

Quick Guide

EC-Link Software

Release 2.61

Data logger software

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1 What is EC-Link?

EC-Link is the data logger software coming with the following instruments.

- PAT-Cell-Press
- PAT-Cell-Gas P and PAT-Cell-Gas SP
- PAT-Chamber-16
- PAT-Stand-16
- ECD-3, ECD-3-nano, ECD-2-DL, ECD-nano-DL
- ECC-Press-DL

With the EC-Link software, the voltage, current and sensor signals of either a single test cell or multiple test cells are recorded into log files and viewed as strip-charts. One set of files is being created for each cell. The files contain the cell data – current, cell voltage and the two half cell voltages – together with the sensor data (temperature and pressure or dilation). EC-Link employs an highly efficient data reduction algorithm to create a compressed log file from the raw data stream. In addition, the software computes cycle-wise integrated and differential capacity data and stores them in separate result files.

Connection between the PC host and the data logger is being established via USB. Multiple data loggers and associated instances of the EC-Link software can be run in parallel on the same PC. The EC-Link software is licence-free. Updates are regularly available at no charge.

2 EC-Link System Requirements

You can install the EC-Link software on any computer running one of these operating systems: Windows 10, Windows 8, Windows 7.

3 Installing the EC-Link Software

1. You must be logged into an account with administrator privileges.
2. Save your work and close down all active programs.
3. On the installation medium, run X:\setup. This will install the EC-Link software. Follow any instructions that may appear on your screen.
4. Once installation is finished, plug in the provided USB cable into both the host PC and the instrument's controller box. When connecting the hardware for the first time, Windows will automatically install the driver.
5. Launch the EC-Link software if you have not already done.

6. After a few seconds, the EC-Link software should report a valid connection and you are ready to start the log.

4 Running the EC-Link Software

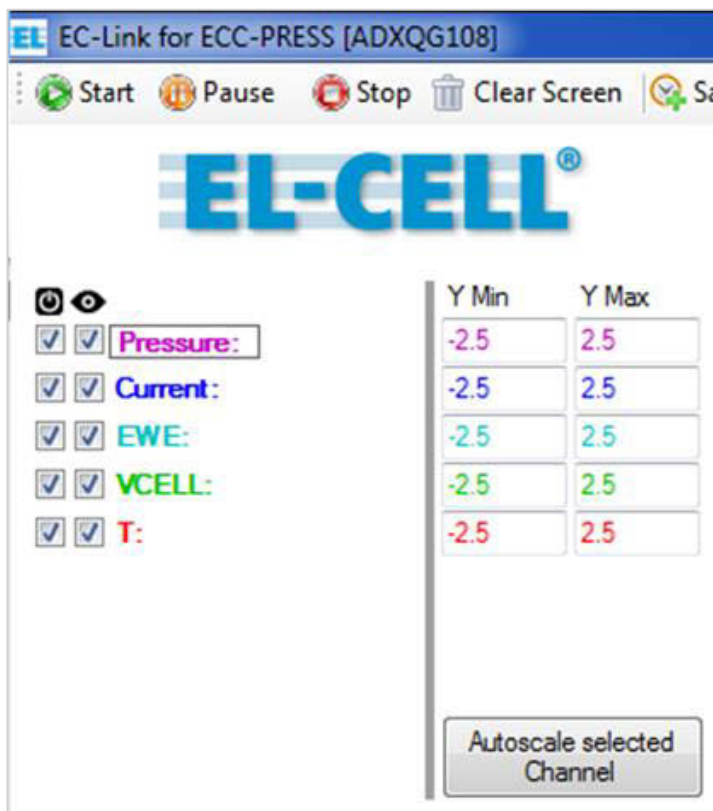
EC-Link is supplied with a suitable program configuration for you. Depending on whether you operate EC-Link with one or multiple test cells, the set program interface is slightly different.

4.1 Using EC-Link in a single cell configuration

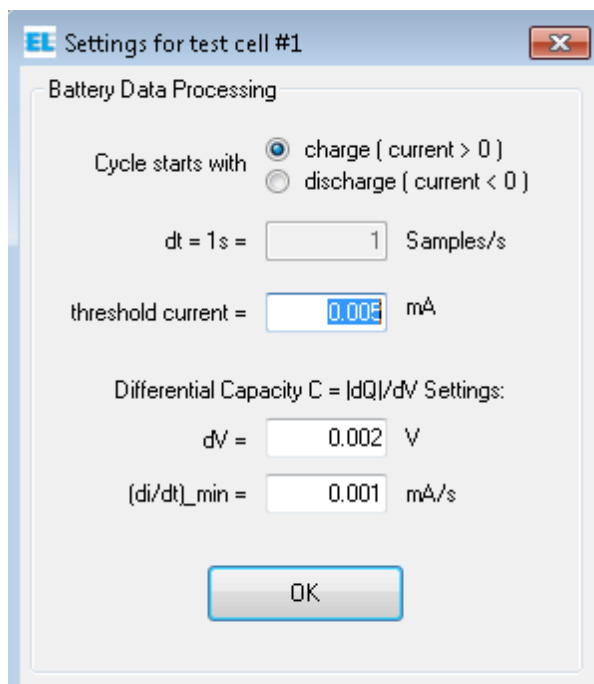
This configuration comes as a standard when using the following devices:

- PAT-Cell-Press
- PAT-Cell-Gas P and PAT-Cell-Gas SP
- ECD-3, ECD-3-nano, ECD-2-DL, ECD-nano-DL
- ECC-Press-DL

1. In the leftmost column, checkmark the channels you want to log. This setting cannot be changed while logging.



2. In the second left column, checkmark the channels to view. This setting can be changed at any time. Unmarking the view box of a given channel during measurement will only remove its trace from the strip chart; the channel's data will still be written into the log files.
3. In the headline, choose an appropriate sample rate ('[Samples per Second](#)').
4. In the headline, click the '[Start](#)' button to start data logging. The program will open the Battery Data Processing dialog asking for the parameters required to calculate additional ("secondary") data from the primary (raw) data. The default setting will be appropriate in most cases. Details on the different log files created for each measurement are given in chapter 5.



- '[Cycle starts with charge \(current > 0\)](#)' applies to full cells (such as LCO vs Graphite) and "cathode" half cells (such as LCO vs Lithium). '[Cycle starts with discharge \(current < 0\)](#)' applies to "anode" half cells (such as Graphite vs Lithium). This parameter is required to distinguish between cycles.
- '[threshold current](#)' refers to the absolute value of the current considered as zero. This parameter is required to detect start and end of cycles. For proper detection, the chosen threshold must be larger than the total error of the measured current.
- '[dV](#)' refers to the voltage difference ΔV used by the software to calculate the differential capacitance $\Delta Q/\Delta V$ from the primary data. The smaller ΔV is chosen, the better gets the voltage resolution, but the larger the noise of the calculated capacitance values.

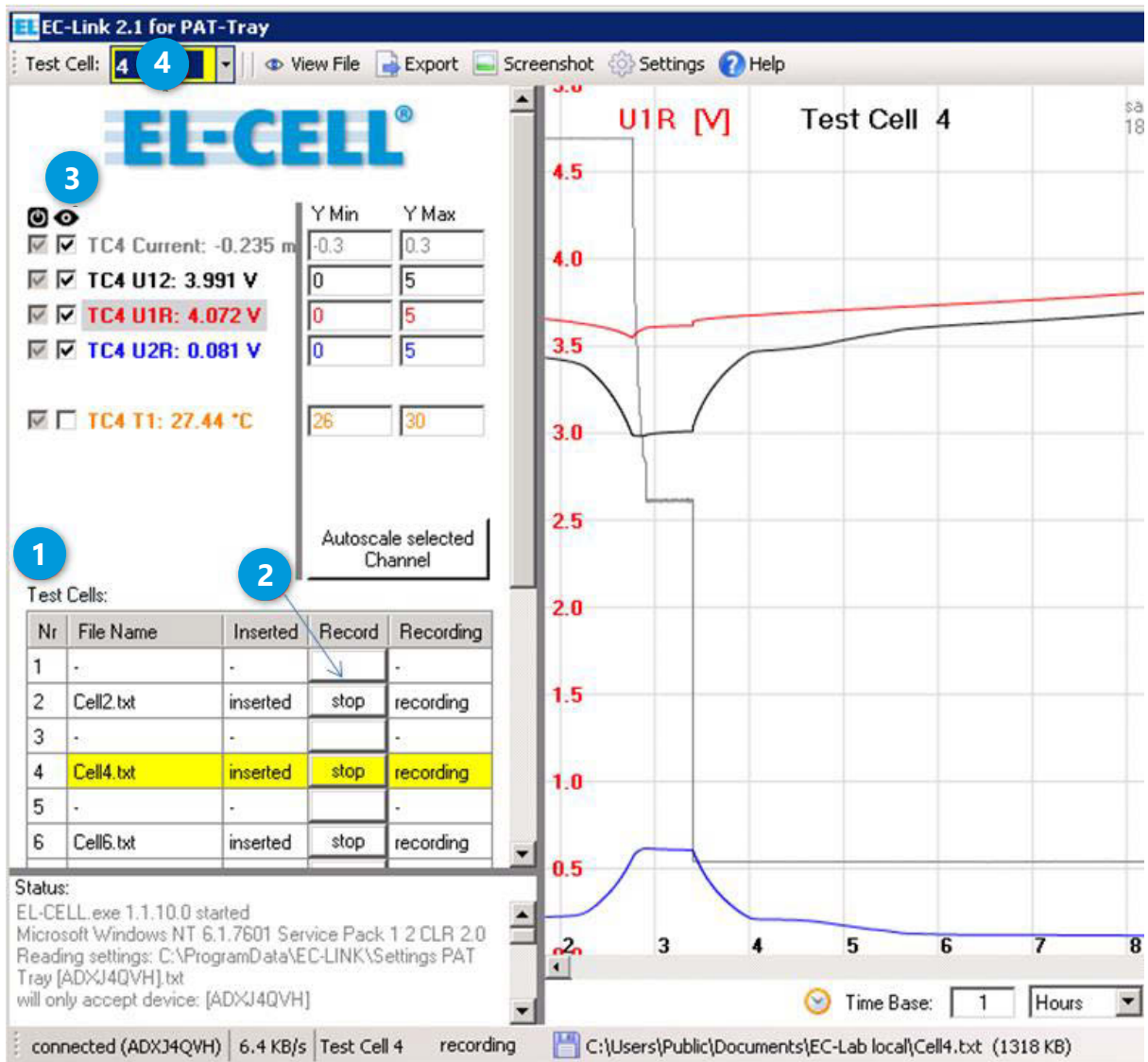
- '(di/dt)_min' refers to the minimum change of current, below which the algorithm considers the current as constant. Only at constant current, the differential capacitance values are being calculated.
5. Choose the active y-axis of the strip chart by clicking on the respective channel name or on the channel trace in the chart.
 6. Click the 'Pause' button to halt data logging, and the resume button to continue.
 7. Click the 'Stop' button to stop data logging.
 8. Click the 'Clear Screen' button to clear the display. The Clear command does not affect the log files.
 9. For a given channel, y-min and y-max define the vertical limits of the displayed trace. Choosing y-min larger than y-max will reverse the y-axis.
 10. Clicking the 'Autoscale selected Channel' button will affect the data in the presently displayed time window only.
 11. Click the 'View File' button to view the log file data in text format.
 12. Double click on one of the channel names to display the current reading in large characters (multimeter mode).
 13. In the headline, click the 'Post-Process' button in order to re-export secondary log file data from any previous measurement with new processing parameters. Note that this function can only be applied to the original (uncompressed) *.txt log file.

4.2 Using EC-Link in a multiple cells configuration

This configuration comes as a standard when using the following devices:

- PAT-Chamber-16
- PAT-Stand-16

The EC-Link software continuously acquires data at a fixed rate of about 1 Hz. The signals of the inserted test cells are displayed in strip charts, one chart for each cell. If no test cell is inserted, the corresponding channels are displayed as zero. Data recording can be started for an inserted test cell only.

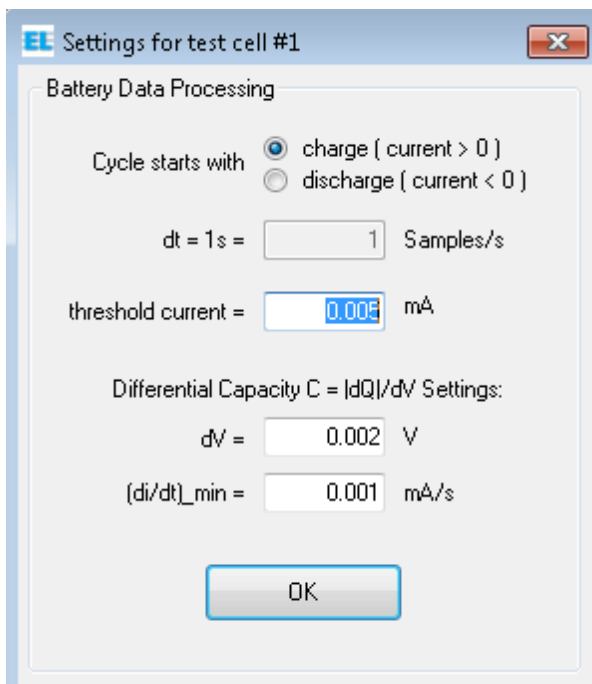


The insertion and recording status of all cell positions is given in the test cell table. **1**

1. Data recording for a given cell can be started in two ways.

- Insert a new cell into the docking station and follow the instructions of the 'New cell detected' dialog.
- Press the 'Record' button **2** of a cell which has been inserted previously and has not been started at that time.

In either case, the program will open the 'Battery Data Processing' dialog asking for the parameters required to calculate additional "secondary" data from the primary (raw) data. The default setting will be appropriate in most cases. Details on the different log files created for each measurement are given in chapter 5.



- 'Cycle starts with charge (current > 0)' applies to full cells (such as LCO vs Graphite) and "cathode" half cells (such as LCO vs Lithium). 'Cycle starts with discharge (current < 0)' applies to "anode" half cells (such as Graphite vs Lithium). This parameter is required to distinguish between cycles.
- 'threshold current' refers to the absolute value of the current considered as zero. This parameter is required to detect start and end of cycles. For proper detection, the chosen threshold must be larger than the total error of the measured current.
- 'dV' refers to the voltage difference ΔV used by the software to calculate the differential capacitance $\Delta Q/\Delta V$ from the primary data. The smaller ΔV is chosen, the better gets the voltage resolution, but the larger the noise of the calculated capacitance values.
- '(di/dt)_min' refers to the minimum change of current, below which the algorithm considers the current as constant. Only at constant current, the differential capacitance values are being calculated.

2. Checkmark the channels you want to view **3**. This setting will apply to all cells.
3. Choose the test cell **4**, the strip chart of which you want to view. With the mouse wheel, you can scroll through the test cells.
4. Select the active y-axis of the strip charts by clicking on the respective channel name or on the channel trace in the chart.
5. For a given channel, y-min and y-max define the vertical limits of the displayed trace. Choosing y-min larger than y-max will reverse the y-axis.
6. Clicking the '**Autoscale selected Channel**' button will affect the data of all inserted cells in the presently displayed time window.
7. Click the '**View file**' button in the headline to view the log file data of the selected channel in text format.
8. Double-click on a channel name to display the current reading in large characters (multimeter mode).
9. Data recording of a given test cell can be stopped in two ways. In either case the corresponding log files will be closed.
 - Press the '**Stop**' button of the test cell, or
 - remove the test cell from the docking station.
10. Data recording can be paused by clicking, in the test cell table, the '**Pause**' button of the respective test cell, and resumed by clicking the '**Resume**' button. This way the test cell can be temporarily removed from the docking station without having to create a second set of log files when resuming the measurement.

5 Log files

For a given measurement, EC-Link generates six different log files.

Important Note: Log files should always be saved on a local hard drive to prevent data corruption due to network crashes.

- ***.txt** contains the uncompressed (primary) data with constant time interval between data rows.

Format (Columns):

- Sample (optional)
- Date and Time (optional)
- Time (s) (since measurement start)
- Time UTC (s) (since 1970, optional)
- Current (mA) (cell current in mA)
- V12 (V) (cell voltage in V)
- V1R (V) (half cell voltage 1 vs R)
- V2R (V) (half cell voltage 2 vs R)
- T (°C) (temperature)
- Pressure (bar) or Dilation (μm)
- Cycle
- t_cycle (s) (time of given cycle)
- P (mW) (power)
- Qtot (mAh) (charge obtained by integration of current over time)
- Qcd (mAh) (same as Qtot, but nulled at start of each half cycle)
- |Qcd| (mAh) (absolute value of Qcd)
- Qc (mAh) (charge of positive half cycle, nulled at start of half cycle)
- Qd (mAh) (|charge| of negative half cycle, nulled at start of half cycle)
- Wcd (mWh) (energy, nulled at start of each half cycle)

- ***_Small.txt** contains the reduced (compressed) data with varying time interval between data rows. Format: same as *.txt

- ***-Cycle.txt** contains the "cycle-wise" computed integral data

Format (Columns):

- Cycle
- Time (s)

- Qc (mAh) (charge of positive half cycle)
 - Qd (mAh) (|charge| of negative half cycle)
 - Wc (mWh) (energy of positive half cycle)
 - Wd (mWh) (|energy| of negative half cycle)
 - Qd/Qc (charge efficiency)
 - Wd/Wc (energy efficiency)
- *-C12.txt contains the differential capacitance data of the full cell

Format (Columns):

- Cycle
 - Time (s)
 - t_cycle (s)
 - V12 (V)
 - Delta V12 (V)
 - Delta Q (mAh)
 - $C12 = |\Delta Q| / \Delta V12$ (mAh/V)
- *-C1R.txt contains the differential capacitance data of the positive half cell

Format (Columns):

- Cycle
- Time (s)
- t_cycle (s)
- V1R (V)
- Delta V1R (V)
- Delta Q (mAh)
- $C1R = |\Delta Q| / \Delta V1R$ (mAh/V)

- *-C2R.txt contains the differential capacitance data of the negative half cell

Format (Columns):

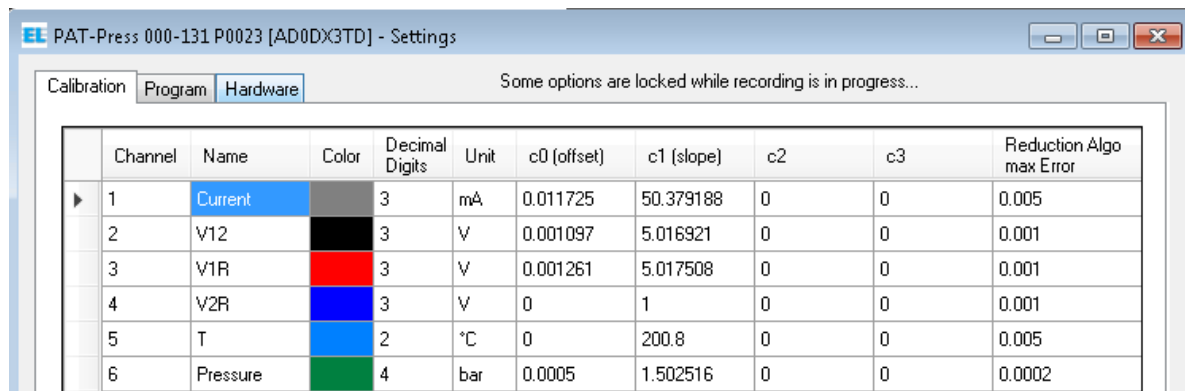
- Cycle
- Time (s)
- t_cycle (s)
- V2R (V)
- Delta V2R (V)
- Delta Q (mAh)

- $C2R = |\Delta Q| / \Delta V2R$ (mAh/V)

In addition to the six log files with the file extension ".txt", EC-Link generates a single empty file *.patmsr.

6 Settings

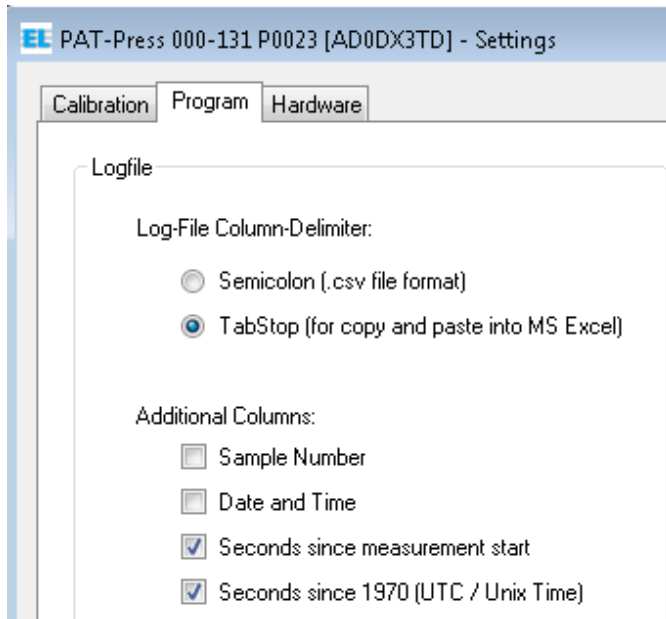
The settings of the EC-Link software being specific to the instrument are contained in the file C:\ProgramData\EC-Link\Settings.... A copy of this file can also be found on the installation media and may be used to restore the original settings. Within the program, in the Settings/Calibration dialog, you can only modify the number of decimal digits displayed, the colours of the individual traces, and the maximum error of the data reduction algorithm.



Channel	Name	Color	Decimal Digits	Unit	c0 (offset)	c1 (slope)	c2	c3	Reduction Algo max Error
1	Current	Grey	3	mA	0.011725	50.379188	0	0	0.005
2	V12	Black	3	V	0.001097	5.016921	0	0	0.001
3	V1R	Red	3	V	0.001261	5.017508	0	0	0.001
4	V2R	Blue	3	V	0	1	0	0	0.001
5	T	Light Blue	2	°C	0	200.8	0	0	0.005
6	Pressure	Green	4	bar	0.0005	1.502516	0	0	0.0002

The 'Reduction Algo max Error' ΔE has a great impact on the efficiency of the data reduction and hence on the size of the compressed *_Small.txt log file. In short, the algorithm checks if a given data point is more than ΔE off the straight line connecting two adjacent data points. If so, then the given data point is kept in *_Small.txt, otherwise it is discarded. Note that the algorithm is applied to all channels. Therefore, if ΔE is set to zero for any channel, then no data reduction takes place.

In the Settings/Program dialog, you can select additional columns to be logged into the *.txt and *_Small.txt log files. The UTC time format is especially useful in case different consecutive measurements need to be referred to the same time scale.



7 Post-Process

In the headline of the program window, click the '**Post-Process**' button in order to re-process existing *.txt log files using new processing parameters. Note that this function can only be applied on the original (uncompressed) *.txt log files.

The Post Process dialog prompts for the maximum error of the reduced data written into the *Small.txt log file, and for the parameters used to create the integrated cycle-wise data (*-Cycle.txt) and the differential capacitance data (*-C12.txt, *-C1R.txt and *-C2R.txt). For more details on the parameters refer to chapter 4.

This dialog can be used to re-process existing output-files with different settings of the built-in Reduction Algorithm.

File

Open existing Log-File

Process File Close

C:\Users\administrator\Desktop\Neuer Ordner\2017-04-01 11-51-18.txt

Measurement Start: 2017/04/01 11:51:18 Device: AD0DX3TD
Sample Rate: 1 samples per second
(5.2 KB)

Reduction Algorithm Tolerance Settings

The reduction algorithm can reduce the size of output files. Please provide the maximum error that you are willing to tolerate for each channel. The algorithm will then reduce the number of sample points in the file.

Column	Channel Name	Max Error	Unit
1	Sample		
2	Date and Time		
3	Time		s
4	1 Current	0.005	mA
5	2 V12	0.001	V
6	3 V1R	0.001	V
7	4 V2R	0.001	V
8	5 T	0.005	°C
9	6 Pressure	0.0002	bar
10	cycle		
11	t_cycle		s
12	P		mW

Keep at least 1 line out of every 1000 lines.

Battery Data Processing

Cycle starts with charge (current > 0)
 discharge (current < 0)

dt = 1s = 1 Samples/s

threshold current = 0.005 mA

Differential Capacity $C = |dQ|/dV$ Settings:

dV = 0.002 V

(di/dt)_min = 0.001 mA/s

Save as default

Apply to test cells now

8 Running Multiple Data Loggers

It is possible to connect multiple USB data loggers (and associated instruments) to a single PC and to run them simultaneously. The EC-Link software only needs to be installed once.

For the installation of an additional device, just copy the settings file from the provided installation media of the new instrument into the directory C:\ProgramData\EC-Link. Note that the Windows operating system may hide the directory C:\ProgramData\ by default.

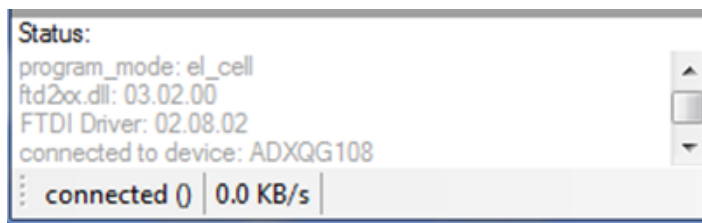
9 Upgrading EC-Link

When upgrading the EC-Link software from version 2.0 or higher, we recommend the following procedure.

- Download and unzip the newest software from <https://el-cell.com/support/software>
- Run setup.exe and overwrite the existing directory C:\Program Files\EC-Link

When upgrading the EC-Link software from a version below 2.0, we recommend the following procedure.

- Download and unzip the newest software from <https://el-cell.com/support/software>
- Run setup.exe
- Launch (double-click) EC-Link, and choose the appropriate setting file from the provided list. This settings file will be copied to the directory C:\ProgramData\EC-Link.
- Follow the instructions on the screen. Notice the 8-digit device number 'ADX.....' as displayed in the status window.



- Quit the software and manually rename the settings file in the directory C:\ProgramData\EC-Link into 'Settings...[ADX.....]'. The device number will be used by the software to unambiguously assign the settings file to the corresponding instrument.
- For housekeeping reasons, delete any unused setting files from the directory C:\ProgramData\EC-Link. Also uninstall any older EC-Link program versions.