EL-CELL®
electrochemical test equipment

User Manual

Release 1.2

PAT-Terminal-1

Disclaimer

EL-Cell GmbH makes no assurances or warranties with respect to this manual and, to the extent permitted by law, limits its liability for violation of any implied warranty to the substitution of this manual for another. In addition, EL-Cell GmbH reserves the right to revise this publication at any time without notice to anyone.

The information provided in this documentation includes general descriptions and/or technical characteristics regarding the performance of the equipment described herein. This documentation cannot serve as a proper evaluation of the suitability or reliability of the equipment for any specific application by any user and should not be relied upon as a substitute for such evaluation. It is the responsibility of each such user or installer to conduct an appropriate and complete risk assessment, evaluation and testing of the equipment with respect to their specific application. EL-Cell GmbH cannot be held responsible or liable for any misuse of the information contained herein.

All relevant state, regional and local safety regulations must always be complied with when installing and using this device. For safety reasons and to ensure compliance with the documented system data, only the manufacturer is authorized to perform repairs on components.

Disregarding this information may result in injury or damage to the equipment.

Manufacturer and customer service

EL-Cell GmbH
Tempowerkring 8
21079 Hamburg – Germany

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Website: el-cell.com

Technical support

Telephone: +49 40 79012-734
Email: support@el-cell.com
Website: el-cell.com/support/technical-support/

Please always quote the serial number on the nameplate when contacting customer service.

Shipping address for repairs

EL-Cell GmbH
Tempowerkring 8
21079 Hamburg - Germany

Please contact our customer service department before making a return. We will not open or process shipments without a completed decontamination report or RMA.

Table of contents

1 Preamble

1.1 Purpose and Target Audience

This manual describes the structure, function, operation, and maintenance of the PAT-Terminal-1. It is intended for the device's end users, who can be any person who interacts directly with it. The term "end user" usually includes laboratory personnel trained to operate this instrument and familiar with all the precautions required to work in the laboratory.

Only an appropriately authorized qualified and experienced person 18 years of age or older may use the PAT-Terminal-1 who:

- has read and understood these installation and operating instructions
- is familiar with the installation and operation of this or a similar device
- is aware of all possible dangers and acts accordingly

1.2 Storage Instructions

Before using this product, make sure you have read and understood the complete instructions and all safety information. Failure to follow these instructions may result in minor or serious injury.

Follow all instructions. This will prevent accidents that could result in property damage or injury. Keep all safety information and instructions for future reference and pass them on to subsequent product users.

The manufacturer is not liable for property damage or injuries resulting from incorrect handling or failure to comply with the safety instructions. In such cases, the warranty becomes void.

1.3 Obtaining Documents and Information

A current version of the documentation is available on the following website:

https://el-cell.com/support/manuals/

Alternatively, you can scan this QR code to access the website:

2 For Your Safety

2.1 Explanation of the Safety Instructions

In this manual, specific recurring terms and symbols are used to warn you of hazards or to give you instructions that are important to prevent injury and damage. You must read and follow these notes to avoid accidents and damage. These terms and symbols are explained below.

2.1.1 Terms Used

NOTICE
„Notice" indicates an important or useful additional information

2.1.2 Symbols Used

Warning symbols (warn of a hazard)	Mandatory sign (prescribes an action)
 Risk of electric shock	 Pull out the power plug

2.2 Product Safety and Hazards

The device described is technically mature, manufactured using high-quality materials, and tested at the factory before delivery. It complies with the state-of-the-art and recognized safety regulations.

2.2.1 Requirements for Operating Personnel

The device may only be operated and maintained by persons of legal minimum age who have been instructed to use it.

2.3 Owner's Responsibility

The owner of the device

- is responsible for the proper condition of the device and for ensuring that it is operated in accordance with its intended use;
- is responsible for ensuring that persons who are to operate or maintain the device are technically qualified to do so, are instructed on the device and are familiarized with these operating instructions;
- must be familiar with the applicable rules, regulations and occupational health and safety provisions and train the personnel accordingly;
- is responsible for ensuring that unauthorized persons do not have access to the device;
- is responsible for ensuring that personal protective equipment is worn by the operating personnel, e.g. work clothing, safety shoes, protective gloves.

2.4 Intended Use

The PAT-Terminal-1 is designed for charging and discharging, as well as for performing functional tests on electrochemical battery test cells. The device can be operated inside a glove box under a protective atmosphere. It can be used independently or in conjunction with a PAT-Tester-x. Other uses can lead to hazards and damage.

NOTICE
The PAT-Terminal-1 may only be used with test cells of the PAT series. Other cell types must be connected using the appropriate adapters available from the manufacturer.

2.5 Modifications and Conversions

The PAT-Terminal-1 must not be modified or altered without authorization. No parts may be added or installed that are not approved by the manufacturer.

Unauthorized conversions or modifications will result in the device no longer being allowed to be operated.

The manufacturer is not liable for any damage, danger, or injury resulting from unauthorized conversions or modifications or from non-compliance with the regulations in this manual.

2.6 Behavior in the Event of Malfunctions and Irregularities

The PAT-Terminal-1 may only be operated in perfect condition. If you, as the operator, notice irregularities, malfunctions, or damage, take the device out of operation immediately and inform your supervisor.

2.7 Switch off Device in Emergency

In case of emergency, unplug the power supply unit to disconnect the device.

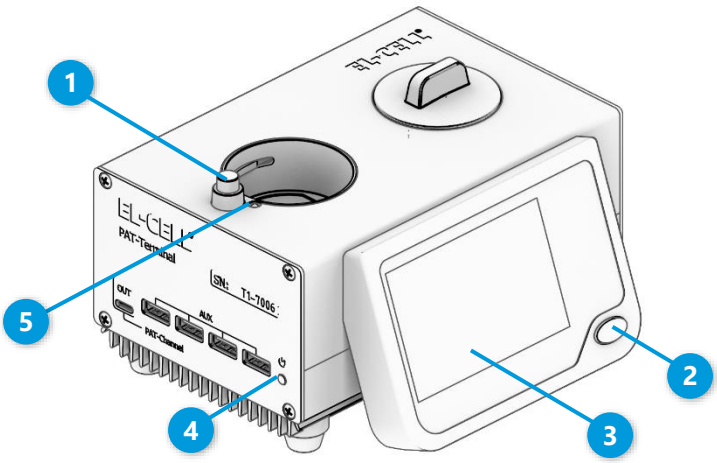
3 Description and Design

3.1 Description

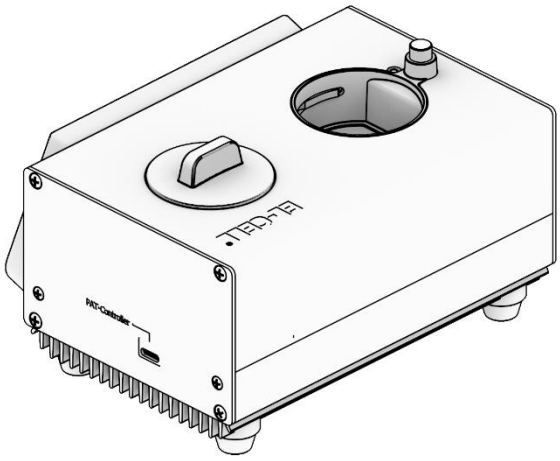
The PAT-Terminal-1 is a single-channel, fully equipped potentiostat/galvanostat and impedance analyzer. It has an LC display for displaying various parameters of the test cell used. The PAT-Terminal-1 can be operated as a stand-alone unit in a glove box to perform functional tests on test cells and to facilitate cell sensor adjustment. Once connected to a PAT Controller-8, it can be used as a normal test channel for full electrochemical measurements.

3.2 Design and Connections

Front side



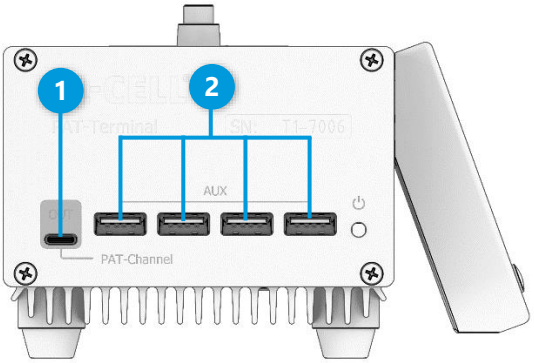
Back side



1	Eject button	4	LED Mainboard Power
2	Function key	5	LED Channel
3	LC-Display		

3.2.1 Connections

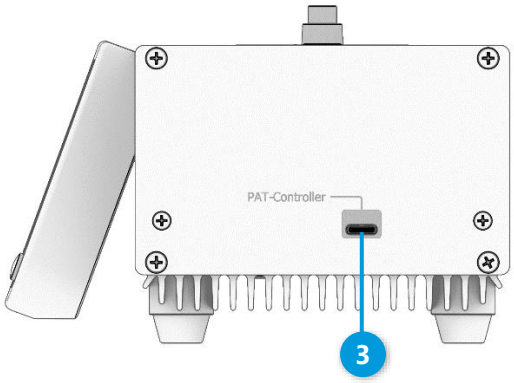
Front side



1. **PAT-Channel connector (USB 2 Type C):** For connecting another PAT-Channel-1

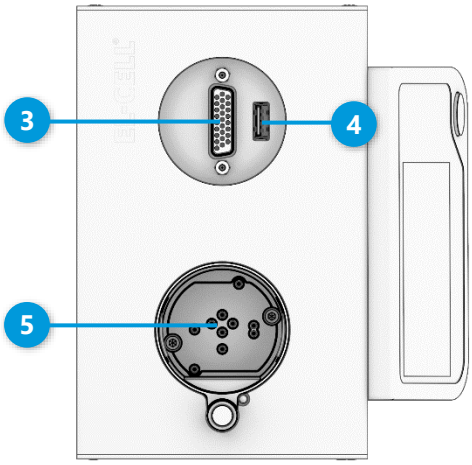
2. **AUX ports (USB 2.0):** For future applications

Back side



3. **PAT-Controller connector (USB 2 Type C):** Used to supply power via the supplied USB power adapter or to connect to a PAT-Controller.

Top side

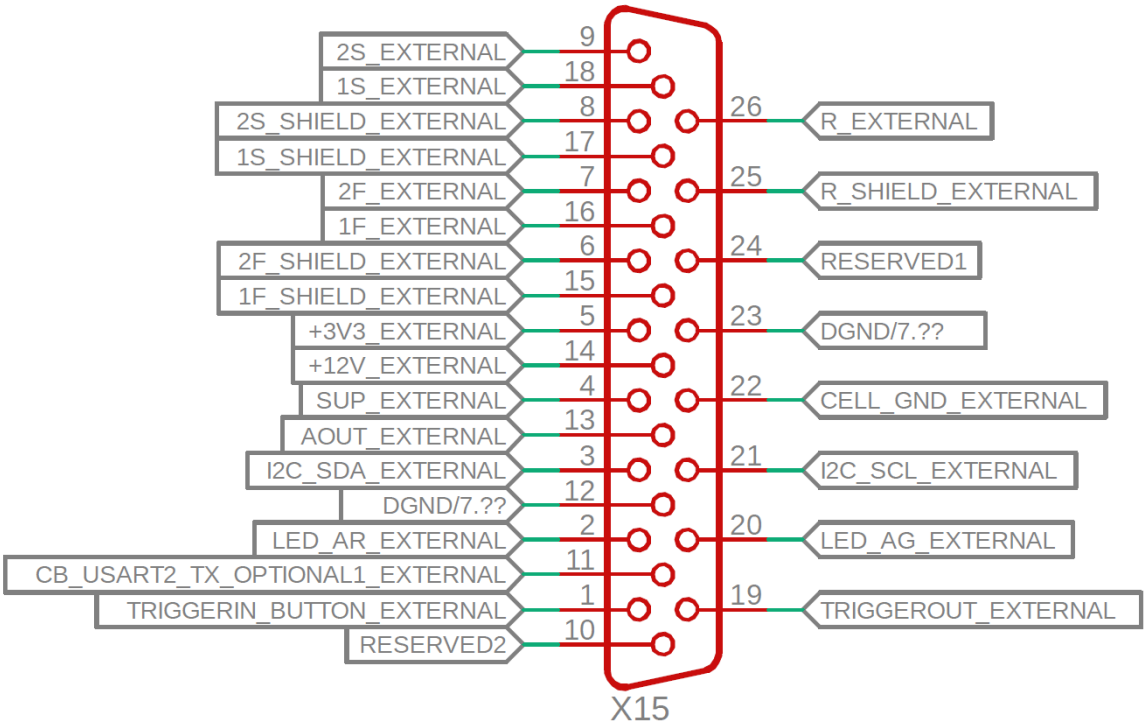


4. **D-Sub connector:** This connector is used to connect a battery test cell or docking station via D-Sub cable.

5. **USB 2.0 port:** Used for power supply and data transfer of external devices.

6. **PAT socket:** This socket is used to connect a PAT series battery test cell or PAT-Adapter.

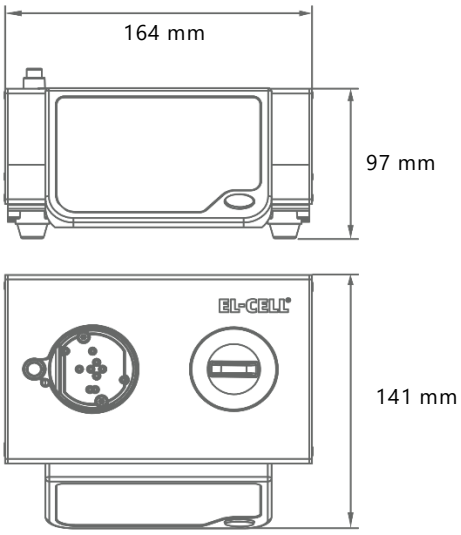
3.2.2 Pin Assignment D-Sub connector



3.2.3 LED Signals Overview

LED	Signal	Meaning
Mainboard Power	Red, lighting interval 3 sec	Initialising mainboard
Mainboard Power	Red, permanent	Mainboard error
Mainboard Power	Green, permanent	Mainboard operational
Mainboard Power	Blue, permanent	PAT-Controller is waiting for the assignment of an IP address from the DHCP server **or** Establishing USB connection **or** Performing firmware update (mainboard+channel board, can take up to 5 min)
Channel	Red, lighting interval 3 sec	Initializing channel board
Channel	Red, permanent	Channel board error
Channel	Green, permanent	Channel board operational

3.3 Technical Data



3.3.1 Dimensions

Weight	1.3 kg (without inserted test cell)
Height	97 mm
Length	164 mm
Width	141 mm

3.3.2 General Device Specifications

Device name	PAT-Terminal-1
Type	Potentiostat/Galvanostat/Impedance analyzer
Operating temperature range	-20 to +40 °C
Connections	• D-Sub connector for actively shielded cell cables, I2C bus, and analog signals • USB 2.0 connectors • USB 2 Type C connector for power supply and connection to a PAT controller-8

3.3.3 Test Channel Specifications

General	
Control voltage	-7 to +7 V
Compliance voltage	-8 V to +8 V (no load)
Current	±100 mA
Cell and electrode connections	3 electrodes, sense connections, connection matrix
ADC	2x24 Bit
DAC	1x18 Bit
PGStat bandwidth ranges	500 kHz 50 kHz 5 kHz
Slew rate	2.5 V/µs
Sampling interval (rate)	1 ms (1000 samples per second) with intelligent data recording
Input Impedance	>100 MΩ || 20 pF
Computer Interface	1 GBit Ethernet Multiuser Device runs standalone (immune to network interruptions)
Voltage	
Acquisition voltages	Full cell voltage Both half-cell voltages Auxiliary voltage
Measurement accuracy	±0.02% FSR (Full Scale Range)
Measurement noise floor	30 µV peak-peak typical
Control resolution	57 µV (18 Bit) EIS amplitude: 3 µV (additional 16 Bit DAC for EIS)

Current	
Current ranges	±100 mA ±10 mA ±1 mA ±100 µA Auto Range
Measurement noise floor	<1 µA @ 100mA <100 nA @ 10mA <10 nA @ 1mA <1 nA @ 100µA
Measurement accuracy	±0.05% FSR
Control resolution	1 nA min. (18 Bit)
Impedance (each channel)	
Frequency range	100 µHz to 100 kHz
Impedance mode	PEIS and GEIS (simultaneous measurement of full- and half-cell impedances)
Impedance range	1 mΩ to 100 MΩ
EIS quality indicator	SFDR (Spurious Free Dynamic Range)
EIS drift correction	yes
EIS adaptive amplitude	yes
Other	
Additional measurement (each channel)	Multiple digital I^2C bus sensors, e.g., for cell temperature and gas pressure, 1x analog voltage input, e.g., for dilatometer signal
Calibration	Fully automatic self-test and self-calibration with internal voltage references and internal calibration cells (maintenance-free)
Cell identification	Supports PAT-Button for reading the unique test cell serial number

3.4 Applied Guidelines and Standards

The product described conforms 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

EL-CELL®

electrochemical test equipment

EU Declaration of Conformity

Manufacturer's name and address:	EL-Cell GmbH Tempowerkring 8 21079 Hamburg Germany
Product:	PAT-Terminal-1

The designated product is in conformity with the

- Low Voltage Directive (LDV) 2014/35/EU
- Electromagnetic Compatibility Directive (CEM) 2014/30/EU
- Restriction of Hazardous Substance Directive (RoHS) 2011/65/EU

and the following harmonised standards:

- Safety: IEC 61010-1
- EMC: IEC 61326

Emissions

EN 55011: Conducted Class B
EN 55011: Radiated Class A
EN 61000-3-2: Harmonic Current

Immunity

IEC 61000-4-3: EM field
IEC 61000-4-4: Burst
IEC 61000-4-5: Surge
IEC 61000-4-6: Conducted RF
IEC 61000-4-8: Magnetic Field
IEC 61000-4-11: Voltage Dip/Short Interruptions

Hamburg, 25.05.2023

Jan Kahrs, CEO

This declaration certifies compliance with the above mentioned directives but does not include a property assurance.
The safety note given in the product documentation which are part of the supply, must be observed.

3.5 Checking for Completeness and Transport Damage

- Check the completeness of the scope of delivery against the delivery note.
- Check the device for damage.

If you find deviations from the scope of delivery or damage, please notify the carrier and the manufacturer.

3.6 Scope of Delivery

- PAT-Terminal-1
- USB 2.0 Typ C Kabel, 1m, ELT9798
- Power cable, 0.75m, ELT1053
- USB-C Power supply 65W, ELT1045

3.7 Recycling of the Packaging Material

Dispose of the packaging material (cardboard, foil) according to the legal regulations applicable in your country.

3.8 Storage after Delivery

Please observe the storage conditions if the device is to be stored initially after delivery.

4 Start-up

4.1 Operation as a Stand-alone Device

4.1.1 Operation inside the Glove Box

1. Place the PAT-Terminal-1 on a dry, horizontal, clean surface.

2. Connect the supplied power supply unit to the PAT-Terminal-1 and then connect the power supply unit to the mains.

3. Insert a battery test cell into the PAT socket. The electrical values of the test cell appear on the display.

NOTICE

After removing the battery test cell, values continue to be shown on the display until a new cell is connected to the device. This is an intended behavior.

4.1.2 Operation inside the Glove Box

1. Insert the PAT-Terminal-1 into the glove box (transport through vacuum permitted).

2. Now connect the device to the supplied power supply outside the glove box. To do this, install the supplied USB feedthrough-4 on your glove box.

3. First, connect the PAT-Terminal-1 to the cable feedthrough using the USB cable supplied.

4. Connect the USB power supply to the cable feedthrough and the mains.

5. Insert a battery test cell into the PAT socket. The electrical values of the test cell appear on the display.

NOTICE

If the PAT-Terminal-1 is not supplied with power even though the cables are connected, disconnect the USB cable in the glove box from the feedthrough, turn it 180 degrees, and plug it back in.

4.1.3 Performing an Impedance Test

By pressing the function key next to the display, an impedance measurement (PEIS, 1 KHz, 10 mV) is triggered and the cell impedances Z12, Z1 and Z2 are output on the display.

4.2 Operation as Test Channel in a PAT-Tester-x Setup

Precondition

To operate the PAT-Terminal-1 as a test channel in a PAT-Tester-x setup, you need a PAT-Controller connected to an Ethernet Local Area Network (LAN). EL-Software Server (the server application of the EL-Software) must be installed on the LAN server and EL-Software Client (the client component of the EL-Software) must be installed on at least one client PC. The installation instructions for the PAT-Controller and the EL software can be found in separate manuals.

IMPORTANT NOTICE
Please ensure the PAT-Controller-8's firmware is up to date before connecting the PAT-Termina-1l to it. For more information on how to perform a firmware upgrade, please refer to the EL-Software manual.

1. Place the PAT-Terminal-1 on a flat, dry, clean surface.

2. Connect the PAT-Terminal-1 to the PAT-Controller-8 using the supplied USB cable. The cable connects the USB port on the PAT-Terminal-1 (labeled "PAT-Controller") to one of the 8 USB ports (labeled "Channel") on the PAT-Controller.

3. Plug a PAT test cell into the PAT socket. Alternatively, you can also connect another cell type or a PAT docking station via the D-Sub connector of the PAT-Channel and a special cable. For example, this option can be used to operate a test cell at extreme temperatures in a temperature chamber. An adapter is optionally available to test button cells in the PAT socket.

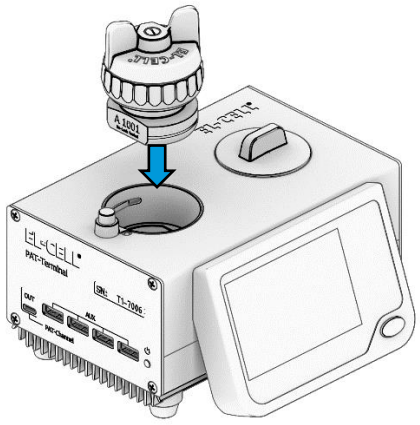
4.3 Switching On and Off

The PAT-Terminal-1 switches on when it is connected to the power supply. Disconnecting the device from the power supply is sufficient to turn it off.

4.4 Inserting and Removing Test Cells

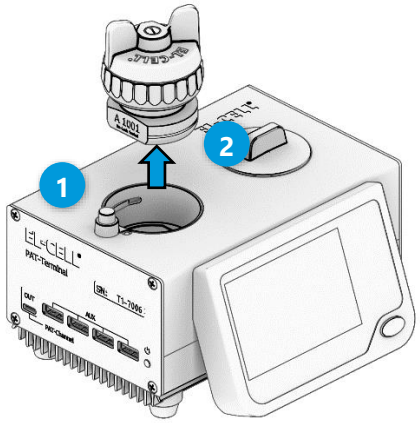
4.4.1 Inserting a PAT Series Test Cell

Insert the cell into the PAT socket until the cell audibly clicks into place. This ensures that the electrical contact is appropriately established.



4.4.2 Removing a PAT Series Test Cell

To remove a cell, press the eject button next to the PAT socket to release the lock (1) and remove the cell (2).



4.4.3 Using Other Cell Types

Other cell types can be connected to the PAT socket via an adapter or to the D-Sub input.

5 LC-Display

Display item	Meaning
Cell ID (in this case, F0001)	Cell ID of the test cell used
Force	The force acting on the cell stack in Newtons (if sensor is present).
Press	The gas pressure in the test cell in mbar (if sensor is present)
Temp	The temperature in the test cell in °C (if sensor is present)
V12, V1R, V2R	The voltages of the full cell and the two half cells in Volts
Z12, Z1, Z2	The impedances of the full cell and the two half cells at 1 kHz in Ohms (only after pressing the function key)

6 Warning Symbols and Troubleshooting

WARNING	
	After removing the covers, electrically live parts may be exposed. If you touch these parts, you may suffer an electric shock.
	Disconnect the power plug before removing any covers. Only qualified electricians may work on the devices' electrical equipment.

6.1.1 Troubleshooting

Problem:

The PAT-Terminal-1 displays an empty display after connecting to a PAT-Controller-8 and no longer reacts.

Possible Solution:

The firmware version on the PAT-Controller-8 is too old and must be updated. This is the case if the installed EL-Software release is older than version 1.1.43.

Proceed as follows:

1. Update EL-Software to the latest version. The EL-Software Manual provides detailed information about the update process.
2. Then update the firmware of the PAT-Controller-8.
3. Reconnect the PAT-Terminal-1 to the PAT-Controller-8. It will now receive the latest firmware and should work properly afterward.

7 Maintenance and Repair

7.1 Cleaning

Wipe the PAT Terminal-1 with a moist cloth. Do not use aggressive chemicals. The metal surfaces can be cleaned with commercially available stainless steel cleaning agents. The affected areas must be cleaned and polished immediately if rust spots occur due to contamination.

Protect the PAT-Terminal-1 from dust and splash water.

8 Storage and Disposal

8.1 Storage

The device may only be stored under the following conditions:

- dry and in a closed, dust-free room
- frost-free
- disconnected from the power supply

8.2 Disposal

The device must not be disposed of in regular household waste. Observe the applicable legal regulations. Please contact your dealer or the manufacturer for disposal.

9 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.