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Cognition Energy
Unit 10 Grove Farm
Abingdon
OX14 4DP

CellPod Operation & Maintenance Manual

Cognition Energy

14/06/2022

1 Change Log

VERSION	DATE	REVISED BY	CHANGES
1	14/06/2022	I. Mo	First issue

2 Table of Contents

3 Notices

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.

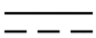
Customer suggestions on this manual and all other issues on the described system should be relayed to Cognition Energy Ltd at the customer's earliest convenience.

4 Abbreviations & Symbols

Table 1: *Glossary of acronyms and abbreviations*

Abbreviation	Meaning
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 2: *Glossary of graphical symbols*

Symbol	Meaning
	**General warning sign** To identify a general warning, meaning documentation must 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

5 Introduction

This document contains the instructions and advice concerning the safe use of CellPods during all phases of the system's life. Before installing or using a CellPod system it is important to read through and understand this manual such that safe use of the CellPods can be practised.

The manual shall provide technicians, researchers and engineers with relevant information on:

- Safe use of the CellPods and supporting equipment, including hazards and risk reduction;
- The CellPod itself, its parts and components;
- Relevant information for the lifecycle of the system (installation & end-of-life);
- Troubleshooting and fault finding procedures.

It is recommended that a copy of this manual is beside the system in-situ so it can be referred to at any point during installation, normal use or maintenance.

5.1 Introduction to CellPods

CellPods are a testing fixture that provide surface cooled battery cell testing at temperatures set by a user. A high level of precision, control and safety is required to complete detailed battery testing campaigns and CellPods are the perfect tool to the perfect tool for this.

Moreover, CellPods have been designed for usability - they're born out of the common difficulties that arise in battery testing and make cell testing rapid and straightforward.

CellPods achieve maximum user convenience and performance by offering these key main features:

- Individual enclosures for cylindrical electrochemical cells, providing base temperature control from -20 °C to +70 °C.
- Confidence in temperature performance, offering ± 0.5°C accuracy, ± 0.2°C stability. Yielding high quality datasets.
- Independent control of pods, meaning tests can be started/stopped without interrupting others; maximising cycler line uptime.
- Interchangeable stands for different cell form factors that provide tool-free loading of cells.
- Electrical contacts that provide temporary 4-wire cell connection totalling < 2mΩ resistance.
- High level of designed safety features; enclosure provides EUCAR Hazard Level 4 protection.
- Optional 5-point cell temperature sensor, to capture cell temperature gradients during testing, doing away with traditional methods of adhesively bonding additional temperature sensors.
- Customised computer software interface to simultaneously control and record data from up-to 96 individual pods.

The CellPod system is a powerful tool to provide their users with complete freedom when it comes to testing electrochemical cells.

5.2 CellPods 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:

1. System; the complete functioning CellPod system including Quads and all associated peripherals
2. Quad; a single item that is comprised of 4 CellPods
3. CellPod; a single test fixture for testing battery cells
4. Cell Stand; a fixture for electrically connecting to a cell without tools or welding

5.2.1 CellPod System

CellPods cannot operate on their own, they need supporting systems to operate. As shown in the block diagram in Figure 1, these include:

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

Note, multiple quads can be controlled by the PC and connected to the PSU and chiller. See Section 9.2 for details.

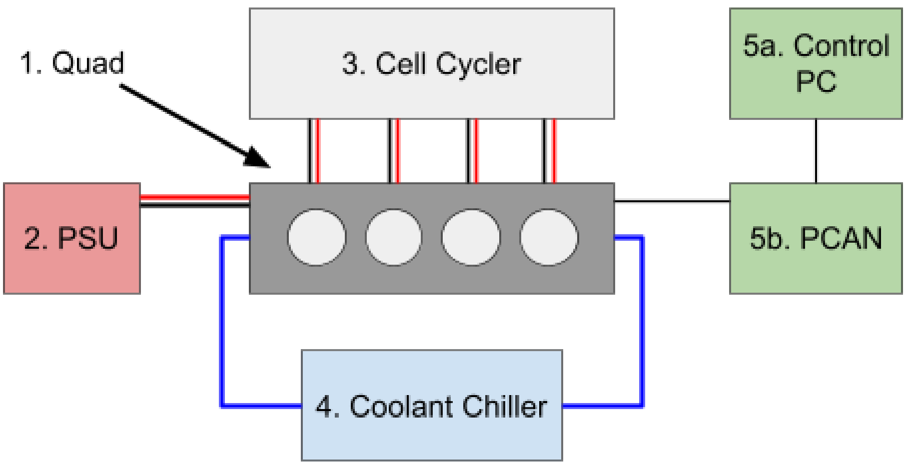


Figure 1: *Block diagram of a simple CellPod System. Note, power cables from the PSU to the Quad shown in red and black, Cell Cycler connections to each of the CellPods shown in red and black, hoses from Coolant Chiller to Quad shown in blue, USB from Control PC to PCAN shown in black & PCAN cable to Quad shown in black.*

A photograph of a simple system, assembled in the same way as described in Figure 1, is shown in Figure 2.

Figure 2: *An example of a simple CellPod System. From top to bottom, items are: PC screen for the GUI, Quad showing four CellPods with insulating pods attached, PC keyboard, laptop control PC, Basytec cell cycler with 4x black cables, PSU (1U rack unit), coolant chiller (large white box). The PCAN is not visible in this image.*

5.2.2 Quad

A Quad comprises 4 CellPods to reduce complexity of the overall system and increase usability. The Cellpods share common power, coolant and communications connections. Each CellPod operates independently of the others in the Quad, allowing each to hold a different temperature and therefore gives maximum flexibility in use. Figure 3 shows the main elements of a Quad.

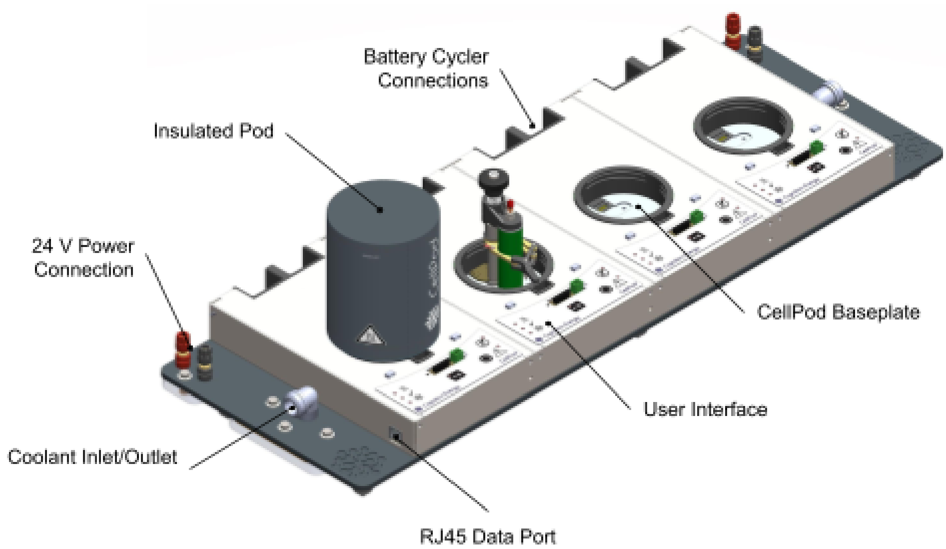


Figure 3: *A Quad with main elements called out.*

5.2.3 CellPod

A CellPod allows testing of a single battery cell at a set temperature. Its power, coolant and communications are provided by the Quad. 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.

A simple user interface is at the front of the CellPod, containing operational information, see Section 10.1 for details. There are also connections for the cell temperature gradient sensor and auxiliary input at the front of the CellPod. See Section 10.2.3-10.2.4 for details. An insulating pod screws down to securely cover the heat plate, Cell Stand and Cell under test. Figure 4 shows a CellPod and its major elements.

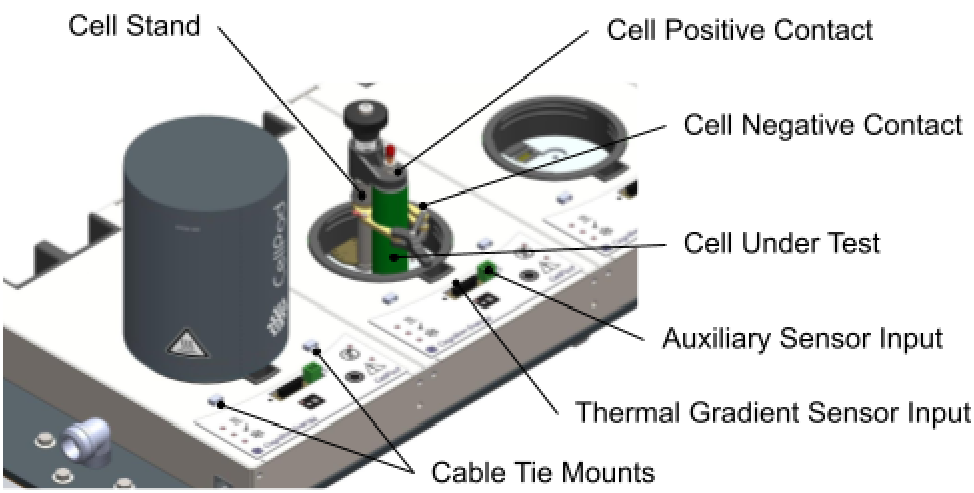


Figure 4: *A closeup view of a CellPod with main elements called out.*

5.2.4 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. The Cell Stand with main elements called out is shown in Figure 5.

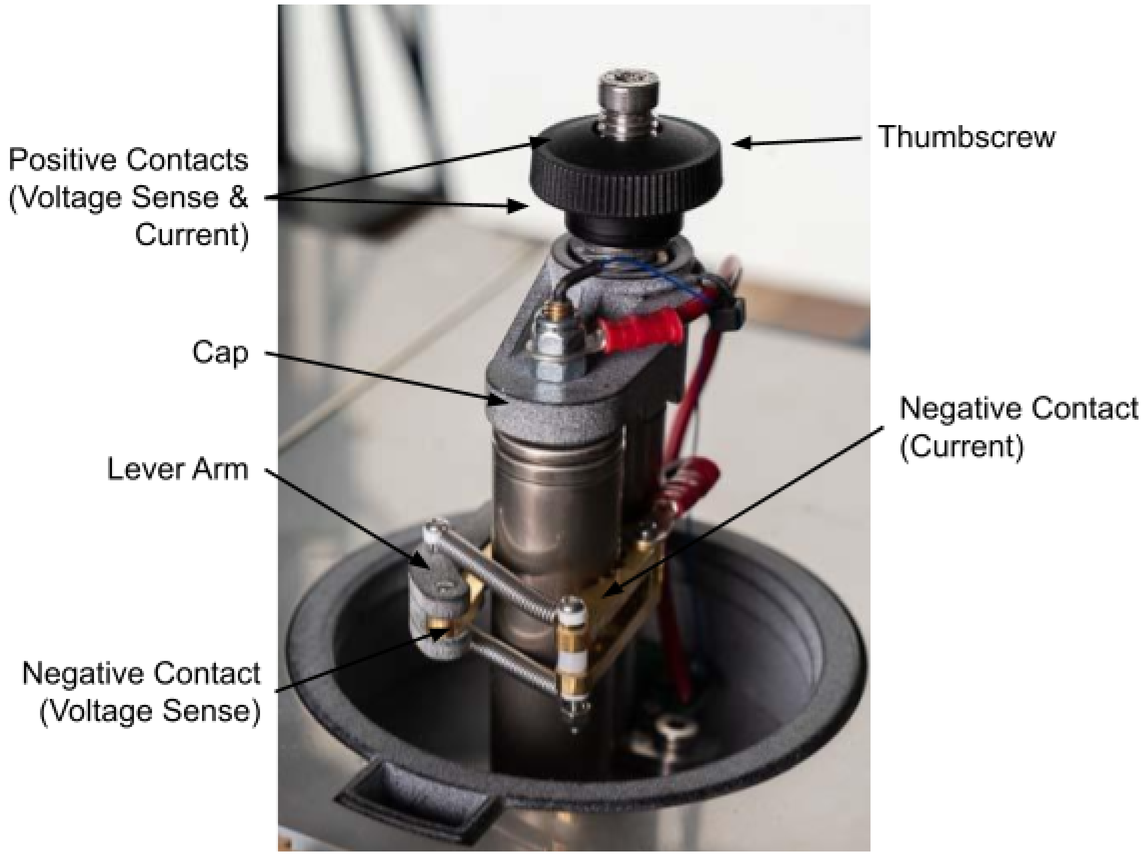


Figure 5: *A Cell Stand with main elements identified.*

6 Safety

6.1 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.

6.2 Personnel Qualification

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.

Competent persons are people whose prior education, professional training, knowledge and experience lends them to adequately assess and complete the work assigned to them safely, in the context of the CellPod.

The CellPod is expected to be used in a laboratory environment, thus users may include (but not limited to) technicians, researchers and engineers. Users must be trained and authorised to use CellPods. These users should also be trained in laboratory conduct and familiar with the precautionary measures taken when working in their lab.

6.3 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. The banners are marked with a single word and coloured to reflect the probability and severity of the hazard that could arise if their warning is unheeded.

The banners used are displayed below:

⚠ **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.

6.4 Position of Safety Information on the System

6.4.1 Position of Warning Labels and Type Plate

Figure 6 shows the location of the warning labels affixed to the CellPod Quad.

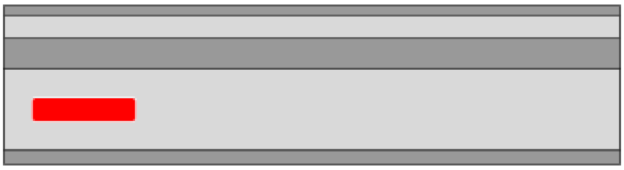


Figure 6: *Warning label location on a CellPod Quad. Underside of Quad is shown, Type Plate Label shown in Red.*

6.4.2 Type Plate

The type plate illustrated in Figure 7 is stuck to the CellPod Quad. The information displayed on the type plate is explained in more detail in Table 3.

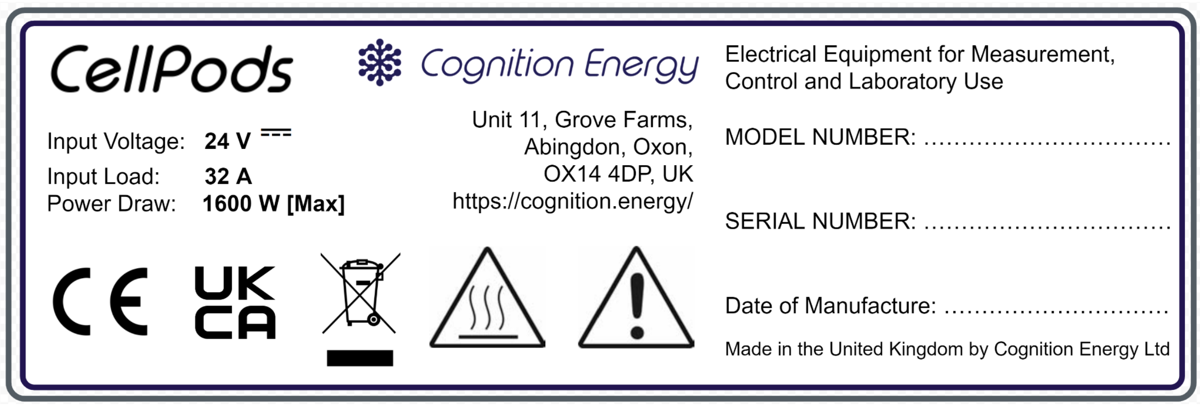
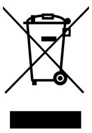


Figure 7: *Type plate shown on system.*

Table 3: *- Type plate information*

Information on type plate	**Meaning**
Cognition Energy	Cognition Energy Ltd; the manufacturer
CellPods	Product line
https://cognition.energy/	Manufacturer website
Model Number	CellPod version
Serial Number	CellPod unique identifier
Input voltage: 24 V ⎓	Direct current input voltage limit
Input load: 32 A	Maximum current draw
Power draw: 1600 W	Maximum power draw
Unit 11, Grove Farms Abingdon, Oxon, OX14 4DP, UK	Manufacturer address
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.

6.5 Intended Use

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

CellPods are fixtures with inbuilt thermal management capability, 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 and enclosing them each in their own pod. The base of this pod is controllable between -20°C and +70°C allowing researchers and engineers to freely carry out cell testing campaigns at the temperatures of their own choosing.

6.5.1 Requirements for Cells used within the CellPod

The CellPod features an interchangeable stand to receive different cell form factors. These stands will each accept a unique form factor of cells.

There are stands available for 18650 and 21700 cylindrical cells. Only electrochemical cells of these forms should be loaded into CellPods with their correct corresponding stands.

Any substance, material or component outside this scope should not be tested within the CellPod. Explosive, flammable or solvent based material should be avoided altogether.

6.5.2 Installation Site Requirements

The operation and installation location of the CellPod 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 9. Do not install the CellPods in a hazardous location.

It is also recommended to operate the CellPods in a restricted access room, preventing curious intervention into tests and minimising interaction with untrained personnel.

6.6 General Safety Instructions

Cognition Energy Ltd is only responsible for the safety features of the CellPods 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 Alvatek Ltd (the UK CellPod distributor) using only original components and accessories.

The user is responsible for the risk of introducing unauthorised components and accessories.

6.6.1 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. These risks can all pose real hazards despite safe design and use, hence they cannot be overlooked and so the user must be aware of them. It is up to the user to consider these risks and take the measures required to mitigate the occurrence of hazardous situations.

The symbols on the CellPod are used to warn of residual risk, and identified in Section 6.4. 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.

CellPods are designed to be used with electrochemical cells.

⚠ WARNING
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.

CellPods include a water cooling system to be plumbed and facilitated by the user.

⚠ 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.

The CellPod is capable of operating at hot and cold temperatures.

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

To improve electrical performance, the temporary electrical connections to the cell are sharp to the touch.

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

6.6.2 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 CellPods does not eliminate these hazards entirely.

The CellPod enclosure is designed to handle a EUCAR 4 level event, meaning that it provides protection to the user in the event of a cell venting. Note, the CellPods do not include gas extraction or filtering.

⚠ **WARNING**
Risk of short circuiting is increased using the CellPod. 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 10.2 to strip cell heatshrink safely. ✅ DO read Section 10.2 to learn how to load/unload cells from CellPods safely.

6.7 Foreseeable Misuse

Reasonably foreseeable misuse cases are listed below. This list should not be considered exhaustive.

- Non battery cell testing
- Ignoring precautionary measures laid out within this manual.
- Ignoring the warning signs affixed to the CellPods.
- Improper set-up, maintenance or operation.
- Operation by non-competent persons.
- Use of testing articles not permitted by this manual.
- Ignoring examples of wear & tear on the equipment.
- Non-compliance with the parameters for water coolant (temperature, pressure, flow rate)
- Installation of replacement components or accessories not specified or authorised by the manufacturer.
- Operation of the system without training or consulting the instructions.
- Bypassing or tampering with the safety systems in the equipment.
- Operating a damaged piece of equipment, including continued operation of equipment with a clear malfunction.
- Loading a damaged test article into the equipment.
- Curious interference with ongoing tests.
- Incorrect connection of periphery equipment.
- Incorrect loading of test article.
- Wearing conductive jewellery, watches etc. leading to short-circuit of cells.

6.8 User Responsibility

Please observe the safety recommendations outlined in this document and practise safe use of the CellPods. The user is directed to comply with both safety considerations within this manual and any local safety requirements and regulations. Safety requirements outlined in this manual should be followed and operators should undertake a risk assessment for use in compliance with local requirements and regulations

Before using the CellPods, users should undertake the following steps:

- Prepare a risk assessment for use of the CellPods 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 means of recording training, equipment use, faults and safety events (e.g. engagement of CellPod safety systems) is available.
- Ensure that required equipment for any emergency actions outlined in the user’s risk assessment are accessible.
- Ensure that the required PPE outlined in this manual and the user’s risk assessment is accessible and used.

6.8.1 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 jewelery, watches, bracelets etc. must be removed.

6.8.2 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 CO2 fire extinguishers can be used. However, other fire extinguishers should not be used, water or foam based extinguishers will accentuate the problem and make the fire worse.

The user should implement a sensible emergency action plan in accordance with their risk assessment and provide the correct safety equipment for reacting to emergency situations.

7 Machine Overview

7.1 System Overview

The CellPod is a thermal chamber and test fixture that is designed for the testing of cells while they are surface cooled. It provides base cooling to the cell under test over a wide temperature window, allowing the user to produce high quality and representative data. The control software allows the user to adjust, check and record the cell temperature gradient. Key features include:

- **Individual cell temperature control from -20 °C to +70 °C:** Each CellPod can be independently controlled. Tests can also be started and stopped without affecting other cells on test.
- **Temperature control +/- 0.5 °C accuracy & +/- 0.2 °C stability :** The CellPod reliably and precisely controls the set point temperature, to ensure high quality test results.
- **Optional 5 point cell temperature gradient sensing:** A flexible PCB is used to record temperature in 5 locations along the cell, it doesn't require tools to fit or remove and is reusable.
- **EUCAR Hazard Level 4 rated:** Each CellPod is EUCAR 4 rated, meaning that a cell venting will be safely contained within the Cellpod. Note, CellPods do not provide gas filtering or extraction.
- **Four wire electrical connection:** The Cell Stands provide a true 4 wire connection to the cell, without requiring tools to attach to a cell, nor welding or soldering.
- **Control Interface reporting real time CellPod Conditions:** The GUI allows users to monitor all CellPods and collect temperature data gathered within the CellPod.
- **Safety:** The CellPod includes a range of redundant safety features designed to reduce the chance of accidents when testing batteries using CellPods.

As described in Section 5.2, a CellPod system contains a number of Quads, plus associated peripheral systems. A block diagram of the system with additional details is shown in Figure 8. Additional information regarding the peripheral system requirements is contained in Section 7.2. See Section 9.2 for information regarding the Quad connectors.

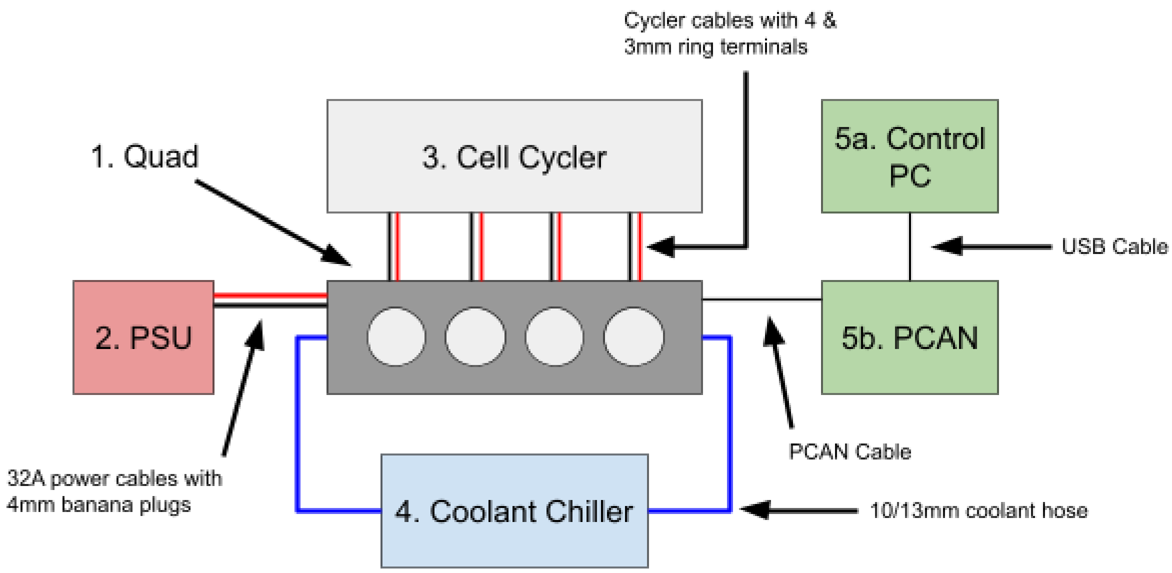


Figure 8: *Block diagram of CellPod System with a single Quad.*

7.2 System Peripherals

7.2.1 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 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.

Figure 9: *Recommended PSU Chassis, populated with 3x 1kW modules.*

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

7.2.2 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 10):
    - Voltage sense: 3 mm ring terminals
    - Current: 4 mm ring terminals
- Temperature sensors (see Figure 11):
    - Cycler temperature sensor: insert into pod via scoop

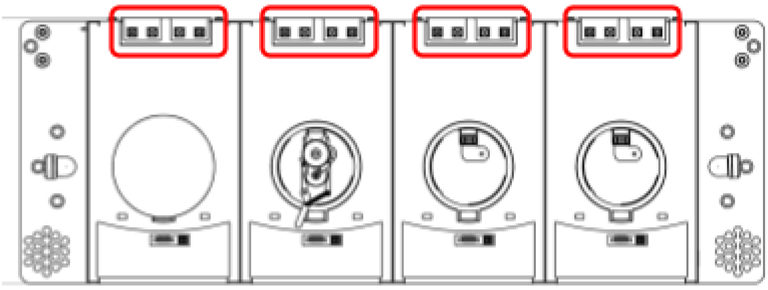


Figure 10: *Cycler connections for each CellPod on a Quad, highlighted red. Note, cable tie mounts are either side of the binding posts (on the rear of the Quad, outlined in red above) to allow the cycler cables to be strain relieved.*

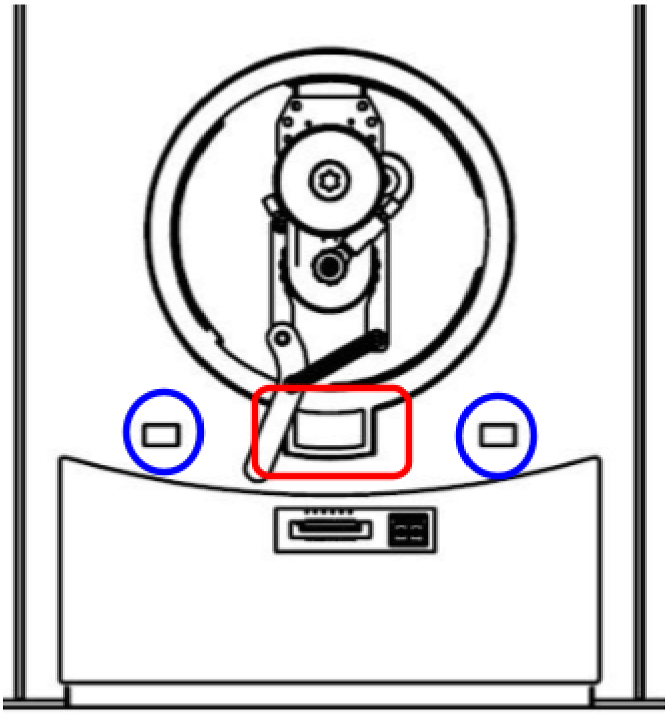


Figure 11: *CellPod scoop for temperature sensor insertion shown in red rectangle. Zip tie mounts for zip ties up to 5mm wide to secure sensor wires shown in blue circles.*

7.2.3 Coolant Chiller

CellPods require a constant flow of coolant in order to maintain a constant temperature. The minimum requirements for a chiller that can support up to 8 Quads (32 CellPods) are as follows:

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

Cognition recommends using a low cost laser chiller such as the S&A CW-5200 to provide suitable cooling, it includes a reservoir and pump, minimising complexity. It also has built in alarms to warn of low coolant levels. This chiller has barb connectors, securing the hose with jubilee clips.

7.2.4 Control PC and PCAN adapter

CellPods are controlled from a PC, a 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 it is connected to by a customised cable that has a D-SUB connector at one end and an RJ45 at the other.

⚠ **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 9.2 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: min 1024 x 768

7.3 CellPod Specifications

The technical specifications of CellPods are displayed in Table 4.

Table 4 - Technical Data

Temperature	Cell thermal gradient measurement points	5
	Temperature range	-20 °C to +70 °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	Yes
	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	18650, 21700 (enquire about custom cell sizes)
	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

The outer dimensions of a quad of CellPods is shown in Figure 12.

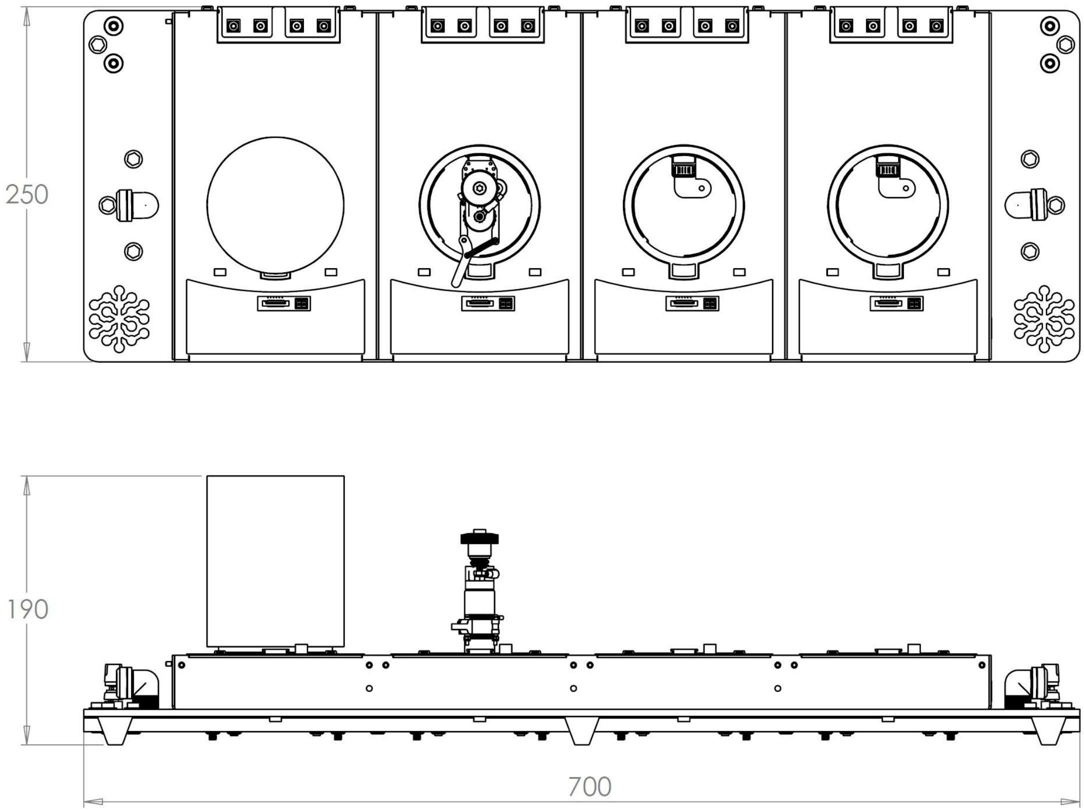


Figure 12: *CellPod Quad dimensions (all dimensions in millimetres).*

7.4 Operating Conditions

CellPods 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

7.5 Quick Start Guide

For trained users that know how to set up and operate CellPods, follow the instructions below for a quick start or watch the video at this location: cognition.energy/support

How to set up and use CellPods

1. Remove all CellPod quads and peripherals from their packaging.
2. Layout Quads and peripherals where you would like them to be, taking care that the numbering of the CellPods will be logical for the user.
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. See Figure 13.

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 CellPods.
9. Run the Auto-Addressing function to number the pods, pods will then number themselves starting from 1 with the nearest pod to the PC on the CAN network. .
10. Check that each pod functions. To do this, set each pod to temperature setpoints of 20 °C, 70 °C & -20 °C. Allow each pod 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 3 mm hex key.
12. You are ready to start testing!

7.6 Lifetime & Warranty

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

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

8 Transportation, Handling & Storage

8.1 Unpacking and Checking Equipment

Please adhere to any local safe lifting policies in place (see Section 8.2). The CellPods will be transported in a specifically packed container, therefore should be kept in the orientation noted on the side of the box and opened from the correct side. Prior to opening the container, remove any transportation protections such as; wrapping, tape or adhesives and take out the operating manuals and accessessory equipment.

If the CellPods are stored upon delivery, make sure the package is kept upright, in a dry environment with nothing resting atop it (see Section 8.3). 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 CellPods, please use the original packaging and observe any local guidelines for safe lifting and handling (see Section 8.2).

💡 **TIP**
Identify and unpack the CellPods in a clean and dry workspace near the installation site. Familiarise yourself with the hardware by watching the unboxing video at cognition.energy/support prior to receiving the CellPods.

8.2 Handling Instructions

When handling the CellPod box, lift from the pallet or the base in accordance with any local manual handling regulations.

If the CellPods need 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 CellPods. Lift the CellPods from either end of the cooling plates.

8.3 Storage Environment

The CellPods 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 % - 70 %

After storing the CellPods in a cold location, allow the CellPods 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 CellPods in environments outside of the recommended environmental parameters.

✅ Remove Insulated Pod and Cell Stand in storage and when not in use.

8.4 Disposal of Packaging

Packaging materials should be kept where possible, in case the unit needs to be returned for servicing under warranty.

9 Assembly, Installation and Commissioning

9.1 Location of Installation

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

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

9.2 CellPod Quad Assembly Instructions

Once the CellPod Quad is set up on an appropriate surface in accordance with Section 9.1, the user should connect the system to coolant, power and data, and connect their battery cycler to each CellPod. Figure 13 shows the location of each connection. Sections 9.2.1-9.2.4 detail how each connection should be made and the specification of all cables and hoses.

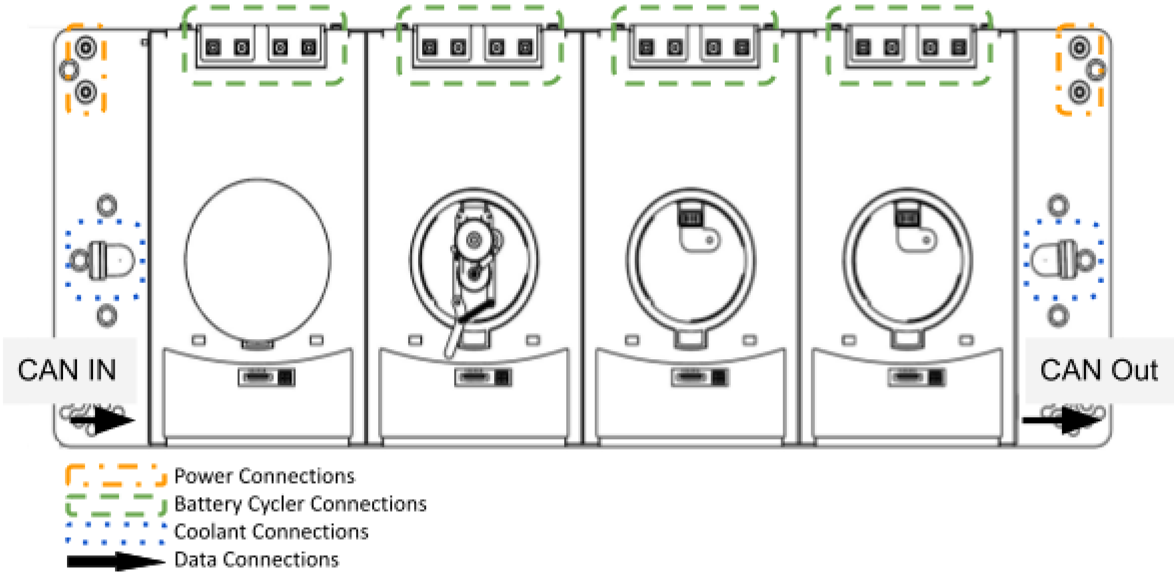


Figure 13: *Location of all CellPod Quad input and output connections.*

💡 **TIP**
An instructional video on how to assemble your CellPod Quad can be found at cognition.energy/support. Cognition Energy recommends watching the instructional video prior to beginning assembly.

9.2.1 Coolant Connections & Coolant

Once the CellPod Quad is set up, coolant connections should be made. The locations of each connection is shown in Figure 13. The following connections should be made;

- Water In - 10 mm inner diameter, 13 mm outer diameter hose
- Water Out - 10 mm inner diameter, 13 mm outer diameter hose

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. Other coolants (for example water-glycol) may be used, however it is recommended to check with the distributor before substituting a different coolant to deionised water

The CellPod system is designed so that a coolant set point temperature of 20°C 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 8 Quads (32 CellPods) can be connected in series to a single coolant chiller. If more than 8 quads are connected in series to the chiller then performance of the CellPods could degrade as too much heat would be rejected into the coolant for the chiller to deal with.

9.2.2 Power Connections

Once the CellPod Quad coolant connections have been made, power connections should be made. The locations of each connection is shown in Figure 13. The following connections should be made;

- Power (+): 4 mm Banana Plug
- Power (-): 4 mm Banana Plug

Power connections should be made using cable specified sufficiently to carry a maximum continuous current of 32 A. Before connecting the power cables, the user should ensure that the power is off.

Up to 2 Quads can be connected in series from the power supply bus bars. There are multiple connection points on the bus bars so that up to 8 Quads (32 CellPods) can be connected to a fully populated power supply, this would be done in a set up wth 4 Quads connecting to the bus bars with another 4 Quads connecting in series to them, as shown in Figure 14. There is no difference between the left and right power connections.

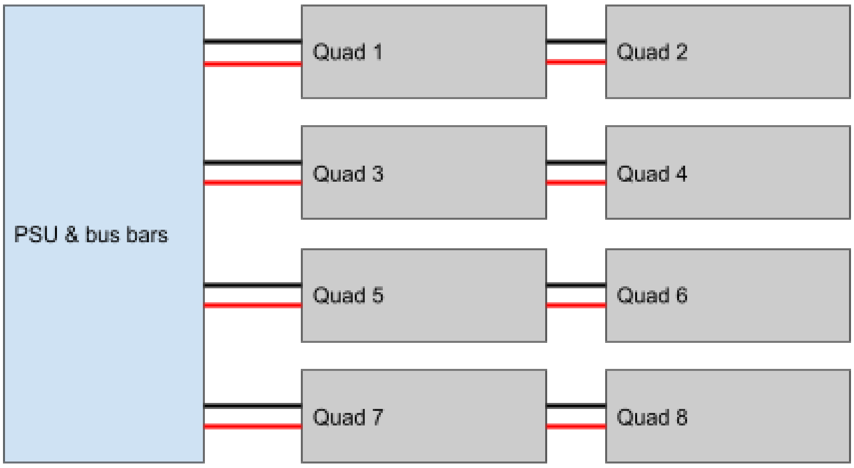


Figure 14: *How to connect 8 Quads to a PSU.*

9.2.3 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 11.3 for details on how the auto addressing functions.

9.2.4 Cell Cycler Connections

Once connections to power and data have been made, the user should connect the battery cycler to the connections indicated in Figure 13 for each pod. The following connections should be made;

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

When connecting a battery cycler to the CellPod Quad, ensure that no cell is present in the pod 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.

9.3 CellPod Cell Stand Assembly

9.3.1 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 9.3.2). All cell stands are installed using an identical methodology. To install the cell stand follow the following steps (referring to Figure 15);

1. Orient the Cell Stand such that the stand plug aligns with the plug in the heatplate (align the key at the base of the stand with the appropriate location 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.

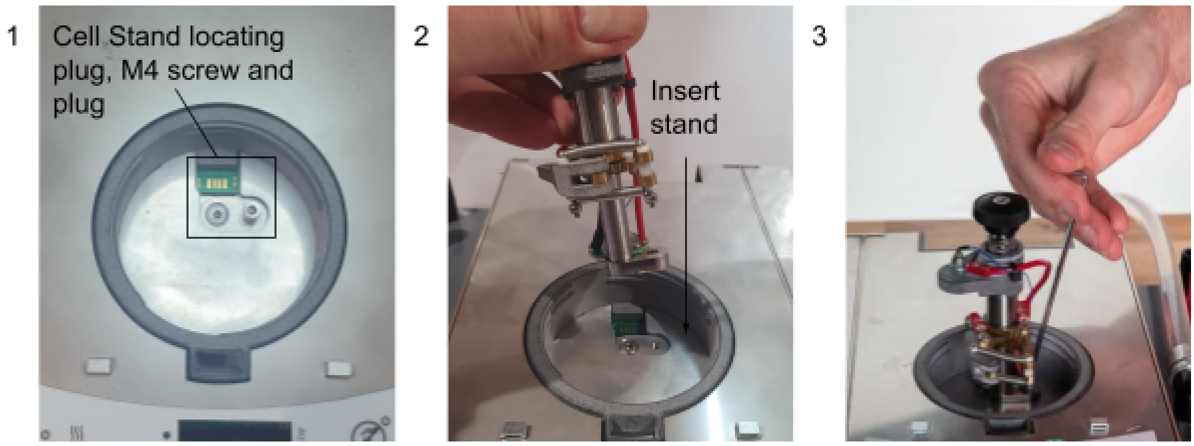


Figure 15: *How to insert a Cell Stand.*

Once the cell stand has been attached to the CellPod, the insulated pod lid should be placed into the pod and secured by screwing it in by turning the lid clockwise. The lid should be tightened to hand-tight; it should not be tightened using tools.

9.3.2 Compatible Attachments

A list of compatible Cell Stands is as follows;

- 18650 Cylindrical Cell Stand (Cognition Part Number: 101166-002)
- 21700 Cylindrical Cell Stand (Cognition Part Number: 101363-001)

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

9.4 Commissioning

9.4.1 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; Ensure coolant is flowing with a visual check. Allow to run for 5 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.

9.4.2 Default System Settings and State

By default when powered on each CellPod will be inactive and not connected to the control PC.

9.4.3 Control Software

The minimum specification of the Control PC can be found in Section 7.2.4.

To install the control software (CellPod Control Software), download the software from cognition.energy/support. Run the installer and open the software.

To install the PCAN driver, download the driver from peak-system.com/Drivers.

9.4.4 Connecting to the System

To connect to CellPod Quad(s), open the CellPod Control Software. All CellPod Quads connected over the same CAN network will be connected to the PC when the 'Connect' function is run . The CellPod Quad will connect to the PC and automatically detect the addresses (identification numbers) of all CellPods on the PC CAN network. Once connected, each CellPod will be listed by the Control Software for each connected Pod in the Quick View window. This process is outlined in Section 11.3

9.4.5 Testing the System

Once the system has been powered up, coolant is running and the CellPod Quad is connected to the CellPod Control Software, basic functionality of the system should be tested. This can be achieved by doing the following;

1. Set each CellPod to a setpoint of 20 °C and allow each CellPod to achieve the setpoint.
2. Allow each CellPod to remain at temperature for a minimum of 10 minutes. Observe the temperature of each CellPod to ensure that it both reaches the set temperature and remains at a stable temperature.
3. Set each CellPod to the maximum temperature setpoint (70 °C) and allow each CellPod to achieve the setpoint.
4. Allow each CellPod to remain at maximum temperature for a minimum of 10 minutes. Observe the temperature of each CellPod to ensure that it both reaches the set temperature and remains at a stable temperature.
5. Set each CellPod to the minimum temperature (-20 °C) setpoint and allow each CellPod to achieve the setpoint.
6. Allow each CellPod to remain at minimum temperature for a minimum of 10 minutes. Observe the temperature of each CellPod to ensure that it both reaches the set temperature and remains at a stable temperature.
7. Turn off each CellPod via the control software.

Once testing is complete the CellPod Quad is ready to be used in your battery testing. If during testing a CellPod either fails to reach the setpoint temperature or remain at 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 13 for further fault finding information or contact your distributor (see Section 15) for further technical support and advice.

10 Hardware Operation

10.1 Overview of Hardware Controls

Each CellPod has a front panel set of hardware controls, as shown in Figure 16.

Figure 16: *CellPod front panel controls, identifying key features.*

1. **Status indicators:** This area indicates what the temperature control system is doing. There are 3 LEDs and symbols:
    a. **Heating (Orange):** Shows that the CellPod is heating up to reach its set temperature.
    b. **At temperature (Green):** Indicates that the CellPod is within 1 ∘C of the set temperature.
    c. **Cooling (Blue):** Shows that the CellPod is cooling down to reach its set temperature.
2. **Temperature sensor input:** Connector for thermal gradient temperature sensor strip.
3. **Auxiliary sensor input:** This may be used to record a sensor output of 0-5 V. Data is synchronised and recorded alongside other CellPod data
4. **Temperature warning:** If the CellPod baseplate is outside of a safe temperature to touch the red LED will illuminate. Do not open or touch internal elements of the CellPod when the Temperature warning light is on.
5. **Pause button:** During normal operation this button's LED is illuminated green. To suspend the test, the operator can press this button and the temperature control will stop, the LED will flash. To resume the test, push the button again.
6. **Trip reset:** If a overtemperature has been sensed the CellPod temperature control will cut out. To reset this trip the user must press this button.
7. **Error warning light**: If the error trip has triggered it will be indicated by the red LED.

⚠ **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.

10.2 Preparing and Loading Cells into CellPods

Cells must be prepared for testing and loaded into CellPods correctly. This section includes important safety information regarding this, plus best practice to ensure good quality test results.

10.2.1 Safely Removing Cell Wrappers

CellPods require 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.

10.2.1.1 Correct Technique

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 17.

💡 **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.

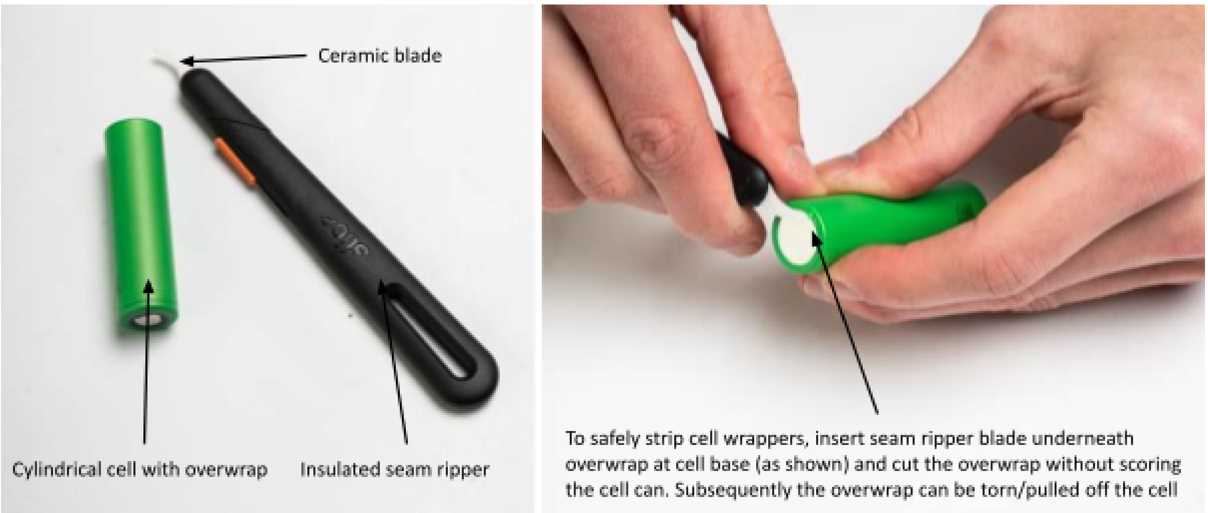


Figure 17: *How to strip a cell of its plastic wrapper correctly.*

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.

10.2.1.2 Incorrect Technique

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, in the worst case scenario, a user can puncture the cell immediately, causing escape of the electrolyte or fire.

This weakness may not lead to immediate failure, instead, cycling a cell will lead to normal degradation which includes generation of gases internally. This gas generation will increase the cell internal pressure and can lead to the cell splitting open along the weakened point. This would mean a leak of gases and electrolyte, it may even lead to cell thermal runaway. An example of a cell that has split due to incorrect removal of the plastic wrapper is shown in Figure 18.

⚠ 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.

Figure 18: *A cell that has split open during cycling due to internal pressure rise and a scratched cell can side wall.*

10.2.2 Cell Inspection and Preparation

Cells must be inspected and prepared for insertion into CellPods for testing. The two critical steps are:

1. **Inspection for damage:** 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.
2. **Cleaning:** Good electrical connection requires a clean cell, 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.

10.2.3 Temperature Sensor Strip Insertion

In order to use the CellPod's cell temperature gradient feature the cell clip and temperature gradient strip must be used. Figure 19 details how to correctly assemble these components with a cell to ensure good results:

1. Get one temperature gradient strip and one 18650 or 21700 cell clip.
2. Carefully thread the temperature gradient strip through the cell clip as shown. 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.

4. Place the cell in position between the clamps, thread the connector of the temperature gradient strip through the access port into the CellPod, and plug in the connector.

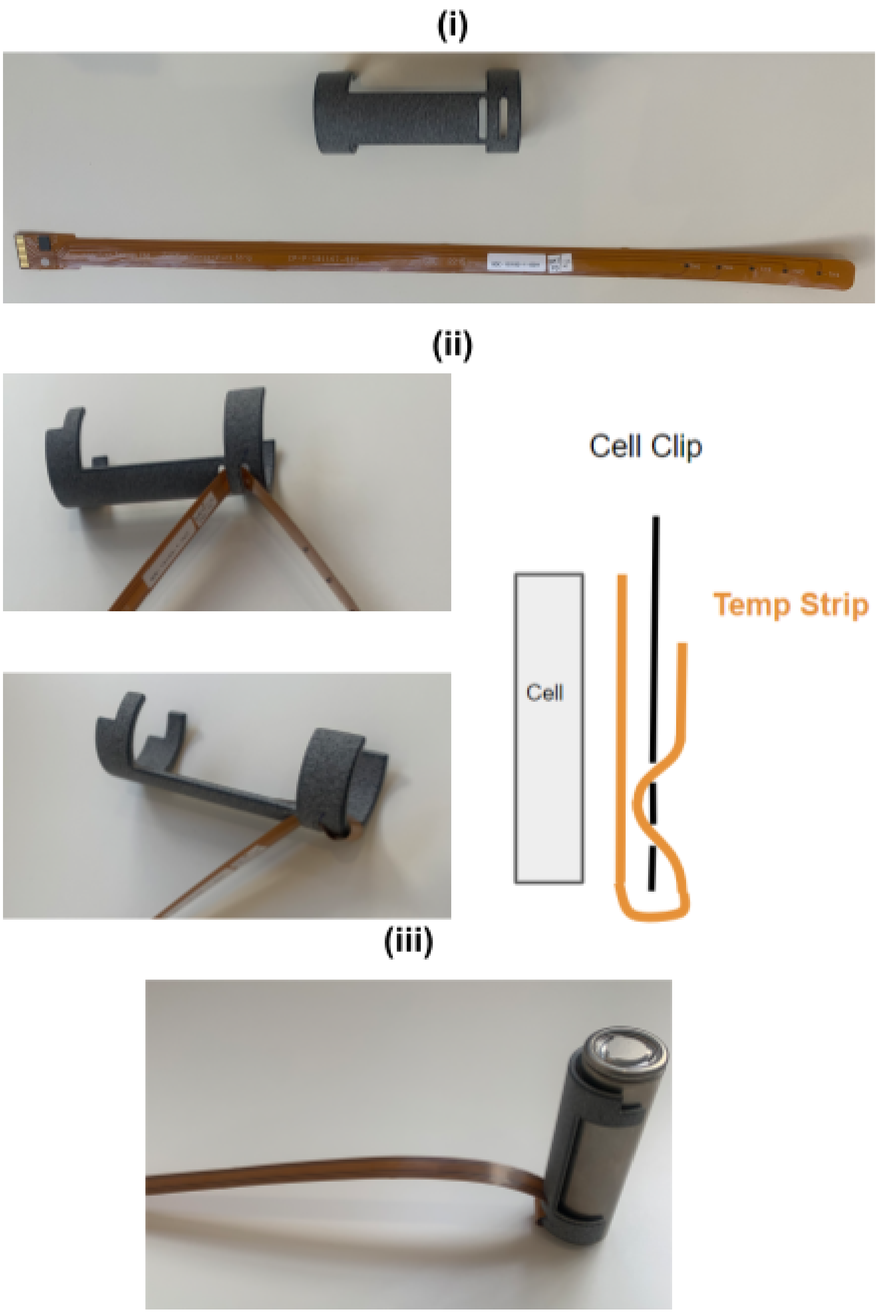


Figure 19: *How to correctly prepare a cell temperature sensor strip and clip.*

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

An image of a correctly loaded cell with sensor strip in place can be found in Figure 20.

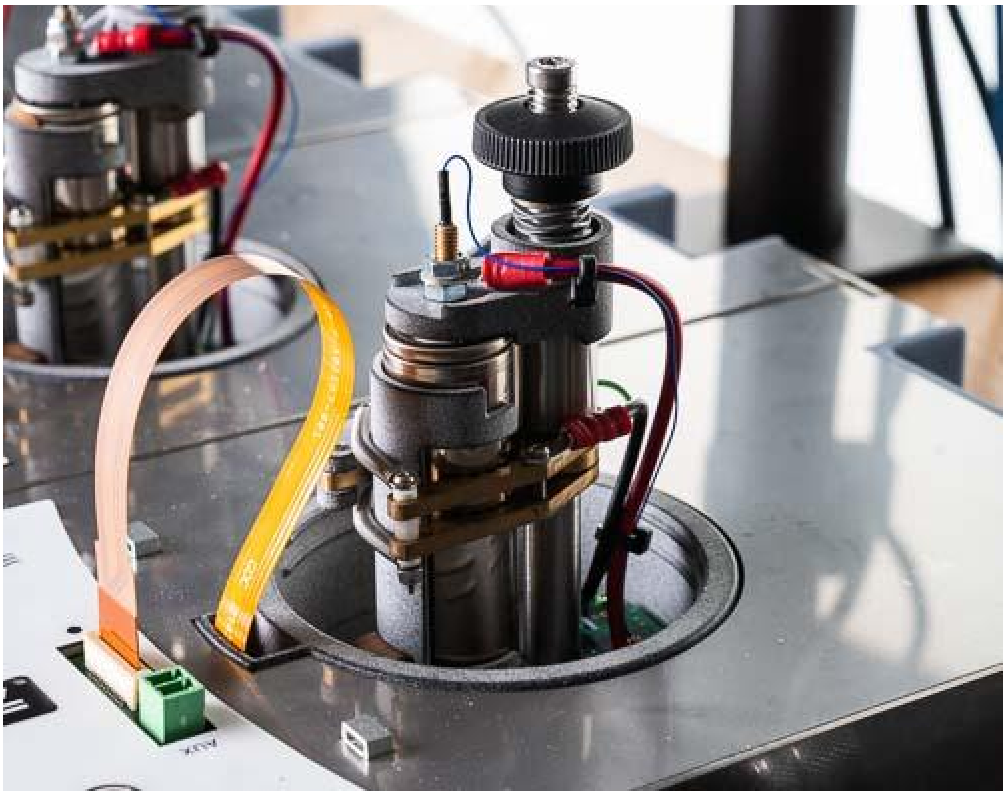


Figure 20: *Cell loaded into CellPod with temperature gradient sensor strip correctly installed.*

10.2.4 Auxiliary Sensor Connection

Each CellPod is able to record measurements from an externally provided sensor. There is a 2 pin connector (Part number: 1882735) that takes input from the external sensor and records a 0-5 V value. The data is stored by the control GUI, along with the other temperature data.

The wiring of the sensor connector is shown in Figure 21.

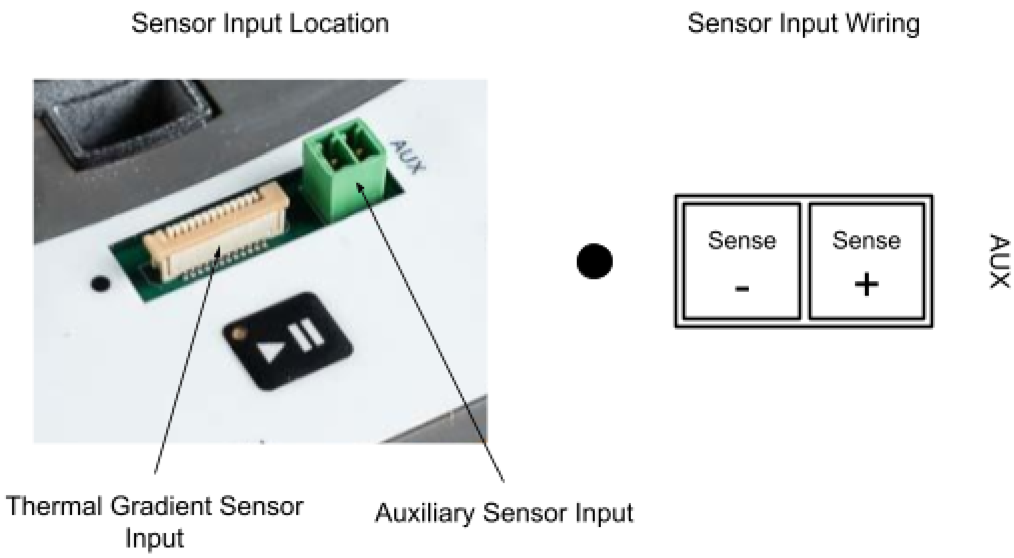


Figure 21: *Wiring of auxiliary sensor connector for insertion into CellPod.*

10.2.5 Cell Loading Procedure

Cognition's 18650 and 21700 cell stands make it easy to switch in and out cells between tests. Before inserting a cell and starting a test, clean the stripped cell and stand contacts. Also, place thermal interface material on the base of the CellPod to sit below the cell. Figure 22 shows how to place a cylindrical cell into the CellPod as follows:

1. Open the jaws of the Cell Stand, and rotate the cap 90° clockwise.
    a. Note, only turn it clockwise, it will lock into position for easy handling. Do not rotate anticlockwise, you may damage the Cell Stand wires by repeatedly doing this.
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.
    a. Note, the sensor strip only loads one way into the ZIF connector, with the chip facing away from the user and towards the Cell Stand. There is a spot printed on the sensor strip, it will be on the same side as the spot printed on the CellPod front panel if it is correctly orientated.
    b. Lift up the ZIF surround to open it for insertion/removal of the sensor strip, push it down to engage it and lock the sensor strip in place.
    c. If using the additional sensors, feed the wires through the access port and plug in the connector.
    d. If using any additional sensors, attach them to the cell, e.g. a cell cycler temperature sensor.
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. The cell is now correctly loaded. Use the provided cable tie mounts to secure and strain relieve any sensor wiring.

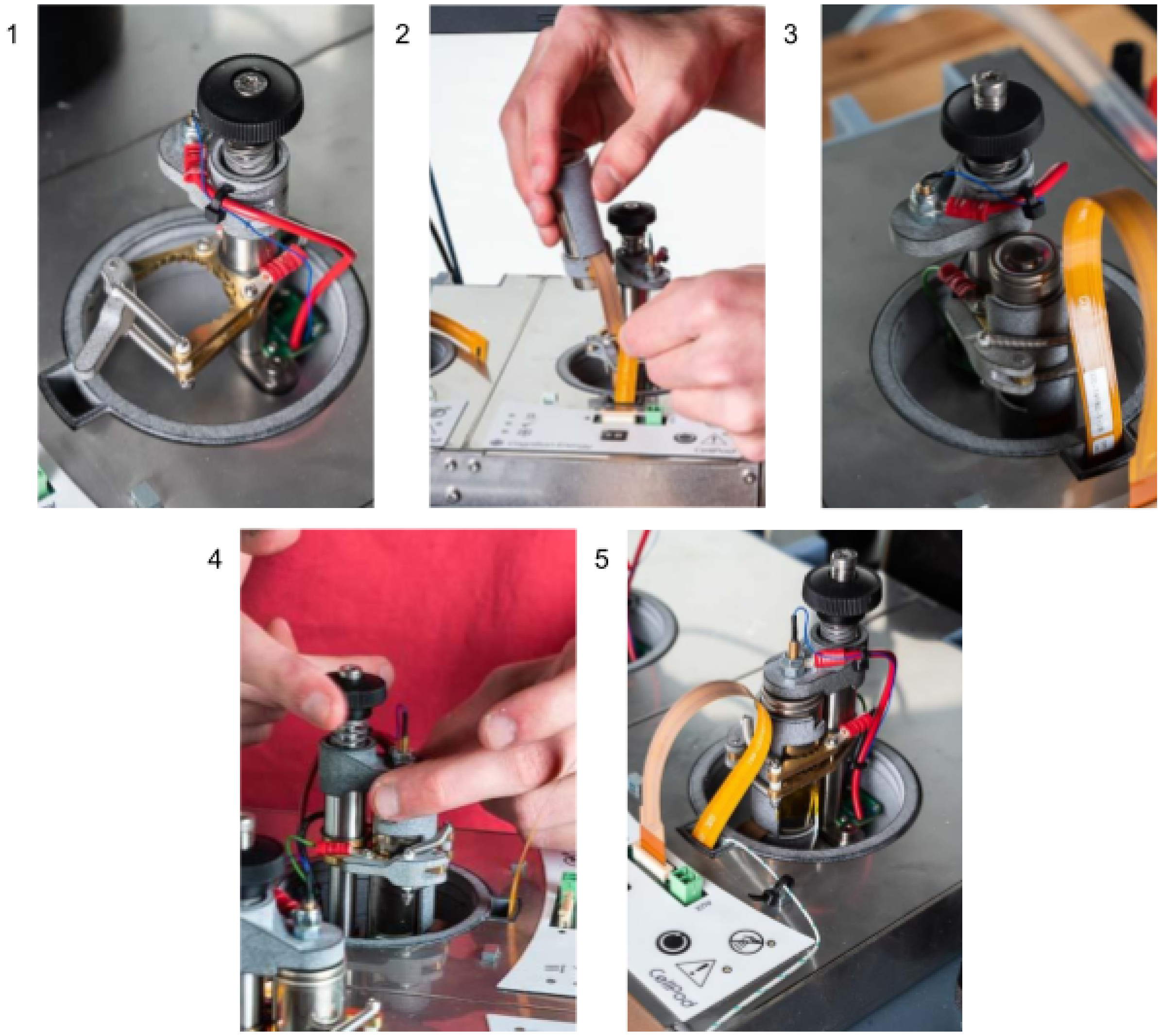


Figure 22: *Cell loading procedure.*

💡 TIP

For best results replace the thermal interface material. Also, 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.

10.3 CellPod Safety Systems

10.3.1 Overview of CellPod Safety Systems

The CellPod Quads and CellPods themselves have a variety of safety systems built in to protect against possible damage and hazardous events. These are:

- Each CellPod Quad is protected from reverse connection of power cables and fused.
- Each CellPod Quad Coolant inlet temperature is monitored and over-temperature will return a fault, protecting against failure of the coolant supply.
- Each CellPod cycler connection is protected against misconnection of the cycler cables (e.g. reverse connection), protecting against mistakes in battery cycler wiring.
- 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

10.3.2 Resetting the CellPod Safety Systems

In the event of any of the built in hardware or software safety systems acting, the Error Warning Light (see Section 10.1) will be lit on the CellPod front panel, indicating that a safety system has acted. The safety systems can be reset by resetting the CellPod. This is done by pressing the CellPod Reset button on the CellPod front panel.

⚠ **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.

11 Software Operation

11.1 Software Setup

Details of how to download and install the CellPod control software can be found in Section 9.4.3.

11.2 Connecting to CellPods

Once the CellPod control software is installed and the CellPod Quads are setup and powered on, open the control software (you may need to adjust your display scale/resolution to fit the window) . To connect to all CellPods connected to the control PC over the CAN network, click File > Auto Address > Yes (identified in Figure 23). The CellPod Quads will automatically connect to the control software, and numbered pods will appear in the Quick View window of the control software (identified in Figure 23). Each CellPod will be assigned an address (identification number) per Section 11.3.

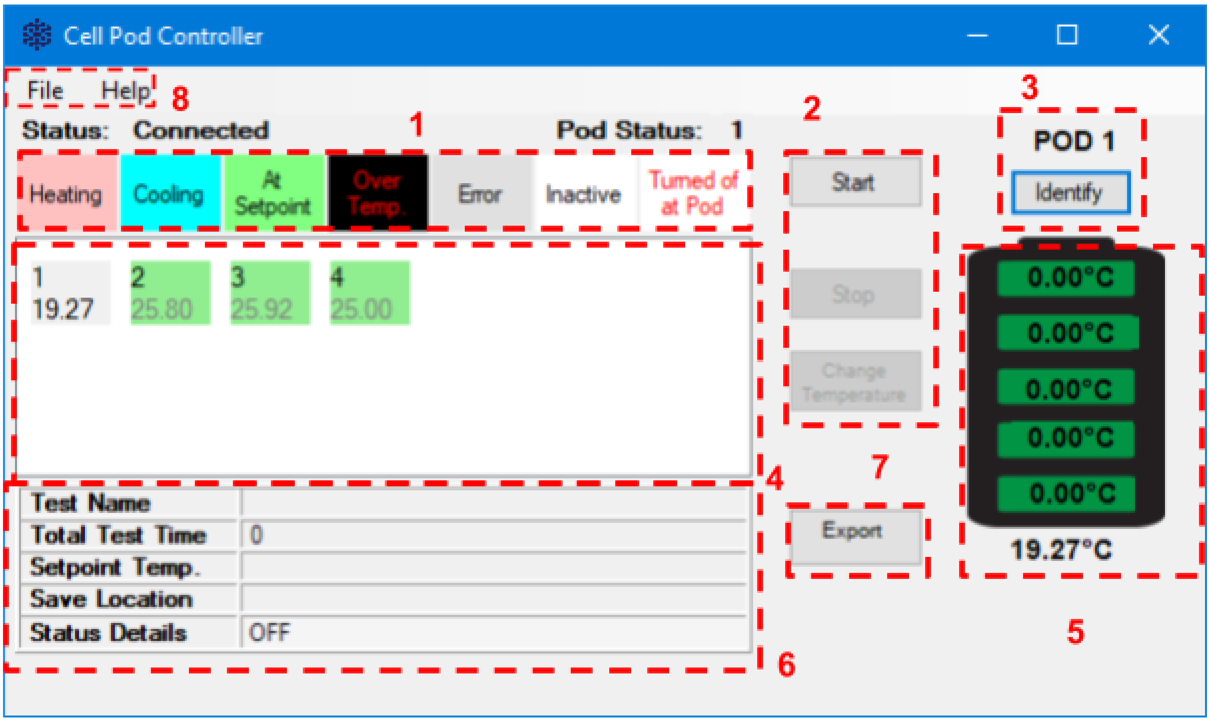


Figure 23: *Overview of the main window of the CellPod Control Software.*

Figure 23 shows the main window of the CellPod Control Software. The annotations identify the following:

1. **Key**: Indicates the meaning of pod colours found in the Quick View window.
2. **Stop/Start/Change Temp.**: Buttons to start, stop and change temperature of test programs on the selected CellPod.
3. **Selected Pod/ Identify**: Indicates the pod selected in the Quick View window / button for pod identification.

4. **Quick View Window**: Provides a quick overview of the status of each pod. Status is indicated by the background and text colour (see key). The CellPod (i.e. base plate) temperature is reported here. To stop/start a test or see details of an ongoing test the CellPod is selected here. All connected CellPods will appear in this window.
5. **Detailed Temperature View**: Provides a detailed view of temperatures measured by the selected CellPod (including by the thermal gradient sensor).
6. **Test Details**: Shows detailed information about any ongoing test on a selected CellPod
7. **Export Data**: Exports data file (.txt) without stopping the test.
8. **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.

11.3 CellPod Addressing and Identification

When connecting to CellPod Quads, the GUI will detect the pods 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' pod to the CAN connection to the control PC, as shown in Figure 24. Addresses held by each CellPod, rather than the GUI, so they are unaffected if you restart the GUI software.

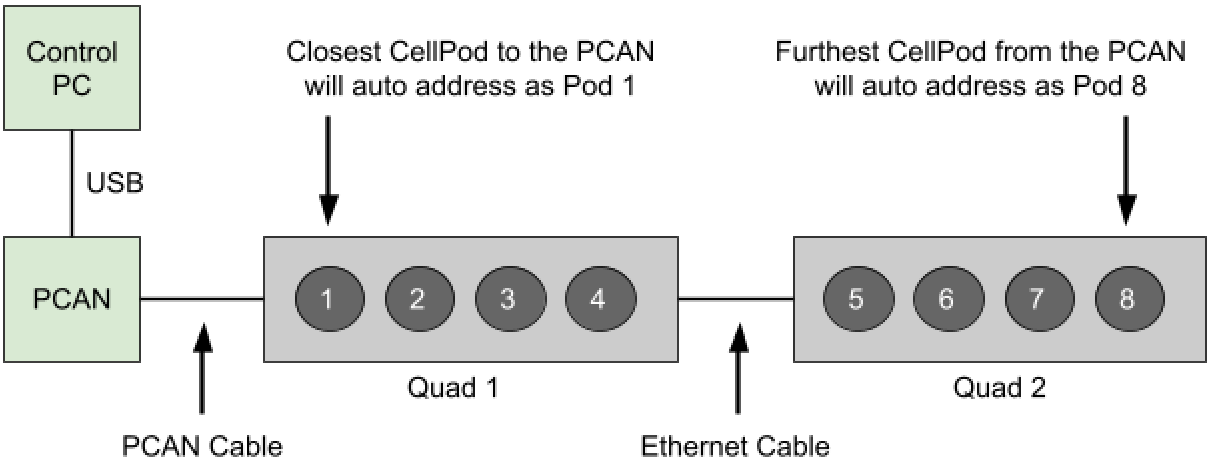


Figure 24: *A two Quad CellPod system demonstrating how the auto addressing will number the CellPods.*

💡 TIP
It is recommended that the layout of multiple CellPod Quads is designed such that auto addressing leads to a logical physical layout of pod identifiers (e.g. 1, 2, 3, 4, 5, 6, 7, 8 etc. which is preferable to 1, 2, 3, 4, 8, 7, 6, 5).

Once addressed, each individual CellPod can be identified by undertaking the following steps (see Figure 23):

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 selected CellPod for identification will come on for 3 seconds

11.4 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). To start a test, carry out the following steps (refer to Figure 25):

1. Select the desired CellPod in the Quick View window. The pod selected is indicated above the detailed temperature view (1).
2. Press the ‘Start’ button (2).
3. Enter the desired temperature setpoint in degrees Celsius (3).
4. Enter the test name (4).
5. Enable saving of data (13). Note that if this is not enabled, test data will not be saved.
6. Enter/select the saved data directory (5).
7. Select the data logging frequency (if required), based on time, temperature or voltage change. Example:
    a. 1 second means data will be stored every 1 second (6).
    b. 1 °C means data will be stored whenever the measured baseplate or cell temperature changes by 1 °C (7).
    c. 1 mV means data will be stored whenever the measured voltage changes by 1mV (8).
8. Enable recording of data from the auxiliary thermal gradient temperature sensor strip (if used) (9).
9. Optionally enable recording of voltage data (10).
10. Optionally enable recording of auxiliary 0-5 V input data (11).
11. Optionally enable **Power Recovery Mode,** in the event of power loss, the pod will resume the test automatically when power is restored.
12. Start test (14).

In order to set a CellPod to a defined temperature, follow steps 1-4. If data logging is required, follow steps 1-4 and applicable steps from 5-10.

💡 **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.

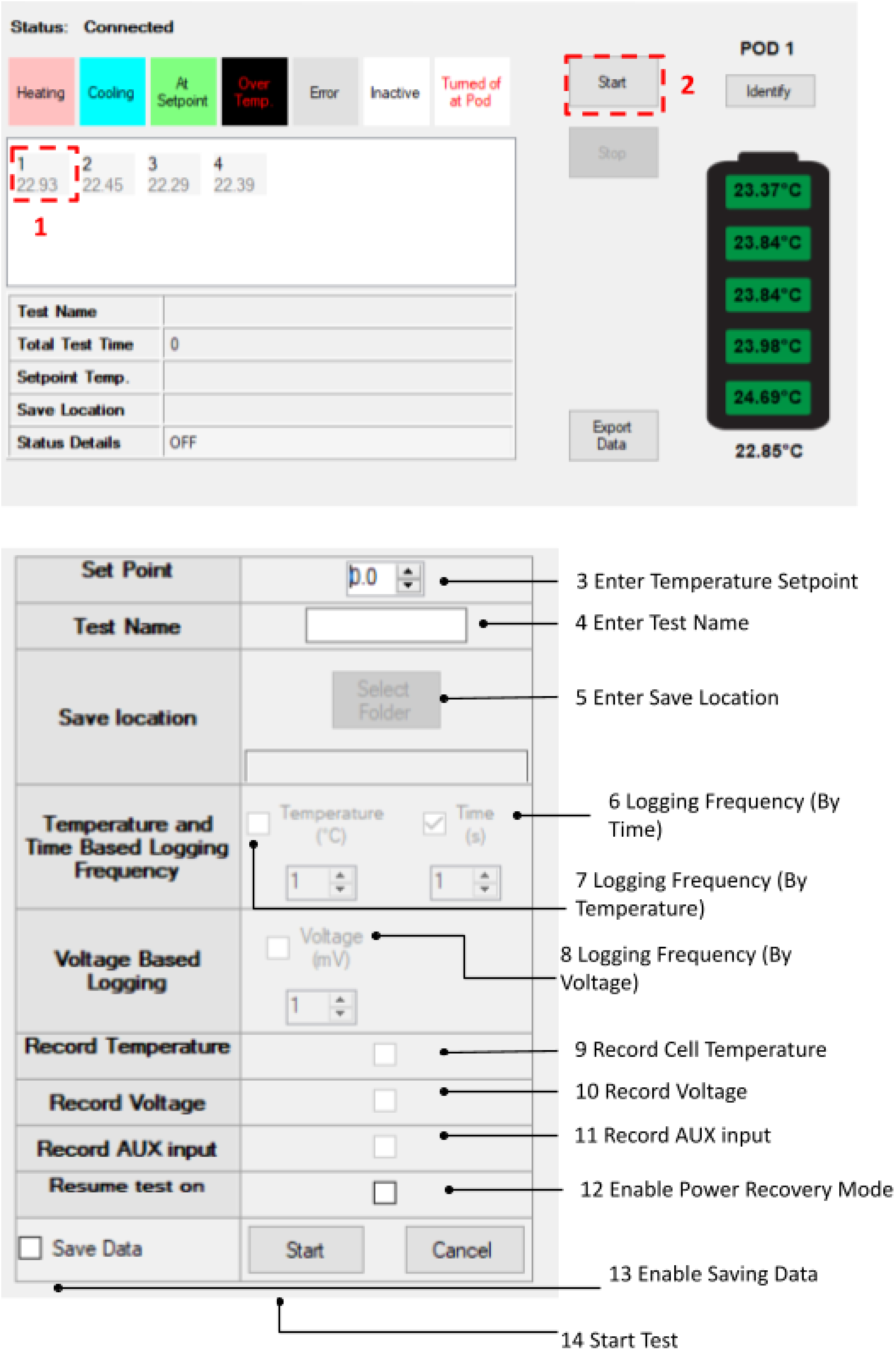


***Figure 25:** Overview of starting tests using the CellPod Control Software.*

11.5 Test Monitoring

Tests and CellPod status can be monitored using the CellPod Control Software in the following ways, outlined in Figure 26 as follows:

1. Key to identifiers of different operation modes (text and background colours) indicated in the Quick View window. This gives an immediate indication of the status of each connected 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. Quick view window, showing the status of each connected CellPod (per the key) and the baseplate temperature of each CellPod.
4. Detailed view of tests on selected CellPod, showing the:
    a. Name of the test.
    b. Total elapsed time for the test.
    c. Temperature setpoint for the selected CellPod.
    d. Location of saved data (if data logging is enabled).
    e. Status of the selected CellPod (if the pod is active i.e. running or deactivated).

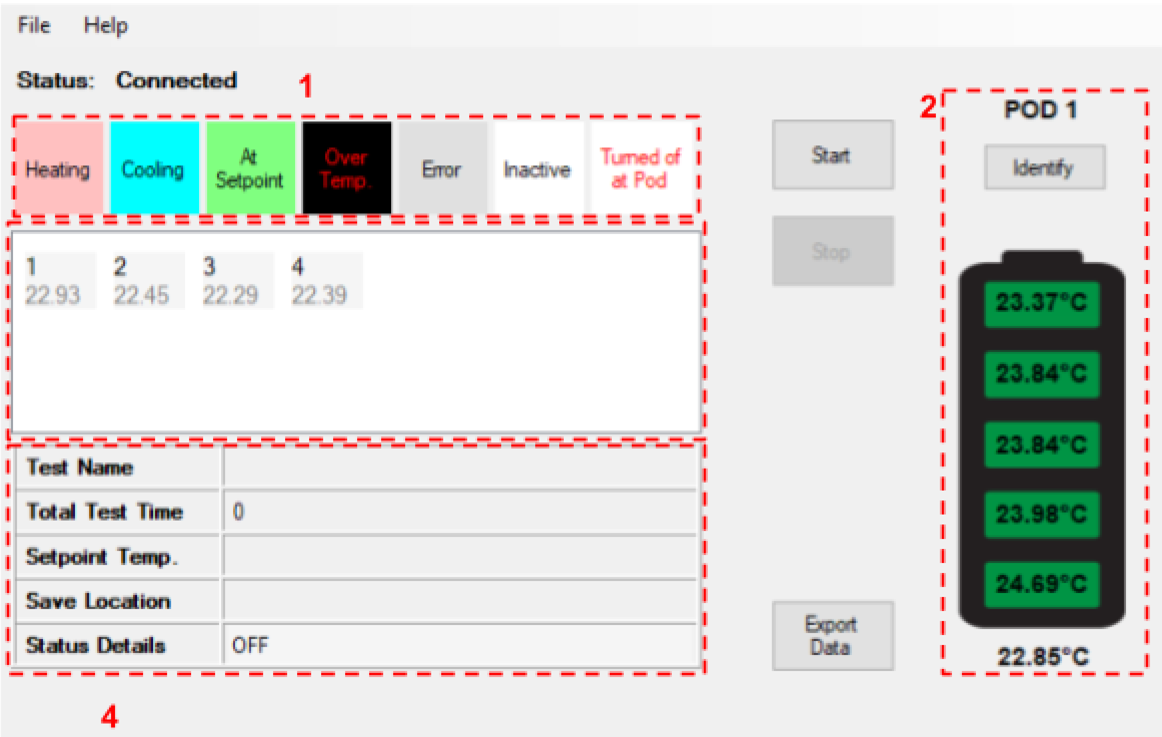


Figure 26: *Overview of test monitoring using the CellPod Control Software.*

11.6 Saved Data Format

If data logging is enabled, data will be recorded for each test into the selected directory under the entered test name. Data is saved in a *.txt* format, comma separated. The format of the *.txt* file is as shown in Figure 27. The following data is recorded:

- Timestamp (DD-MM-YYYY hh:mm:ss per ISO 8601).

- Elapsed time (s)
- Setpoint temperature (°C) .
- Pod baseplate temperature (°C).
- Thermal gradient sensor strip temperatures 1-5 (°C).
- Voltage (V).

```
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 27: *Example data file format including thermal gradient sensor strip values.*

12 Maintenance

CellPods are designed such that there are no maintenance activities to be performed by users and only occasional checks are required.

12.1 Overview and Personnel Qualifications

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.

12.2 Maintenance Intervals

There is no scheduled maintenance required for CellPods.

12.3 Inspections

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

- Leak checks on CellPod Quads, coolant hoses and coolant chillers.
- Check and top up if required: Coolant chiller reservoir.

It is also recommended that the users periodically check the status of CellPods in use to ensure that no errors are reported. The regularity of these checks is up to the discretion of the users, it could be daily, weekly or monthly depending on the types of tests being performed.

If issues are discovered, refer to Section 13.

12.4 Maintenance Procedures

No periodic maintenance procedures are required. If a fault is discovered that requires repair, then this can be carried out by a suitably qualified person. CellPods can be hot swapped from a Quad, allowing other tests to continue while one CellPod is removed and replaced.

13 Fault Finding, Troubleshooting and Spare Parts

13.1 Common Troubleshooting

Problem	Solution
CellPods are off	Check power supply is on and cable connections are undamaged and plugged in
A water leak has been discovered	Check all pipes and connections for damage or loose fittings. Tighten if required. If leaking from the underside of the quad or not from a fitting, refer to Section 15.
A CellPod cannot maintain temperature	Check the pod 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, see section 13.2, if it is a trivial error, press the reset button on the CellPod UI to re-enable the pod.
GUI cannot connect to CellPods	Check data cables to ensure they are free of damage and connect the CellPods to the PC via the PCAN as described in section 11.3
Cell electrical connection is intermittent	Check that negative jaws are closed fully and thumb screw is fully tightened. Clean electrical contacts and cell 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 pod is inactive.

13.2 Error Codes

If an error is displayed on the GUI, follow the instructions displayed to resolve it.

If an error occurs that instructs you to contact Cognition, contact your distributor in the first instance if you bought the CellPods from them. If you bought them from Cognition then contact us directly using the contact information in section 15.

13.3 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 pod

13.4 Spares and Replaceable Components

If you require additional/spare parts, or the CellPods need servicing, the following parts are available:

- User replaceable parts
  - Cell Stands
    - 21700
    - 18650
  - Cell clip & temperature strips
    - 21700
    - 18650
- Distributor/Manufacturer repair
  - Internal fuse
  - All CellPod internals
  - Full Quad

14 Dismantling & Disabling

14.1 Decommissioning

To decommission a CellPod Quad, undertake the following steps. Prior to decommissioning it is assumed that all cells have been removed from the CellPod Quad.

- Turn off mains power to the CellPod Quad and remove power cables
- Remove data cable(s) from CellPod Quad
- Disconnect coolant supply and fully drain coolant from CellPod Quad

Once decommissioned, the CellPod Quad may be stored as per Section 8.3, or disposed of per Sections 14.2-14.4.

14.2 Disposal within the UK

According to Schedule 3 of The Waste Electrical and Electronic Equipment Regulations 2013, CellPods are classified as “monitoring and control instruments” (category 1) only intended for professional use. The CellPod Quad bears the symbol (WEEE marking: crossed-out wheeled bin with solid bar under) for the marking of electrical and electronic equipment placed on the market after 1st January 2019. 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.

Prior to disposal either with the distributor or via a registered WEEE recycling contractor, the CellPod Quad should be decontaminated, removing any toxic or otherwise harmful substances, to avoid any health hazards to recycling company employees

14.3 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 Quads are classified as “monitoring and control instruments” (category 9) only intended for professional use. The CellPod Quad bears the symbol (WEEE marking: crossed-out wheeled bin with solid bar under). 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.

Prior to disposal either with the distributor or via a registered WEEE recycling contractor, the CellPod Quad should be decontaminated, removing any toxic or otherwise harmful substances, to avoid any health hazards to recycling company employees.

14.4 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.

Prior to disposal the CellPod Quad should be decontaminated, removing any toxic or otherwise harmful substances, to avoid any health hazards during disposal.

15 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:

- UK Support - Alvatek Ltd:
    - +44 (0) 800 566 8228
    - info@alvatek.co.uk
- Rest of World Support - Cognition Energy Ltd
    - +44 (0) 1235 797370
    - cellpod.support@cognitionenergy.uk

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