ZSCircuits Electronic Systems
ZS-2102-A
IOT Power profiler: User Guide Ver 2.24

Contents

1. Welcome

Thank you for purchasing the IOT Power Profiler tool. This user guide will help you to perform the accurate power measurements of IOT devices with minimal effort. The user guide refers to the Ver 2.2.x of the IOT Power Profiler software. For latest information and updated please visit the following links. It is recommended to view the product demo video for easy understanding. The videos can be viewed on our website www.anglercircuits.com

Additional information from various users is available on the online forums https://www.anglercircuits.com/forum

However, not all of the information on the forums are posted by ZSCircuits and cannot be verified for accuracy.

2. Terms and Abbreviations

DUT	:	**D**evice **U**nder **T**est
IOT	:	**I**nternet **O**f **T**hings

3. PC Requirements

For using the IOT power profiler a computer with the following specifications are required.

Operating System	:	Windows 10
Processor	:	Intel Core i3 2.3 GHz or AMD Ryzen3 2.1 GHz and above
RAM	:	1GB Free RAM needed
Hard Disk space	:	20MB for installation, 10 GB for data. SSD drive preferred.
Display resolution:	:	1600x900 or higher. (1920x1080 recommended)
Connectivity	:	USB 2.0 port (Do not use USB hub or front panel ports on a desktop PC)

Note : The product is tested extensively on a PC with AMD Ryzen3 2200g @ 3.5GHz with 16GB DDR4 RAM and a 250GB SSD drive. It is also verified to work reliably on a laptop with Core i3 @ 2.1GHz with 8GB RAM and 160GB SSD drive. In case of battery powered laptop, set the power options for Best Performance to ensure that the CPU performs at its best rate.

4. Contents of the package

Sr No	Feature	Type	Qty	Notes
1	ZS-2102-A IOT Power Profiler tool	Hardware	1	
2	USB 2.0 cable Type-A to Type-B	Hardware	1	
3	Banana to Crocodile/Alligator clip wires	Hardware	3	RED, YELLOW, BLACK
4	Jumper Wires for Digital Data	Hardware	4	
5	USB storage with Software, Calibration Data, License key file	Hardware	1	Please keep this safe for future use
6	Quick Start Guide	Documentation	1	

7	Quality Certificate	Documentation	1	

5. Software Installation

Insert the USB drive provided with the kit into an USB slot on the PC. Go to the Setup Folder and Click on PowerProfilerSetupXXX.exe. Follow the instructions on the screen. On the first run, the GUI will prompt the user to insert the USB stick in order to copy the Key files stored on them. Please follow the instructions.

The files are installed to C:\Program Files (x86)\ZSCircuits\IOTPowerProfiler\

The data files are written to C:\Users\username\AppData\Roaming\ZSCircuits\IOTPowerProfiler\Data

Other folders created include

License File Directory : C:\Users\username\AppData\Roaming\ZSCircuits\IOTPowerProfiler\License

Data Model Directory : C:\Users\username\AppData\Roaming\ZSCircuits\IOTPowerProfiler\Models

Please keep the USB Key securely for future usage. An installation on a new PC requires this key storage. Without the key files, the Power profiler tool will not work.

Users updating from older versions are recommended to un-install the older versions before installing the new Ver 2.x.x. If the original USB drive is not available, please copy the license file and device models from the install path C:\ZSCircuits\IOTPowerProfiler\ to The above License and Model folders after installation. Without these two files, the power profiler tool will not work.

In case these files are deleted, please contact support@zscircuits.in with your product serial number. The serial number is printed at the bottom side of the ZS2102A tool and on the Invoice. It is also printed on the quality certificate. The GUI also displays the serial number on the bottom left side corner (Ver 1.4.4 and above)

6. Graphical User Interface (GUI)

The IOT Power Profiler requires a GUI which is provided as part of the kit. The users may also download the same on our website at www.anglercircuits.com. The GUI is intuitive and easy to use which features many advanced features.

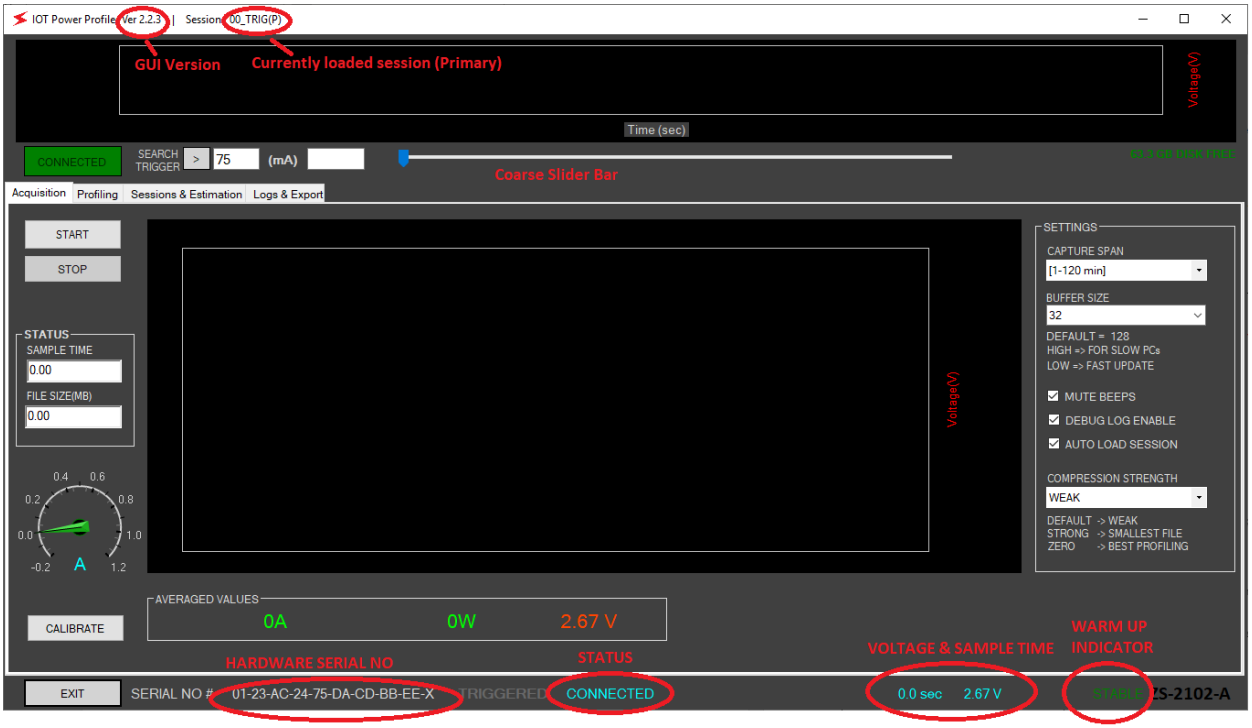


Figure 1 : GUI ver 2.2.3

The first step is to connect the device to the PC using the USB cable and clicking on the CONNECT button. On a successful connection, the CONNECT button turns to GREEN colour and the status shows CONNECTED. The product's serial number is displayed at the bottom left corner of the screen. The GUI as multiple tabs and is organized based on functionality. The LINK LED on the front panel starts to blink once every 2 seconds (Ver 2.2.4 and above). On the older GUI versions, the LINK LED would remain lit after successful connection.

6.1. Acquisition Tab

This tab has all the functions related to the acquisition of data. The START button starts the acquisition and the STOP button stops it. The CALIBRATE button is used to calibrate out the offsets in the measurements and is typically performed before each long measurement. Note that it is recommended to let the device warm up in the CONNECTED mode for a couple of minutes, before performing calibration. This will minimize drift and offset errors.

The acquisition tab has a chart which displays the current and voltage in real time. Note that these are just random samples chosen from the stream and is for display only. The tab also shows the average current, voltage and power consumption. In this context, the negative current and power indicates that the current is being fed to the battery.

The various settings are explained in subsequent sections.

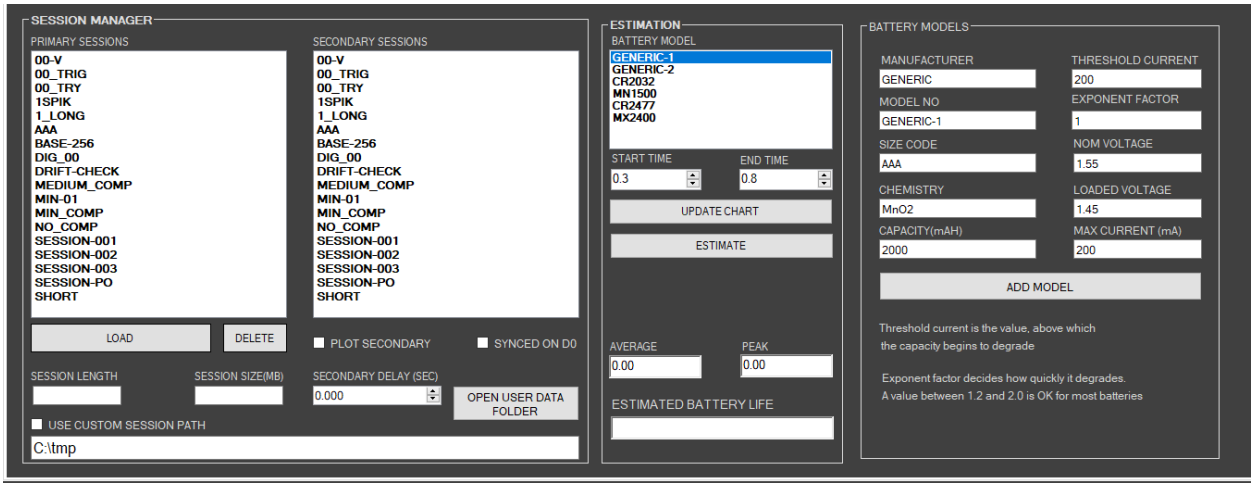
6.2. Profiling Tab

This tab has all the functions needed for power profiling. After acquiring the waveform, the profiling tab is used to visualize the current, voltage and digital signals in sync with each other. There are several trigger search functions available. The Digital Trigger can be used to find out a toggle on the D0 line. The current trigger can be used to detect, when the current value breaches a certain threshold. The graphs can be zoomed in and out using the mouse scroll wheel and can be moved in time using the slider bar.

The middle graph shows a zoomed in version of the top chart. The middle chart shows only the current waveform. The area zoomed in is indicated by a shaded region on the top chart. The digital values are shown in the bottom chart. By hovering the mouse on the current waveform, a tool tip appears which indicates the current and the time. By selecting the top chart with a span < 1 sec, the same area is displayed in the middle chart with the data zoomed in. By selecting the top chart with a span of > 1sec, the average current and energy is displayed on a popup message. By using the coarse slider bar, the top chart can be moved in sync with the middle and the bottom charts. The fine slider bar moved only the middle and the bottom chart. Note that the charts always slide in sync with time.

Using the SEARCH TRIGGER buttons, the GUI can search for any transitions in the Digital IO signals. This can be used to sync the digital activity with the current and voltage waveforms.

6.3. Sessions & Estimation Tab



After capturing the waveforms, the data is stored in the session which is named before the capture starts. This is a directory stored in the users App Data folder. The session needs to be loaded to be displayed on the charts. Alternately, by clicking the AUTO LOAD SESSION checkbox, the session gets loaded automatically after the capture completes.

Two sessions can be displayed on the chart at the same time. Note that analytics only apply to the primary session. The secondary session can be plotted by checking the PLOT SECONDARY checkbox. If there is a sync on the D0 digital input, both the waveforms can be synchronized using that pulse, by checking the SYNC ON D0 checkbox. More details are available in further sessions.

7. Measurement

7.1. Measurement setup

The IOT Power Profiler works like a multimeter in series with the load. It can be used on both the high side and low side of the load for current measurements. But for voltage measurements, the IOT Power Profiler must be connected on the high side. The below picture shows the basic connection needed for the measurements.

Ensure that the IOT Power Profiler is connected to the USB port before making the connections. Always connect the GND first followed by the BATT and LOAD. Follow the reverse procedure for disconnection. LOAD, BATT, GND, USB Cable.

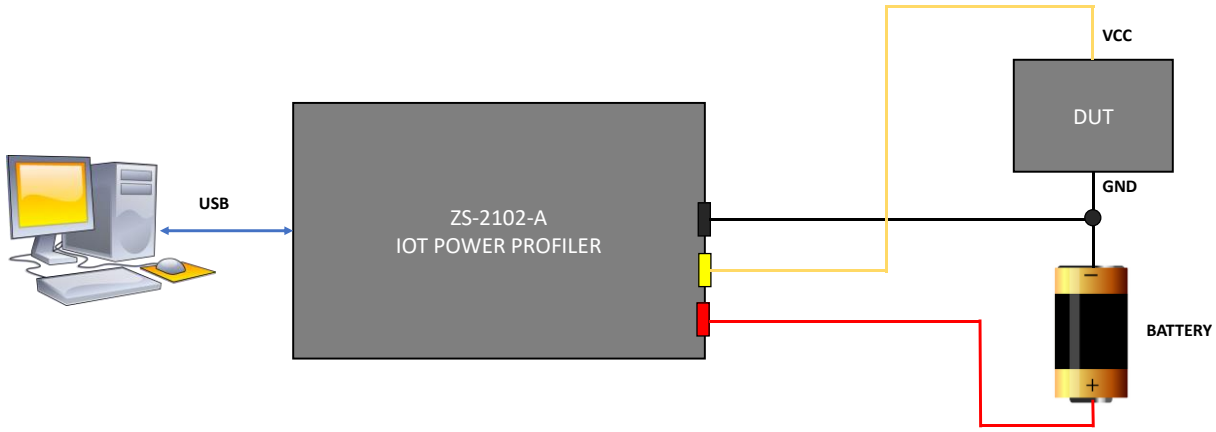
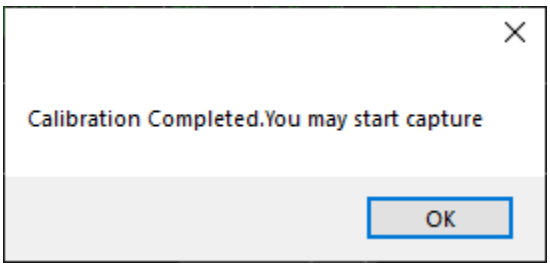


Figure 2: Basic measurement setup

7.2. Calibration

- Before starting any measurement, it is required to calibrate the equipment with the applied voltage. For calibration perform the following steps.
- Arrange the setup as shown in Figure 2 & Start the GUI Software on the PC
- Click on the **CONNECT** button. Wait for the prescribed time for the equipment to warm up. Typically 2 minutes.
- The device emits a single beep when connected. If the connection fails, then close the software, reconnect the USB cable and try again.
- Remove the LOAD cable (YELLOW wire) from the load end. Do not disconnect the BANANA jacks from the IOT Power Profiler as it can impact the calibration results.
- Click on the **CALIBRATE** button. Follow the instructions on the screen. The load needs to be disconnected during calibration. The calibration progress is indicated with periodic beeps.
- Wait for about 15 seconds for the calibration procedure to end. This is indicated with 2 beeps and a pop-up window as below



At this point the system has finished calibration and is ready for measurement.

7.3. Basic measurement

- Calibrate the equipment as in the procedure listed in 7.2
- Connect the DUT back at the LOAD terminal.
- Click on START to start the measurement. Create a new session or use an old session.
- The current meter and the pilot graph will indicate the current measurement on the run.
- When the required data is captured (At least 2 minutes minimum needed), click on STOP button.
- The measurement is now completed and a popup message will indicate this.
- The total length of the measured data is also indicated by the RECORD LENGTH in seconds.
- The session can be loaded from the “Session and Files” tab on the GUI by selecting that session name and clicking on Load Session.
- The chart in the “profiling” tab now shows the measured data.
- A Zoomed in version of the chart is displayed in the middle graph. The zoom factor of the middle chart can be set by scrolling the mouse over the chart.
- In the Sessiond & Estimation Tab, the ESTIMATE button can be used to calculate the battery life by considering the profile from the START to END times.
- The correct battery type may be chosen from the tool for accurate analysis.

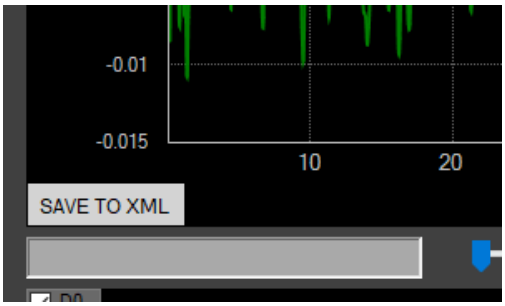
7.4. Exporting data

The data captured from the tool is stored directly to a proprietary binary file. This file is directly read by the GUI to display the current profile using additional Metadata. Exporting of the data to the following formats is supported in GUI Ver 1.1.0 and above

1. XML format
2. Sigrok format (To be displayed in PulseView, An open source signal Analysis software)

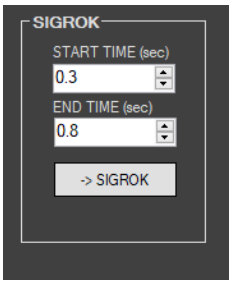
7.4.1. XML format

To export the data in an XML format, click on “SAVE TO XML” button below the middle chart. Then follow the instructions on the screen. Note that the XML format is an ascii file and takes large amount of space. Hence the export is limited to the data span shown by the middle chart only. A maximum length of 1sec of data can be exported to XML format



7.4.2. Sigrok Format

Sigrok™ is a popular tool used to connect to various instruments like logic analyzers and oscilloscopes. A graphical user interface Pulseview is available for Windows which works with Sigrok. The IOT Power Profiler GUI supports exporting the waveform file to Sigrok using the button “->SIGROK”

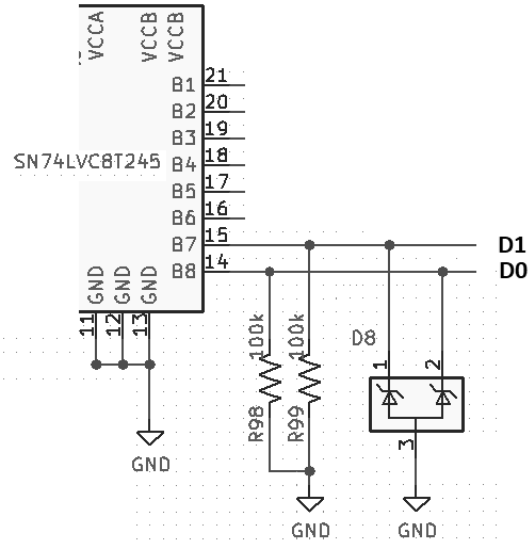


In order to save space on the disk, only the time span between the markers defined by START TIME and END TIME would be saved to the Sigrok file (.sr extension). This file can be directly opened in Pulseview. Using this tool, multiple protocol analyzers like I2C, SPI can be run on the digital IO captured by the ZS-2102-A. This is very handy while analyzing current waveform in sync with application software.

Note : Since Pulseview supports only viewing of voltage waveform, the current data is also displayed as voltage. In this the scaling is 1V = 1A.

7.5. Capturing digital data

The tool can capture any digital data connected to the 8-bit GPIO port on the front panel. The inputs are sampled at 1Msps and has input pull-down resistor of 100K as shown below. Note that this may cause problems with open drain outputs connected to the port. Ensure that the external pull-ups used on the open drain outputs are less than 10K in order to avoid meta-stable states and high current draws by the internal level translator.



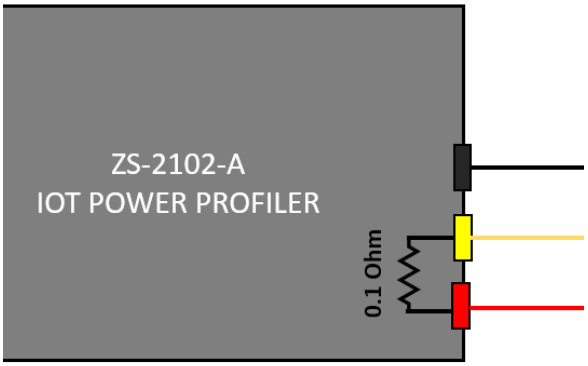
7.6. Synchronizing with external equipment

The IOT Power Profiler outputs the 1MHz sampling clock on the external SMA connector located on the back panel. This can be used to synchronize any external circuits with the power profiler. Ensure that the external load on this connector do not exceed 1K Ohm || 30pF.

Note that the sync is an output only port and no signal should be fed externally on this pin.

8. Advanced technical details

8.1. Analog input



The device uses an internal 0.1 Ohm precision resistor between the BATT and the LOAD terminal to measure the current. This can cause some drop in the load voltage based on the load current. At a current of 1A, about 100mV drop is to be expected. The system used with this setup should ensure that it will not trip with a 100mV drop. While this may not be a problem for majority of the IOT devices, this should be expected during the measurement.

Note that the GND terminal of the IOT Power Profiler is not expected to carry any current under normal conditions. Only when there is a ground loop current due to common grounding of the IOT Power Profiler and the load, will the GND terminal carry current. This grounding loop should be broken to reduce noise and minimizer errors.

Never exceed the input voltage limit of 9V on the BATT or LOAD terminals. Doing so may cause permanent damage to the IOT Power Profiler or significantly impact measurement accuracy.

Never exceed the 3A limit on the BATT and LOAD terminals for more than 100mS. Doing so may cause permanent damage to the equipment and voids warranty.

8.2. Digital inputs

The digital inputs of the IOT Power Profiler features a level shifter to accommodate any voltage level from 1.8V to 5V. The default port voltage is set internally to 3.3V. This can be forced to a different voltage by using external power applied to the VCC pin of the Digital IO port as explained below.

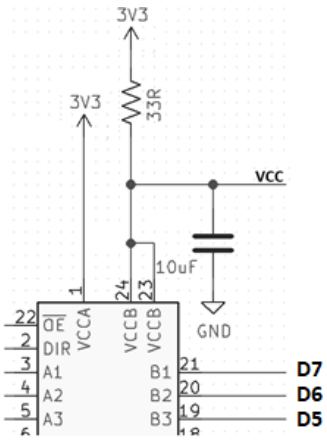


Figure 3 : Level translator power supply

Note that the external power supply should be able to overcome the 33 Ohm resistor connected to the VccB of the level translator.

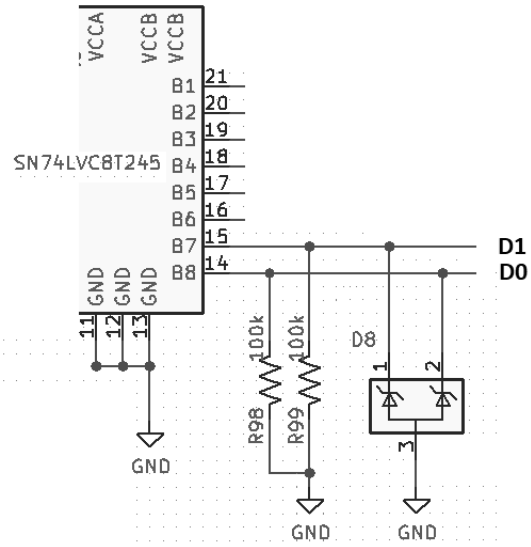


Figure 4 : Digital input circuit

The digital inputs have a 100K ohm pull-down resistor connected at each pin to prevent them from floating. It also has ESD diodes to protect it from ESD strikes. The impact of the 100K pull-down must be analyzed while connecting the digital signals. For e.g. an output drain signal with weak pull-up of 47K will not be able to drive this pin high.

9. Improving measurement accuracy

9.1. Avoid long cables

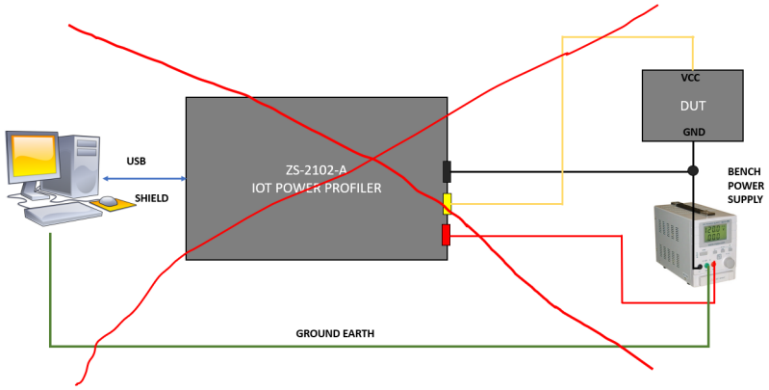
Longer cables will have higher IR drops on them and will cause voltage drops. The longer cables can pick-up magnetic fields which will induce currents into the loop and cause noise. This can be avoided by using a twisted pair for the BATT and LOAD connections.

9.2. Avoid strong magnetic fields

The IOT power profiler is electro-magnetically shielded using a metal Faraday cage. This can suppress electric fields and electro-magnetic radiations. However strong magnetic fields can be problematic as the material is not magnetically shielded. Very strong magnetic fields can induce currents which can cause measurement errors. Hence it is recommended to keep the unit away from strong magnetic fields like induction motors, speakers, DC motors, high current bus bars etc. while in use.

9.3. Breaking ground loops

An IOT Power Profiler connected to a desktop measuring a load which is powered by a bench top supply connected to the mains is an example of ground loop. This can cause significant measurement errors while measuring low level currents.



Do not use an external bench power supply to power the DUT. Always use batteries. Bench power supplies are found to be noisy and can introduce magnetic pick-up due to the ground loop created by the earth returns. When using a bench power supply is un-avoidable for some reasons, it is recommended to use a Laptop which is disconnected from the main supply to power the ZS-2102-A. Doing this is found to improve the noise in the overall measurement. Using USB isolators rated at high speed (480Mbps) can also be used to break the ground loops and improve measurement accuracy. Using isolated power supplies for the DC source is also a easy method to break the ground loop.

9.4. Improving the calibration accuracy

The IOT Power Profiler uses precision components which can be affected by large temperature changes. While this is taken care by the calibration, there are ways to improve this further. Some of the OPAMPs take few minutes to stabilize their internal bias voltages. Hence it is recommended to start the calibration, a few minutes after the product is plugged into the USB port and a connection is established. This ensures that the entire board inside attains thermal equilibrium and yields the best performance.

9.5. Avoid temperature drift

The IOT Power Profiler uses precision components which can be affected by larger temperature changes. It is recommended to avoid temperature gradients while using the power profiler. For e.g. using it in direct sunlight can cause the unit to get heated up and cause measurement errors of few micro amps. Similarly using it near a fan, air blower, air conditioning duct or cooling fan of a desktop computer can cause thermal gradients. It is recommended to use it at a place where the thermal gradient or air flow is minimum.

9.6. Hand-held measurements

Quite often in the lab, quick connections are made by hands & measurements are performed. The human body is an excellent conductor and depending upon the humidity and the skin dryness, currents of several hundred micro amps can easily pass through it even with low voltages. Hence all measurements should be performed with soldered or well joined connections. Avoid touching any of the conductors during the measurements.

9.7. Avoid RF interference

Keep cellphones and wireless routers away from the IOT power profiler when under use.

RF equipment like wireless transmitters including mobile phones, Wi-Fi routers can interference with current measurements if proper care is not ensured during measurements. In order to minimize the impact of RF interference, it is recommended to keep the wire lengths short and using a twisted pair cable for the BATT and LOAD connections. In case, longer wires are needed, it is recommend to keep the lengths of the cables equal. This ensures that the same amount of RF interference is picked up on the differential inputs and ensures better immunity to such pick-up.

While the IOT Power Profiler is primarily intended to be used with wireless products, the same wireless transmissions can cause errors in the current measurement. It has been observed that keeping a mobile phone close (< 1m) to the unit can cause noise spikes of about 0.1mA. While this may not be significant in average measurements, the impact can still be felt when analyzing power profiles. Hence it is recommended to Keep mobile phones and Wi-Fi access points which are not being measured, far away from the IOT Power Profiler. The units under measure do not cause major problems as the transmit current will usually be in the tens of milli amps range and 0.1mA during that time would be not significant.

RF energy can also get rectified by the non-linear components on the board and can show up as DC offset at the output. This can cause measurement drift and offset which are difficult to filter out. Hence it is necessary to take precautions to avoid RF interference.

10. Troubleshooting and error codes

Error 102: Throughput error

This error indicates that the GUI is not able to read the data from the USB or write the data to the hard disk at the required speed of at least 8MBytes/sec. This can be due to the following reasons

- A slow hard disk drive or SSD drive.
- Using a USB hub to connect the IOT Power profiler.
- Using front panel USB slots on a desktop
- Faulty USB cable or long length cable (> 1m)
- An active download session which is writing to the disk at a high throughput.
- A copy program running in the background or some other process which is accessing the hard disk with large amount of data.
- An active antivirus which is running high priority scan
- Windows update is running and downloading updates. This can cause disk writes to slow down.

Possible solutions:

- If any USB hub is used to connect the power profiler tool to the PC, this could slow down the overall USB bus. Remove the USB hub and connect the ZS2102A directly to the USB slot on the PC.
- On some desktops, there has been issues seen with the front panel USB slots. This is due to poor signal integrity on the cables connecting from the motherboard to the front panel USB slots. For optimum speeds, it is recommended to use only the back panel USB slots which are directly connected on the motherboard.
- Upgrade the firmware on the SSD drives if any.
- Disconnect the power profiler from USB, close all programs, Shutdown the PC (NOT Restart) and try again.
- Install all the latest windows updates.
- Wait for Windows to complete the update process and the run again. In the Task Manager, we can check for any applications which is accessing the hard disk with high speed data transfer. Please wait for that task to complete.
- Close all Web Browsers. There are cases where the web browsers would write large amounts of data to the disk in the background for short durations. This can choke the CPU and Disk Access.
- Install the IOT Power Profiler software to a separate hard disk on which the operating system is not residing. The operating system can perform paging which accesses hard disk drive when the memory is low.
- Upgrade the RAM to at least 16GB.
- Disable anti-virus scans.
- Defragment the disk to optimize the disk performance.
- Create a RAM Drive on the computer, copy the IOT power profiler software to that and run. This will eliminate all hard disk limits. Create at least a 4GB RAM Drive for optimal performance.
- Update the BIOS on the PC mother board and update the motherboard drivers.

11. Frequently asked questions

Q1. Why is my measurement showing a lot of noise? For e.g. I am measuring a current of 10uA, but the chart shows that the samples are a low as -20uA. How is this possible?

Answer: Noise is inherent part of any electronic system. In order to get a fast rise time performance, the bandwidth of the system has been increased. The noise power is directly proportional to the bandwidth and hence we observe higher noise in the system. However, the noise will not impact the measurement adversely as the average value of the noise would tend to zero across enough samples.

Q2. Why do I observe some ringing and overshoot in the measured current?

Answer: The ringing observed is caused by the inductance of the wires. If this length can be reduced, the overshoot and ringing can also be minimized. The chart display on the GUI uses cubic spline interpolation to display data. In some cases, this can lead to overshoots which are not necessarily part of the measurement. However the overshoot and undershoot is limited to 5% of the settled value.

Q3. Can I use this tool to measure the power consumption of a line powered device operated from a DC adapter?

Answer. Yes, it is possible to perform this measurement. But the accuracy of this is limited by various factors. The DC adapter may not have a very good isolation from the mains supply, and this can cause leakage currents of several mA due to ground loop. Some of the DC adapters tend to be noisy and this can add to the overall noise of measurement. The leakage current can be however be minimized by using a laptop which is disconnected from the mains charger instead of using a desktop PC to control the IOT power profiler.

Q4. Can I use any USB cable with the IOT Power Profiler?

Answer. Not all USB cables are the same. The USB cable provided with the kit is tested with the IOT power profiler for optimal performance. The shield impedance and signal integrity are verified with this cable. Using another cable may work with the unit but the noise performance and stability must be verified. The common mode choke used on the USB cable suppresses the common mode noise emitted from the PC and minimizes overall system noise. Use of another cable is permitted provided it uses a common mode choke (Black cylindrical object on the cable).

Q5. Is it necessary to perform the calibration before each measurement session?

Answer: The accuracy of the measurement is impacted by the ambient temperature and the input voltage provided to the IOT Power Profiler. Hence it is recommended to perform calibration with each session where the input voltage and temperature would have changed from the previous calibration. As a rule of thumb, it is recommended to perform calibration after each power-up of the unit, or the battery voltage changes by 500mV. It is also recommended to wait for few minutes in CONNECTED mode, before performing the calibration. This is to ensure that the tool reaches electrical and thermal equilibrium.

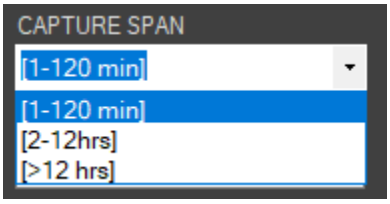
Q6. My battery voltage is 12V. Can I use this to measure my current consumption?

Answer: The power profiler is rated to measure currents when the input voltage is within 6V. In case the battery voltage is 12V, the Power Profiler can be connected on the low side (between the load and ground). Thus, the voltage at the power profiler input is very close to 0V and this is within acceptable limits. Note that the low side measurement cannot measure the battery voltage. The presence of a series resistor of 0.1 Ohm between the load and the main ground can cause ground bounce of 100mV with 1A current. This needs to be accounted as ground noise.

12. Advanced settings

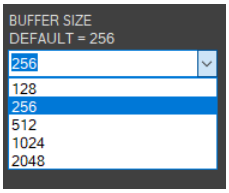
Answer: The power profiler is rated to measure currents when the input voltage is within 6V. In case the battery voltage is 12V, the Power Profiler can be connected on the low side (between the load and ground). Thus, the voltage at the power profiler input is very close to 0V and this is within acceptable limits. Note that the low side measurement cannot

12.1. Capture Span



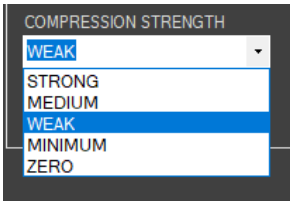
This setting is used to set an internal buffer size to decide how frequently the GUI will write to the disk. Since the files are incremented from the name suffix “0000” to “9999”, the limit is set on the maximum number of data files in one folder. This pull down menu is used to set that. Select the value based on the estimated time of capture needed.

12.2. Buffer size



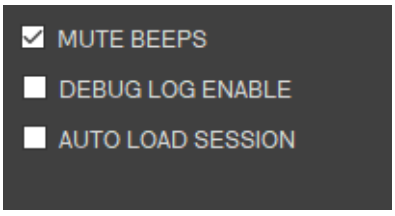
This field is used to set the internal Buffer Size on the GUI. The buffer decides, how fast the PC will process and compress the incoming data. A smaller buffer would mean frequent Task switching and increased processor load. A value of 128 or 256 is found to be adequate on most computers. In case the application crashes, or becomes un-responsive, please raise the value of buffer size and try again. Note that this does not impact the measurement accuracy or the profiling accuracy in any manner. It only affects the real time graph display on the GUI.

12.3. Compression Strength



This field is used to set compression ratio for the current capture. A STRONG compression would ensure the lowest file size, but the pulse shapes may get distorted. ZERO would produce the largest file size but will have raw samples stored in the file for maximum fidelity. A WEAK or MINIMUM compression is found adequate for most IOT device current profiles. This is a balance between the file size and compression accuracy. Note that the compression does not impact the average estimation.

12.4. Misc settings

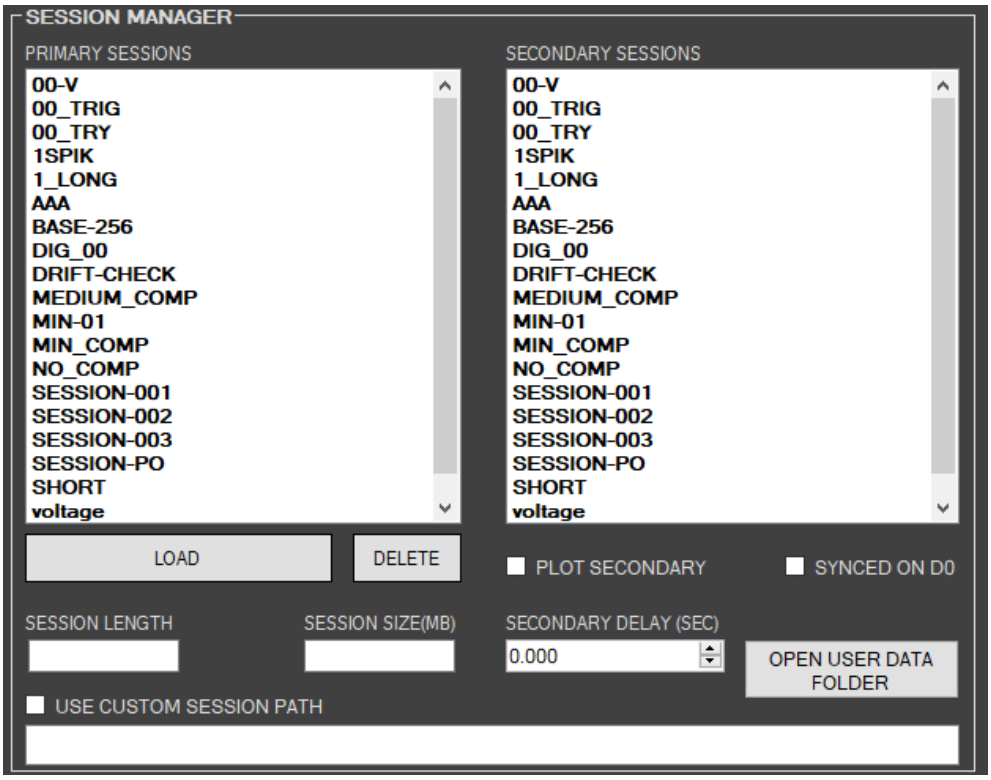


Check the MUTE BEEPS checkbox to disable the beep sounds

Check the DEBUG LOG ENABLE to add log data to the file. The log file is stored in the sessions data path.

Checking the AUTO LOAD SESSION enables the current capture session to be loaded and displayed automatically at the end of the capture session.

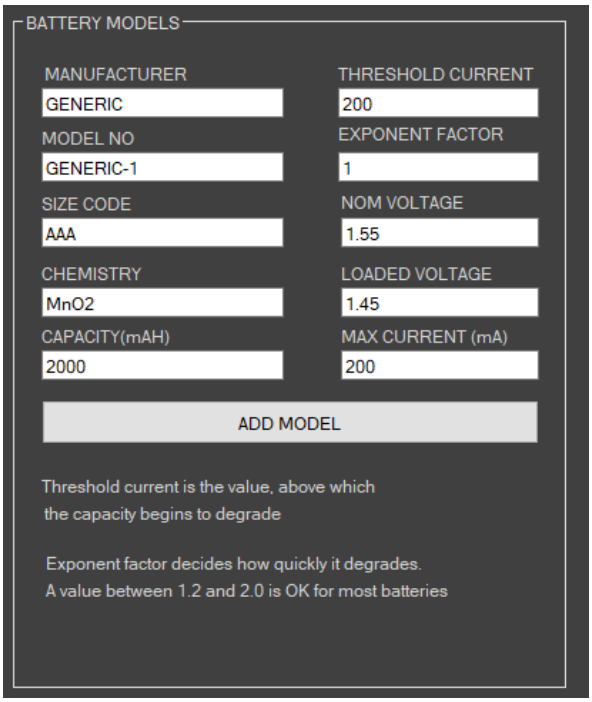
12.5. Session Manager



This section is used to control the sessions of the tool. Each data capture is logged into a separate folder, referred here as sessions. This enabled multiple capture cycles to be saved on the disk. The load button can be used to load the sessions and display them on the charts. The secondary plot can be enabled by using the checkbox PLOT SECONDARY. The primary and secondary plots are synchronized if the checkbox SYNCED ON D0 is checked. The sync is aligned to a data change on the D0 bit.

The default session path is “%APPDATA\ZSCircuits\IOTPowerProfiler\” This can be changed by checking the checkbox for “USE CUSTOM SESSION PATH” and entering the path below.

12.6. Battery models



The users can add custom battery models, using this window. Just add the parameters based on the battery data sheet and click on ADD MODEL button. The model file is added to the existing models, and can be retrieved later for analysis.

13. Technical Specifications

Parameter	Specification	Notes
Current Measurement range	-1A to 1A (Linear Range)	1.2A max measured value with compression.
Current measurement accuracy	1% of value +/- 1uA	After calibration. Measured across range.
Current measurement resolution	< 0.1uA	Average Window Resolution
Max Current Input	3A with 10% Duty	Measured with 100ms pulse for every 1 second.
Input Bandwidth	300KHz	3dB bandwidth, Single pole RC filter.
Step Response	2μS	10% to 90% of full range.
Current Sampling rate	1MHz	
Sampling jitter	10ps	RMS jitter
Input impedance differential	0.1 Ohm	Measured between BATT and LOAD terminal.
Input voltage range	0 to 6V	9V absolute maximum measured w.r.t. GND
Voltage measurement accuracy	1 %	Voltage is measured at the BATT terminal.
Voltage sampling rate	Once in every 20ms by GUI	Hardware capable of 10ms sampling.
Digital Capture	8 bits at 1Msps	Digital data is in sync with the current by +/- 1us
Digital input impedance	100KOhm w.r.t GND	Pull down resistor of 100K
Maximum capture length	Limited by HDD space.	Tested to 24 hrs on GUI ver 2.0.0 using compressed mode.
Error Rate	< 1E-12	Less than 1 error in 10^{12} samples. Or less than one sample error in 24 hours.
Export format	XML, SIGROK	Sigrok File can be opened in PulseView.
Operating environment	15C-40C < 90% RH	
Power Consumption	< 1W	USB 5V powered
Standard Conformance	CE, FCC, RoHS	

Note : Error rate does not include errors caused by external interference.

14. Known limitations

14.1. Hardware limitations

No short circuit protection

The inputs between BATT and LOAD terminals (RED and YELLOW) has an internal 0.1 Ohm precision resistor. In order to keep the overall burden resistance small, there is no internal fuse or short circuit protection. Most of the batteries used in IOT systems have low peak current capability and thus pose no real risk to the power profiler. However, when customers are using Lithium Polymer or Li-Ion batteries which can source high current (> 1A), it is recommended to add a fuse in the path. In-line fuses with the desired capacity can be added in line with the current carrying cables. These are available at most electronic shops. A 3A slow blowing fuse should be suitable for most applications.

No isolation from USB ground

The front panel Banana Jacks and the Digital IO ports are not galvanically isolated from the USB ground on the PC. This could cause issues with measurements made on another grounded load. For example, if a load is powered from a Benchtop DC power supply which is grounded, the ground loop formed between the PC and the DC power supply can cause measurement errors. In such a scenario, it is recommended to use a laptop with the DC adapter disconnected from the mains. This cuts the ground loop and improves measurement accuracy and noise. Note that the error can be only a few micro amps and can be ignored in many cases.

15. FCC Supplier Declaration of Conformance (SDoC)

These devices comply with Part 15 of the FCC Rules and Regulations for Information Technology Equipment. Operation is subject to the following two conditions:

(1) These devices may not cause harmful interference, and

(2) These devices must accept any interference received, including interference that may cause undesired operation.