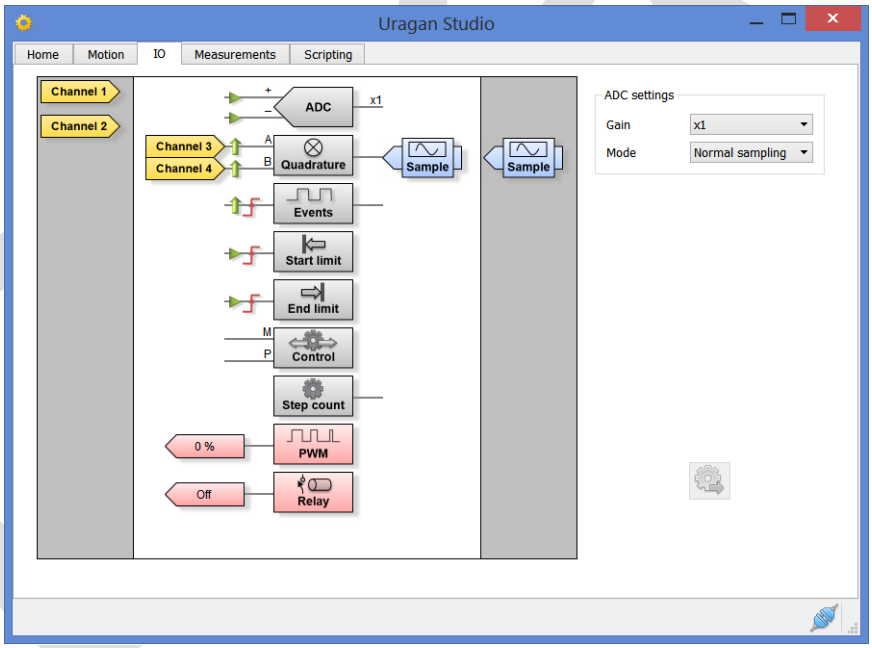
Home settings

Position	Select the home position either as *at start limit* or as *at end limit*.
Use accurate home search	When enabled, the motor driver performs a home search with increased accuracy at a lower motor speed
Zero position at home	The absolute position is automatically set to zero, when the home position is reached.
Fast velocity [Full-steps/s]	The motor speed used to move towards the home position.
Slow velocity [Full-steps/s]	The motor speed used for the accurate home search.

If no limit switches have been configured, the home search will not work correctly.

IO page

The IO page contains an interactive diagram for connecting the input channels to different function blocks. On the right-hand side is a context-sensitive control panel. Select a function block in the diagram to gain access to the corresponding controls.



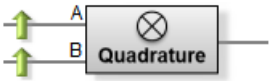
Input channels

Four input channels are available. When not connected to a function block, the channels are listed in the left-hand column of the diagram. The following symbols indicate the four input channels:

Input function blocks

Input functions blocks are coloured in grey. Each function block has one or more input terminals and an optional output terminal. Input channels can only be connected to the input terminals. Connect an input channel by dragging it to the corresponding input terminal. While dragging an input channel, orange dots highlight all valid terminals. When a channel is close enough to a valid terminal the dot colour changes to dark orange. To disconnect a channel, simply drag the channel away from the terminal and release the mouse key. The channel will move back to the left-hand column. The following input function blocks are provided:

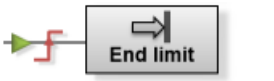
ADC (Analogue to digital converter) for performing voltage measurements



Quadrature decoder

Event counter

Start limit switch



End limit switch

External motor control

Additional symbols are shown at the input terminals of some of the function blocks. These indicate:

High-impedance input terminal

Input terminal with internal pull-up

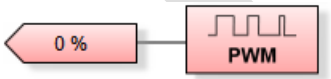
Input terminal with internal pull-down

Triggered on rising edge

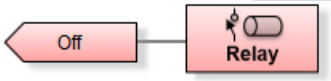
Triggered on falling edge

Output function blocks

Output functions blocks are coloured in red. Each function block has one fixed output terminal. The following output function blocks are provided:



PWM output



Solid-state relay

Special function blocks

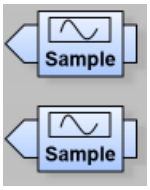
Addition function blocks are provided, which are not connected with any input or output terminal:

Current motor step count

Sampling buffers

Sampling buffers are used for measurements. Each buffer represents a data stream, which transmits measured data over USB to a PC. Connect sampling buffer by dragging it to the output terminal of one of the

function blocks. While dragging sampling buffer, blue dots highlight all valid terminals. When a buffer is close enough to a valid terminal the dot colour changes to dark blue. To disconnect a buffer, simply drag the channel away from the terminal and release the mouse key. The channel will move back to the right-hand column. Two buffers are available. When not connected to a function block, the buffers are listed in the right-hand column of the diagram. The following symbols indicate the two buffers:



When changing channel or buffer connections, the  button must be pressed for these changes to be uploaded to the *Uragan* device. The  button is disabled, when there are no pending changes.

ADC function block

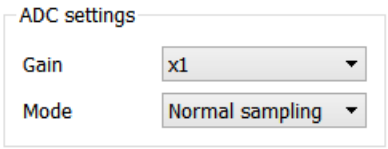
To perform single-ended voltage measurements:

- connect one channel to the + terminal of the ADC function block
- connect one sample buffer to the output terminal of the ADC function block

In order to perform differential voltage measurements:

- connect two channels to the input terminals of the ADC function block
- connect one sample buffer to the output terminal of the ADC function block

Select the ADC function block to gain access to the ADC control panel:

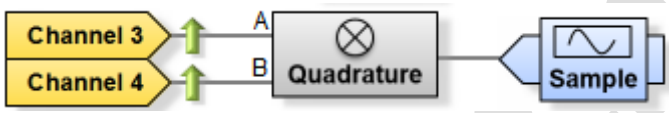


Gain	The gain factor for the ADC: x1 x2 x4 x8 x16 x32 x64 For single-ended measurements only a gain of x1 is supported. For differential measurements, the gain factors x1, x2, x4, x8, x16, x32 and x64 is supported.

Mode	The ADC measurement mode: Normal sampling Peak-peak values *Normal sampling* — Standard logger mode *Peak-peak values* — Performs peak-peak measurements (see "Peak-peak voltage measurements")
	Upload the new settings.

Quadrature decoder function block

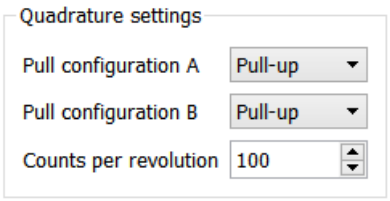
To perform quadrature decoder measurements:



- connect a channel to each of the two input terminals, *A* and *B*
- connect one sample buffer to the output terminal of the quadrature decoder function block

Two adjoining channels must be connected. For example: channel 1 and 2, channel 2 and 3 or channel 3 and 4.

Select the quadrature decoder function block to gain access to the quadrature decoder control panel:



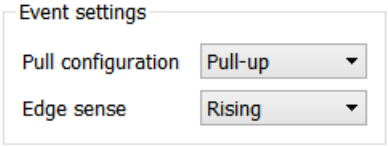
Pull configuration A *Pull configuration B*	The pull configuration for input terminals *A* and *B*: High-Z Pull-up Pull-down See "Connecting quadrature encoders" for more information.
Counts per revolution	The number of counts per revolution for rotary encoders. This value is used for measurements when displaying the rotary encoder data as a phasor.
	Upload the new settings.

Events function block

To count events:

- connect a channel to the input terminal of the events function block
- connect one sample buffer to the output terminal of the events function block

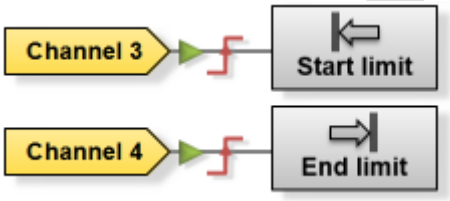
Select the events function block to gain access to the events control panel:



Pull configuration	The pull configuration for the input terminal: High-Z Pull-up Pull-down See “Using the input channels” for more information.
Edge sense	Events are detected on either the rising or falling edge: Rising Falling See “Using the input channels” for more information.
	Upload the new settings.

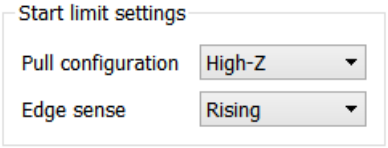
Limit switch function blocks

To enable limit switches:



- connect a channel to the input terminal of the relevant limit switch function block

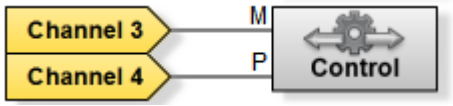
Only the limit switches with a connected channel will be enabled. If none of the limit switch function blocks are connected, the limit switch functionality will be disabled. Select a limit switch function block to gain access to the limit switch control panel:



Pull configuration	The pull configuration for the input terminal: High-Z Pull-up Pull-down See “Connecting limit switches” for more information.
Edge sense	The signal edge, which triggers the limit switch: Rising Falling See “Connecting limit switches” for more information.
	Upload the new settings.

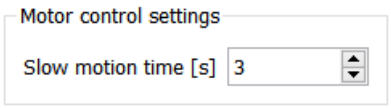
External motor control function block

To enable the external motor control:



- connect a channel to the *M* input terminal
- connect a channel to the *P* input terminal

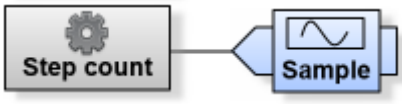
See “Connecting external motor control switches” for more information. Select the motor control function block to gain access to the motor control panel:



Slow motion time [s]	When the motor starts moving, it will first move at 25% of the set motor speed. After the *Slow motion time* the motor accelerates to the set motor speed. Set the value to zero to disable this feature.
	Upload the new settings.

Step count function block

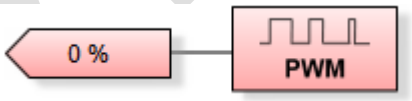
To measure the motor step count:



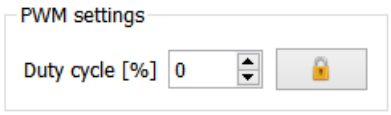
- connect a sample buffer to the output terminal of the step count function block

PWM function block

The PWM function block has a dedicated output terminal. The current PWM duty cycle is indicated on the output terminal symbol.



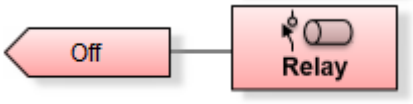
Select the PWM function block to gain access to the PWM control panel:



Duty cycle [%]	The duty cycle of the PWM output. A duty cycle of 0% is equivalent to logic low. A duty cycle of 100% is equivalent to logic high. The duty cycle is updated in real-time.
	Click this button to set an upper limit for the PWM duty cycle. The duty cycle cannot be set higher than this limit. This can be used as a safety feature when controlling external voltage references or current sources.

Solid-state relay function block

The solid-state relay function block has a dedicated output terminal. The current relay state is indicated on the output terminal symbol.

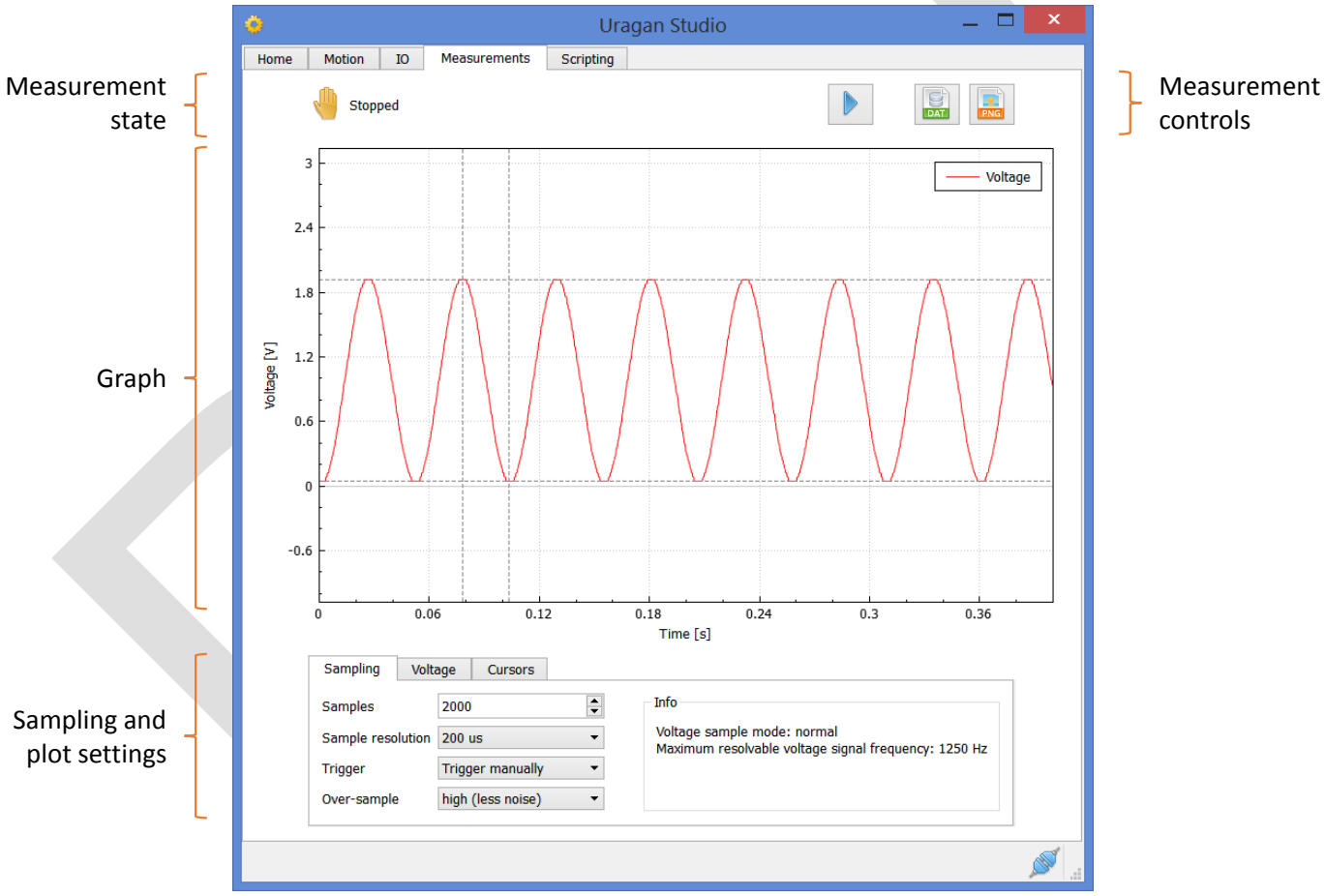


Select the solid-state relay function block to gain access to the solid-state relay control panel:

Turn on	When checked, the solid-state relay turns on. This setting is updated in real-time.

Measurements page

The measurements page contains the measurement state, measurements controls, graph and sampling and plot settings.



The sampling and plot settings consist of several tabs at the bottom of the page. The *Sampling* and *Cursor* tabs are always present. Depending on the measurement buffer connections on the IO page, additional tabs are added. Measurements will only be performed for buffers connected to a function block output. See “IO page” for more information. The following measurements are possible:

Voltage	Buffer connected to ADC function block
Quadrature	Buffer connected to quadrature decoder function block
Events	Buffer connected to events function block
Steps	Buffer connected to step count function block

Measurement state

The measurement state is one of the following:

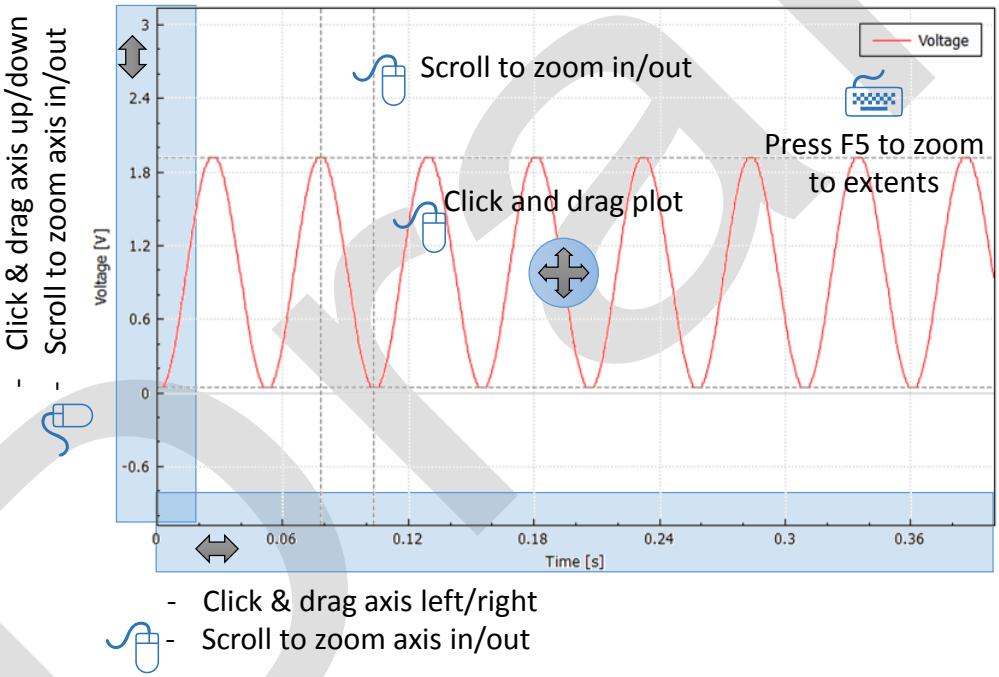
Stopped	The measurement was stopped and no data is collected from the connected *Uragan* device.
Waiting for trigger	The *Run* button was pressed and the device is waiting for the measurement trigger.
Running	A measurement trigger was encountered. Data acquisition is in progress and data is streamed from the *Uragan* device to the PC.

Measurement controls

	Start the measurement sequence. This icon changes to after the measurement is started.
	Stop the measurement.
	Export measured data in CSV (comma separated values) format.
	Export graph as PNG image.

Graph and graph interactions

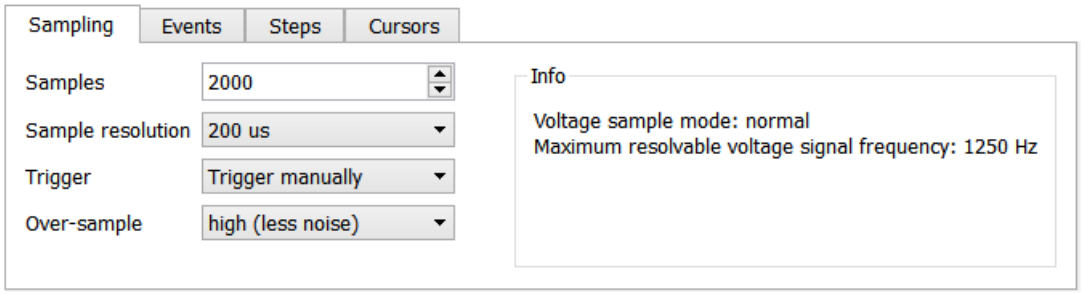
The diagram below summarises the different keyboard (⌨) and mouse (🖱) graph interactions.



Zoom per axis	Place the mouse cursor over one of the axes and scroll up/down to zoom in/out on that axis.
Zoom graph	Place the mouse cursor over one of the plots and scroll up/down to zoom the whole graph in/out.
Zoom to extents	Press the F5 key.
Change y-axis range	Click on the y-axis and drag it up/down.
Change x-axis range	Click on the x-axis and drag it left/right.
Change plot ranges	Click on a plot and drag it left/right/up/down.

Sampling tab

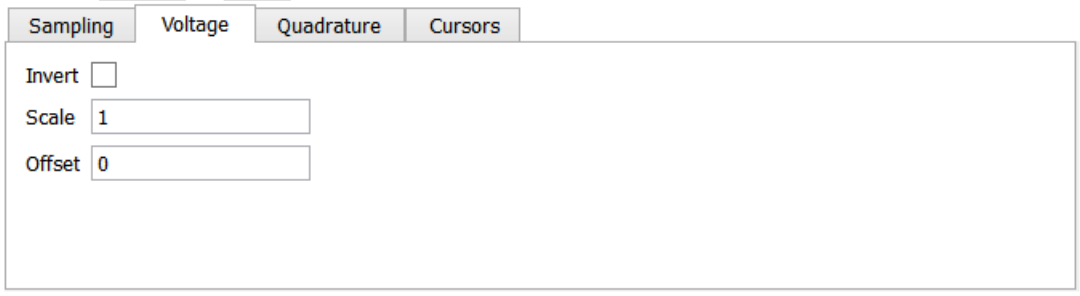
The sampling tab contains settings for the measurement run.



Samples	The number of sample points for one measurement run. Any value in the range [100 .. 5000].
Sample resolution	This is the timer interval between successive measure data points. The sample resolution can be set from 200 µs up to 2 s.
Trigger	When the ▶ button is pressed, the measurement run is started. The *Uragan* device will wait until the specified trigger is encountered. Data acquisition will start after the trigger is encountered. The following triggers are available: Trigger manually Trigger on motor start Trigger on event *Trigger manually* — Data acquisition starts when the measurement is started. In other words: when the ▶ button is pressed. *Trigger on motor start* — Data acquisition starts when the motor starts moving. *Trigger on event* — Data acquisition starts when an event is encountered. An event is any signal encountered by the quadrature decoder or events function block.
Over-sample	Over-sampling is a technique to reduce measured noise levels. For each data point several measurements are taken and averaged. The following oversampling options are available: none low (faster) high (less noise)
Info	Information about the current sampling mode.

Voltage tab

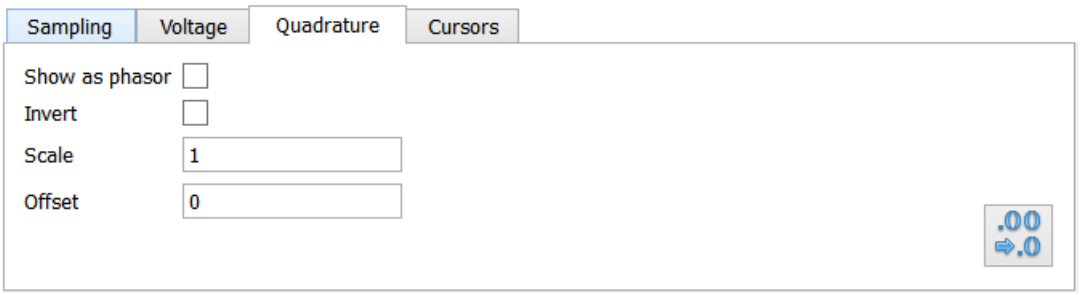
This tab is added when a sampling buffer is connected to the ADC function block.



Invert	When checked, the trace is inverted.
Scale *Offset*	Scales and offsets the trace: $V_{trace} = V_{meas} \cdot \text{Scale} + \text{Offset}$

Quadrature tab

This tab is added when a sampling buffer is connected to the quadrature decoder function block.



Show as phasor	When checked, the quadrature count is converted to a phasor: $Q_{phasor} = \sin(Q_{count} \cdot 2 \cdot \pi / CPR)$ CPR is the counts per revolution for the quadrature encoder. This must be correctly specified on the IO page. See “Quadrature decoder function block” for more information.
Invert	When checked, the trace is inverted.
Scale *Offset*	Scales and offsets the trace: $Q_{trace} = Q_{meas} \cdot \text{Scale} + \text{Offset}$
.00 .0	Sets the quadrature counter to zero.

Events tab

This tab is added when a sampling buffer is connected to the events function block.

Invert	When checked, the trace is inverted.
Scale *Offset*	Scales and offsets the trace: $E_{trace} = E_{meas} \cdot \text{Scale} + \text{Offset}$
.00 .0	Sets the event counter to zero.

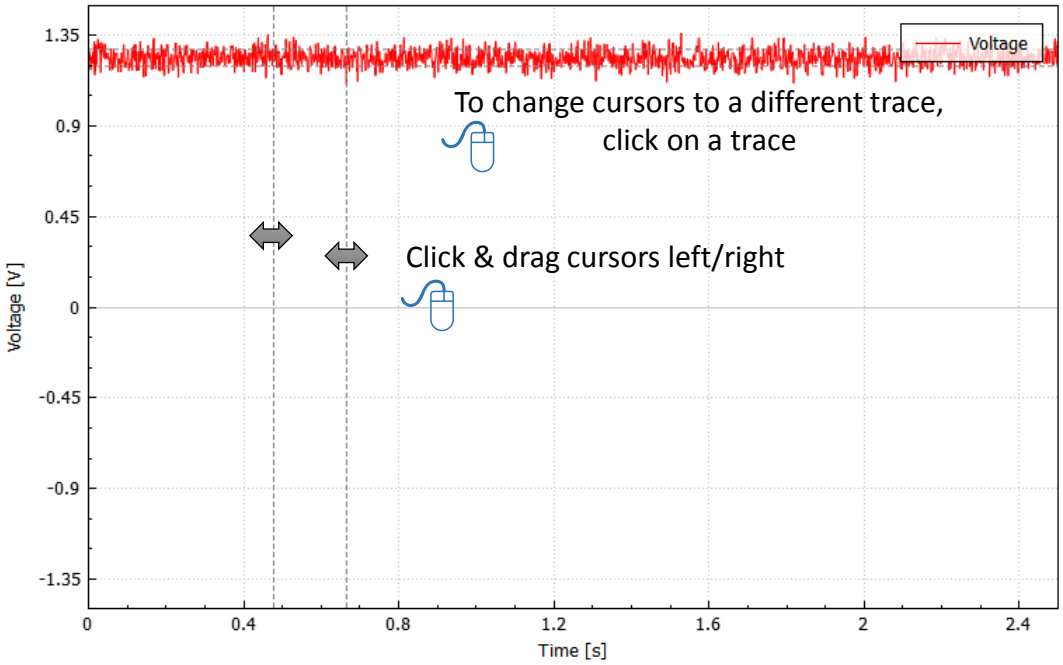
Steps tab

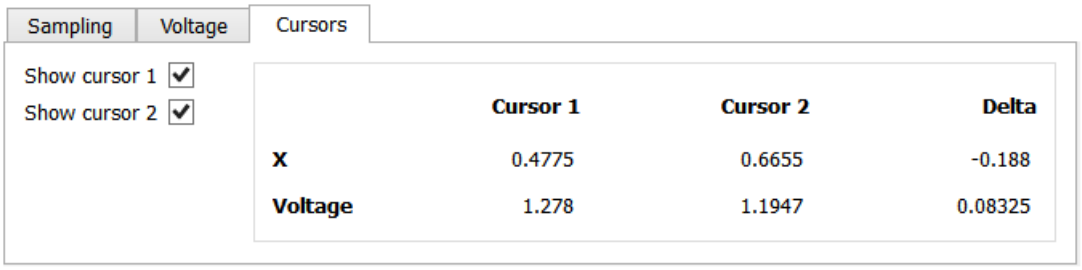
This tab is added when a sampling buffer is connected to the step count function block.

Show as	The step count can be converted to different units: Phasor Number of full steps Number of rotations Distance [mm] *Phasor*: Displays the step count as a phasor: $S_{phasor} = \sin(S_{count} \cdot \text{Motor step size})$ The motor step size must be correctly specified. See "Motor parameters" for more information. *Number of full steps*: The number of full steps. *Number of rotations*: The number of rotations. The motor step size must be correctly specified. See "Motor parameters" for more information. *Distance [mm]*: This option can be used for linear translation stages. The motor position is given in [mm]. The motor step size and pitch must be specified correctly. See "Motor parameters" for more information.
Invert	When checked, the trace is inverted.
Scale *Offset*	Scales and offsets the trace: $S_{race} = S_{meas} \cdot \text{Scale} + \text{Offset}$
.00 ⇨.0	Sets the step counter to zero.

Cursors tab

Cursors are displayed on the graph as vertical and horizontal dotted lines. Cursors are associated on the graph with a specific trace. To associate the cursors with a different trace, click on that trace. A cursor can be moved left or right by clicking on it and dragging it.



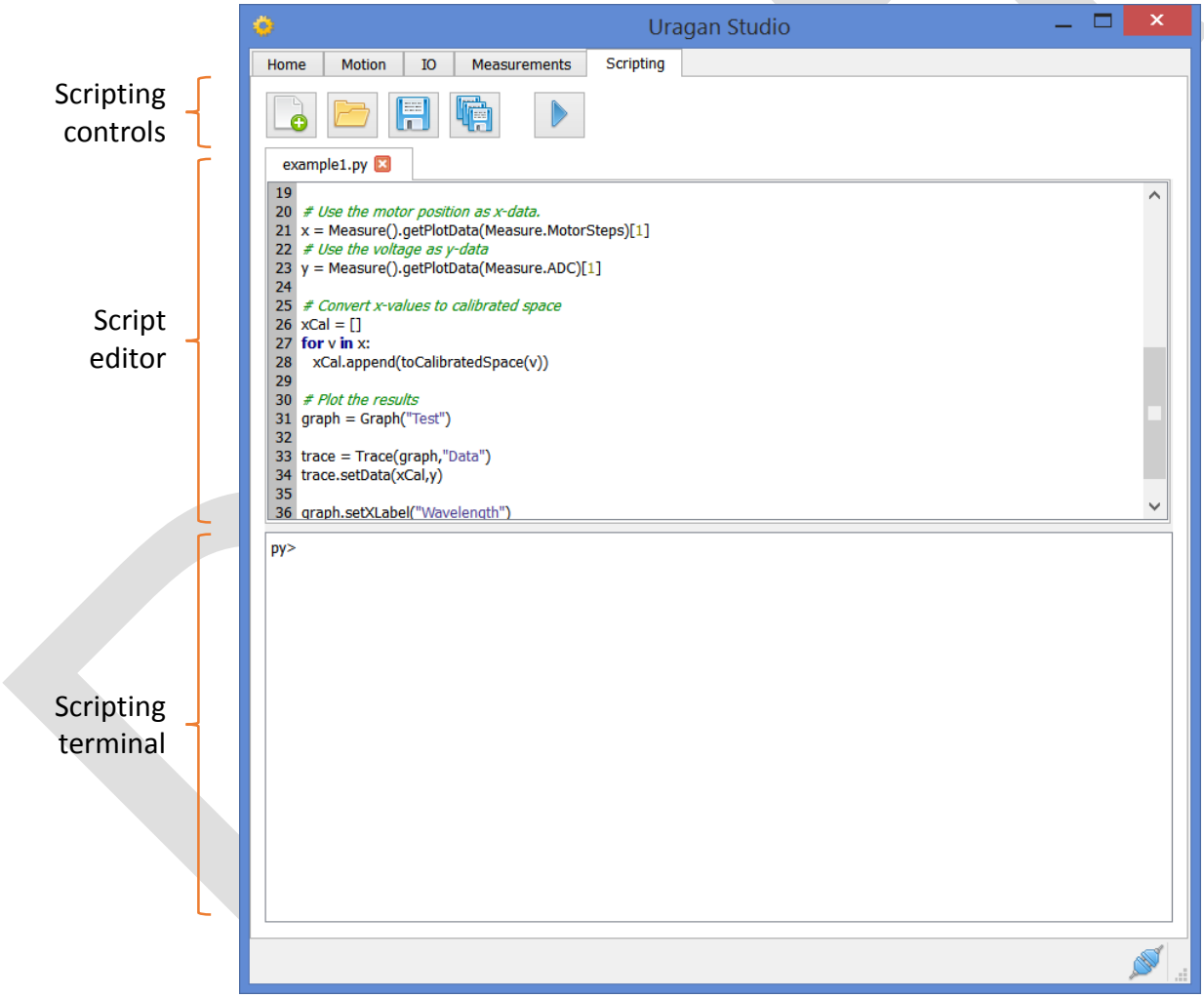


Show cursor 1	When checked, cursor 1 is enabled.
Show cursor 2	When checked, cursor 2 is enabled.

A table with the current cursor values and their deltas are also shown on the *Cursors* tab. The first data row in the table is always for the x-values. The x-values are time values in [s].

Scripting page

The scripting page contains a python scripting IDE.



Scripting controls

	Adds a new script to the script editor.
	Open an existing script file.
	Save currently active script to a file.
	Save all scripts.
	Execute the currently active script.

Script editor

The script editor contains different scripts. Each script is shown in a different tab. The currently visible script is also the currently active script.

Scripting terminal

The scripting terminal is an interactive Python environment. Python commands can be executed in real-time. Errors encountered while running a script are also displayed in this terminal.

UraganPy

UraganPy is the Python interface for interacting with *Uragan* devices. This can be done directly in the script terminal or by writing and executing script files. The *UraganPy* syntax is not covered in this manual.

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