Cognition Energy

Better testing, Better batteries, Better world

OPERATIONS & MAINTENANCE MANUAL

Contents

Change Log

Version	Comments
1.0	14/06/2022 I.Mo First version
2.0	30/07/2024 K.Ma

Notices

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This operations and maintenance manual is intended for informational purposes only. Whilst precautions have been taken to ensure the information in this manual is current, the contents and system described are subject to change without notice.

Understanding this manual is a prerequisite for safe use of the described system. To the extent of the law Cognition Energy Ltd is not liable for any loss, damage or other consequences whatsoever arising from non-compliant use.

Abbreviations & Symbols

Abbreviation	Description
AUX	Auxiliary sensor input
BMS	Battery Management System
CAN	Controller Area Network
GUI	Graphical User Interface
PSU	Power Supply Unit
WEEE	Waste Electrical and Electronic Equipment
ZIF	Zero Insertion Force

Table 1: Glossary of acronyms and abbreviations

Symbol	Description
	General warning sign To identify a general warning, meaning documentation must be consulted before handling or using components affixed with this symbol
	Warning; hot surface Used to indicate the presence of a hot surface (this could be enclosed)
+	Plus; positive polarity Used to indicate terminals of the system that are used with direct current
—	Minus; negative polarity Used to indicate terminals of the system that are used with direct current
⎓	Direct Current Used to indicate the equipment is suitable for direct current only and accompanies the voltage rating
	Do NOT touch Warning to indicate a surface that is dangerous to touch, may be cold as well as hot

Table 2: Glossary of graphical symbols

Introduction

CellPod One is our patented individual thermal chambers, making testing more accurate, flexible and safer. Each CellPod One contains four CellPods, which are independently thermally controlled. Main features include:

- Individual enclosures for cylindrical, coin and small pouch electrochemical cells, providing base temperature control from -20°C to +120°C, with rapid setpoint changes of under three minutes.
- High quality datasets created through ± 0.5°C accuracy and ± 0.2°C stability
- 15A maximum continuous current
- Independent control of each CellPod, meaning tests can be started/stopped without interrupting others; maximising cycler channel uptime.
- Interchangeable stands for different cell form factors which provide tool-free loading of cells.
- Electrical contacts that provide 4-wire cell connection totalling ~1mΩ resistance (typical).
- High level of designed safety features; enclosure provides EUCAR Hazard Level 7 protection for coin cells and EUCAR Hazard Level 4 protection for cylindrical and pouch cells.
- Optional 5-point cell temperature sensor, to capture cell temperature gradients during testing, doing away with traditional methods of adhesively bonding additional temperature sensors.
- Optional 0-5V auxiliary input
- Customised computer software interface to simultaneously control and record data from up-to 96 individual CellPods.

1. CellPod Nomenclature

CellPods work as part of a wider system. The naming conventions of this system are described here. The four key parts of the system hierarchy are as follows:

- System; the complete CellPod system including peripherals
- Quad; a single unit that is comprised of four CellPods
- CellPod; a single testing chamber
- Cell Stand; a fixture for electrically connecting to a cell without tools or welding

Safety

2. Responsibility Disclaimer

If the CellPod system is not used as stated in this manual, the safety protection provided by the equipment may be impaired. The manufacturer, Cognition Energy Ltd, will not be responsible for damages and/or injuries caused as a result of:

- Improper installation
- Use contrary to instructions provided
- Non-original spare parts used
- Non-manufacturer approved modifications

3. CellPod Type Plate

The warning label and type plate will be on the underside of the CellPod Quad. The type plate illustrated in Figure 1 is stuck to the CellPod Quad. The information displayed on the type plate is explained in more detail in Table 3.

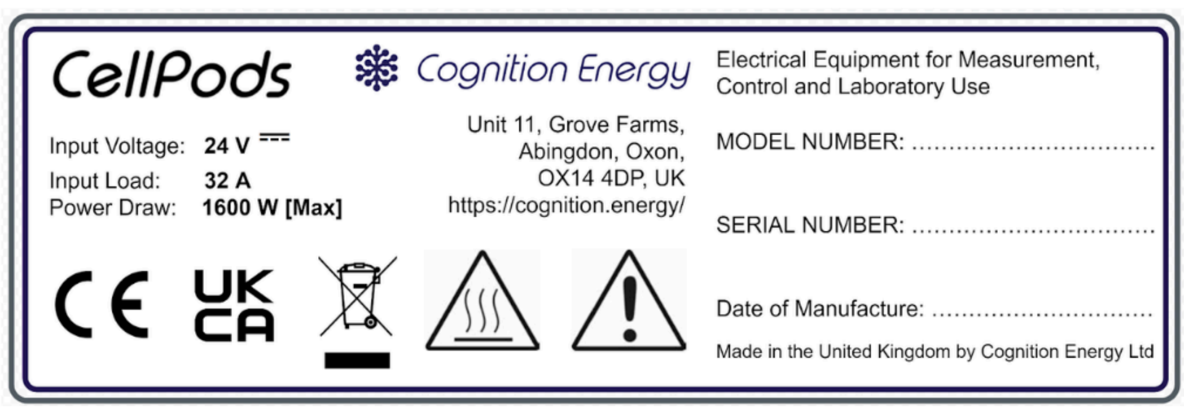


Figure 1: Type plate shown on system.

Type plate	Meaning
Input voltage: 24 V ⎓	Direct current input voltage limit
Input load: 32 A	Maximum current draw
Power draw: 1600 W	Maximum power draw
Electrical Equipment for Measurement, Control, Laboratory Use	Title of standard applied for compliance: EN 61010

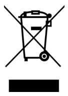
CE	CE conformity marking
UK CA	UKCA conformity marking
	This product is WEEE waste, and should not be discarded as unsorted waste but must be sent to separate collection facilities for recovery and recycling.
	Hot surface warning, used to show the product includes a concealed hot surface.
	General warning sign, used to indicate the necessity to consult safety documentation before use.

Table 3: Type plate information

4. Notices Used in the Manual

Throughout this manual banners are used to notify the reader of important information and potentially dangerous situations that could arise if precautions aren't followed correctly.

⚠ DANGER
Indicates an imminent hazard that, if not avoided, could cause serious irreversible injury or death.

⚠ WARNING
Indicates a potentially hazardous situation that, if not avoided, could result in serious injury or permanent damage to equipment.

⚠ CAUTION
Indicates a potentially hazardous situation that, if not avoided, could result in minor injury, repairable equipment damage or conditions that limit CellPod function.

💡 TIP
Indicates best practice procedure to get the best performance from the CellPod.

5. General Safety Instructions

Cognition Energy Ltd is only responsible for the safety features of the CellPod One providing the system has been operated and installed by a competent person, and if all maintenance and repair operations have been completed by Cognition Energy Ltd or an approved CellPod One distributor, using only original components and accessories. The user is responsible for the risk of introducing unauthorised components and accessories.

5.1. Intended Use

Any use of the CellPod One not described in this manual shall be considered improper use.

CellPods are thermal chambers with interchangeable cell fixtures, designed for connection to battery cyclers, for testing of battery cells. They're designed to receive cells of common industry form factors by providing temporary electrical connection.

5.2. Installation Site Requirements

The operation and installation location of the CellPod One system should be an indoor laboratory environment, in accordance with the conditions described in EN61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use. These are further detailed in Section 12. Do not install the CellPods in a hazardous location.

5.3. Residual Risk

There exists some unavoidable risks in the system design and in the field of its intended purpose even if all recommended operating procedures and precautions are followed. The symbols on the CellPod are used to warn of residual risk, and identified in Section 3. There are also other residual risks that are summarised with corresponding banners below. The user must take measures to minimise the hazards caused by residual risk.

CellPods do not have safety provisions to protect against explosions, or ignition of combustible test specimens.

⚠ DANGER
Danger of explosion due to the introduction of hazardous material loaded into the equipment, abusive testing of loaded equipment or explosive gas mixtures in the vicinity of CellPods. Serious injury, death, poisoning or burns could result. 🚫 Do NOT load substances into the CellPod which are combustible or flammable at testing temperature. 🚫 Do NOT test electrochemical cells, in the CellPod, beyond their manufacturer's specification. ✅ DO sufficiently plan and monitor ongoing tests.

⚠ WARNING
The testing of electrochemical cells is inherently dangerous. Risk of short circuiting, cell venting or thermal runaway. Serious injury or burns could result. ✅ DO sufficiently plan and monitor ongoing tests. ✅ DO be aware of how dangerous situations arise with cell testing, and implement procedure to avoid these scenarios.

⚠ CAUTION
Electrical hazards are present in the event of a leak from the system. Leaks may also introduce tripping hazards from pooled water. Electric shock or minor injury could result. ✅ DO leak check the system while the electrical power is disconnected.

⚠ CAUTION
Risk of burning by touching hot or cold CellPod parts during operation. Burns could result. 🚫 Do NOT touch the surfaces within the CellPod during operation. ✅ DO check the warning indication on the membrane switch to see if the surfaces within the CellPod are hazardous to touch, before removing the lid. ✅ DO note that cells under test in the CellPod One may remain hot or cold despite the CellPod temperature being in a safe range. Care should be taken to allow cells to warm or cool before handling.

⚠ CAUTION
Sharp surfaces are present on the stand components within the CellPod that connect to the cell. Cuts or grazes could result. ✅ DO proceed with caution when interacting with these components, in loading or unloading cells.

5.4. Cell Testing Risks

Hazards that are found as part of cell testing include but are not limited to; cell short circuits, cell venting, and cell thermal runaway. Because of these risks cells need to be handled with care when testing them. Using the CellPod One does not eliminate these hazards entirely.

The CellPod One enclosure is designed to handle:

- EUCAR 4 level event for cylindrical and pouch cells, meaning that it provides protection to the user in the event of a cell venting
- EUCAR 7 level event for coin cells, meaning that it provides protection to the user in the event of a cell explosion

Note, the CellPods do not include gas extraction or filtering.

⚠ WARNING

Risk of short circuiting is increased using the CellPod One. This is because the heat shrink insulative wrapping needs to be removed so that the cell case can be used as the negative connection.

Serious injury or burns could result.

✅ DO follow procedure detailed in Section 17.1 to strip cell heatshrink safely.
✅ DO read Section 20 to learn how to load/unload cells from CellPods safely.

6. User Responsibility

CellPods are designed to be used by competent persons. Meaning the installation, testing, operation and maintenance of CellPods should all be carried out by a competent person. Users must be trained and authorised to use CellPods.

Please observe the safety recommendations outlined in this document and practise safe use of the CellPod One. Before using the CellPods, users should undertake the following steps:

- Prepare a risk assessment for use of the CellPod One for testing of electrochemical cells
- Prepare a standard operating procedure in compliance with the user's risk assessment for use
- Ensure that authorised personnel are trained in the use and general maintenance of CellPods
- Ensure that the required PPE outlined in this manual is used

6.1. Recommended PPE

The recommended PPE for testing electrochemical cells using CellPods is listed below:

- Safety glasses shall be worn
- Nitrile gloves shall be worn when handling cells

Other PPE should be used in line with local rules and regulations. When handling cells all metallic jewellery, watches, bracelets etc. must be removed.

6.2. Emergency Actions

Foreseeably, the worst case scenario for an emergency with the CellPods is a cell catching fire. In the unlikely event that this does happen, to attempt to control fire (directly resulting from a cell) a fire extinguisher designed for battery fires (such as the LithEx brand) should be used if in accordance with your organisation's guidance/procedures and if safe to do so. To prevent a fire from spreading further or to combat resulting fires CO_2 fire extinguishers can be used. However, other fire extinguishers should not be used, water or foam based extinguishers will make the fire worse.

Transportation, Handling & Storage

7. Checking Equipment

The CellPod One will be transported in a specifically packed container. Keep the package orientated as noted on the side of the box and open from the correct side.

If the CellPod One is stored upon delivery, make sure the package is kept upright, in a dry environment (see Section 9). Report any external damage to the package or missing items to the carrier or seller as soon as noticed. If you need to return the CellPod One, please use the original packaging.

8. Handling Instructions

If the CellPod One needs to be moved once assembled, make sure all pipes and wires going into the system are disconnected. Make sure the coolant is drained from the system prior to moving the CellPod One. Lift the CellPod One from either end of the cooling plates.

9. Storage Environment

The CellPod One should be stored flat, unstacked and in the following conditions:

- Permissible ambient temperature range during storage is: 5 °C to 40 °C
- Permissible ambient relative humidity range during storage is 0 % to 70 %

After storing the CellPod One in a cold location, allow the CellPod One to rest in the installation site for at least one hour until the unit has reached ambient temperature.

⚠ CAUTION
Risk of condensate forming in the insulated Pod. 🚫 DO NOT store or use the CellPod One in environments outside of the recommended environmental parameters. ✅ Remove Insulated Pod and Cell Stand in storage and when not in use.

Quick Start Guide

For trained users that know how to set up and operate CellPods, follow the instructions below for a quick start.

How to set up and use CellPod One

1. Removel CellPod One and peripherals from their packaging.
2. Layout Quads and peripherals, taking care that the numbering of the CellPods is logical.
3. Attach the PCAN to the control PC, then connect the left hand RJ45 of the first Quad to the PCAN with the PCAN cable. Then attach further Quads using ethernet cables.
4. Cut hoses to length and create coolant loop
5. Fill the chiller with de-ionised water and biocide, and power it on. Wait five minutes and check the system for leaks.
6. Attach bus bars to the PSU and connect up the power to each Quad.
7. Install the GUI onto the control PC.
8. Power up the PSU and CellPods, start the GUI and connect to the CellPod unit.
9. Run the Auto-Addressing function to number the CellPods. CellPods will number themselves starting with the nearest CellPod to the PC.
10. Check that each CellPod functions. To do this, set each pod to temperature setpoints of 20 °C, 70 °C & -20 °C. Allow each CellPod to hold each temperature setpoint for 10 minutes and verify the temperature is stable in each case.
11. Turn the CellPods off at the GUI and install Cell Stands using a 4 mm hex key.

Machine Overview

Temperature	Cell thermal gradient measurement points	5
	Temperature range	-20 °C to +120 °C
	Temperature measurement accuracy	± 0.5 °C
	Pod temperature stability	± 0.1 °C
	Time temperature resolution	1 s
	Response time (+70°C to -20°C)	Less than 5 minutes
Software	Program	Cognition CellPod Control Software
	Export formats	.txt
	Interface	USB
Protection	Over Temperature protection	Resettable hardware cut off
	EUCAR 4 & 7	Coin cells EUCAR 7, all others EUCAR 4
	Overcurrent protection	No
Electrical	Max current (continuous)	15 A
	Max current (pulse)	17.5 A
	Voltage sense resolution	2 mV
	Max voltage	5 V
	Typical connection contact resistance[2]	1 mΩ
CellPod Quad Information	Compatible cell form factors	Cylindrical: 18650, 21700, 26650, 26700 Coin: 2016, 2032 Small pouch cells (Max. size 80x45x8 mm)
	Weight	8.5 kg (not including coolant)
	Cell cycler connection type	Ring terminals: Current: M4, Voltage Sense: M3
	Input	24 V DC
	IP Rating	None
	IK Rating	IK4
	Maximum altitude for use	2000 m

[1]All technical data is specified for CellPods under normal operating conditions at an ambient temperature of +22℃ ±3℃. All temperature data is taken in accordance with EN-61010. All indications are average values. Cognition Energy Ltd reserves the right to change technical specifications at any time.
[2]Connection contact resistance is dependent on the specific surface finish of cells under test, how clean the cell is and how clean the contacts are. Whilst it is expected that the total connection contact resistance will be < 2 mΩ as a worst case, the exact value will depend on the cell under test

Table 4: Technical Data

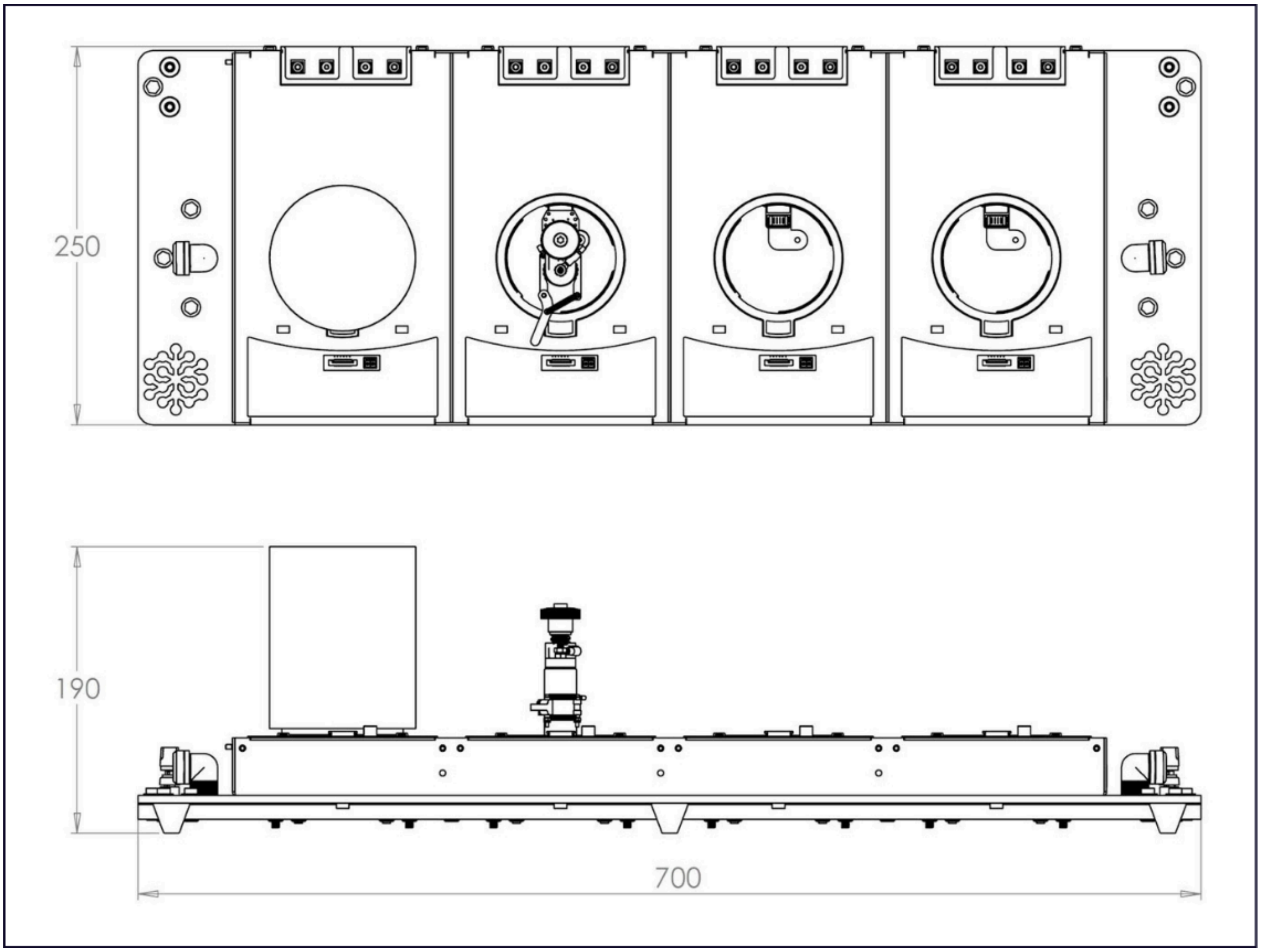


Figure 2: CellPod Quad dimensions (all dimensions in millimetres)

CellPod One operating conditions limits are derived from EN61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use. These conditions are described as follows:
Indoor use;

- Ambient Temperature of 5°C to 40°C
- Maximum relative humidity of 80%
- Pollution Degree 2 environment (only non-conductive pollution occurs, except for temporary conductivity caused by condensation)
- Maximum altitude: 2000m

10. Lifetime & Warranty

The warranty period is 1 year from the date of delivery, normal wear and tear is excluded.

Hardware servicing of CellPod One for overseas customers (i.e. non-UK) is returned to base, unless Cognition agrees otherwise.

11. CellPod System

CellPods cannot operate on their own, they need supporting systems to operate. As shown in the block diagram in Figure 3, these include:

- Quad, each of which is comprised of four CellPods
- Power Supply Unit (PSU) & associated cables
- Cell Cycler for electrical test of the cells, connecting its cycling cables to each CellPod
- Coolant chiller & associated piping
- Control system, comprising of:
  - Control PC with Graphical User Interface (GUI), connecting to the Quad via;
  - USB PCAN dongle and comms cable.

Note, multiple quads can be controlled by the PC and connected to the PSU and chiller. See Section 13 for details.

Additional information regarding the peripheral system requirements and Quad connectors is contained in Section 13.

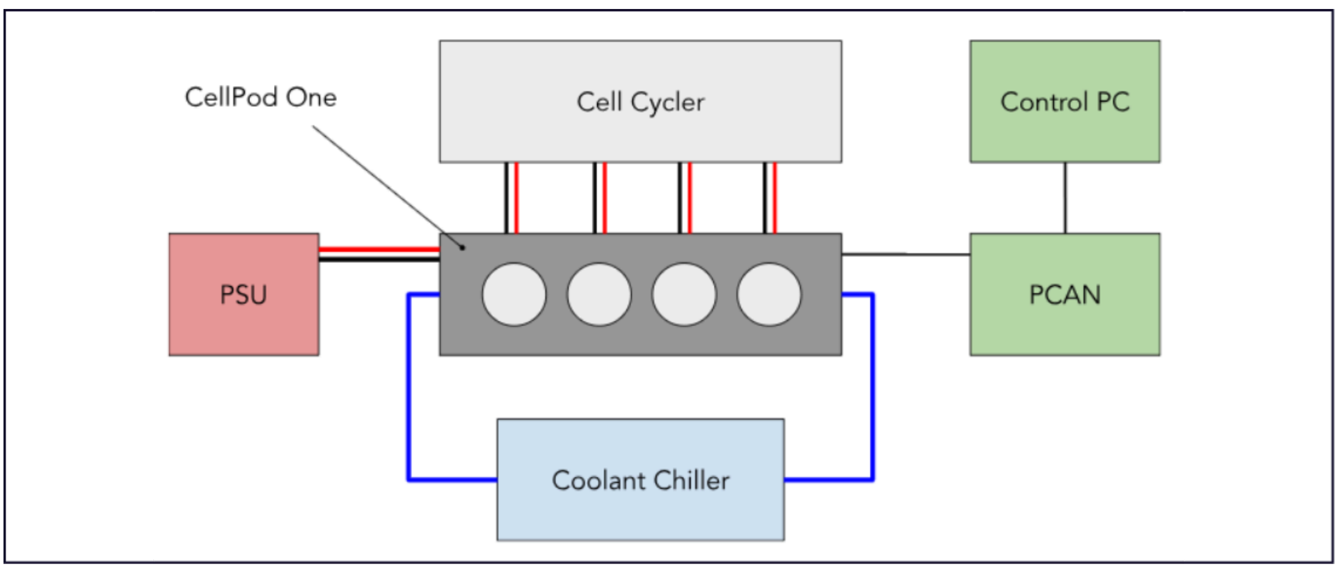


Figure 3: Diagram of a simple CellPod System. Note, power cables from the PSU to the Quad shown in red and black, Cell Cycler connections to each of the CellPods shown in red and black, hoses from Coolant Chiller to Quad shown in blue, USB from Control PC to PCAN shown in black & PCAN cable to Quad shown in black.

11.1. Quad

A Quad comprises four CellPods, these share common power, coolant and communications connections. Each CellPod operates independently of the others in the Quad.

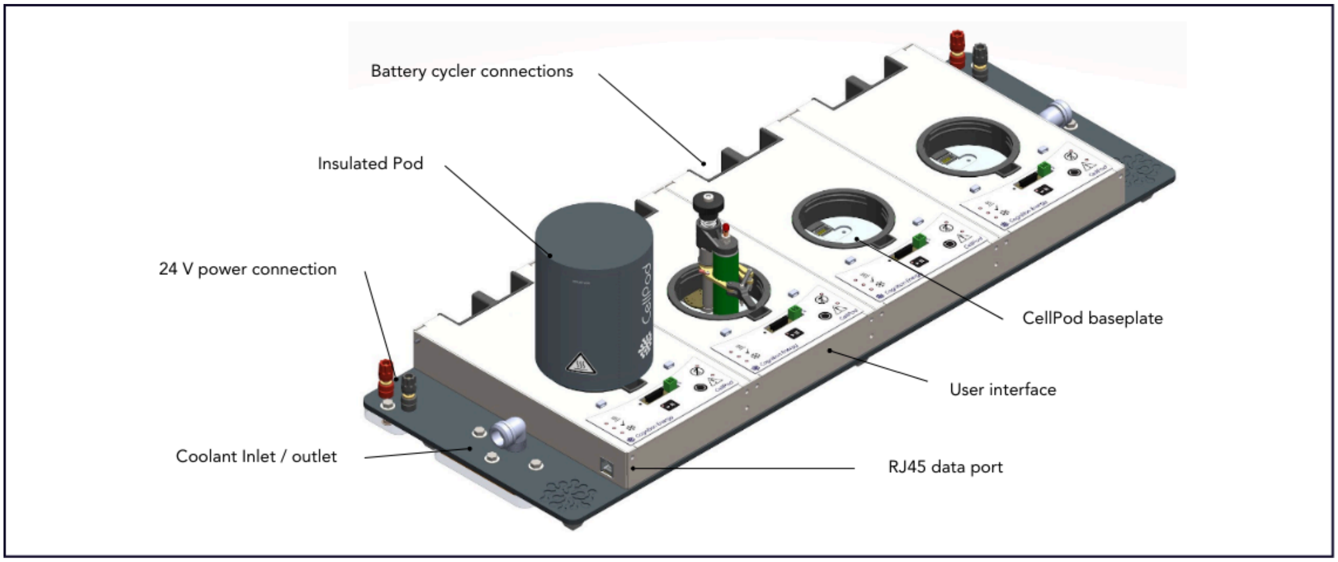


Figure 4: A Quad with main elements called out

11.2. CellPod

A CellPod allows testing of a single battery cell at a set temperature. The CellPod connects directly to the cell cycler system via ring terminals on the rear of the Quad. The heat plate provides the surface cooled contact point for the cell and a Cell Stand provides both electrical connection and the mechanical force required to maintain good thermal contact between the cell and the heat plate. An insulating lid screws down to securely cover the heat plate, Cell Stand and Cell under test.

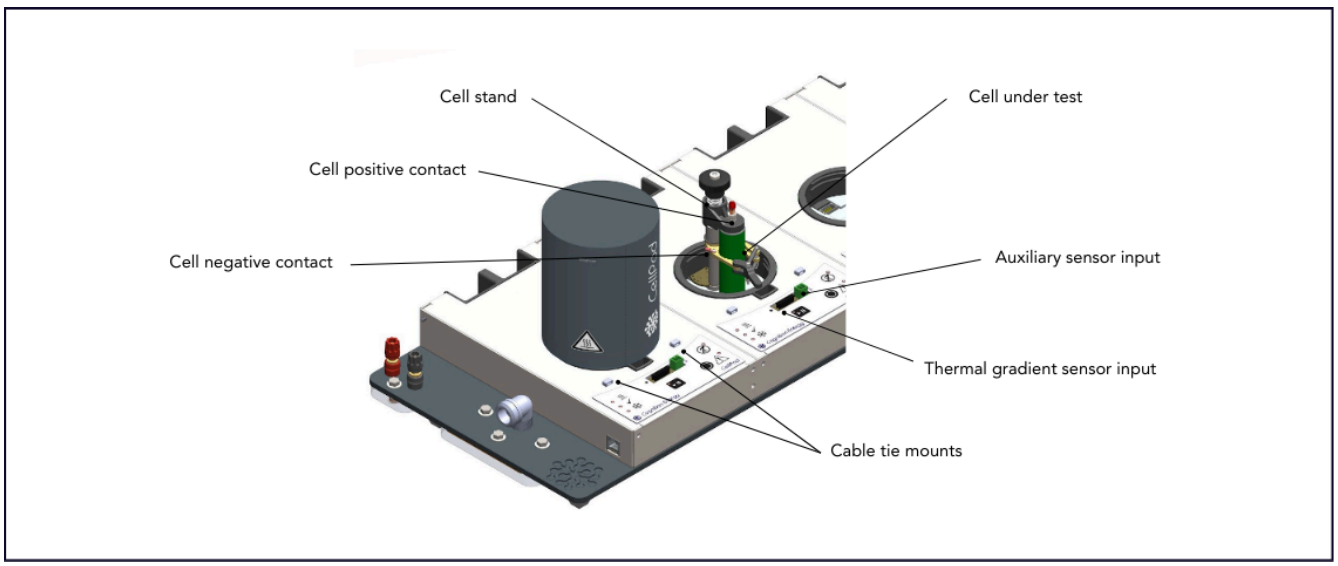


Figure 5: A closeup view of a CellPod with main elements called out

11.3. Cell Stand

The Cell Stand allows the user to electrically connect to a cell without the need for tools, welding or soldering.

The stand is also designed to provide mechanical force to maintain good thermal contact between the cell and the CellPod heat plate. Cell Stands can be changed out by undoing a single screw.

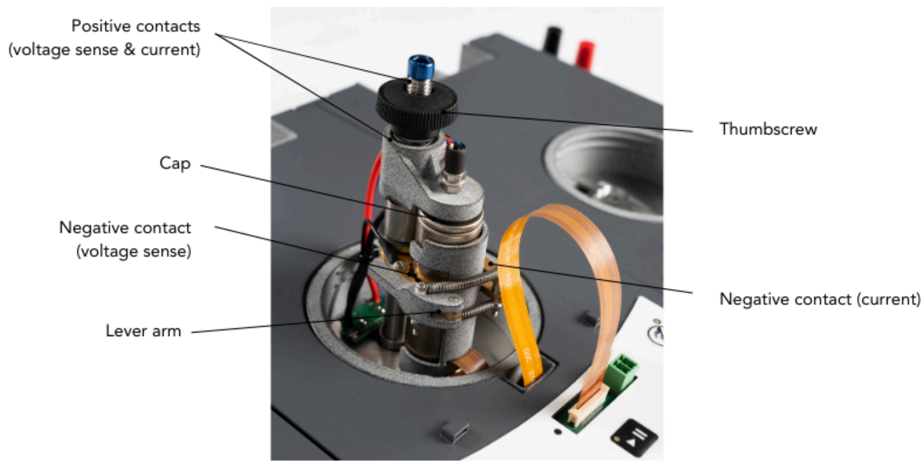


Figure 6: A Cell Stand with main elements identified

11.4. System Peripherals

11.4.1. Power Supply Unit (PSU)

The PSU shall have the following minimum specifications in order to run up to 8 Quads (32 CellPods):

- Output Voltage: 24 V DC
- Total Output Current: 125 A

Cognition Energy recommends the following PSU chassis and modules to power the CellPod system:

- Chassis: MEAN WELL USA Inc. RCP-1UI
- Modules: MEAN WELL USA Inc. RCP-1000-24

Note, only one module is required to run one or two Quads. More power supply modules are required as the number of Quads increases.

Cognition Energy can supply bus bars to attach to the recommended power supply, allowing easy connection to the CellPod One via cables terminated in 4mm banana plugs.

11.4.2. Cell Cycler

CellPods are designed to operate with any commercially available battery cycler. The interfaces for the cycler are as follows:

- Electrical connections (see Figure 7):
  - Voltage sense: 3 mm ring terminals
  - Current: 4 mm ring terminals
- Temperature sensors (see Figure 8):
  - Cycler temperature sensor: insert into CellPod via scoop

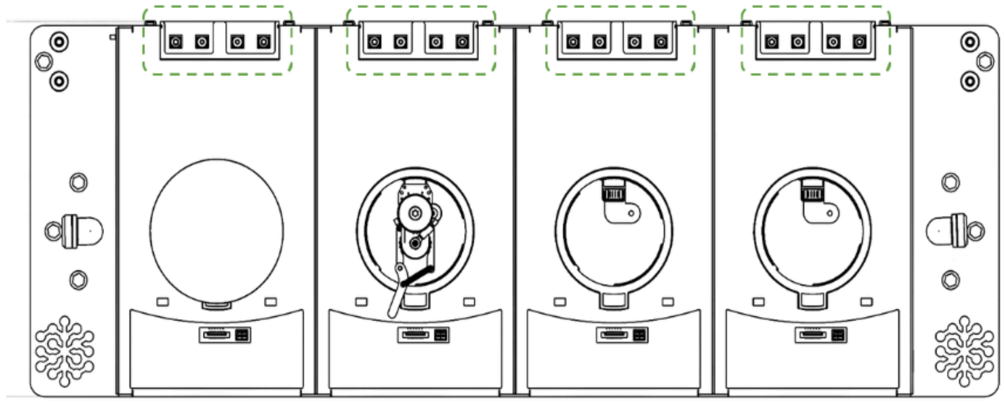


Figure 7: *Cycler connections for each CellPod on a Quad, highlighted red. Note, cable tie mounts are either side of the binding posts (on the rear of the Quad, outlined in red above) to allow the cycler cables to be strain relieved*

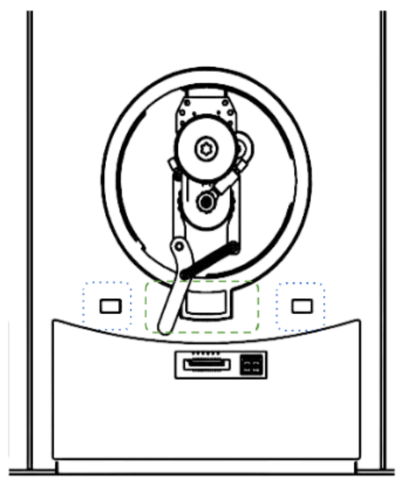


Figure 8: *CellPod scoop for temperature sensor insertion shown in red rectangle. Cable tie mounts for zip ties up to 5mm wide to secure sensor wires shown in blue circles*

11.4.3. Coolant Chiller

CellPod One requires a constant flow of coolant in order to maintain a constant temperature. The minimum requirements for a chiller that can support up to four Quads (16 CellPods) are as follows:

- Cooling Power: 1700 W
- Coolant Flow Rate: 10 L/min

Cognition Energy recommends using a low cost laser chiller such as the S&A CW-5200 to provide suitable cooling.

11.4.4. Control PC and PCAN adapter

CellPod One is controlled from a PC, the software GUI allows the user to view status, start and stop tests. The PC connects to the Quads via a PCAN USB adapter.

The PCAN attaches to the PC via a USB port. The PCAN communicates with the Quad by a customised cable that has a D-SUB connector and an RJ45.

⚠ WARNING
Trying to connect a Quad directly to the PC via an ethernet cable will not work and may cause damage to the Quads or PC.

Connections from Quad to Quad can be done with standard ethernet cables. Refer to Section 13 for details on how to assemble the Quad and connect the PC.

The control PC stores data saved by the GUI in .csv files. The size of the storage the PC has access to defines the maximum amount of data that can be stored. The minimum requirements for the PC to ensure that the GUI is stable are as follows:

- Processor: 1 GHz or faster
- Memory: 2 GB
- Storage: 20 GB
- Operating System: Windows 10 or 11
- Inputs: 1x USB Type-A port
- Screen resolution: minimum 1024 x 76

Assembly, Installation and Commissioning

12. Location of Installation

Set up the CellPod One on a flat, even surface. The surface should be free from vibration. The CellPod One should be set up in a well ventilated and dry environment. The CellPod One should be positioned with a minimum distance of 100 mm from walls or other equipment (including other CellPod Ones). Sufficient space should be provided to allow routing of connections to battery cyclers, data and power connections to the CellPod One and for water connections to be made.

All ancillary equipment (power supplies and chillers) should be set up with the manufacturers specifications.

13. CellPod One Assembly Instructions

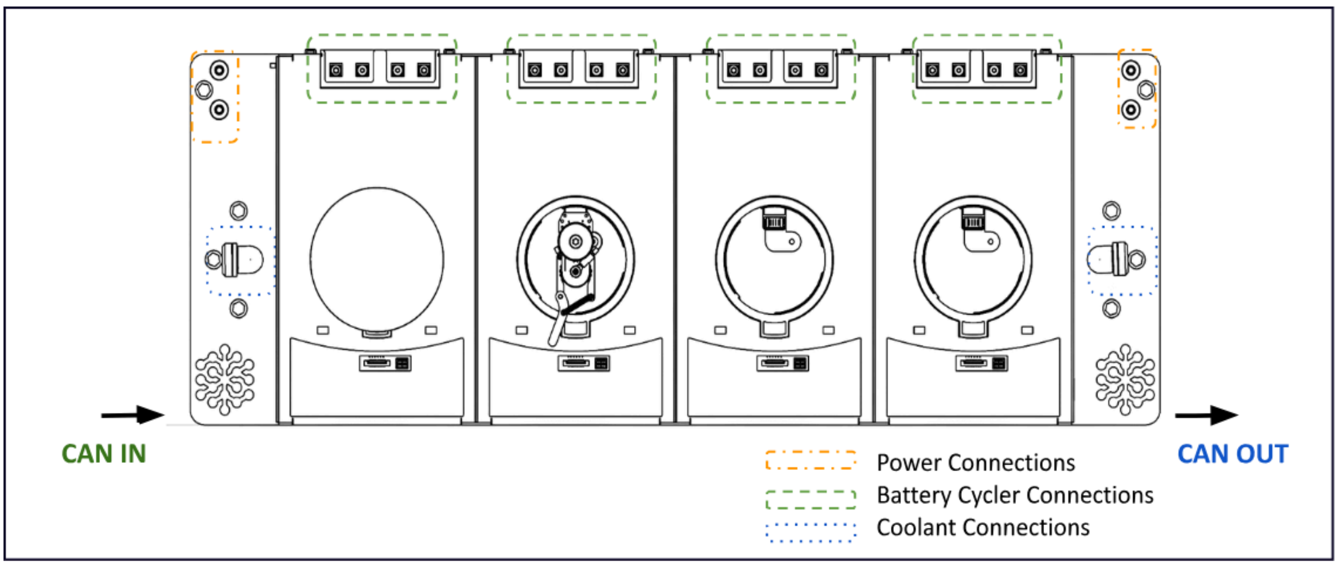


Figure 9: Location of all CellPod Quad input and output connections

13.1. Coolant Connections & Coolant

Once the CellPod One is set up, coolant connections should be made. The locations of each connection is shown in Figure 9. The connections should be made with 10 mm inner diameter, 13 mm outer diameter hoses.

Coolant connections should be made by inserting the hose into the compression fittings, and tightening the compression fitting cap nut by hand until tight. Tools should not be required to sufficiently tighten the compression fitting nut. Note that there is no difference between the left and right coolant connections, and either may be used as the inlet/outlet to the system.

Deionised water is suitable as a coolant, with added biocide, to prevent build up of limescale or algae. Using tap water without biocide is likely to cause issues with the chiller or create blockages in the system after time. The CellPod system is designed so that a coolant set point temperature of 20°C (CellPod One T70) or 35°C

(CellPod One HT120) at the chiller is suitable for operation. Note, if the chiller is set to a lower temperature, this may cause condensation throughout the system which could cause reliability issues.

Up to four Quads (16 CellPods) can be connected in series to a single coolant chiller. If more than four Quads are connected in series to the chiller then performance of the CellPod One could degrade.

13.2. Power Connections

The locations of each connection is shown in Figure 10. The positive and negative connections should be made with a 4mm Banana Plug .Power connections should be made using cable specified sufficiently to carry a maximum continuous current of 32A. Before connecting the power cables, the user should ensure that the power is off.

Up to two Quads can be connected in series from the power supply bus bars. There is no difference between the left and right power connections.

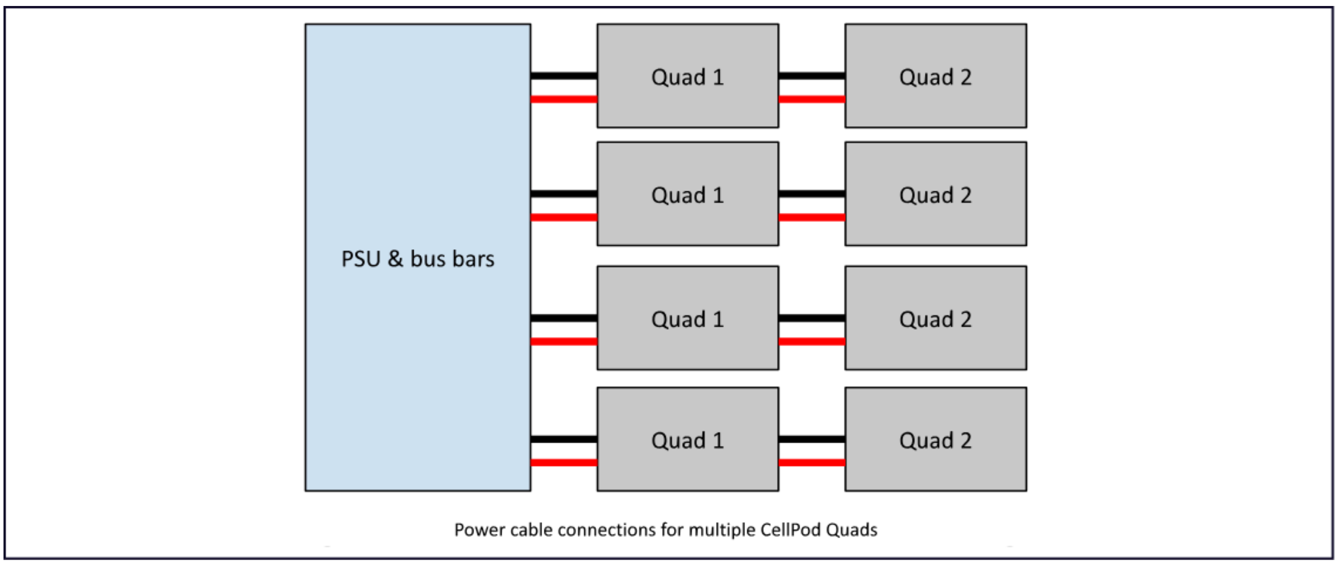


Figure 10: How to connect 8 Quads to a PSU

13.3. Data Cable Connection

The data connection to the control PC is made via a PCAN USB converter and a specific cable.

⚠ WARNING
Trying to connect a Quad directly to the PC via an ethernet cable will not work and may cause damage to the Quads or PC.

Quads can be connected in series to each other using standard ethernet cables. Up to 24 Quads (96 CellPods) can be connected to a single PCAN converter.

💡 TIP

CellPod Quads use auto addressing to set their identifiers in the control software, so when multiple systems are connected they should be laid out in a logical fashion.

See Section 26 for details on how the auto addressing functions.

13.4. Cell Cycler Connections

Connections to the battery cycler indicated in Figure 9 should be made using:

- Current (+/-): 4 mm ring terminal
- Voltage Sense (+/-): 3 mm ring terminal

When connecting a battery cycler to the CellPod One, ensure that no cell is present in the CellPod to avoid short circuiting at the cycler connections.

⚠ DANGER

When a cell is present in a CellPod, the CellPod external cycler connections should be considered live and care should be taken to avoid short circuiting the cell via the cycler connections.

Serious injury or burns could result.
🚫 DO NOT change or alter cycler connections while a live cell is present in the CellPod; always remove the cell under test before commencing work.
✅ DO take care to avoid short circuiting of the cycler connections by removing conductive items, tools and jewellery when working with the CellPod.
✅ DO always consider the cycler connections to be live once the system is commissioned, and take precautions to avoid short circuits.

14. CellPod Cell Stand Assembly

14.1. Stand Installation/Removal

The only tool required to insert or remove a CellPod Stand is a 3 mm hexagon key (suitable for M4 cap head machine screws).

Various cell stands are available (see Section 14.2). All cell stands are installed using an identical methodology.

1. Orient the cell stand such that the stand plug aligns with the plug in the heatplate.
2. Insert the stand plug into the plug on the heatplate.
3. Insert and tighten the provided M4 screw into the Cell Stand.

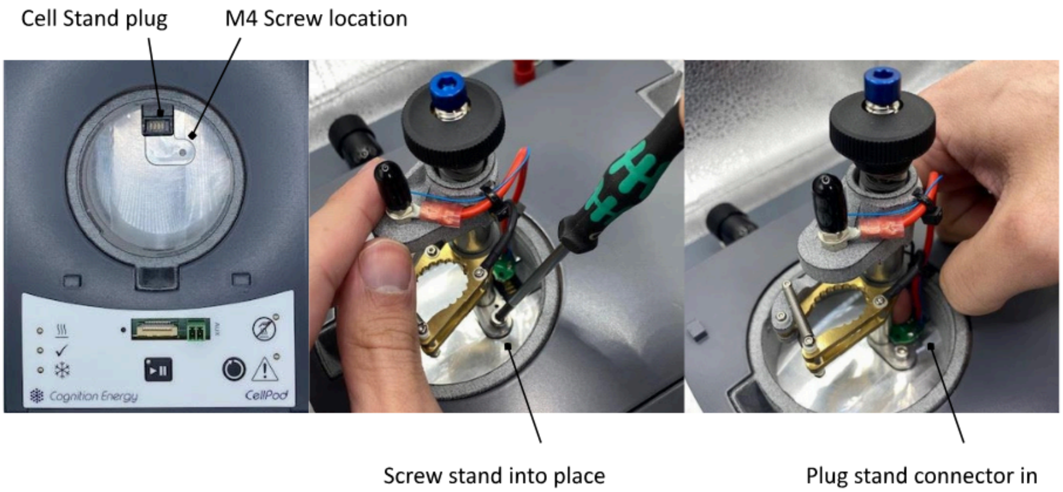


Figure 11: How to insert a Cell Stand

Once the cell stand has been attached to the CellPod, the insulated pod lid should be screwed on. The lid should be tightened to hand-tight; it should not be tightened using tools.

14.2. Compatible Attachments

A list of compatible Cell Stands is as follows;

- Cylindrical Cell:
  - 18650 Cylindrical Cell
  - 21700 Cylindrical Cell
  - 26650 Cylindrical Cell
  - 26700 Cylindrical Cell
- Coin Cell:
  - 2016 and 2032 Coin Cell (same fixture)
- Pouch Cell:
  - Max. size 80x45x8 mm (LxWxH) with tabs on the short end (Min. tab separation: 7mm).

Design of custom Cell Stands is possible; please get in touch with us to discuss further.

15. Commissioning

15.1. Preparing the System

In order to start the CellPod system for the first time, carry out the following steps;

1. Turn on coolant supply and set to 20°C (CellPod One T70) or 35°C (CellPod One HT120); ensure coolant is flowing with a visual check. Allow to run for five minutes.
2. Check for any coolant leaks at the inlet and outlet of each CellPod Quad.
3. Check for bubbles in coolant flow, which indicate trapped air in the coolant system. If bubbles are present, tilt the CellPod Quad by 10-15° so that the Quad coolant outlet is the highest point for the air to escape downstream. Start with the closest Quad to the chiller and work your way down the Quads

until all air bubbles have been removed. This is to ensure optimal heat rejection from each CellPod.
4. Turn on the CellPod Quad power supply. Check status lights enabled on each CellPod.

The CellPod Quad is now powered on and ready to be connected to the control PC.

15.2. Control Software

The minimum specification of the Control PC can be found in Section 11.4.

The PCAN drivers must be installed before the control software, download the driver from peak-system.com/Drivers. To install the control software (CellPod Control Software) download the software from cognition.energy/support. Run the installer and open the software.

15.3. Connecting to the System

All CellPod Quads on the CAN network will be automatically connected to the PC once the CellPod Controller software is opened. The Auto-address feature in the CellPod Controller software will assign each CellPod an ID, starting at one, from the CellPod closest to the PCAN cable. Once all CellPods have been assigned an ID, they will be listed in the CellPod Controller software Quick View window. This process is outlined in Section 24.

15.4. Testing the System

Once the system has been powered up, coolant is running and the CellPod One is connected to the CellPod Control software, basic functionality of the system should be tested:

1. Set each CellPod to a setpoint of 20 °C and wait for the setpoint to be reached.
2. Allow each CellPod to remain at temperature for a minimum of 10 minutes, observing that a stable temperature is kept.
3. Set each CellPod to the maximum temperature setpoint (70 °C or 120 °C) and wait for the setpoint to be reached.
4. Allow each CellPod to remain at temperature for a minimum of 10 minutes, observing that a stable temperature is kept.
5. Set each CellPod to the minimum temperature setpoint (-20 °C or 0 °C) and wait for the setpoint to be reached.
6. Allow each CellPod to remain at temperature for a minimum of 10 minutes, observing that a stable temperature is kept.
7. Turn off each CellPod via the control software.

If during testing a CellPod either fails to reach the setpoint temperature or a stable temperature, check that:

- Sufficient coolant is flowing through the CellPod Quad
- No air bubbles are trapped in the CellPod Quad
- Coolant temperature at the inlet is in the specified range for the CellPod Quad

If issues remain once these checks have been completed, refer to Section 30 for further fault finding information or contact your distributor for further technical support and advice.

Hardware Operation

16. Overview of Hardware Controls

Each CellPod has a front panel set of hardware controls, as shown in Figure 12.

1. Status indicators
   - Heating (Orange)
   - At temperature (Green)
   - Cooling (Blue)
2. Temperature sensor input
3. Auxiliary sensor input
4. Temperature warning
5. Pause button
6. Trip reset
7. Error warning light

Figure 12: CellPod front panel controls, identifying key features

⚠ CAUTION

Cells within a CellPod will take longer to change temperature than the CellPod baseplate, and as such no temperature warning may appear despite parts of the cell remaining at high or low temperature.

Burns could result
✅ Ensure that cells that have been tested at high or low temperatures have sufficient time for temperatures to rise or fall to a safe level before handling the cells.

17. Preparing and Loading Cells into CellPods

Cells must be prepared for testing and loaded into CellPods correctly.

17.1. Safely Removing Cell Wrappers

CellPod One requires bare cylindrical cells to be used for testing, this may require the user to strip off the plastic cover before they can be used. It is easy to damage the cells and this must be done carefully. We show the right and wrong ways to strip cells in this section, plus the potentially dangerous results of incorrectly stripping a cell.

⚠ DANGER

When a cell is stripped incorrectly it can be punctured or split at a later date, causing leak of electrolyte and potential cell thermal runaway. This could cause serious injury.

Serious injury or burns could result.
🚫 DO NOT damage the cells when stripping off their plastic wrappers.
✅ DO dispose of damaged cells safely if scratches or other damage is identified.
✅ DO always strip cells correctly and check them for damage.

Care must be taken to not scratch the cell in any way. The user should insert a cutter carefully under the plastic wrapper at the base of the cell with the blade parallel to the base. The plastic should be cut and then torn off the cell without the blade making contact with the cell metal. An example of how to do this is shown in Figure 13.

💡 TIP

It is recommended to use a seam ripper-type blade to remove cell wrappers, as this helps to avoid accidental scoring of the cell can.

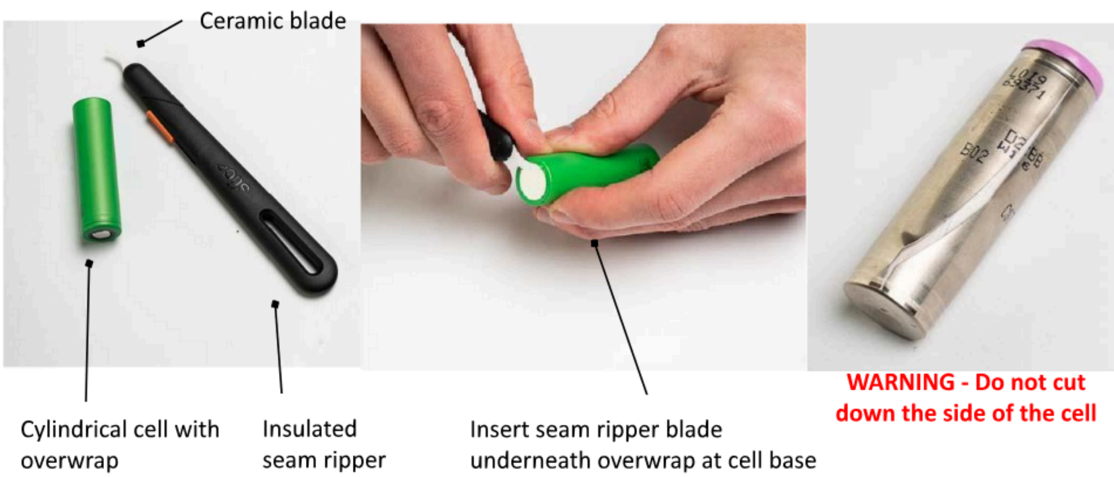


Figure 13: How to strip a cell of its plastic wrapper correctly

Once a cell has been stripped, it must be checked for damage, with any damaged cells disposed of safely.

⚠ DANGER

ONLY insulated blades should be used when stripping cells to avoid cell short circuits.

Serious injury or burns could result.
🚫 DO NOT use metal blades or metal bodied knives when stripping cell wrappers.
✅ DO use insulated ceramic bladed knives when stripping cell wrappers.

Scratching the cell, particularly on the side of the cell can, may lead to dangerous consequences. The cell side wall is very thin and a scratch will introduce weakness. By running a knife down the side of a cell and scoring it, a large weakness is introduced.

⚠ DANGER
NEVER strip the plastic wrapper from a cell by running a blade down the side wall. Serious injury or burns could result. 🚫 DO NOT scratch or damage the cell can. ✅ DO check cells for damage and safely dispose of any that are scratched/punctured/dented.

17.2. Cell Inspection and Preparation

Cells must be inspected and prepared for insertion into CellPods for testing.

- Cells must be inspected for damage before use, any scratches, cuts or dents could lead to later failure. Any damaged cells must be disposed of.
- It is recommended that cells are cleaned with a non-electrically conductive cleaning solution such as isopropanol before they are inserted into the CellPods. This will ensure good quality data is gathered.

18. Temperature Sensor Strip Insertion

CellPod One's cell temperature gradient feature requires the cell clip and temperature gradient strip. To use:

1. Get one temperature gradient strip and one cylindrical cell clip.
2. Thread the temperature gradient strip through the cell clip as shown in the figure below. Making sure the top of the strip lines up with the top of the cell clip. It is recommended to stick double sided tape on the inside of the clip and press the strip against it to keep it in place.
3. Press the stripped cell into the cell clip securing the sensors against the cell.

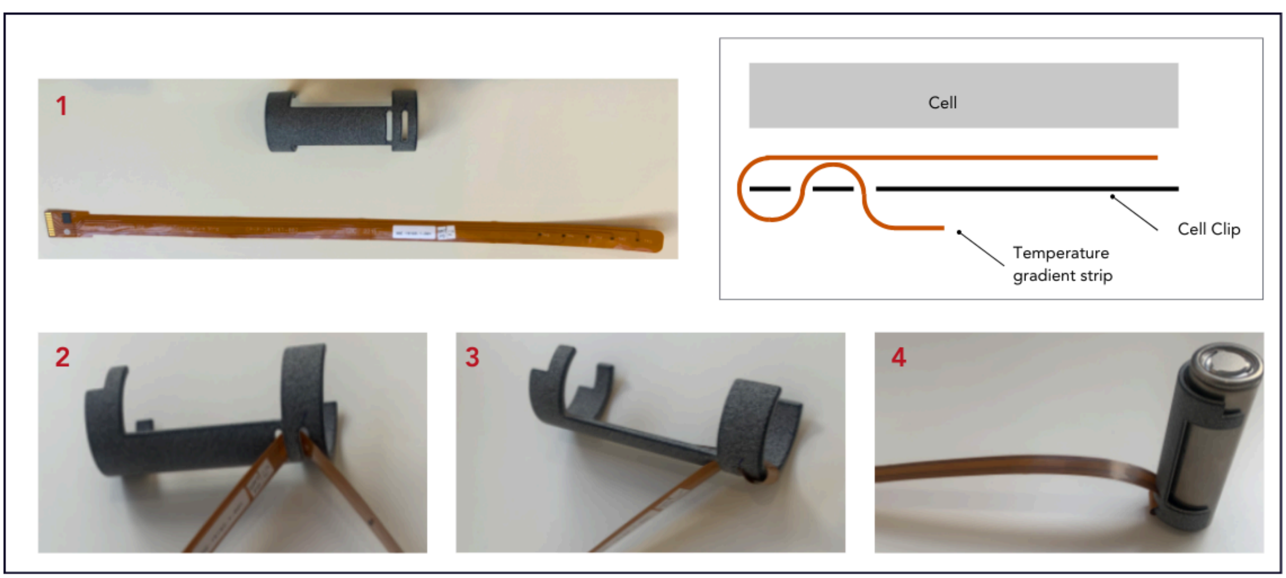


Figure 14: How to correctly prepare a cell temperature sensor strip and clip

⚠ CAUTION

Take care when assembling and handling the temperature gradient strip. Damage to the traces or thermistors can cause permanent damage to the device.

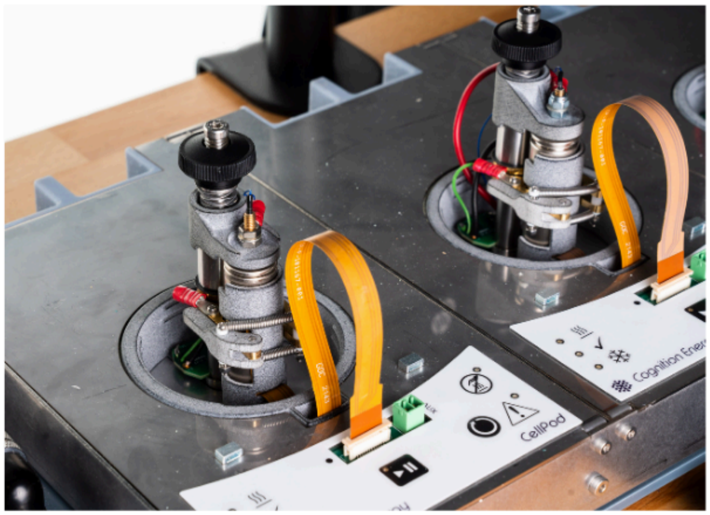


Figure 15: Cell loaded into CellPod with temperature gradient sensor strip correctly installed

19. Auxiliary Sensor Connection

CellPods are able to record measurements from an externally provided sensor, via a 2 pin connector that takes input from the external sensor and records a 0-5 V value. The data is stored by the CellPod control software.

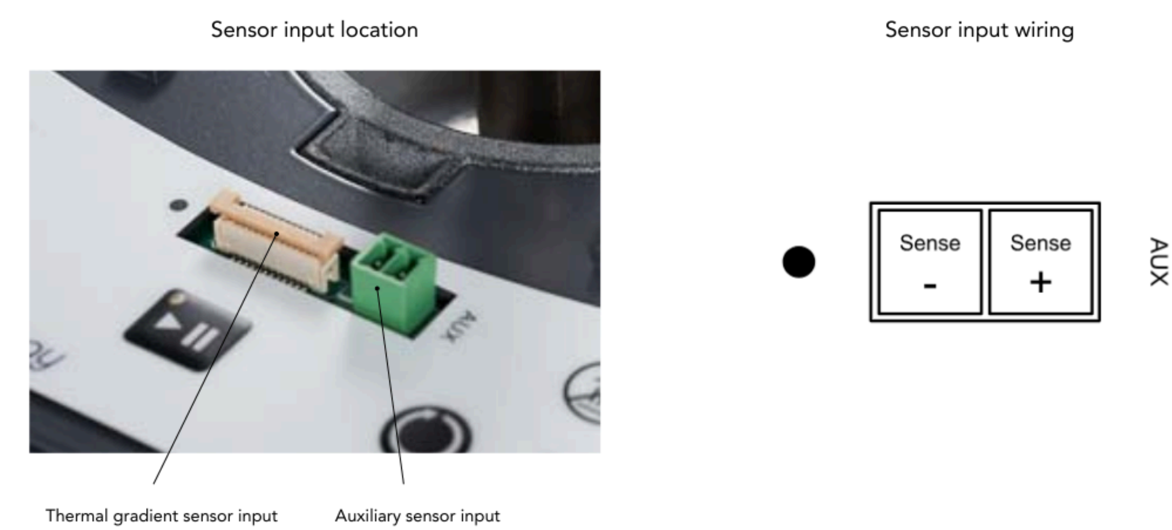


Figure 16: Wiring of auxiliary sensor connector for insertion into CellPod

20. Cell Loading Procedure

Cognition Energy's cell stands make it easy to switch in and out cells between tests:

1. Open the jaws of the Cell Stand, and rotate the cap 90° clockwise (Note, only turn clockwise to prevent damage of connection wires)
2. If using a temperature gradient sensor strip, feed the sensor through the access port on the CellPod and plug into the Zero Insertion Force (ZIF) connector on the front panel (Note,the sensor strip and the CellPod front panels' spot print should align)
3. If using a thermal interface material (recommended for optimal heat transfer between the CellPod baseplate and cell base), place a disc of thermal interface material approximately 2 mm greater diameter than the cell on the CellPod baseplate where the cell will be sited
4. Insert the cell into the stand from the top and close the jaws with the lever, ensuring good contact with the cell sidewall. The cell should resist rotation under gentle pressure. If using thermal interface material, ensure that the cell is sited centrally on the thermal interface material
5. Rotate the cap over the cell and tighten the knob until it is hand tight. Do not tighten using tools.
6. Use the provided cable tie mounts to secure and strain relieve any sensor wiring.

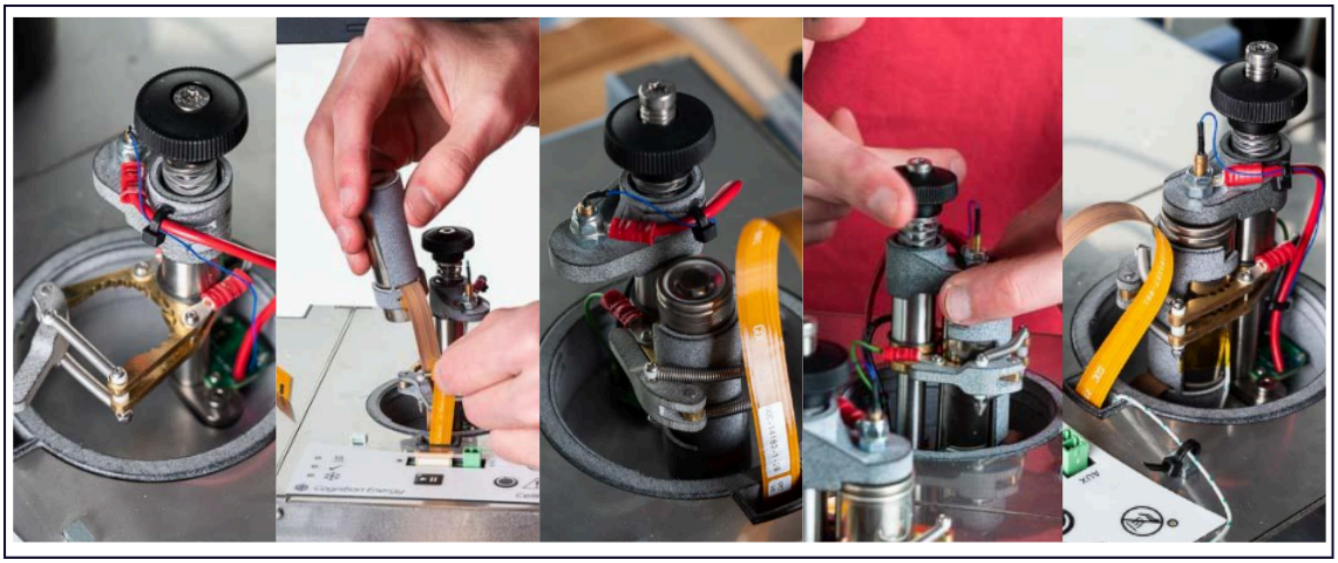


Figure 17: Cell loading procedure

💡 TIP
For best results: ● Replace the thermal interface material ● Clean the contacts and cell before every test

⚠ CAUTION
Incorrect insertion of the cell into the test fixture will cause poor results.

⚠ WARNING
Care should be taken when handling live and stripped cells. These can be easily short circuited causing significant damage and injury.

21. CellPod Safety Systems

21.1. Overview of CellPod Safety Systems

The CellPod One has a variety of safety systems built in to protect against possible damage and hazardous events. These are:

- Protection from reverse connection of power cables and fuse.
- Coolant inlet temperatures are monitored and over-temperature will return a fault, protecting against failure of the coolant supply.
- CellPod cycler connections are protected against misconnection of the cycler cables
- Each CellPod is protected against overheating by redundant software and hardware temperature sensing, protecting against any cell under test reaching unsafe temperatures.

At any time CellPod operation may be stopped by pressing the Start/Pause button on each CellPod, by powering the system down or by using the Control GUI to stop testing

21.2. Resetting the CellPod Safety Systems

In the event of any of the built in hardware or software safety systems acting, the Error Warning Light will be lit on the CellPod front panel, indicating that a safety system has acted.

⚠ WARNING
Prior to resetting the CellPod safety systems and continuing a test it is critical that the cause of the safety system acting is identified, and any recurring cause mitigated.

Software Operation

22. Software Setup

Details of how to download and install the CellPod control software can be found in Section 15.2.

23. Connecting to CellPods

Once the CellPod control software is installed and the CellPod One is set up and powered on, open the control software. To connect to all CellPods, click File > Auto Address > Yes. The CellPod Quads will automatically connect to the control software, and numbered CellPods will appear in the Quick View window. Each CellPod will be assigned an identification number.

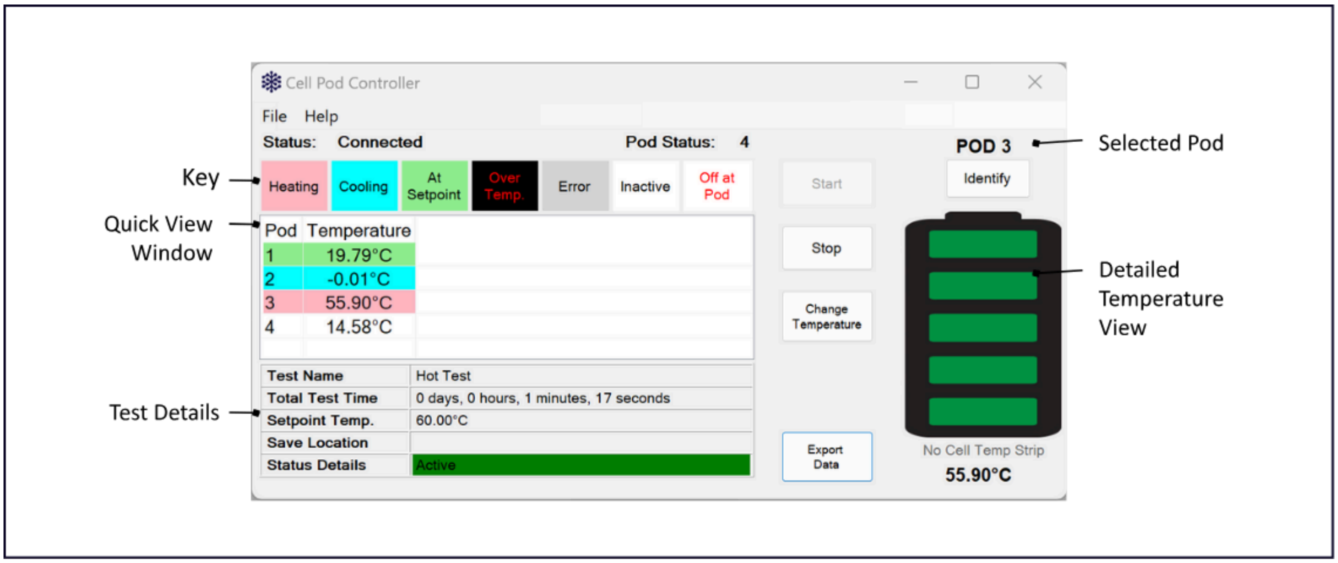


Figure 18: Overview of the main window of the CellPod Control Software

Figure 23 shows the main window of the CellPod Control Software:

- Key: Indicates the colours of individual CellPods in the Quick view window
- Stop/Start/Change Temp: Buttons to start, stop and change temperature of test programs on the selected CellPod
- Selected CellPod/ Identify: Indicates the CellPod selected in the Quick View window
- Quick View Window: Provides a quick overview of the status of each CellPod. Status is indicated by the background. The CellPod (i.e. base plate) temperature is reported here.
- Detailed Temperature View: Provides a detailed view of temperatures using the temperature sensor strip.
- Test Details: Shows detailed information about any ongoing test on a selected CellPod
- Export: Exports data file (.txt) without stopping the test.
- File / Help: Connect to pods using auto address / Software and firmware version control.

Further details of the function of each feature can be found in their respective Section of the manual.

24. CellPod Addressing and Identification

When connecting to CellPod Quads, the CellPod Controller software will detect the CellPods on the CAN bus and display them on the Quick View panel. If the pods do not have addresses or need renumbering, you can assign addresses by clicking on the Auto address option in the File menu. Addresses are assigned sequentially from the 'closest' CellPod to the CAN connection to the control PC, as shown in Figure 19. Addresses are held in each CellPod, rather than the CellPod Controller software, so they are unaffected if you restart the CellPod Controller software software.

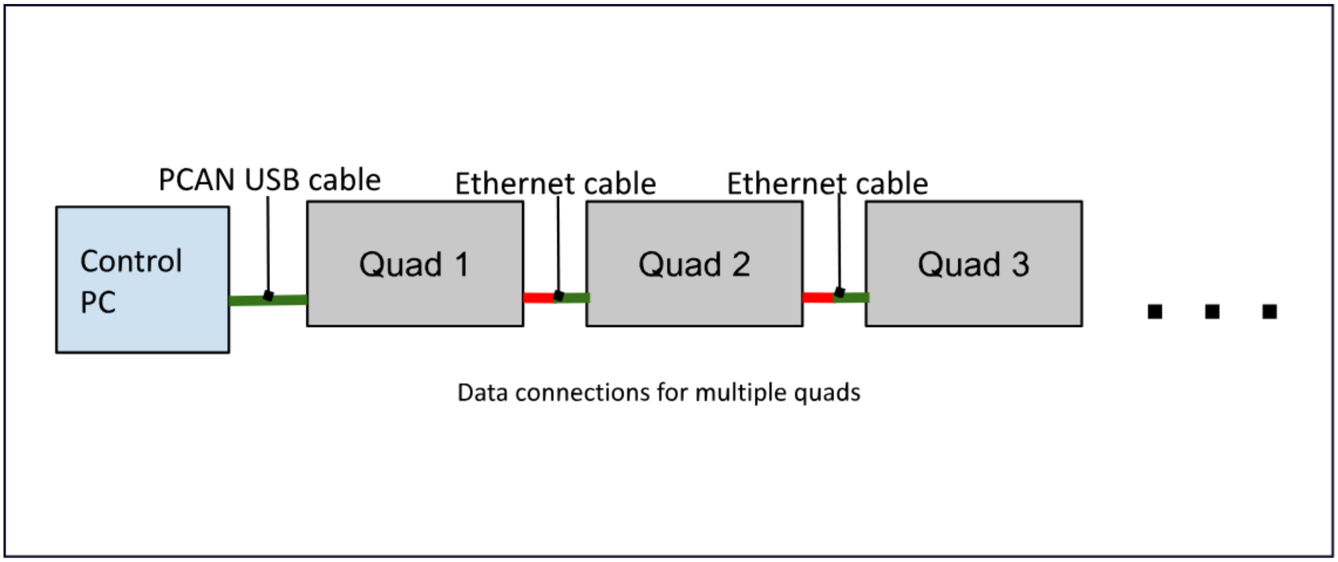


Figure 19: A CellPod system demonstrating how the auto addressing will number the CellPods

Once addressed, each individual CellPod can be identified by undertaking the following steps:

1. Select the CellPod to identify in the Quick View window.
2. Press the 'identify' button in the CellPod Control Software.
3. All indicator lights on the CellPod will illuminate for three seconds

25. Starting a Test

Once setup, tests can be started using the CellPod Control software. Tests may be considered as either defining a temperature setpoint (i.e. no data is recorded, similar to setting a temperature in a thermal chamber) or running a test (i.e. where test data is recorded).

1. Select the desired CellPod in the Quick View window
2. Press the 'Start' button and complete the form:
    a. Set Point: desired temperature setpoint in degrees Celsius
    b. Test Name: Name of test to be displayed in the file
    c. Save Location: Location file will be saved (Note: test data will not be saved if not enabled)
    d. Temperature and Time Based Logging Frequency: Select if data logging is required by either of these options
        i. 1 second: data will be stored every 1 second
        ii. 1°C: data will be stored when the baseplate or cell temperature changes by 1°C

e. Voltage Based Logging: Select if data logging is required
    i. 1 mV means data will be stored whenever the measured voltage changes by 1mV
f. Record Temperature: optionally enable recording of auxiliary temperature sensor strip data
g. Record Voltage: optionally enable recording of voltage data
h. Record AUX input: optionally enable recording of auxiliary 0-5 V input data
i. Resume Test On: enable Power Recovery Mode, in the event of power loss, the pod will resume the test automatically when power is restored

> 💡 TIP
>
> Data can be recorded by sampling at a fixed frequency in time or for a given change in CellPod baseplate/cell temperature or voltage. Note that these operate with an OR condition, so for example if both temperature and time based data logging are enabled, the CellPod will record test data at a fixed frequency in time AND for a given change in measured temperature.

26. Test Monitoring

Tests and status' can be monitored using the CellPod Control Software (Figure 20) in the following ways:

1. Quick view window, showing the status of each connected CellPod (per the key) and the baseplate temperature of each CellPod.
2. Detailed view of temperatures measured by a CellPod, including the baseplate temperature and temperatures recorded on the thermal gradient sensor strip (if fitted).
3. Detailed view of tests on the selected CellPod.

27. Saved Data Format

If data logging is enabled, data will be recorded for each test into the selected directory. Data is saved in a .txt format, comma separated.

```
Time,Setpoint Temperature,Pod Temperature,Cell Temp1,Cell Temp2, Cell Temp3,Cell Temp4, Cell Temp5,Voltage,
21/06/2022 09:29:37,19.50,19.47,19.26,19.66,19.75,19.75,19.57,2.812,2.007
21/06/2022 09:29:38,19.50,19.47,19.26,19.67,19.76,19.75,19.58,2.794,2.007
21/06/2022 09:29:39,19.50,19.48,19.28,19.67,19.76,19.75,19.57,2.778,2.007
21/06/2022 09:29:40,19.50,19.48,19.28,19.67,19.76,19.75,19.58,2.762,2.007
21/06/2022 09:29:41,19.50,19.51,19.28,19.68,19.76,19.75,19.58,2.748,2.007
21/06/2022 09:29:42,19.50,19.50,19.28,19.69,19.77,19.76,19.58,2.734,2.007
21/06/2022 09:29:44,19.50,19.51,19.30,19.70,19.78,19.75,19.59,2.705,2.007
21/06/2022 09:29:45,19.50,19.51,19.30,19.71,19.78,19.76,19.59,2.738,0.006
21/06/2022 09:29:46,19.50,19.53,19.30,19.71,19.80,19.76,19.60,2.793,0.005
```

Figure 20: Example data file format including thermal gradient sensor strip values

Maintenance

CellPod One is designed such that there are no maintenance activities to be performed by users and only occasional checks are required. The following qualifications are required for maintenance:

- User inspection: a trained, competent person
- Repair/servicing: A Cognition Energy engineer/technician or equivalent from authorised distributors.

28. Maintenance Intervals

There is no scheduled maintenance required for CellPod One.

29. Inspections

The following actions are recommended to be undertaken on a weekly basis:

- Leak checks on CellPod One, coolant hoses and coolant chillers.
- Check and top up the coolant chiller reservoir if required.

It is also recommended that the users periodically check the status of CellPod One in use to ensure that no errors are reported.

Fault Finding and Troubleshooting

30. Common Troubleshooting

Problem	Solution
CellPod One doesn't turn on	Check power supply is on and cable connections are undamaged and plugged in
Water leak	Check all pipes and connections for damage or loose fittings. If leaking from the underside of the quad or not from a fitting, refer to Section 13.1.
A CellPod cannot maintain temperature	Check the CellPod is attached, check power connections and coolant connections are functioning correctly. Check that the power supply has sufficient power to drive the CellPod.
CellPod is flashing the error LED and will not function	Refer to the GUI to note the error code, if it is a trivial error, press the reset button on the CellPod UI to re-enable the pod.
GUI cannot connect to CellPod One	Check data cables to ensure they are free of damage and connect the CellPods to the PC via the PCAN as described in section 22.
Cell electrical connection is intermittent	Check that the negative jaws are closed fully and the thumb screw is fully tightened. Clean electrical contacts and cells with acetone or similar cleaning fluid.
GUI is not displaying temperatures from the cell strip sensor	Start a test to see the strip temperature values for a selected cell. The GUI will not read the strip if the selected CellPod is inactive.

Table 5: Common troubleshooting

31. Calibration

Item	Calibrated When	Details
Heat plate temperature sensor	End of production acceptance test	0.5°C resolution
Voltage sensor	End of production acceptance test	2mV resolution
Cell temperature strip sensor	End of production acceptance test	0.5°C resolution Calibration stored on strip EEPROM so they can be used on any CellPod

Table 6: Calibration

Disposal

32. Disposal within the UK

According to Schedule 3 of The Waste Electrical and Electronic Equipment Regulations 2013, CellPod One is classified as "monitoring and control instruments" (category 1) only intended for professional use. They must not be disposed of at public waste electrical and electronic equipment (WEEE) collecting points.

At the end of the device's service life, notify the distributor who sold you the device, who may take back and dispose of the chamber according to The Waste Electrical and Electronic Equipment Regulations 2013. If the distributor does not operate a 'takeback' scheme, disposal should be via a registered WEEE recycling contractor.

33. Disposal within Member States of the EU

According to Annex I of Directive 2012/19/EU of the European Parliament and of the Council on WEEE, CellPod One is classified as "monitoring and control instruments" (category 9) only intended for professional use. They must not be disposed of at public WEEE collecting points.

At the end of the device's service life, notify the distributor who sold you the device, who may take back and dispose of the CellPod Quad according to the Directive 2012/19/EU on WEEE. If the distributor does not operate a 'takeback' scheme, disposal should be via a registered WEEE recycling contractor.

34. Disposal Outside of the UK/EU

When disposing of a CellPod Quad outside of the UK or EU, please observe applicable local regulations concerning the disposal of WEEE, and remember your obligation to protect the environment by reducing waste.

Support & Contact Details

For technical support, or to organise any maintenance and repair, please contact the specialist support team of the local distributor. The contact details are as follows:

- For UK, Europe & Canada enquiries contact Alvatek LTD: info@alvatek.co.uk
- For Europe, USA & Rest of world contact Digatron Power Electronics:
  - info@digatron.de (Europe & Rest of world),
  - info@digatron.com (USA)
- For Cognition Energy: info@cognitionenergy.uk

All warranty claims and technical enquiries that require further investigation will be passed on to Cognition Energy Ltd via the selected distributor.

About Us

We at Cognition Energy believe we can help make **batteries better**

Cognition Energy is committed to world-class cell testing, enabling the delivery of safer and more reliable batteries, quickly. Cognition Energy has over 600 channels in its test facility, making it the second largest in the UK. We also produce CellPods, our patent pending individual thermal chambers, making testing more accurate, flexible and safer.

Our Values

Here at Cognition Energy we believe our core principles are an integral part of the business, ensuring we conduct ourselves in a manner we pride ourselves in.

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