

User Manual

Release 1.0

PAT-Chamber-16 / PAT-Chamber-16 C

Temperature-controlled docking station



The information in this manual has been carefully checked and believed to be accurate; however, no responsibility is assumed for inaccuracies.

EL-CELL GmbH maintains the right to make changes without further notice to products described in this manual to improve reliability, function, or design. EL-CELL GmbH does not assume any liability arising from the use or application of this product.

EL-CELL GmbH

Tempowerkring 8 21079 Hamburg - Germany

phone: +49 40 79012-737
fax: +49 40 79012-736
e-mail: info@el-cell.com
web: www.el-cell.com



Content

1	Product description	4
2	Safety instructions	5
3	Technical data	6
4	Installation	8
5	Operation1	0
6	EC-Link software1	2
7	Cleaning1	2
8	Unpacking1	2
10	EC declaration of conformity1	3
11	Technical support1	6
12	Warranty1	6

Included component manuals

PAT-Connect-16	
EC-Link software	

1 Product description

The PAT-Chamber-16 is a temperature controlled docking station / cell chamber for up to 16 test cells of the PAT series. The temperature of the chamber can be precisely controlled by means of a Peltier device between 5 and 80°C. The PAT-Chamber-16 is the first high throughput docking station supporting the PAT-Cell-Press for in-situ pressure monitoring of up to 16 test cells at the same time.

The PAT-Chamber-16 is to be connected to a multi-channel potentiostat (like the Biologic MPG-2) or battery tester (like the Maccor 4000). Mixed connection of the 16 cell positions to different potentiostats / battery testers is possible as well.

The PAT-Chamber-16 features a built-in data logger for recording all cell signals – cell current, cell voltage and the two half cell voltages of each cell – along with the chamber temperature and the individual pressure signals, if used with the PAT-Cell-Press.

The PAT-Cell, the PAT-Core, and the EC-Link data logger software are covered in detail by other manuals (<u>http://el-cell.com/downloads/downloads-manuals</u>).



PAT-Chamber-16 and PAT-Chamber-16 C (with integrated PAT-Connect adapter box)

Features

- Peltier temperature-controlled docking station, ready for connection to any potentiostat or battery tester.
- Temperature range 10 80°C
- Holds up to 16 PAT series test cells for 2- and 3-electrode measurements.
- Charge/discharge/EIS compatible with any PAT series test cell
- Supports up to 16 PAT-Cell-Press for additional pressure monitoring
- Compatible with all of today's multi-channel potentiostats and battery testers. Mixed operation of the 16 cell positions with different potentiostats and/or battery testers possible.
- Integrated data logger hard- and software for recording of cell current, cell voltage, half cell voltages, global temperature, and individual cell pressure.
- Analog outputs available of the buffered half cell voltages (16 x V2R), sensor signals (16 x AOUT) and chamber temperature (VT). The analog outputs allow for easy interfacing with the external inputs of the connected battery tester / potentiostat.



2 Safety instructions

The PAT-Chamber-16 should only be operated by laboratory personnel especially trained for this purpose and familiar with all precautionary measures required for working in a laboratory. To avoid injuries and damage observe the safety instructions of this user manual.

NOTE: The PAT-Chamber-16 must only be used with test cells of the PAT series. Don't place other goods inside the chamber.

2.1 Localization / position of safety labels on the PAT-Chamber-16

The following lables are located on the unit

4	Electrical hazard! After removing covers, live parts may be exposed. You may receive an electric shock if you touch these parts. Disconnect the mains plug before removing any covers. Only electrical technicians may work on the electrical equipment of the appliances.
<u>SSS</u>	Hot surface! The parts of the inner chamber will become hot during operation. Danger of burning. Do not touch the inner surfaces during operation without protective gloves.
	Wear protective gloves







3 Technical data



- **1** Dimensions: 635 mm (width) x 378 mm (depth) x 374 mm (height)
- Dimensions with attached PAT-Connect-16 C:
 635 mm (width) x 378 mm (depth) x 449 mm (height)
- Temperature: +10 to +80°C
- Weight: 24 kg (without PAT-Cells)



3.1 Designation (nameplate)

The nameplate provides information about the appliance model, manufacturer and technical data. It is attached to the back of the appliance.

1 Type: PAT-Chamber-16 2 100-230 V~ 50/60 Hz 430 W → 6.3 A	Serial number:000-123
³ Protection class: IP 20	○ (€
4 EL-CELL GmbH Tempowerkring 8 Phone: +49 40 79012-737	21079 Hamburg Germany Made in Germany
 Type designation Operating voltage, Connection / power ratings 	 4 Address of manufacturer 5 Serial number 6 CE conformity

4 Installation

Place the PAT-Chamber-16 on a flat, horizontal surface. Do not place the instrument on a flammable surface. A 230 V or 115 V power connection must be available. The distance between the wall and the rear of the instrument must be at least 15 cm. The top clearance must not be less than 25 cm. Sufficient air circulation in the vicinity of the instrument must be guaranteed at all times.

4.1 Connection to the external battery tester or potentiostat

Two versions of the PAT-Chamber-16 are available which differ in the way the connection to the external battery tester or potentiostat is being established.

1. PAT-Chamber-16: Direct connection with fixed assignment of WE, CE and RE for a Connection to battery tester given channel. Battery tester Blo CELL Connection to PC (USB)

PAT-Chamber-16

2. PAT-Chamber-16 C:

Indirect connection via PAT-Connect-16 C with variable assignment of WE, CE and RE for a given channel.





Power

suppl

4.2 Connection to the power supply

Caution:

Observe the country-specific regulations when making connections. Observe the connection and power ratings (see nameplate.). Make sure to establish a safe PE conductor connection.

Plug the provided power cable into the rear of the instrument. Lay the power cable so that it is always accessible and within reach so it can be disconnected quickly in the event of failure or emergencies.

Connect the other end of the power cable to the power supply (wall outlet). The instrument will immediately power up once connected. Note that the cells docked into the PAT-Chamber-16 will experience self-discharge (across a resistance of approx. 10 kOhm between WE and CE) in case the instrument is powered down.

4.3 USB connection to the host PC

Plug one end of the provided USB cable into the USB socket at the rear of the PAT-Chamber-16, the other end into the USB socket of the Windows PC. From the provided CD, install the EC-Link software on the Windows PC and launch the EC-Link software.

For details of the software installation and operation, refer to the EC-Link software manual. Note that the USB data logger hardware of the PAT-Chamber-16 is powered from the host PC, and is galvanically isolated from the power supply of the PAT-Chamber.

5 Operation

5.1 Control display, push buttons, and LED matrix



By default, the LC display at the front of the PAT-Chamber-16 shows the actual and the setpoint temperature. The 4x4 LED matrix on the right informs about whether the corresponding cell socket is free (LED off) or occupied (LED lit).



In order to change the setpoint temperature, press the select button, then adjust the displayed setpoint with the arrow buttons, and confirm with the select button.

In order to change the device number or the display contrast, hold the select button for at least one second. A settings list shows up. From this list, select the device or contrast entry with the arrow buttons and change as required.

====== Settings ADDRESS Device Number: Display Contrast: 90 Set Temperature: 80.0 degC Info ----- $31.5 \\ 100$ Actual Temp. degC eating Power: 36 Relative Humidity: 50.0 96 irmware: Nov 1 2017 [Exit Menu]



5.2 Dry Mode

Under certain operating conditions, especially when heating up the chamber from a setpoint below ambient temperature, water may start to condense inside the chamber. When detecting such an operating condition, the chamber automatically enters the so-called Dry Mode: The user is prompted to open the lid of the PAT-Chamber.



Once the lid has been opened, the user is prompted to wait (to leave the chamber open) for a given time period.



Once the countdown is finished, the user is prompted to close the lid.



5.2 Workflow

This section gives a quick overview on how to run a test with a PAT-Cell docked into the PAT-Chamber, and connected to an external battery tester. More details on the EC-Link software are given in a separate manual.

- Open the cover of the PAT-Chamber
- Insert a new PAT-Cell into a free socket, and close the cover.
- In EC-Link, a menu pops up, notifying that a new test cell has been inserted.
- Follow the instructions of the 'New cell detected' dialog. Data recording for the given cell will be started.
- In the software application of the battery tester, start the test procedure of the corresponding channel.
- Once the test is completed, remove the PAT-Cell from the PAT-Chamber.
- In EC-Link, a menu pops up, notifying that recording has been stopped.



6 EC-Link software

How to install and operate with the EC-Link software is described in a separate manual.

Please note that the EC-Link software is only required for the standard configuration of the PAT-Chamber-16, which contains a data logger. A passive version of the PAT-Chamber-16 without a data logger is available on request.

7 Cleaning

Wipe the PAT-Chamber-16 with a moist tissue. Do not use aggressive chemicals for cleaning. Protect the PAT-Chamber-16 from dust and splash water.

8 Unpacking

Check the contents of the packages against the list given below to verify that you have received all of the required components. Contact EL-CELL, if anything is missing or damaged. **NOTE**: Damaged shipments must remain within the original packaging for freight company inspection.

List of components

- PAT-Chamber-16 ECC1-03-0300-A
- optionally with PAT-Connect-16 C ECC1-03-0130-A
- Power cord ELT9412
- USB cable (Type A/B; 2,0m) ELT9167
- EC-Link installation CD ECE1-00-0052-A

NOTE: The cables for connection between PAT-Chamber-16 and the external battery tester must be ordered separately.

10 EC declaration of conformity

I-CELL	electrochemical test equipmen
EC Declaration	n of Conformity
Manufacturer's name and address:	EL-CELL GmbH Tempowerkring 8 20170 Userburg
	Germany
Product:	PAT-Chamber-16 with optional PAT Cell Cable Set and optional PAT-Connect-16
Туре:	PAT-Chamber
The designated products are in conf	ormity with the European Low Voltage Directive
201	4/35/FU
includ	ing amendments
Council Directive on the appr States relating to Electrica vo	oximation of the laws of the Member Il equipment for use within certain Itage limits
The designated products are in c	onformity with the European EMC Dicrective
201	4/30/EU
includ	ing amendments
laws of the Member Sta	y 1989 on the approximation of the ates relating to electromagnetic ompatibility
The object described in the declarati of the European Parliament and the of certain hazardous substar	on above corresponds to the directive 2011/65/EC Council of 8 June 2011on the restriction of the use Ices in electrical and electronic equipment.
Hamburg, 24.11.2017	
p.ke	
Michael Hahn, CEO	
This declaration certifies compliance with the above	mentioned directives but does not include a property assurance. which are part of the supply, must be observed.



The products described are in conformity with the following harmonized standards:

EN 61010-1:2010	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte – Teil 1: Allgemeine Anforderungen (DIN EN 61010-1, VDE 0411-1:2011-07)				
	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements (IEC 61010-1:2010 + Cor. :2011)				
EN 61010-2-201:2014	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte - Teil 2-201: Besondere Anforderungen für Steuer- und Regelgeräte (DIN EN 61010-2-201:2014, VDE 0411-2-201:2014-01)				
	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment (IEC 61010-2-201:2013)				
EN 61010-2-010:2015-05	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte - Teil 2-010: Besondere Anforderungen an Laborgeräte für das Erhitzen von Stoffen (DIN EN 61010-2-010:2014; VDE 0411-2-010:2015-05)				
	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment (IEC 61010-2-201:2013)				
EN 61326-1:2013	Elektrische Mess-, Steuer-, Regel- und Laborgeräte - EMV- Anforderungen - Teil 1: Allgemeine Anforderungen (DIN EN 61326-1:2013-07, VDE 0843-20-1:2013-07) EMC requirements - Part 2-3: Particular requirements - Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning (IEC 61326-2-3:2012)				

EN 61326-2-3:2013-07	Elektrische Mess-, Steuer-, Regel- und Laborgeräte - EMV- Anforderungen - Teil 2-3: Besondere Anforderungen - Prüfanordnung, Betriebsbedingungen und Leistungsmerkmale für Messgrößenumformer mit integrierter oder abgesetzter Signalaufbereitung (DIN EN 61326-2-3:2013-07, VDE 0843-20-2-3:2013-07)		
	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-3: Particular requirements - Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning (IEC 61326-2-3:2012)		
EN 50581: 2013-02	Technische Dokumentation zur Beurteilung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkung gefährlicher Stoffe (DIN EN 50581; VDE 0042-12:2013-02)		
	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances		

11 Technical support

Technical support for this product is exclusively provided by EL-CELL GmbH.

EL-CELL GmbH Tempowerkring 8 21079 Hamburg - Germany phone: +49 40 79012-737

fax: +49 40 79012-736 e-mail: info@el-cell.com

web: <u>www.el-cell.com</u>

12 Warranty

For a period of one year from the date of shipment, EL-CELL GmbH (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is void when repairs are performed by a non-authorized person or service center. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of Germany.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supersedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.





User Manual

Release 1.0

PAT-Connect-16

Adapter box for flexible wiring connections



The information in this manual has been carefully checked and believed to be accurate; however, no responsibility is assumed for inaccuracies.

EL-CELL GmbH maintains the right to make changes without further notice to products described in this manual to improve reliability, function, or design. EL-CELL GmbH does not assume any liability arising from the use or application of this product.

EL-CELL GmbH

Tempowerkring 8 21079 Hamburg - Germany

phone: +49 40 79012-737
fax: +49 40 79012-736
e-mail: info@el-cell.com
web: www.el-cell.com



Content

1	Product description	. 4
2	Technical data	. 5
3	Installation	. 6
4	Cleaning	. 8
5	Unpacking	. 9
6	Accessories	. 9
7	Technical support	10
8	Warranty	10

1 Product description

The PAT-Connect-16 box serves the most flexible connection between an external battery tester or multi-channel potentiostat and the PAT-Stand-16/PAT-Chamber-16. The individual connection between a given PAT-Cell in the stand /chamber and the corresponding channel of the battery tester can be configured via an array of banana sockets at the front of the connection box. That gives the largest possible freedom to choose between the various full and half cell control modes.

In addition, the PAT-Connect box feeds through all the auxiliary analog signals provided by the PAT series test cells - temperature, pressure and buffered half cell voltages - and makes these signals available to the external battery tester.

PAT-Connect-16

Two different versions of the PAT-Connect-16 are available:

- The PAT-Connect-16 for connection to the PAT-Stand-16. This version is for wall mounting or placing on the bench.
- **2** The PAT-Connect-16 C for connection to the PAT-Chamber-16. This version is permanently attached to the PAT-Chamber.

Features

- Easy-to-access banana sockets for plug-in of the cell cables of the battery tester / potentiostat (sockets available for WE, WE-Sense, RE, CE, CE-Sense, and GND)
- Sub-D Connector for optional auxiliary signals: buffered half cell voltages, temperature, sensor signals
- Available as modular box (PAT-Connect-16) to be placed on the bench or fixed on the wall, or as an attachment on top of the PAT-Chamber-16 C (PAT-Connect-16 C)



2 Technical data



Dimensions PAT-Connect-16:

334 mm (width) x 195 mm (depth) x 106 mm (height)





Dimensions PAT-Connect-16 C:

350 mm (width) x 177 mm (depth) x 75 mm (height)



3 Installation

When purchased in combination with a PAT-Stand-16 or PAT-Chamber-16, the PAT-Connect box comes always readily connected upon delivery. The connection cables between docking station and connect box are available in different lengths:

- PAT-Connect-16 Cable Set (10/10), 700 mm length, ECE1-00-0152-A
- PAT-Connect-16 Cable Set (10/10), 1000mm length, ECE1-00-0152-B
- PAT-Connect-16 Cable Set (10/10), 2000 mm length, ECE1-00-0152-C





3.1 PAT-Connect-16 connections



3.2 Control modes

The following schemes show how to connect, for a given test channel, the cell cable of the external battery tester or potentiostat to the banana sockets at the PAT-Connect box. Note that the naming conventions for the cell cable signals, and the number of signals (between 3 and 5), may differ between battery testers. The leads WE, CE and RE are always present, albeit possibly with other names.

1. Full cell control

Battery tester / potentiostat	WE	CE	RE	WE Sense	CE Sense
PAT-Connect-16	1	2	25	15	25

2. Half cell control 1 vs R (lower half cell)

Battery tester / potentiostat	WE	CE	RE	WE Sense	CE Sense
PAT-Connect-16	1	2	R	15	25

3. Half cell control 2 vs R (upper half cell)

Battery tester / potentiostat	WE	CE	RE	WE Sense	CE Sense
PAT-Connect-16	2	1	R	25	15

The connection namings mentioned in the operation mode tables can differ from the used potentiostat. To view specific naming conventions from selected different manufacturers see the table below.

Important note: The application of our test cells is not limited to the potentiostats listed below. Our test cells can be used with all other potentiostats as well.

3.3 Cable colors and naming conventions

Exemplary potentiostat	WE	WE-Sense	CE	CE-Sense	RE
BioLogic	WE	Ref1	CE	Ref3	Ref2
(i.e. VSP, VMP3)	Red cable	Red cable	Blue cable	Blue cable	White cable
Gamry Instruments (i.e. Reference 3000 [™])	Green cable	Blue cable	Red cable	Orange cable	White cable
lvium Technologies	WE1	S	CE	-	RE
(i.e. lviumStat)	Red cable	White cable	Black cable		Blue cable
Metrohm Autolab	WE	S	CE	-	RE
(i.e. PGSTAT Series)	Red cable	Red cable	Black cable		Blue cable
Princeton Applied Research (i.e. PARSTAT 2273)	Green cable	Grey cable	Red cable	-	White cable

4 Cleaning

Wipe the PAT-Connect-16 with a moist tissue. Do not use aggressive chemicals for cleaning. Protect the device from dust and moisture.

5 Unpacking

Check the contents of the packages against the list given below to verify that you have received all of the required components. Contact EL-CELL, if anything is missing or damaged. **NOTE**: Damaged shipments must remain within the original packaging for freight company inspection.

List of components

• PAT-Connect-16 ECE1-00-0130-A or PAT-Connect-16 C ECC1-03-0130-A

NOTE: The cables for connection between PAT-Chamber-16/PAT-Stand-16 and the PAT-Connect-16 must be ordered separately.

6 Accessories

Adapter male 4 mm to female 2 mm, black (10pcs) ELT9081/X

7 Technical support

Technical support for this product is exclusively provided by EL-CELL GmbH.

EL-CELL GmbH Tempowerkring 8 21079 Hamburg - Germany phone: +49 40 79012-737

fax: +49 40 79012-736

e-mail: info@el-cell.com

web: <u>www.el-cell.com</u>

8 Warranty

For a period of one year from the date of shipment, EL-CELL GmbH (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is void when repairs are performed by a non-authorized person or service center. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of Germany.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supersedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.





Quick Guide EC-Link Software

Release 2.5

Using with PAT-Tray, PAT-Stand-16, PAT-Chamber-16

© 2017 EL-CELL GmbH

The information in this manual has been carefully checked and believed to be accurate; however, no responsibility is assumed for inaccuracies.

EL-CELL GmbH maintains the right to make changes without further notice to products described in this manual to improve reliability, function, or design. EL-CELL GmbH does not assume any liability arising from the use or application of this product.

EL-CELL GmbH

Tempowerkring 8 21079 Hamburg - Germany

phone: +49 (0)40 790 12 733
fax: +49 (0)40 790 12 736
e-mail: info@el-cell.com
web: www.el-cell.com

Content

1	What is EC-Link?
2	EC-Link System Requirements4
3	Installing the EC-Link Software
4	Running the EC-Link Software
5	Log files
6	Settings10
7	Post-Process
8	Running Multiple Data Loggers12
9	Upgrading EC-Link

1 What is EC-Link?

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

- PAT-Stand-16/PAT-Tray (docking station for up to 16 PAT-Cells)
- PAT-Chamber-16
- PAT-Press, ECC-Press-DL, ECD-2-DL, ECD-3, ECD-nano-DL, ECD-3-nano (please refer to separate quick start guide)

With the EC-Link software, the signals of the cells attached to the PAT-Stand-16 or PAT-Chamber-16 are recorded into log files and viewed as strip-charts. One set of files is being created for each of the 16 test cells. The files contain the cell signal data of the given cell – current, cell voltage and the two half cell voltages – together with the temperature of the docking station. If the PAT-Chamber-16 is used with the PAT-Cell-Press, the files also contain the pressure data of the respective test cell. 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 instruments 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 8, Windows 7, Windows Vista, Windows XP (SP2 or later).

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 CD, 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

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.

	E	-CE			- 	U1R [V]	Tes	st Cell	4		sa 18
		t: -0 235 m	Y Min	Y Max	4.5						
	7 TC4 U12: 3	.991 V	0	5	4.0					-	T
1	7 TC4 U1R: 4	.072 V	0	5			-				-
	7 TC4 U2R: 0	0.081 V	0	5	3.5						-
R	TC4 T1: 27	44 °C	26	30	20						
					3.0	1					
1 Test	Cells:	2	Autosca Cł	ale selected nannel	2.5						
1 Test Nr	Cells: File Name	2 Inserted	Autosca Cł	ale selected nannel Recording	2.5						
1 Test Nr 1	Cells: File Name	2 Inserted	Autosca Cł Record	ale selected nannel Recording	2.5						
1 Nr 1 2	Cells: File Name - Cell2.txt	2 Inserted - inserted	Autosca Cr Record stop	Recording	2.5						
1 Nr 1 2 3	Cells: File Name - Cell2.txt	2 Inserted - inserted -	Autosca Cr Record stop	Recording	2.5						
1 Nr 1 2 3 4	Cells: File Name - Cell2.txt - Cell4.txt	2 Inserted - inserted - inserted	Autosca Cr Record stop	Recording - recording - recording	2.5						
1 Nr 1 2 3 4 5	Cells: File Name - Cell2.txt - Cell4.txt	2 Inserted - inserted - inserted -	Autosca Cr Record stop	Recording - recording - recording -	2.5 2.0 1.5 1.0						
1 Nr 1 2 3 4 5 6	Cells: File Name - Cell2.txt - Cell4.txt - Cell6.txt	2 Inserted - inserted - inserted - inserted inserted	Autosca Cr Record stop stop	Recording - recording - recording - recording - recording	2.5 2.0 1.5 1.0						
1 Test Nr 1 2 3 4 5 6 tatus L-CE	Cells: File Name Cell2.txt Cell4.txt Cell6.txt : LL.exe 1.1.10.0 oft Windows N1	2 Inserted - inserted - inserted - inserted started 5.1.7501 Ser	Autoscz Cł Record stop stop	Recording - recording - recording - recording - recording - recording	2.5 2.0 1.5 1.0 ▼ 0.5						

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.

EE Settings for test cell	#1 💌
- Battery Data Processing	J
Cycle starts with	charge (current > 0) discharge (current < 0)
dt = 1s =	1 Samples/s
threshold current =	0.005 mA
Differential Capa	city C = dQ /dV Settings:
dV =	0.002 V
(di/dt)_min =	0.001 mA/s
	ОК

- '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.

 *.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 cyclenulled 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 CD 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 ΔE of the data reduction algorithm.

💶 PAT-Tray 1 [ADXJ4R35] - Settings

Test Cell	Channel	Name	Color	Decimal Digits	Unit	c0 (offset)	c1 (slope)	c2	c3	Reductior Algo max Error
1	1	Current		4	mΑ	-0.008759	-50.161136	0	0	0.005
1	2	V12		3	V	-0.001026	-5.01736	0	0	0.001
1	3	V1B		3	V	0	1	0	0	0.001
1	4	V2R		3	V	0.001108	5.017371	0	0	0.001

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.

EL PAT-Press 000-131 P0023 (AD0DX3TD) - Settings							
Calibration Program Hardware							
Logfile							
Log-File Column-Delimiter:							
Semicolon (.csv file format)							
 TabStop (for copy and paste into MS Excel) 							
Additional Columns:							
Sample Number							
Date and Time							
Seconds since measurement start							
📝 Seconds since 1970 (UTC / Unix Time)							
 Date and Time Seconds since measurement start Seconds since 1970 (UTC / Unix Time) 							

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 cycle-wise integrated data (*-Cycle.txt) and the differential capacitance data (*-C12.txt, *-C1R.txt and *-C2R.txt). For more details on these parameters refer to chapter 4.

EL Post-Process										
This dialog ca	This dialog can be used to re-process existing output-files with different settings of the built-in Reduction Algorithm.									
- Filo										
Copen existing L	.og-File		Process File So Close							
C:\Users\administra	ator\Desktop\Neuer	Drdner\2017	18.txt							
Measurement Start: Sample Rate: 1 san (5.2 KB)	Measurement Start: 2017/04/01 11:51:18 Device: AD0DX3TD Sample Rate: 1 samples per second (5.2 KB)									
	Tolerance Settings			⊂ Batterv Data Processir	na					
The reduction algori	ithm can reduce the r	vize of output	t files	Dattery Data Flucessing						
Please provide the r	maximum error that yo	u are willing	to tolerate	Cycle starts with ocharge (current > 0)						
for each channel. I sample points in the	he algorithm will then file.	reduce the i	number of							
				dt = 1s =	1 Samples/s					
Column Channel	Name	Max Error	Unit	threshold current =	0.005 mA					
2	Sample Data and Time									
2	Date and Time			Differential Cap	acity C = dQ /dV Settings:					
J 1	Furrent	0.005	s mA	dV =	0.002 V					
5 2	V12	0.000	V	(di/dt) min –	0.001 mA/a					
6 3	5 2 V12 0.001 6 3 V1R 0.001 7 4 V2R 0.001 8 5 T 0.005			(מואמנ)_ווווין =	0.001 11475					
7 4				Sa	we as default					
8 5					te test sells warr					
96	6 Pressure 0.0002		bar	Арру	to test cells how					
10	cycle									
11	t_cycle		s							
12	Р		m₩							
Keep at least 1 line	out of every 1000	lines.								

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 CD of the new instrument into the directory C:\ProgramData\EC-Link. Note that the directory C:\ProgramData\ may be hidden 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 <u>https://el-cell.com/support/software</u>
- 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 <u>https://el-cell.com/support/software</u>
- 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.

Status:	
program_mode: el_cell	*
ftd2xx.dll: 03.02.00	
FTDI Driver: 02.08.02	-
connected to device: ADAQG 108	•
connected () 0.0 KB/s	

- 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.