

BATTLAB-ONE USER MANUAL

A Better Way to Estimate Battery Life for IOT Projects

FEBRUARY 22, 2021

BLUEBIRD LABS LLC

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1. BattLab-One Overview:

1.1. Application Software:

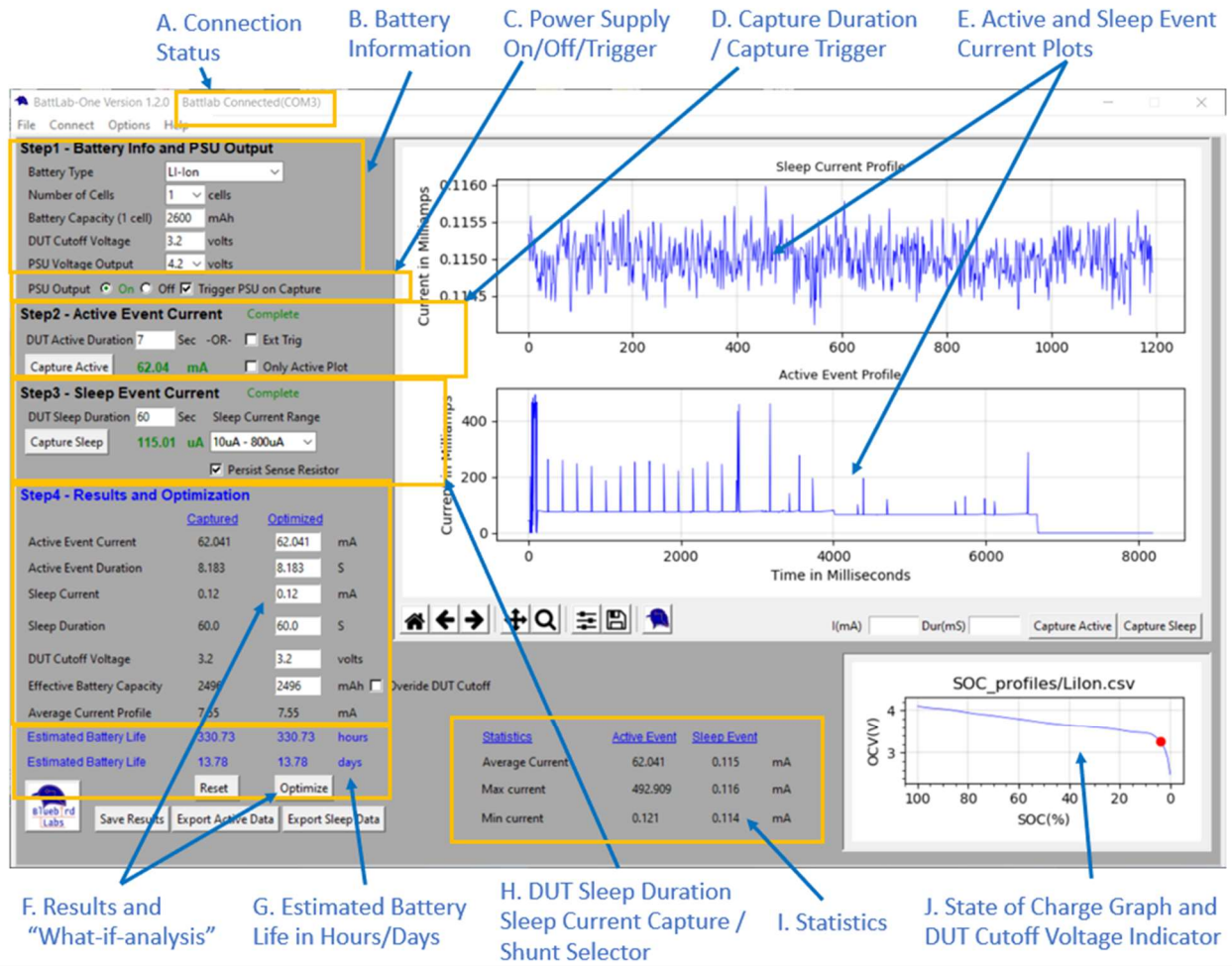


Figure 1. BattLab-One Application Software

- A. Connection Status – Indicates the BattLab-One connection status
- B. Battery Information section – User defined battery information
- C. PSU control – PSU Manual ON/OFF control or Triggered ON by Capture Button
- D. User entered active event duration or externally Triggered by DUT hardware
- E. Active and sleep event current profile. Graphs of the sampled current for the DUT.
- F. Displayed results of sampled current profile (active and sleep events) profile. “What-if” analysis data entry.
- G. Estimated Battery life for both the captured and “what-if-analysis” data
- H. DUT sleep duration and shunt resistor selector (10uA – 800uA or 800uA to 500mA).
- I. Statistical information. Average max/min currents for active and sleep events.
- J. State of Charge information with DUT Cutoff Voltage indicator

1.2. Hardware Overview:

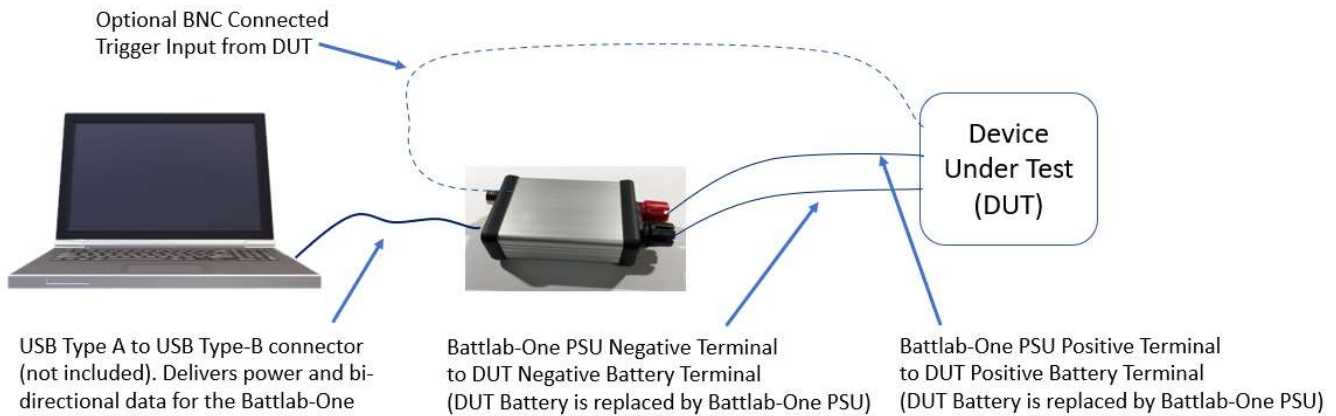


Figure 2. System Connections

NOTE: The BattLab-One is USB isolated from both data and power circuits.

NOTE: The BattLab-One Power Supply Unit (PSU) is capable of outputting up to 2 watts with voltage settings for the most common battery types:

Voltage Setting: 1.2V, 1.5V, 2.4V, 3.0V, 3.2V, 3.6V, 3.7V, 4.2V, 4.5V

Current: up to 450mA

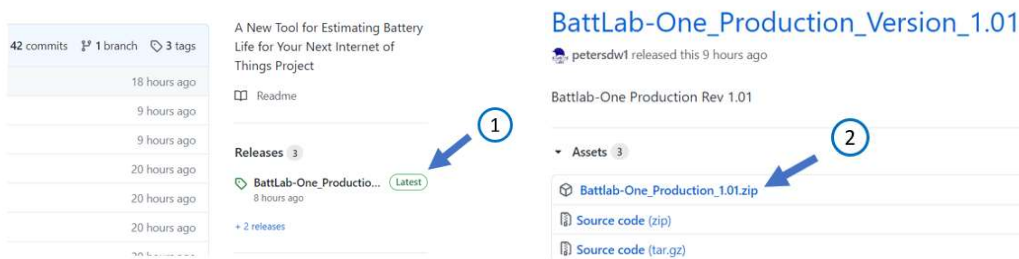
Max Power: ~ 2.0 Watts

2. Getting Started

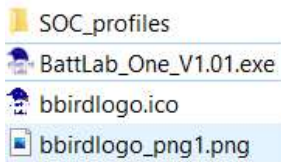
The executable for the BattLab-One application software can be found here:

<https://github.com/petersdw1/BattLab-One>

Look for the Latest Release ① and click on the Zip file ②:



Once you've downloaded the Zip file, un-compress it to the location you choose. The BattLab-One application is the .exe file shown below. The un-compressed folder should look like this:

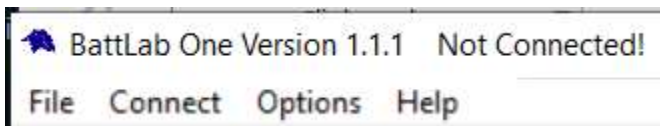


NOTE: The SOC_profiles folder **must** be present and contain the State of Charge (SOC) .csv files for the batteries you intend to use. Bluebird Labs will be updating these from time to time, so please check the website for newer profiles at www.bluebird-labs.com.

Plug in your BattLab-One using a Type-A to Type-B USB cable and launch the BattLab-One executable. Once the software is running, you should see the connection status and COM port that your Windows device chose for the connection as shown below in the title bar of the main window (Figure 1:A).



If you forget to connect your BattLab-One with the USB cable you will see this:



To get connected:

1. Connect your BattLab-One to your computer with a Type-A to Type-B USB cable
2. Open the **Connect** menu and choose **Select COM** from the drop down
3. Click the Refresh Button
4. You should see a new COM port listed in the drop-down menu (usually the last one in the list)
5. Click the Connect button. You should now see the connected status and COM port as shown above.
6. Click **Okay** button.

Congratulations!

You are now ready to start estimating battery life for your IOT projects.

3. Capturing Current Profiles

3.1 Enter Battery Information

The first step in the process is to enter the battery information you intend to use for your product or project. Selecting the **Battery Chemistry** drop down will default in values for all other data entry fields, but you can override any of them for your particular battery.

Step1 - Battery Info and PSU Output

Battery Chemistry: LI-Ion

Battery Capacity: 2600 mAh

Number of Cells: 1 cells

DUT Cutoff Voltage: 3.2 volts

PSU Voltage Output: 4.2 volts

PSU Output: On Off Trigger PSU on Capture

Once you've entered your battery information you can either turn **ON** the PSU output to power your device, or you can have the PSU output turned on after the **Capture Active** button is pressed in Step 2 below.

This option can be useful when your DUT does not have a power switch. Essentially, you're using the BattLab-One to power on and off your DUT device.

To turn on the PSU output now, you must first uncheck the **Trigger PSU on Capture** checkbox as shown below and then click the **ON** radio button for the PSU output. Notice that the PSU Output **ON** text is green.

PSU Output On Off Trigger PSU on Capture

If you would like to trigger the output of the PSU when you click the **Capture Active** button in Step 2, then you should check the **Trigger PSU on Capture** checkbox and then click the **ON** radio button for the PSU output. Notice that the PSU Output Off text is still red. It should look as shown below:

PSU Output On Off Trigger PSU on Capture

3.2 Capture Active Event Duration and Average Active Current

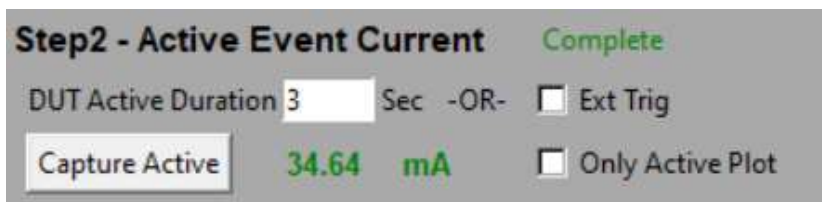
Now it's time to capture the active event duration and current of your DUT. The active event is defined as the combined set of processor activities that occur after your device wakes up from sleep mode. Typical states involved with your active event include reading sensors, processing data, transmitting and receiving data, etc. before going back to sleep mode.

There are 2 ways to capture the active event duration: *User Entered or Triggered*.

3.2.1 User Entered Active Event Duration

The first is by entering in the number of seconds into the **Capture Duration** field. If you know your active state duration of your device (3 seconds in the example below) this is the quickest method.

After entering the number of seconds for data capture, click on the **Capture Active** button. Your device should now be powered and executing in its active mode. Once complete, the captured average current of your active event should be displayed in green text as shown:

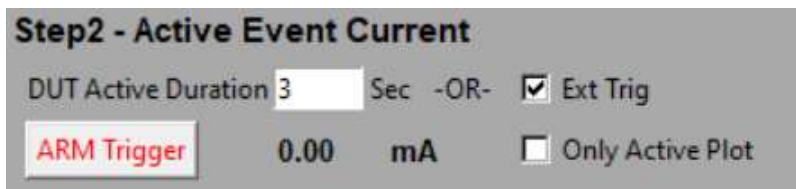


3.2.2 Triggered Active Event Duration

The second method for setting the capture duration is to use the External Trigger on the BattLab-One (BNC connector on the back of the BattLab-One).

For triggering, you will need an external voltage source that can deliver between 3 to 5 volts. This can be from a DUT microprocessor pin or any other external source capable of delivering 3-5 volts. The BattLab-One will start capturing data on the rising edge of the 3 to 5 volt input. The BattLab-One will stop capturing data on the 3 to 5 volt falling edge.

To arm the BattLab-One for triggering, first check the **Ext Trig** checkbox. This will replace the text in the **Capture Active** button to now display **ARM Trigger**. Click the **ARM Trigger** button and the BattLab-One will now wait for a rising edge of 3-5 volts to start capturing data. Data capture will stop on a falling edge of 3-5 volts. Make sure you've connected the BNC cable for triggering.

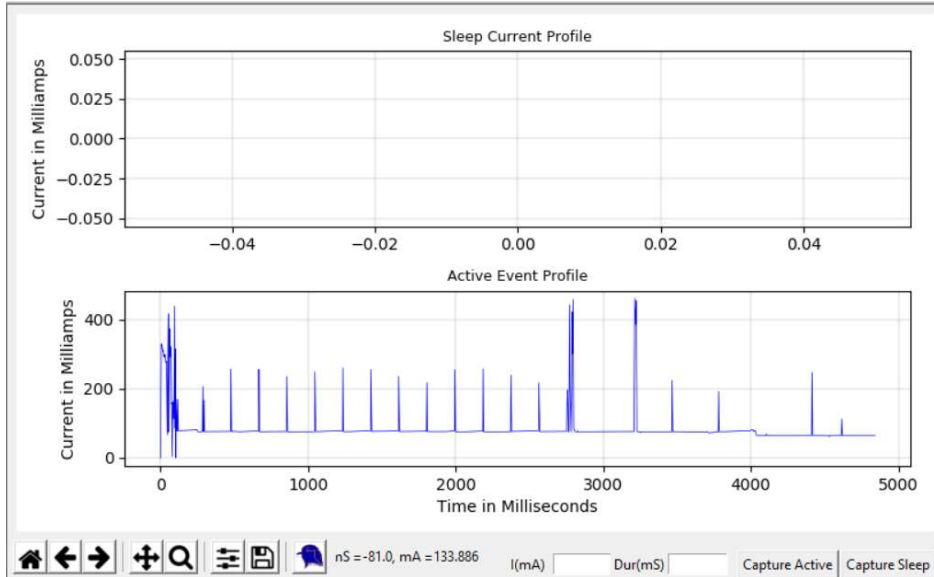


Once complete, the captured average current of your active state should be in green text and a plot of the active event current as shown:

Step2 - Active Event Current Complete

DUT Active Duration 5 Sec -OR- Ext Trig

Capture Active 126.96 mA Only Active Plot

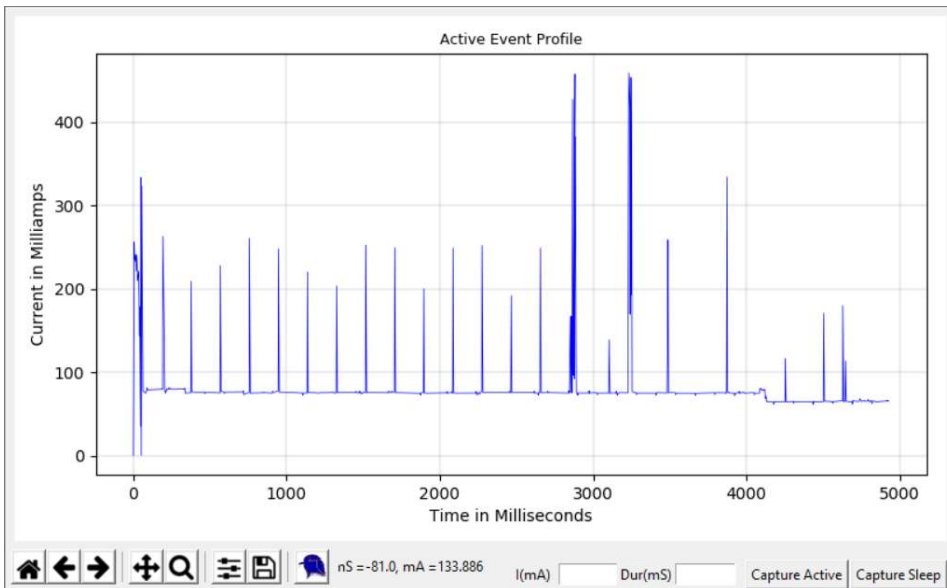


If you only want to plot the active event data, then select the **Only Active Plot** checkbox and you will see a larger display of the active event data as shown below:

Step2 - Active Event Current

DUT Active Duration 4 Sec -OR- Ext Trig

Capture Active 0.00 mA Only Active Plot



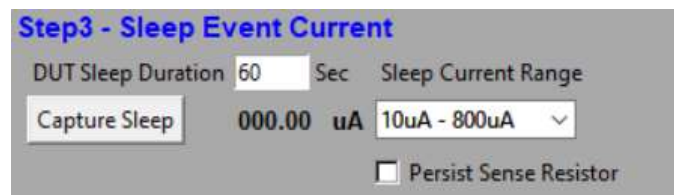
3.3. Capture Sleep Duration and Sleep Current

Once the active state capture of your device is completed (in Step 3.2 above) you can now capture the sleep duration and sleep current of your device.

Sleep duration is defined as the sleep mode duration between your active mode events. Sleep duration is captured by entering the time you have selected for your DUT's sleep mode duration. Enter that value in seconds into the **DUT Sleep Duration** field as shown below (e.g. 60 seconds)

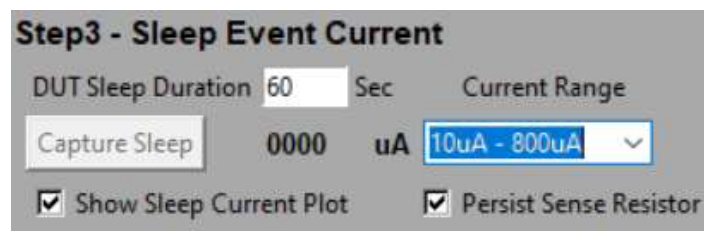


Next, select the appropriate current range you expect your sleep current to be within by selecting either the **800uA-500mA** or **10uA-800uA** range selectors. By selecting these ranges, the BattLab-One will switch the appropriate shunt resistor for data capture mode.



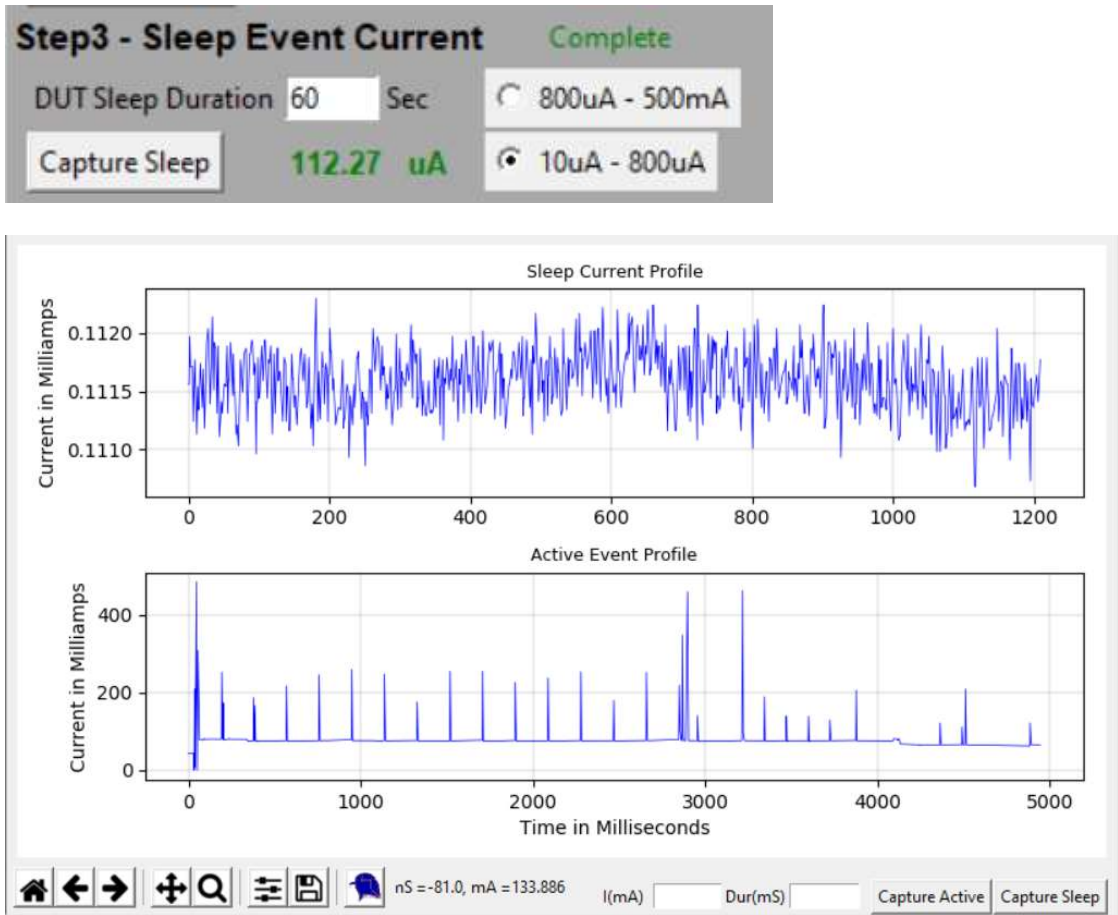
NOTE: If you do not know your expected range, select the 800uA – 500mA range. If the actual sleep current falls below this range then BattLab-One will pop up a message and recommend the **10uA-800uA** range. **Selecting the 10uA-800uA range may damage the BattLab-One shunt resistor if the power output of your sleep mode state is greater than 1 Watt (e.g. 4.5 volt PSU output x 225mA sleep current = 1.01 watts).**

Checking the **Persist Sense Resistor** box keeps the selected sense resistor turned on after sleep event capture. Use this option unchecked to have the BattLab-One switch back to the high current sense resistor so your DUT can continue functioning. Checking this box would leave the low current sense resistor (100 ohm) turned on and might affect your DUT from functioning once it comes out of sleep mode due to burden voltage.



Once you've entered the sleep duration, selected the appropriate sleep current range, and selected any additional options, click the **Capture Sleep** button. You should see your average sleep current

displayed in green as shown below and a display of the sleep current plot above the Active Current plot if you have not selected the **Only Active Plot** box.




4. Results and What if Analysis

After completing steps 3.2 and 3.3 above, you should now see the statistics, results of your DUT device, and the battery life estimation as shown below. The **Captured** data is shown in the first column. The second **Optimized** column allows you to enter new values and to calculate new optimized Battery Life expectations by clicking on the **Optimize** button.

Step4 - Results and Optimization

	<u>Captured</u>	<u>Optimized</u>	
Active Event Current	77.11	<input type="text" value="77.11"/>	mA
Active Event Duration	4.944	<input type="text" value="4.944"/>	S
Sleep Current	0.11	<input type="text" value="0.11"/>	mA
Sleep Duration	60.0	<input type="text" value="60.0"/>	S
DUT Cutoff Voltage	3.2	<input type="text" value="3.2"/>	volts
Effective Battery Capacity	2496	<input type="text" value="2496"/>	mAh <input type="checkbox"/>
Average Current Profile	5.97	5.97	mA
Estimated Battery Life	417.86	417.86	hours
Estimated Battery Life	17.41	17.41	days











<u>Statistics</u>	<u>Active Event</u>	<u>Sleep Event</u>	
Average Current	77.11	0.112	mA
Max current	485.015	0.112	mA
Min current	0.152	0.111	mA


The BattLab-One calculates the Effective Battery Capacity using the DUT Cutoff voltage and the Battery type data entered in Step 1. By checking the **Override DUT Cutoff** checkbox you can enter any value for the Effective Battery Capacity.

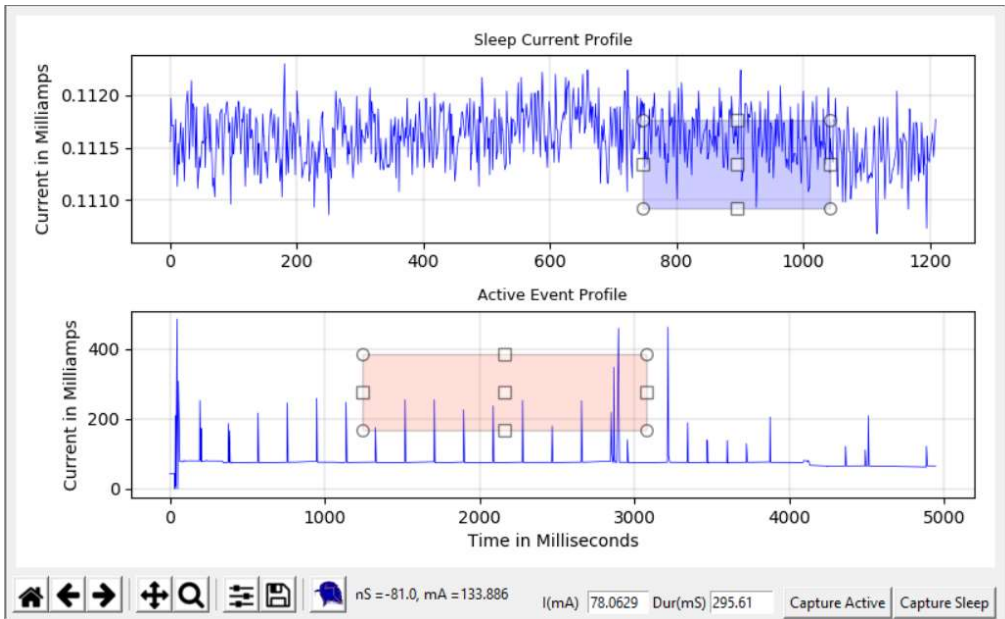
Effective Battery Capacity	2496	<input type="text" value="2496"/>	mAh	<input checked="" type="checkbox"/> Override DUT Cutoff
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5. Working with the Current Plot Tools

After capturing the active event current in step 3.2 above, the Active event Current Profile Plot will be displayed (Figure 1: E). The graph has several features for working with the plot as shown below:

-  Reset original view
-  Back to previous view
-  Forward to next view
-  Pan axes with left mouse, zoom with right
-  Zoom to rectangle
-  Configure subplots – NOT USED in this version of BattLab-One
-  Save the figure
-  Capture current ranges directly from the Active current plots

The capture current range tool can be used to select ranges of data directly from the Active plots. Clicking the Bluebird logo  will activate a range selector on the plots as shown:

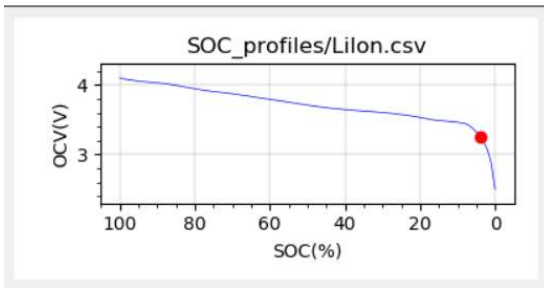


Note that the current I(mA) and duration Dur(mS) fields are automatically updated with the selected range values. Clicking the **Capture Active** or **Capture Sleep** buttons will replace the values in the Optimized column for further “what-if” analysis.

6. The State of Charge Graph


The State of Charge Graph is displayed and updated based on the selected battery information as shown. The graph is meant to provide an indicator of the Open Circuit Voltage vs. State of Charge for a given battery chemistry. The BattLab-One uses this data, the user entered battery capacity (manufacturer's stated mAh) and the entered **DUT Cutoff Voltage** to determine an estimated actual battery capacity. The graph indicates the DUT Cutoff voltage with a red dot as shown below.

Sate of Charge Graph



NOTE: The SOC_profiles folder **must** be present in the working directory where the BattLab-One executable file resides and must contain the State of Charge (SOC) .csv files for the batteries you intend to use. Bluebird Labs will be updating these from time to time so please check the website for newer profiles at www.bluebird-labs.com.

7. Options and Menus

 BattLab-One Version 1.2.0 Battlab Connected(COM3)

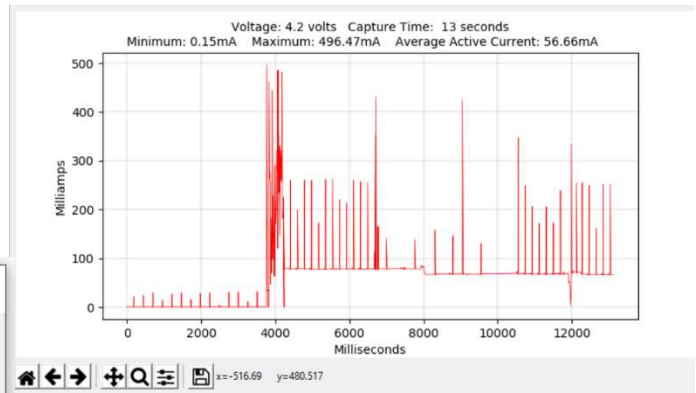
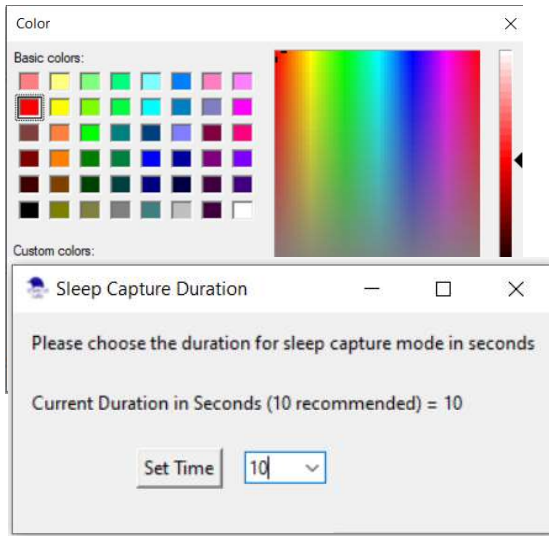
File Connect Options Help

The BattLab-One has several other Menus and Options. There is a **Reset** button that if clicked, will restore the original state of the BattLab-One. Only use the **Reset** button if you want to discard your current data. To save a BattLab-One profile, you can either click on the **Save Results** button or use the **File/Save** dropdown in the menu. To open a saved profile, you can use the **File/Open** dropdown in the menu.



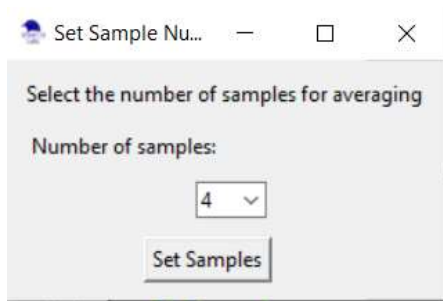
Under the **Options** menu, there are several selections that users can make:

Line Color: This will select the line color for the Active Event Profile Plot



Sleep Capture Duration: This allows the user to select the duration that BattLab-One will use to average the captured current in Step 3.3 above.

Select number averages per sample: This allows the user to select how many samples will be collected for the ADC to sample on data capture. The default is 4, but users can select 16 or 64. Be aware that selecting larger averaging samples will reduce the resolution of the data capture. However, the increased sample rates can help in noisy DUT environments.



Help Menu: The **Help/About** menu will provide the BattLab-One and the Firmware version numbers as well as a url for support. Support can also be reached by clicking the Bluebird Labs logo in the bottom left corner of the screen. This will take you to the Bluebird Labs website where you can click on the Support page to enter any questions.



Exporting Data:

Data can be exported using the **Export Active Data** and **Export Sleep Data** buttons shown under the results. You may also save only the results only (battery life and selections for profile) by clicking the **Save Results** button. These options are also available in the File dropdown menu.

