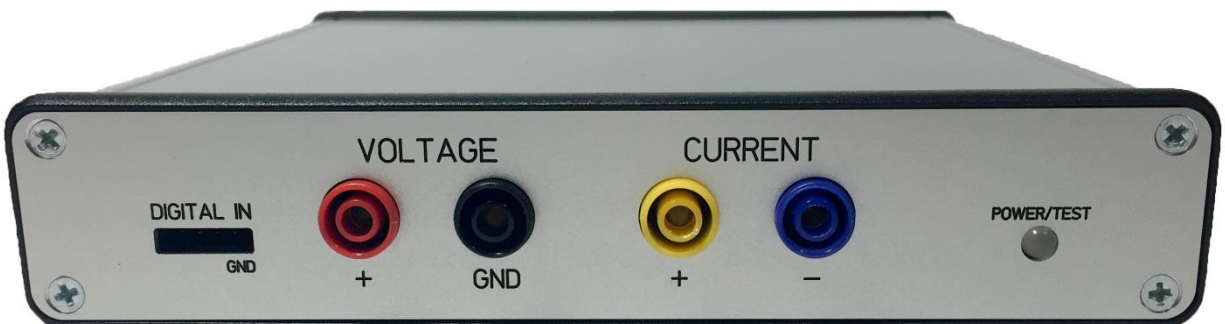


IntelliDAQ Current Sense

User's Manual

Document Version 2.0.0.0

7 January 2018



© 2018 Harborside Technology LLC. All rights reserved

CONTENTS

1	Overview	3
2	Modes of Operation.....	3
2.1	Waveform Capture Mode	3
2.1.1	Graph Info	4
2.1.2	Capturing Data	4
2.1.3	Triggers.....	4
2.1.4	Ranging.....	5
2.1.5	Data Export/Import.....	5
2.1.6	Processing Events.....	6
2.2	Continuous Measurement Mode.....	6
2.2.1	Connecting	6
2.2.2	Starting a Test	7
2.2.3	Status View.....	7
2.2.4	Event List.....	8
2.2.5	Event Summary	9
2.2.6	Scheduled Event Graph.....	9
2.2.7	Data Export	10
3	Setup	10
3.1	Software.....	10
3.2	Serial/Network Connection.....	10
3.3	Power	10
3.4	Connecting to a Device for Measurement.....	11
4	Configuration	11
4.1	Creating a test Config.....	11
4.2	Calibration.....	14
4.3	Network Configuration	15
4.4	Upgrades	15
5	Automation	16
6	Support.....	16

1 OVERVIEW

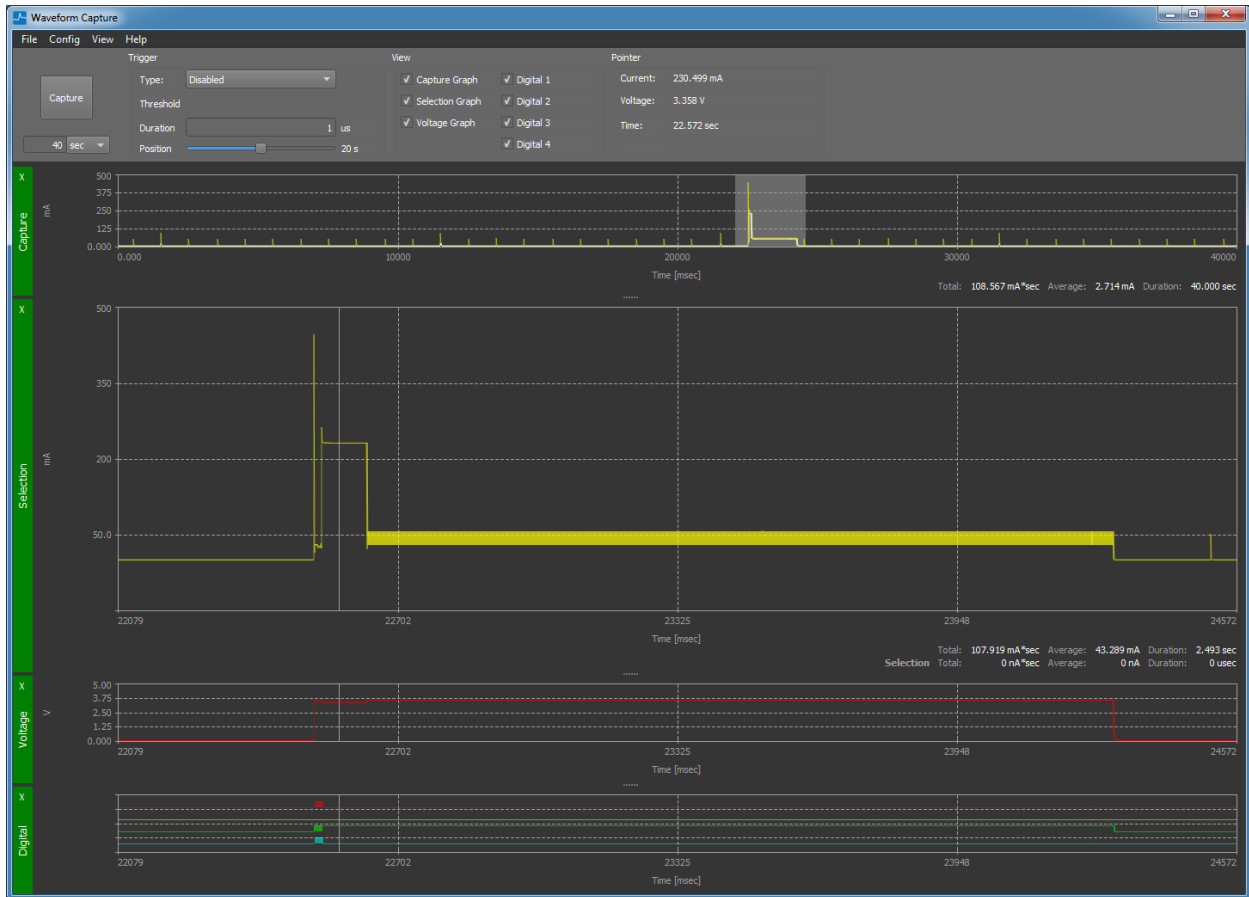
IntelliDAQ – Current Sense is a system targeted at developing and validating battery powered systems with a wide range of current consumption. Battery powered devices must operate at a very low quiescent current to conserve battery life, but must often do high current operation, such as an RF transmit, that can draw a large amount of current, typically for a short period of time. IntelliDAQ allows you to measure current over a continuous range of 100nA to 2A. This can be done in both a graphical, oscilloscope-like mode, or a continuous measurement mode where all the current that is consumed is measured.

2 MODES OF OPERATION

There are two primary modes of operation: Waveform Capture mode, and Continuous Measurement mode.

2.1 WAVEFORM CAPTURE MODE

Waveform capture mode gives you an oscilloscope like view of the current, voltage, and digital inputs. This operates through the local USB connection only.



2.1.1 Graph Info

The top graph is the current for the entire capture. The next graph is a zoomed in selection view. You can select a portion of the capture view to zoom to by left clicking in the capture view, and dragging over the portion you want to view. In the selection view, you can zoom in by using the mouse wheel, and can move the selection by left clicking and dragging. The next two graphs are the voltage and digital view. The scale is the same as the selection view. You can enable and disable the display of any of the graphs using the view check boxes at the top of the screen. Additionally, you can close any of the graphs by clicking the X at the left side of the graph. The size of the graphs can be adjusted by clicking on the dots at the top of the graph and dragging.

Summary data for the capture view and selection view can be seen at the lower right of those graphs. You can select a subsection of the selection view by right clicking and dragging. Additionally, the pointer section at the top of the screen gives you the current, voltage, and time at the cursor.

2.1.2 Capturing Data

To capture data, hit the capture button. This will capture the amount of data specified below the capture button. If you need to cancel the capture, you can hit cancel on the capture dialog.

2.1.3 Triggers

You can set up triggers much like you would on an oscilloscope. The triggers can be either current, voltage, digital line, or digital match. These are selected from the trigger type drop down to the right of the capture button. Selecting Disabled for the trigger type will just run the capture without a trigger.

The trigger position selects how much data will be stored before the trigger occurs. If the trigger occurs prior to the trigger position, only the elapsed time will be stored prior to the trigger, so the triggered waveform can occur prior to the trigger position.

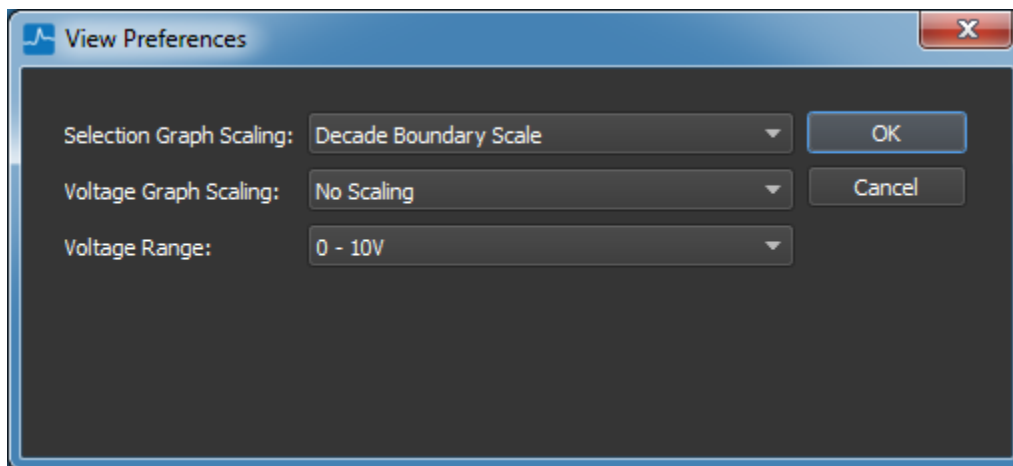
The threshold specifies the trigger level for voltage and current, and the digital line(s) for the digital line and digital match. The trigger edge specifies which direction it must cross the trigger, and the duration specifies how it must have exceeded the threshold before the trigger is considered valid (basically a glitch filter).

The digital match is only looking for the level. It will occur after an edge transition where all the levels match what is expected.

2.1.4 Ranging

To achieve such a wide measurable current range, IntelliDAQ uses two burden resistors, and rapidly switches between them. While this gives an accurate measurement of the total current used, the higher resistance burden resistor can affect the shape of the current waveforms, especially if the device under test has a lot of bulk capacitance. To get a better view of the shape of the current waveforms, you can operate in high range only mode by selecting the menu option Config->High Range Only. This is good for measurements in hundreds of micro amps and up, and should not be used to evaluate current consumption below that.

You can select how the selection and voltage graphs are scaled, as well as the voltage input range in the view Preferences dialog by selecting the menu option View->Preferences.



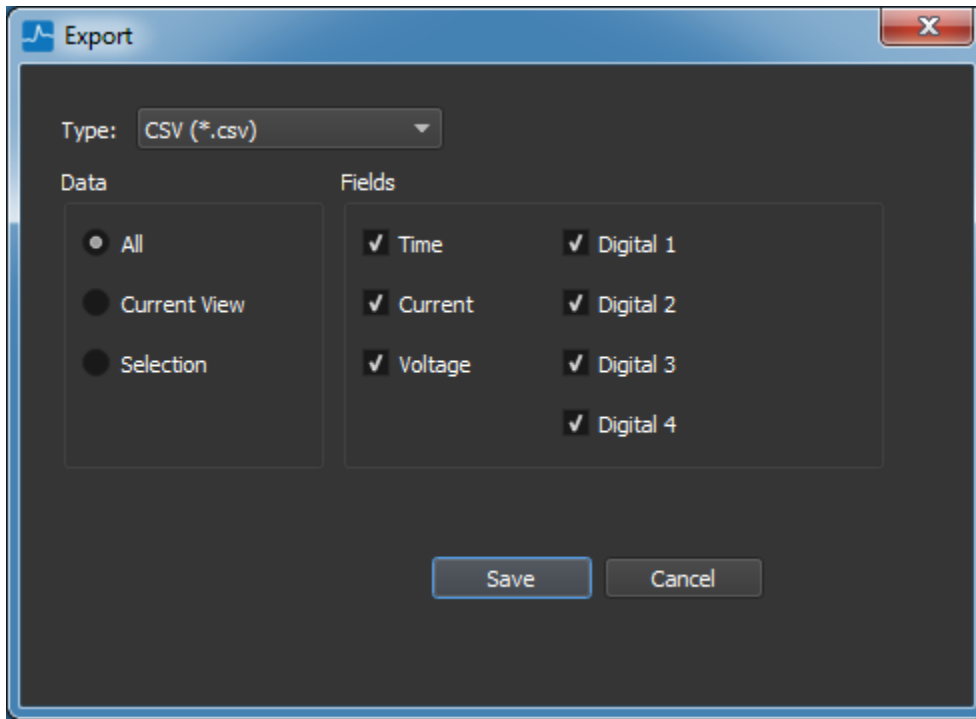
Decade boundaries selects the scaling by rounding to the most significant digit of the min and max range. Full Scale will utilize as much of the graph window as possible, and can create odd vertical scale values. Additionally, voltage can be displayed as full scale.

There are 2 selectable voltage input ranges: 0-5V and 0-10V.

2.1.5 Data Export/Import

Under the File->Export menu item, you bring up the export dialog. This allows you to export all the waveform data (Waveform *.cap) so that it can later be loaded back into waveform capture (this is binary data that will not be readable by other software). You can also select an image which will

export the whole window image, or csv data for use by other software. The csv file can get very large, so you can select only the data you want in it to keep the size manageable.



2.1.6 Processing Events

The menu item View->Process Events displays the processing events window. This can be used to process all the events in the capture using the current test configuration. The primary use case for this is to define event categories, and to validate configs. Its use is described in more detail under the Test Configuration section.

2.2 CONTINUOUS MEASUREMENT MODE

Continuous Measurement mode is a semi-autonomous mode where once kicked off, your IntelliDAQ will constantly measure the current consumed by the device under test, and will monitor and record and time the device goes above quiescent current. You can read out the summary information and event log data at any time using the IntelliDAQ app, or automation interface. The PC does not have to be connected for the measurement to continue.

To get the most out of your system, you should create a test configuration to characterize all the current events of your device under test. This will automatically identify all the events as they are logged, and will generate a summary of the consumption for each category. See the Test Config section under configuration for more information on how to generate a test configuration.

2.2.1 Connecting

You must first connect to an IntelliDAQ before communicating to it. In the lower left-hand corner of the IntelliDAQ app, select the type of connection, and the port or IP address of that connection (there is no connection description required for USB). Hit the connect button to connect to that device.

NOTE: When using the socket connection, be sure to verify the identity of the device you are communicating with prior to stopping a test! You can view the name of the IntelliDAQ under the device tab.

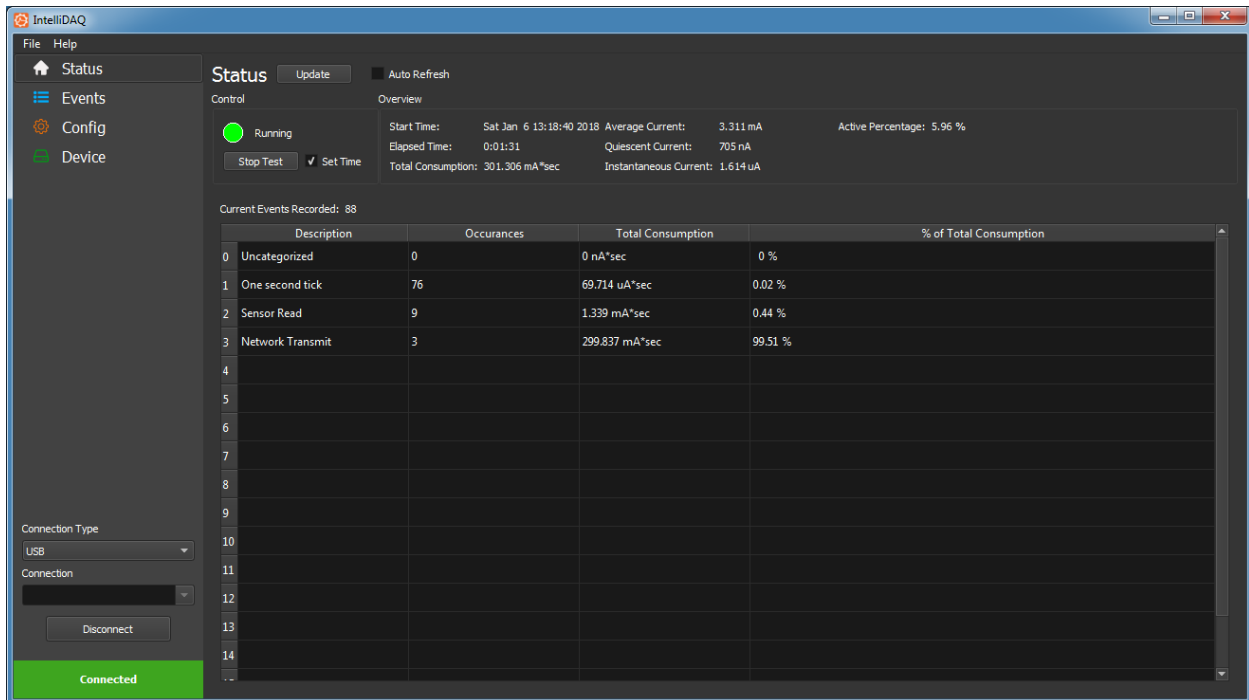
2.2.2 Starting a Test

To start a continuous measurement test, connect to an IntelliDAQ in the IntelliDAQ App, and press the start test button on the Status tab. It will bring up a confirmation dialog so that you do not accidentally erase data from a previous test. If your IntelliDAQ is not set up for NTP, you should leave the Set Time check box checked, so that it will have a valid start time (this uses the PC time). This time is used to timestamp all the event data. When you start a test, the LED on the front of the IntelliDAQ will turn green.

NOTE: You cannot use Waveform Capture mode while a test is running. You must stop a test before starting a capture.

After you stop a test, you can continue to read out all the information about the previous test until you start a new test. Starting a new test will erase all the data from the previous test, so be sure to save your test data if you need it before kicking off a new test.

2.2.3 Status View



When a test is running, you can hit the update button in the status view to see the summary data, as well as the categorized summary. If you select the Auto Refresh check box, it will refresh once a second.

The following data items are available in the status view:

- Total Consumption - The total current consumed by the device (it is in current * seconds, basically an energy unit without voltage).
- Average Current - The average for the test, and is the total divided by the elapsed time.

- Events Recorded - The number of times the device has gone above quiescent current (this is driven by the test config).
- Start Time - The time the test started as seen by the IntelliDAQ device (this will be the same as the PC start time if the set time option was selected when starting the test).
- Active Percentage - The percentage of time spent in an event.
- Uncategorized Events - The number of events that did not fit into a category in the test config (a well characterized device shouldn't have any uncategorized events).
- Elapsed Time - The total time of the test.
- Instantaneous Current - The average current over the previous second.
- Quiescent Current – The average for the previous second minus the consumption of any events. The second must start and end not in an event for this calculation to be valid. It will display the last value that was valid.

The list of category summaries contains the number of occurrences for each category, the total consumption for that category, and the percentage of the total contributed by that category.

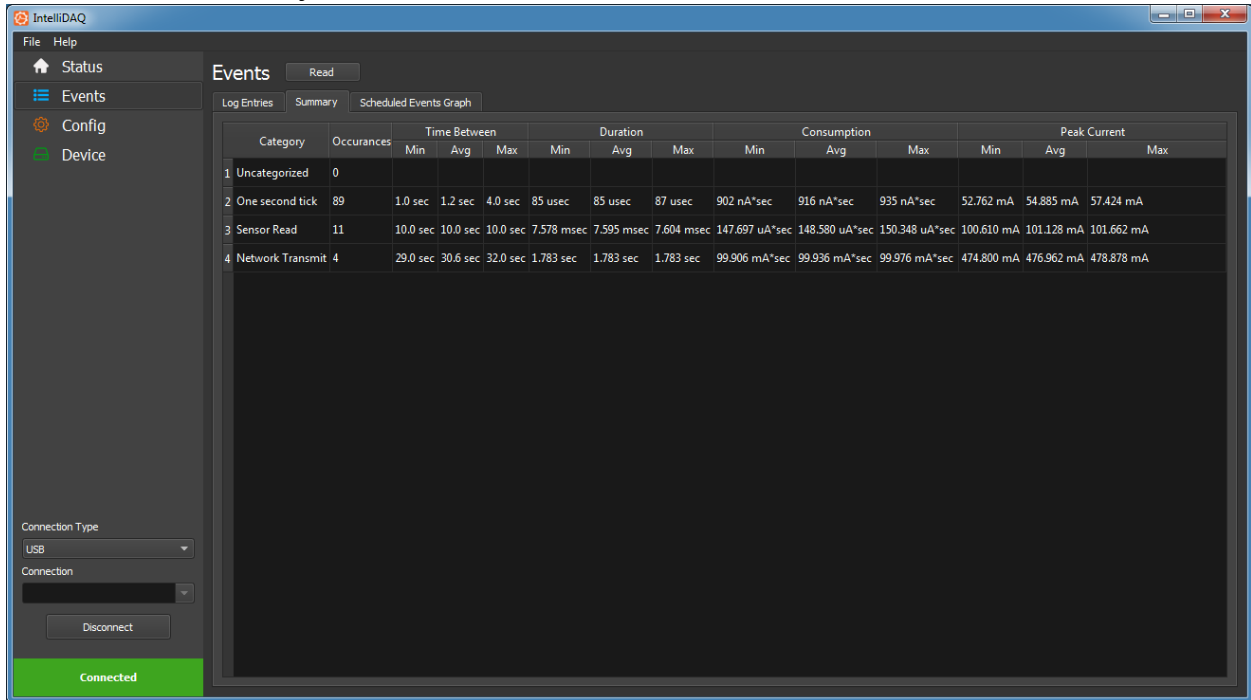
2.2.4 Event List

Category	Time	Duration	Total	Peak Value	Voltage Min	Voltage Max	
0	One second tick	0.9 sec	85 usec	931 nA*sec	55.066 mA	0.000 V	0.007 V
1	One second tick	1.9 sec	86 usec	935 nA*sec	56.026 mA	0.000 V	0.007 V
2	One second tick	2.9 sec	86 usec	931 nA*sec	54.598 mA	0.000 V	0.007 V
3	One second tick	3.9 sec	86 usec	913 nA*sec	54.628 mA	0.000 V	0.004 V
4	One second tick	4.9 sec	87 usec	913 nA*sec	54.106 mA	0.000 V	0.007 V
5	One second tick	5.9 sec	86 usec	918 nA*sec	54.951 mA	0.000 V	0.004 V
6	Sensor Read	6.9 sec	7.600 msec	148.332 uA*sec	100.610 mA	0.000 V	0.009 V
7	Network Trans...	7.9 sec	1.783 sec	99.976 mA*sec	475.438 mA	0.000 V	0.012 V
8	One second tick	9.9 sec	85 usec	909 nA*sec	54.889 mA	0.000 V	0.007 V
9	One second tick	10.9 sec	85 usec	907 nA*sec	53.085 mA	0.000 V	0.007 V
10	One second tick	11.9 sec	86 usec	909 nA*sec	55.650 mA	0.000 V	0.009 V
11	One second tick	12.9 sec	86 usec	912 nA*sec	55.243 mA	0.000 V	0.007 V
12	One second tick	13.9 sec	86 usec	913 nA*sec	54.221 mA	0.002 V	0.007 V
13	One second tick	14.9 sec	85 usec	910 nA*sec	55.796 mA	0.000 V	0.007 V
14	One second tick	15.9 sec	86 usec	910 nA*sec	54.744 mA	0.000 V	0.004 V
15	Sensor Read	16.9 sec	7.599 msec	148.222 uA*sec	100.818 mA	0.000 V	0.009 V
16	One second tick	17.9 sec	86 usec	913 nA*sec	54.774 mA	0.000 V	0.007 V
17	One second tick	18.9 sec	86 usec	908 nA*sec	54.191 mA	0.000 V	0.007 V

To read out all the events of the current, or last run test, select the Events tab, and hit read. Depending on the length of the test, and the frequency of the events, this can be a very long read.

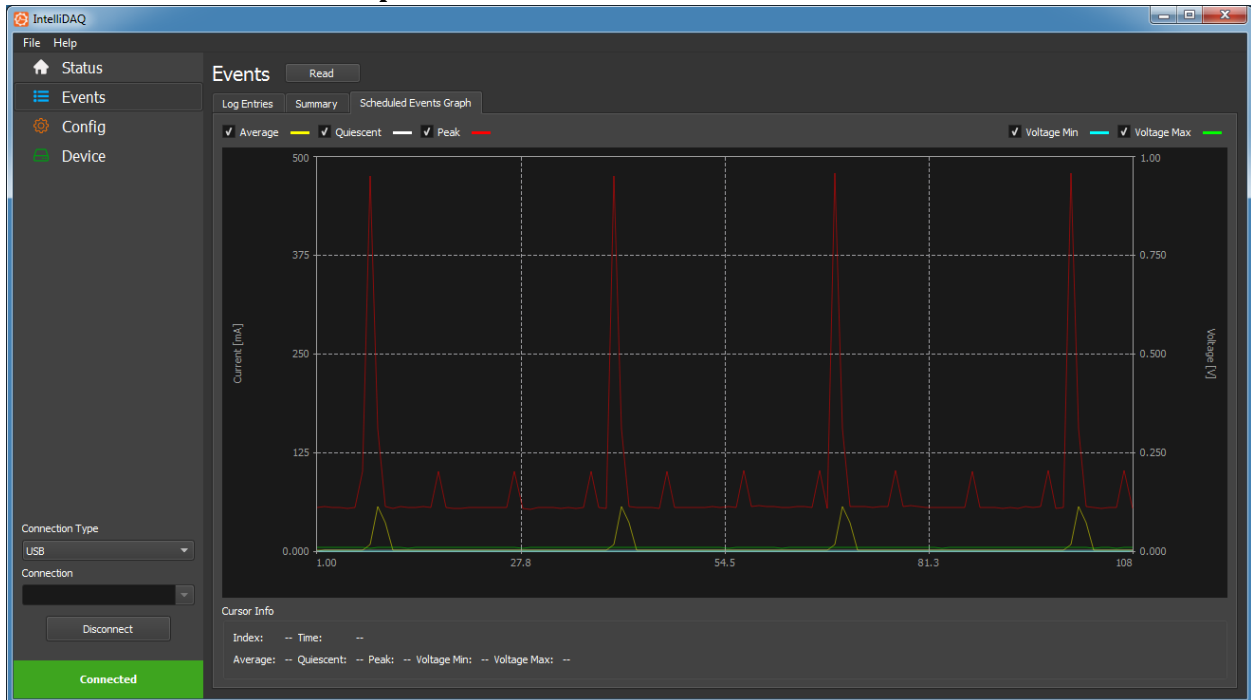
The dropdown box on the right will allow you to switch between scheduled summary events, and current events. It will also allow you to filter on the different event categories.

2.2.5 Event Summary



To quickly see summary information about when the events of each category are occurring and what the min/max/average are for the different parameters, you can view the summary tab.

2.2.6 Scheduled Event Graph



If there are scheduled events in the configuration, they can be viewed in the scheduled events graph. This can be helpful to visualize quiescent, peak, and average currents over time. Voltages can also be

viewed on this graph. This can be used to map external factors of the test like temperature through a thermocouple for example.

2.2.7 Data Export

Data that has been read out (through the status update, and the log read) can be exported either as raw data, or a comma delimited file. To save out raw data that can be reloaded into the IntelliDAQ app go to File->Save data. This data can then be reloaded for viewing later by going to the menu item File->Load Data. To export as csv data use the File->Export To Csv option.

3 SETUP

3.1 SOFTWARE

Install the included windows installation package on a Windows 7 or later PC. At the end of the installation you will be prompted to install the FTDI drivers for the USB interface.

3.2 SERIAL/NETWORK CONNECTION

IntelliDAQ has three different methods of communication: RS232 Serial, USB, and Ethernet. Each interface operates the same from the software perspective in the IntelliDAQ app and automation interface (speeds are different), and the Ethernet interface adds a basic web interface. The waveform capture app only works with USB, as it needs a very high speed, deterministic interface.

The RS232 interface connects to a standard PC serial port or USB to serial converter. To use this interface in the IntelliDAQ app select Serial from the connection type, and the specific PC serial port from the dropdown (all available serial ports will be enumerated). This connection is not supported in the waveform capture app, as it is not fast enough.

The USB interface will automatically configure itself as long as you installed the FTDI drivers at install time. To use this interface in the IntelliDAQ app, just select USB from the connections drop down. It will be automatically selected in the waveform capture app, as it is the only one supported.

The Ethernet port can be configured for a static or dynamic IP (see network configuration in the configuration section). It should be configured while connected to the serial or USB interfaces. To use this interface, select Socket from the connection type, and input the IP address in the connection field. After initial use, the application will maintain a list of recent IP addresses. This interface is not supported in waveform capture.

After selecting a communications interface in the IntelliDAQ app, click the connect button to establish a connection. The software will verify the connection, and will read out and display the version, serial number, and fixture name.

3.3 POWER

Connect the supplied power supply to the 12V input on the back panel. If the included power supply includes multiple blades, attach the blade that works for your location. With the power connected, and

the switch on the back switched on, the LED indicator on the front should be red if the device is not running a continuous measurement test, and green if it is

3.4 CONNECTING TO A DEVICE FOR MEASUREMENT

Your IntelliDAQ system came with two dual banana plug to grabber hook cables, and a 4-bit digital in cable. The banana plugs have a tab on the side indicating which side is ground. That should always go to the right when connecting to the IntelliDAQ (toward black for voltage, and blue for current). The digital in cable is keyed, and only goes in with the center tab facing up.

NOTE: The grounds for the voltage and digital inputs are connected together, and are connected to the IntelliDAQ ground. The current input is isolated.

To connect your device under test for current measurement, you should connect the red lead of the cable connected to the current input to the battery or power supply, and the black lead to the power input of your device under test. When making these connections, take care to minimize the loop area between the conductors. The greater the loop area, the higher the electric field noise you will pick up (typically 60 hz). This noise will not directly affect the average measurement, as it is an AC sign wave on top of your DC level, but it will make it more difficult to view individual events. Additionally, you want to make sure the current connectors are not touching anything conductive (including an anti-static pad), as this can act as an antenna. If you need to make your own cable, connect twisted pair wire to a dual banana plug. Again, take care to minimize your loop area, and to keep the cable as short as possible.

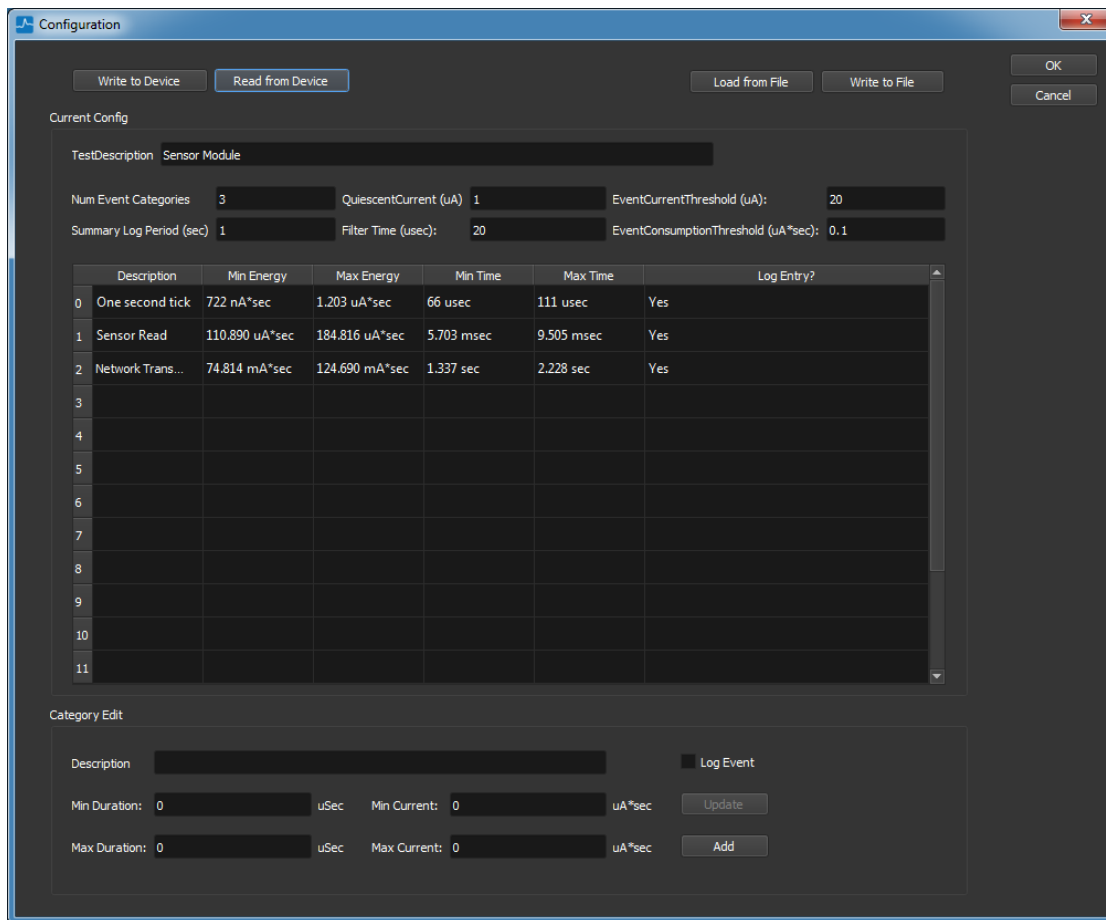
For most testing, you will need only the current cable connected (the fewer cables connected to your device under test, the less noise you will pick up). For situations where you need more information (typically for bench top use using Waveform Capture), you can connect the voltage and digital inputs. The voltage input allows 0-10V, and the digital input allows 0-5V (greater than ~2V is considered a high digital signal). These signals, can be used for triggers in Waveform Capture, and can be viewed graphically as well. When connecting both the voltage and digital connections to your device under test, the grounds **MUST** be connected to the same reference point as they are connected internally.

4 CONFIGURATION

4.1 CREATING A TEST CONFIG

To get the most benefit out of continuous capture mode, you should characterize your device with a test config. This config defines categories for all the operations your device does that are above the quiescent current. With these fully defined, when you are running a test, you can view the summary data for the test to quickly be able to see every operation your device is doing, and how much power it consumes.

You can access the test config dialog from either the IntelliDAQ app or Waveform Capture. In the IntelliDAQ app, it can be viewed under the config tab. In Waveform Capture, it can be viewed by selecting the menu item Config->View.

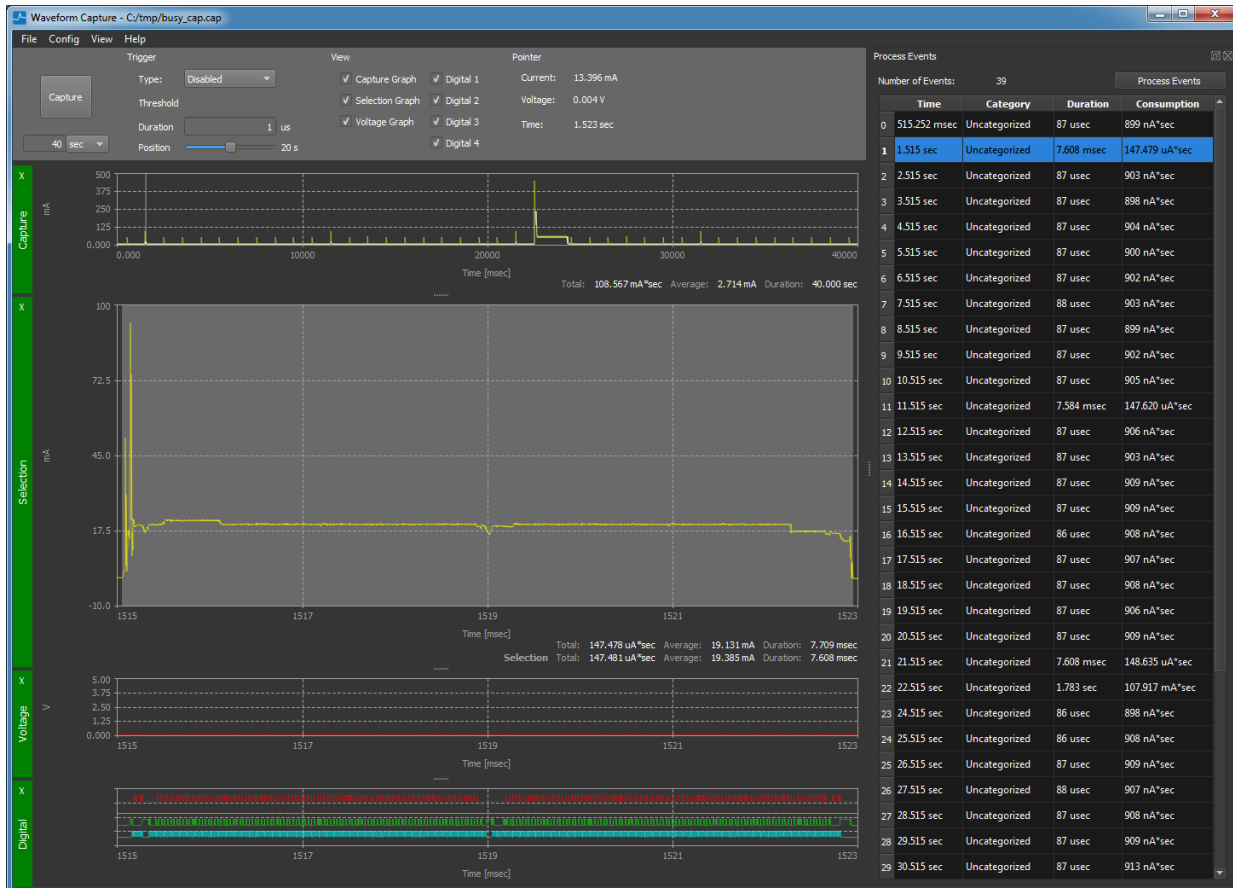


To Create the config, you will need to manually enter the quiescent current and the event current threshold. These are approximate values that are used to determine when the device has entered a loggable event. The event current threshold should be significantly higher than your quiescent current to avoid being triggered by noise, but lower than anything you would want to log. The filter time is the amount of time to keep an event open to look for additional consumption. It is possible to have a very short reduction in current that could cause the current to bounce to near zero. This filter time keeps that from creating an additional event. The event consumption threshold is the minimum consumption to trigger an event. If there are very small events in your system that you want to ignore, this threshold can filter them out.

In addition to the base parameters used to define what will trigger an event, you can specify when summary events are logged by setting the summary log period. These summary events contain the average, quiescent, and max current, as well as the min/max voltage since the last summary event. Setting this to 0 disables the events.

Each category defines a min and max current consumed (in uA*Sec, basically an energy measurement without voltage), as well as the min and max duration. IntelliDAQ compares to the list in order, so if a particular event is a subset of another, you would put the one with the tighter range first, so it can be distinguished from the larger one.

To actually define the categories themselves, you can manually add and edit them in the New Category group box. While manually editing works fine, the easiest way is to use waveform capture to define the categories for you. Make sure you have the quiescent current and event current threshold set in your config, then capture one or more events in waveform capture (use triggers to capture them, or just do a long duration capture). Select the View->Process Events menu item to open the process events window. Then press the Process Events button.



If you have events that are uncategorized, they will show up with the category “Uncategorized”. If you double click on the event, it will highlight the event in the selection window. You can select the menu item Config->Add Section to open the Test configuration dialog with a sample config for that event. It will apply a +25% level to the thresholds. You can modify these thresholds (or leave them as is), and add a description before adding the category. If you close the Test Configuration dialog, and hit the process button again on the Event Processing dialog, it will reprocess the capture with the updated configuration.

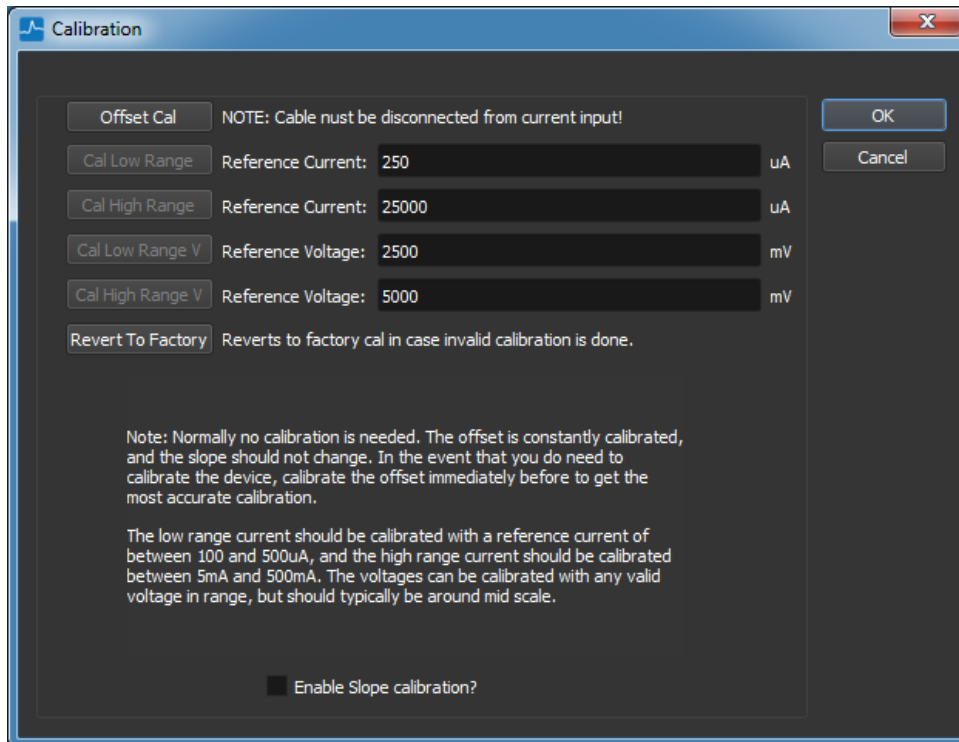
You can manually edit any category in the configuration by clicking on the category. This will populate the fields at the bottom. After editing, click update to update the entry. If you select add, it will add a new entry with the modified parameters. You can delete a category by right clicking it and selecting delete. If you need to reorder categories, you can right click, and select move up.

When you are satisfied with your configuration, you can hit the Write to Device button to write it to your IntelliDAQ device. Additionally, if you plan to use this configuration on other IntelliDAQs, or just

want to back it up, you can save it by hitting the Write to File button. Additionally, you can load an existing config by hitting the Load from File button.

4.2 CALIBRATION

Your IntelliDAQ was factory calibrated for both gain, and offset, and has a continuous offset calibration mechanism. In normal circumstances, it should not need recalibration. If you feel that your device needs to be calibrated, select the Config->Calibrate menu item in the waveform capture app or select the device tab in the IntelliDAQ app, and select Calibration.



To calibrate the offset, make sure there is nothing connected to the current input (remove the cable), and hit the Offset Cal button.

To calibrate either the low or high gain ranges, you will need to first select the Enable Slope Calibration check box (this is in place to avoid accidental modification of calibration).

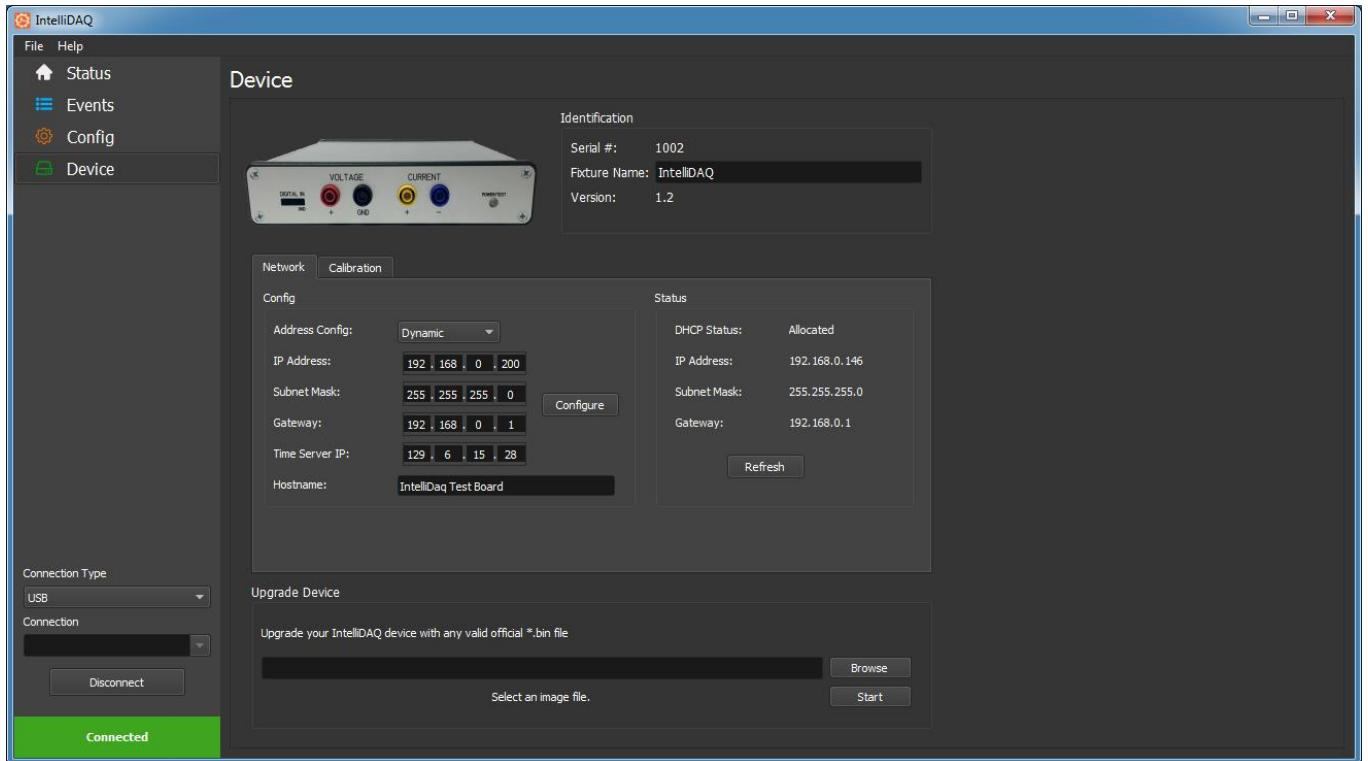
Prior to calibrating, make sure you have a stable current source in the ranges recommended (100-500 uA for low range, and 5-500mA for high range). If the resulting calibration is out of range (because of a reference current different than entered), then the calibration will not be accepted, and an error message will be displayed.

When calibrating the slope, always do an offset calibration first to ensure the highest accuracy, then calibrate the low range, then the high range.

In the event that you have run a calibration that is not valid, you can always revert to the factory calibration by hitting Revert to Factory.

4.3 NETWORK CONFIGURATION

To configure the network interface, you must be connected to an IntelliDAQ (preferably via serial or USB) in the IntelliDAQ app, and select the Device tab, and select Network.



Use the address config to select whether it is a static IP or dynamic one. If it is static, fill in the IP info. Additionally, you can configure the hostname as well as the time server. If a time server is configured and enabled, the device will stay time synced. This is primarily important when running in event mode.

The network status field will display the current IP address for the device. If the configuration is changed, hit the Configure button to write the config to the IntelliDAQ. To see an updated status (primarily needed when in dynamic address mode), you can hit the refresh button in the status pane.

4.4 UPGRADES

The firmware on your IntelliDAQ is upgradeable. After downloading the image (or receiving on from Harborside support), you will use the IntelliDAQ app to do the upgrade. With a device connected, go to the Device tab. The upgrade section will be at the bottom. Hit the browse button to select the new image, and hit start. The status bar will give you an indication of the upgrade process. Toward the end of the process, you will see the LED on the front turn off for several seconds before turning back on. This is part of the upgrade process. At the end of the upgrade, the Identification pane will display the new firmware version number.

5 AUTOMATION

The automation interface is a COM object that gives you access to everything that you can do within the IntelliDAQ Continuous Measurement PC application. While the PC application gives the user a good way to interface the device and analyze the data, the automation interface gives you all the tools to integrate it into your automated verification system. See the automation interface specification included in the doc section of the install directory, as well as the included scripting samples for how to use the interface.

6 SUPPORT

For tech support, reporting bugs, or just general feature recommendations, please email: support@harborsidetechology.com. Please reference the product name, and be as detailed as possible if reporting a bug. We appreciate your feedback!