



UHPC System User Manual

1 Safety Precautions

These safety precautions must be read and understood before using any of the products described herein.

Regardless of whether this equipment is to be used to generate and measure non-hazardous voltages, stored energy may be present in battery cells and other hazardous conditions may be present.

Ensure that all users of this system are qualified professionals, trained to recognize shock hazards and familiar with the risks and precautions necessary when working with chemical and electrical energy.

Use this hardware in the manner specified only.

Follow all installation and operation information provided.

Do not exceed the maximum signals specified. Refer to the product-specific specifications sheets where necessary.

Do not defeat or otherwise circumvent built-in hardware or software safety limits (see Safety Limits).

Use all equipment as delivered. Do not use 3rd party software or firmware to control NOVONIX-supplied equipment.

Regardless of operating environment, it is a good safety practice to assume that all unknown cells contain hazardous levels of stored energy prior to measuring.

Observe the specific power supply requirements for each UHPC Channel Module. Note that the 10A and 20A Channel Module must be powered via a NOVONIX-supplied Power Module only and not directly connected to building-supplied power.


Where fuses are present, replace with the same type and rating only. Do not attempt to replace a damaged breaker or power switch.

Keep Thermal Chamber doors closed while power is applied or testing is underway.


Do not physically disconnect cell holders without first ensuring there is no test is running.


If using stripped wire connectors, alligator clip connectors or otherwise “floating” connectors, ensure that unused connectors are electrically isolated to eliminate the risk of a short circuit developing.

This equipment is intended to be used in a location having equipotential bonding (such as a telecommunication centre, a dedicated computer room or a restricted access area) and has installation instructions that require verification of the protective earthing connection of the socket-outlet by a skilled person.

Where  a symbol is present, connect that point to earth ground directly using the appropriate wire.

The  symbol in the documentation indicates that a surface may be hot.

The  symbol indicates a safety warning specific for its context in the documentation

The  symbol indicates a NOVONIX recommendation or tip to help ensure the best practice when using the equipment

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Acronyms

AC	Alternating Current
BS	British Standards
CEE	Consortium for Energy Efficiency
CE	Coulombic Efficiency
DC	Direct Current
I/O	Input / Output
IEC	International Electrotechnical Commission
LED	Light Emitting Diode
NEMA	National Electrical Manufacturers Association
PCC	Peltier Cooled Chamber
ppm	Parts per million
RTD	Resistance Temperature Detector
UHPC	Ultra High Precision Coulometry
UPS	Uninterruptible Power Supply
VA	Volt-Amps
VAC	Volts Alternating Current
VDC	Volts Direct Current
WRC	Wide Range Chamber

2 UHPC System Introduction

NOVONIX's Ultra High Precision Coulometry (UHPC) battery testing systems offer industry leading accuracy and precision for battery test electronics.

Each testing channel can operate in constant current or constant voltage charge or discharge mode across the full 0–5V load window.

Systems typically come with integrated Thermal Chambers to ensure the temperature stability of the cell., In UHPC experiments, this is critical for minimizing noise and ensuring consistency in data collected. Each channel has integrated local and remote (i.e., cell-level) temperature sensing to monitor room and cell temperature.

When used under appropriate environmental conditions and with quality cells, each channel can measure Coulombic Efficiency to better than 20 ppm precision and better than 50 ppm accuracy.

The NOVONIX software suite allows users to build and run test protocols with live monitoring of each channel. Output data is stored as text and can be examined using the powerful NOVONIX plotting software provided, or exported in various formats for data analysis and understanding of cell performance.

Read and understand all Safety Precautions prior to first use. The system supplied is designed to be used for testing of electrochemical cells within the known limits between 0-5 Volts in different operation modes (constant current charge/discharge, constant voltage charge/discharge or open circuit storage). This includes, but is not limited to, such devices as rechargeable batteries (Lithium-ion or other) and supercapacitors.

3 System Modules

3.1 Control Module (EMA-HXX-99-56)

The Control Module houses the communication board for connections between control software running on a lab PC, and up to 8 UHPC Channel Modules.



Figure 1: Front and rear panels of Control Module

Note that the USB-B port and the Serial interface are used only by NOVONIX for setup and debugging and are not intended to be connected to by users. The serial number of the Control module can be found on the rear of the unit near the C14 power socket.



The USB-B port and the Serial interface are used only by NOVONIX for setup and debug and are not intended to be connected to by users

The connections on the rear of the Control module are highlighted in Figure 2, below.

PC Communications. Use a standard straight-through Cat5e/6 Ethernet cable to connect the Control Module's "Computer" port to the Ethernet connection of your lab PC.

Channel Module Communications Use a standard straight-through Cat5e/6 cable to connect to each Channel Module. A Channel Module connected to Port 1 will appear on the PC's UHPC-Control software as Channels 1-8 (or Channels 1-4 in the case of a 20A Channel Module), and so on.



The Control Module ports will function **only** with standard, straight-through Ethernet cables. Crossover style cables, which are less common, will not work

AC Power. The Control Module accepts 90 – 240VAC power (50/60Hz, 12VA) via a C14 socket. Each module ensures that the switch or breaker is in the OFF position. Use the NOVONIX-supplied C13/C14 cable to connect the module to AC power.

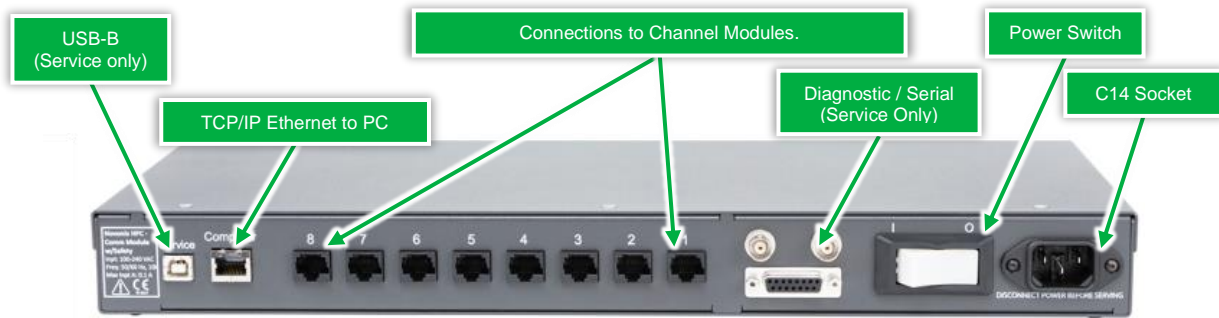


Figure 2: Control module rear panel connection scheme



Control Modules use a single breaker switch, but some legacy units may use a 6.3A Time Delay fuse. See Appendix C: Fused Devices (Legacy) for more information.

To power on the Control module for the first time, verify that the switch is OFF.

Connect the provided power cable to your UPS and the C14 socket on the rear of the Control module. Turn the switch ON.

Once powered, the RESET switch on the front panel illuminates. The RESET functions to reboot the module. Use this if there is a loss of communication or during troubleshooting.



Do not reset the Control Module while tests are running on any channels!
Always stop any running tests via the software before performing a reset of the Control Module

Communication between the software and all channels will need to be re-established after performing a reset or otherwise cycling power to the unit. The Control Module can take up to 30s to initialize. Please wait this time before starting Channel Modules and/or starting the control software.

3.2 Power Module (PMA-XXX-99-56)

The UHPC Power Module (PMA-XXX-99-56) is the DC power supply to all NOVONIX 10A or 20A Channel Modules. 2A Channel Modules do not require a Power Module.

A single Power Module can provide power to any of: a single 10A Channel Module, a single 20A Channel



Module, two 20A Channel Modules, two 10A Channel Modules OR a 10A and 20A Module combination.

Figure 3: Power Module, front

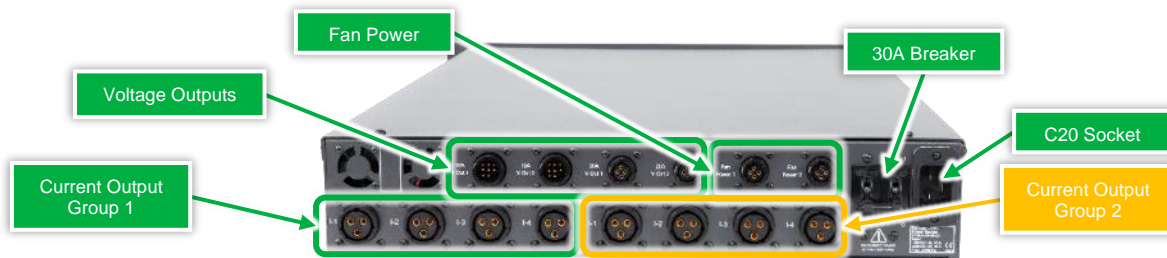


Figure 4: Power Module, rear

AC Input

The Power Module accepts 120 – 240 VAC input (50/60Hz, 3000VA Max). All AC power is delivered via a C20 socket, and all cables are supplied by NOVONIX. The power input socket is protected by a 30A breaker.



Use only the correctly rated, NOVONIX-supplied cable to connect the Power Module to mains power. Reset the breaker by flipping the switch if tripped. Do not power on until all DC Outputs are connected.

DC Output

All DC output is located on the rear of the Power Module.

Connect current outputs. Use Group 1 I-1to I-4 to connect the corresponding connectors on your first 10A or 20A module (Figure 6, above). Only use Group 2 if connecting a second module.

Connected Channel Modules do not have to be identical, i.e. if a 10A Channel Module is connected to Group 1, a 20A may be subsequently connected to Group 2.



If connecting a single module, use **only** the Group 1 I-1 – I-4 current outputs. Mixing current output groups can cause serious damage.

Connect voltage outputs. Only one voltage output is required per Channel Module. Use the appropriately labelled output for your Channel Module.

Connect fan power. Only one fan power connection is required per Channel Module.



Connect all I/O **before** powering on the power module.

3.3 Channel Modules (CMA-XXX-99-56)

2A Channel Module (CMA-HDX-99-56)

The 2A Channel Module provides 8 numbered channels, each with a maximum current of 2A and 5 ranges for measurement: 2A, 200mA, 20mA, 2mA and 200μA.

Based on the current requested by the control software, the 2A Channel Module selects the best range available automatically.



Figure 5: 2A Channel Module, front (left) and rear (right)

The front panel is equipped with an LED indicator and a 9-pin output connector (front panel) for each channel, as well as a RESET switch. The serial number of the Channel Module is located on the rear of the unit near the power entry.

The rear panel houses a C14 socket for AC power supply, a power switch and an RJ45 comms connection that accepts a standard, straight through Cat 5e/6 Ethernet cable.

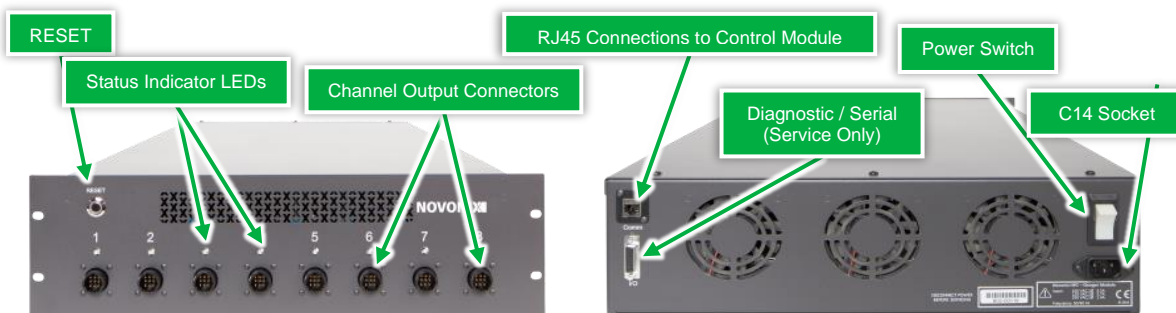


Figure 6: 2A Channel Module front and rear panel I/O scheme

Channel Module Communications Use a standard, straight through Ethernet cable to connect to a Control Module. Ensure the Channel Module is connected to its Control Module before powering on. A Channel Module connected to Port 1 of a Control Module will appear on the PC's UHPC-Control software as Channels 1-8, Port 2 as 9-16 etc.

AC Power The 2A Channel Module accepts 100 – 230VAC power (50/60Hz, 320VA) via a C14 socket.



2A Channel Modules use a 15A breaker switch, but some legacy units may use a 6.3A Time Delay fuse. See Appendix C: Fused Devices (Legacy) for more information.

To power on the Channel Module for the first time, verify that the switch is OFF. Connect the green NOVONIX Communication cable from the Channel Module to a spare port on a Control Module.

Connect the provided power cable to your UPS and the C14 socket on the rear panel of the Channel Module. Turn the switch ON.

Once powered, the RESET switch on the front panel illuminates. The RESET functions to reboot the module. Use this if there is a loss of communication or during troubleshooting.



Do not reset a Channel Module while tests are running on any channels! Always stop any running tests via the software before performing a reset of a Channel Module

Note that the Status Indicator LEDs for each channel will not illuminate until communication is established with the Control Module and the software. The LED code reference is as follows:

Colour	Status
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Red	Charging Step (normal operation)
-----	----------------------------------

Green	Discharging Step (normal operation)
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Yellow	Paused/Suspended Step (normal operation) OR Error, abnormal operation – check log
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Each channel on the 2A charger module has the capabilities described in its specification sheet, with current/voltage source across the 0–5V operating window, voltage sense, local (electronics) RTD temperature sensing and RTD temperature sensing from the remote RTD included on NOVONIX-built cell holders (See 2.2 Cell Holders)

10A Channel Module (CMA-HEX-99-56)

The 10A Channel Module provides 8 independent channels, each with a maximum current of 10A and 6 ranges for measurement: 10A, 1A, 100mA, 10mA, 1mA and 100µA.

Based on the current requested by the control software, the 10A Channel Module selects the best range available automatically.



Figure 7: 10A Channel Module front (left) and rear (right)

The front panel is equipped with an LED indicator and a 9-pin output connector for each channel, as well as a RESET switch. The serial number is located on the rear of the unit.

The rear panel houses a 4 DC Current inputs, a DC Voltage input and a Fan Power input. Each of these inputs is provided by a corresponding output on the Power Module (required). An RJ45 comms connection for standard, straight-through Ethernet cables is located in the left corner of the panel.



This module does not connect to AC power! It accepts **DC Power** from a NOVONIX Power Module across 6 cables (4 current, 1 voltage, 1 fan power).

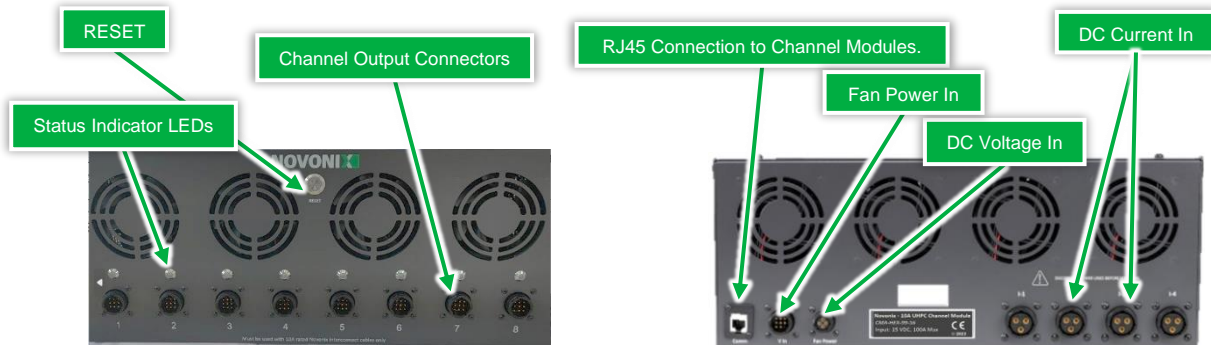


Figure 8: 20A Channel Module front and rear panel I/O scheme

Channel Module Communications Use a standard, straight through Ethernet cable to connect to a Control Module. Ensure the Channel Module is connected to its Control Module before powering on. A Channel Module connected to Port 1 of a Control Module will appear on the PC's UHPC-Control software as Channels 1-4, Port 2 as 9-12 etc.

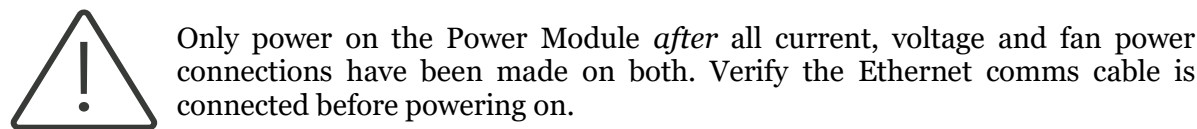
DC Power As noted above, this device accepts DC power supplied by the Power Module (required). Ensure that the communications cable has been connected and that the Power Module is OFF prior to connecting cables.

Connect Current Inputs. See 1.2 Power Module in this manual. If this is the first module connected to the Power Module, use Group 1 I-1 to I-4 outputs to connect the corresponding DC Current In connectors on the 20A module. Only use Group 2 if you are connecting your second Channel Module. Connect all four I-1 to I-4 inputs.

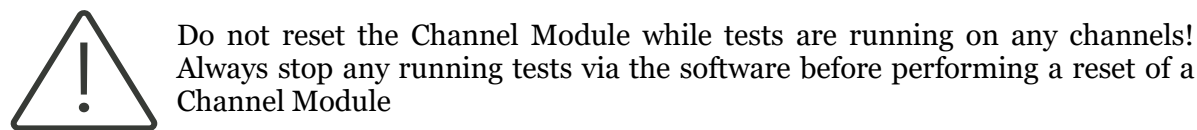
Connect Voltage Inputs. Only one input is required per Channel Module. Connect a voltage cable from a 20A output on the Power Module.

Connect Fan Power. Only one fan power connection is required per Channel Module. Connect a fan power cable from a Fan Power output on the Power Module.

Power on your Power Module to begin delivering power to the 10A Channel Module



Once powered, the RESET switch on the front panel illuminates. The RESET functions to reboot the module. Use this if there is a loss of communication or during troubleshooting.



Note that the Status Indicator LEDs for each channel will not illuminate until communication is established with the Control Module and the software. The LED code reference is as follows:

Colour	Status
Red	Charging Step (normal operation)
Green	Discharging Step (normal operation)
Yellow	Paused/Suspended Step (normal operation) OR Error, abnormal operation – check log

Each channel on the 10A Channel Module has the capabilities described in its specification sheet, with current/voltage source across the 0–5V operating window, voltage sense, local (electronics) RTD temperature sensing and RTD temperature sensing from an external RTD attached to a cell holder (See 2.2 Cell Holders).

20A Channel Module (CMA-HFX-99-56)

The 20A Channel Module provides 4 numbered channels, each with a maximum current of 20A and 2 ranges for measurement: 20A and 2A.

Based on the current requested by the control software, the 20A Channel Module selects the best range available automatically.



Figure 9: 20A Channel Module front (left) and rear (right)

The front panel is equipped with an LED indicator and a 10-pin output connector for each channel, as well as a RESET switch. The serial number is located on the rear of the unit.

The rear panel houses a 4 DC Current inputs, a DC Voltage input and a Fan Power input. Each of these inputs is provided by a corresponding output on the Power Module (required). An RJ45 comms connection for a custom green NOVENIX communications cable is located in the center of the panel.



This module does not connect to AC power! It accepts **DC Power** from a NOVENIX Power Module across 6 cables (4 current, 1 voltage, 1 fan power).

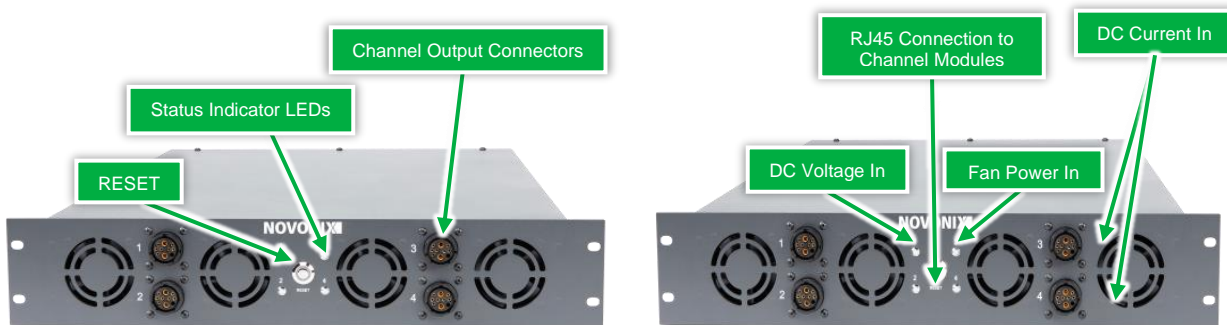


Figure 10: 20A Channel Module front and rear panel I/O scheme

Channel Module Communications Use a standard, straight through Ethernet cable to connect to a Control Module. Ensure the Channel Module is connected to its Control Module before powering on. A Channel Module connected to Port 1 of a Control Module will appear on the PC's UHPC-Control software as Channels 1-4, Port 2 as 9-12 etc.

DC Power As noted above, this device accepts DC power supplied by the Power Module (required). Ensure that the communications cable has been connected and that the Power Module is OFF prior to connecting cables.

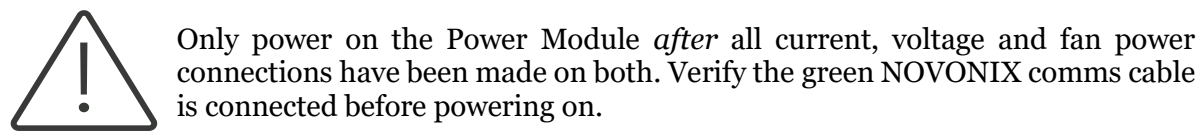
Connect Current Inputs. See 1.2 Power Module in this manual. If this is the first module connected to the Power Module, use Group 1 I-1 to I-4 outputs to connect the corresponding DC Current In connectors

on the 20A module. Only use Group 2 if you are connecting your second Channel Module. Connect all four I-1 to I-4 inputs.

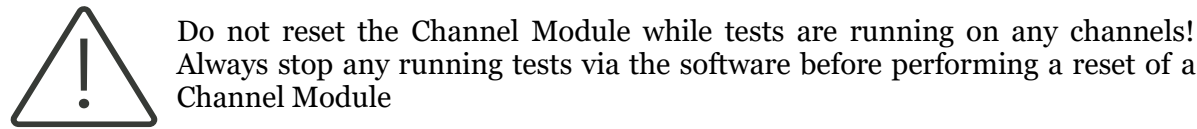
Connect Voltage Inputs. Only one input is required per Channel Module. Connect a voltage cable from a 20A output on the Power Module.

Connect Fan Power. Only one fan power connection is required per Channel Module. Connect a fan power cable from a Fan Power output on the Power Module.

Power on your Power Module to begin delivering power to the 20A Channel Module



Once powered, the RESET switch on the front panel illuminates. The RESET functions to reboot the module. Use this if there is a loss of communication or during troubleshooting.



Note that the Status Indicator LEDs for each channel will not illuminate until communication is established with the Control Module and the software. The LED code reference is as follows:

Colour	Status
Red	Charging Step (normal operation)
Green	Discharging Step (normal operation)
Yellow	Paused/Suspended Step (normal operation) OR Error, abnormal operation – check log

Each channel on the 20A Channel Module has the capabilities described in its specification sheet, with current/voltage source across the 0–5V operating window, voltage sense, local (electronics) RTD temperature sensing and RTD temperature sensing from an external RTD attached to a cell holder (See 2.2 Cell Holders).

3.4 Thermal Chambers (TCA-XXX-XX-XX)

NOVONIX Thermal Chambers are broadly divided into two categories, distinguished by the cooling technology employed.

Peltier Thermal Chambers use a Peltier-effect thermoelectric cooler, alongside resistive heat, to hold a specified temperature. Peltier-cooled chambers can maintain a temperature typically only about 10°C below the ambient room temperature, but are much better at maintaining fixed temperatures close to ordinary room temperatures.

Wide Range Thermal Chambers (WRC) use a traditional compressor-evaporator cooling loop alongside resistive heat to meet the setpoint temperature. This design allows for much colder temperatures to be reached and maintained. Due to the mechanical nature of the cooling system, WRCs are much larger and heavier than their Peltier counterparts. Additionally, they are not as efficient as Peltier chambers when operating at temperatures at or around the ambient environment temperature.

Both styles of Thermal Chambers may be designed to accommodate between 4 and 16 cell holders (depending on the model) on individual channels.

The serial number for the Thermal Chamber is located on the rear of the unit, near the power socket.



If your application calls for consistently low temperatures (more than 10°C below ambient), use a WRC. In other cases, Peltier Chambers are more reliable and efficient devices, due to their solid state cooling.



Peltier Thermal Chamber

Temperature Range	10°C to 60°C*
Input Power	100-120VAC 50/60Hz 5A or 220VAC 50/60Hz, 3A
Circuit Breaker	15A, 250VAC
Thermal Auto-Off	85°C

*Cooling capability is approx. 10°C below ambient room temperature



Wide Range Chamber (WRC)

Temperature Range	-20°C to 60°C*
Input Power	100-120VAC 50/60Hz 5A or 220VAC 50/60Hz, 5.5A
Circuit Breaker	20A, 250VAC
Thermal Auto-Off	85°C



The power configuration is specified on the rear of the Thermal Chamber adjacent to the power socket. Ensure only the appropriate input voltage is used to power the chamber.



Figure 11: Front Panel I/O Scheme, Thermal Chamber

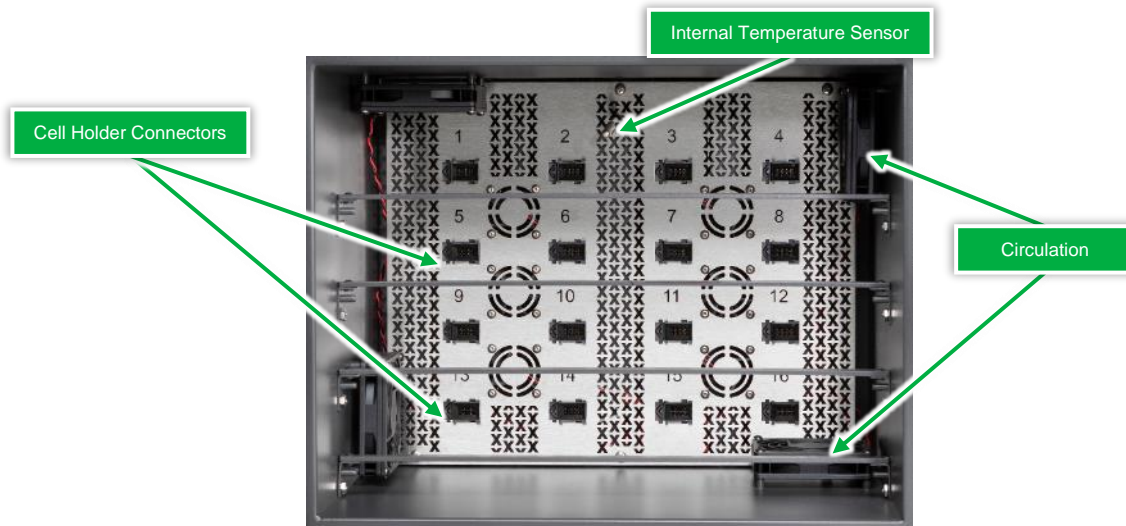


Figure 12: Internal I/O Scheme, Thermal Chamber

Channel Module Communications. Each Thermal Chamber connects directly to a Channel Module via a proprietary NOVONIX Interconnect Cable (See ‘2.1 Interconnect Cables’).

In the example shown above, in Figure 9, the front panel Thermal Chamber connections should be directly connected to the front panel connections on a Channel Module.



Each channel on the Thermal Chamber is individually mapped and isolated, so connections can be made with any correctly rated channels from any combination of UHPC Channel Modules.

Front Panel connections are labelled and mapped 1:1 to their respective internal Cell Holder Connectors.



Always use caution when working inside thermal chambers. Inner walls may be hot during operation. Human skin can sustain first-degree burns at temperatures as low as 50°C.

The Thermal Chamber contains internal fans for air circulation as well as a 4-wire RTD, which provides closed-loop feedback to the temperature controlled.

For safety, thermal auto-shutoff is integrated inline with the resistive heaters; if the temperature inside the chamber exceeds the thermal cut-off temperature of 85°C, power is cut to the heater until the temperature before resuming operation.



The auto-shutoff should never be triggered in normal operation; if this occurs, power off the Thermal Chamber immediately and contact NOVONIX customer support.

AC Power. NOVONIX Thermal Chambers accept 100–230VAC power (50/60Hz) via a C14 socket. To power on the Channel Module for the first time, verify that the switch is OFF. Connect the provided power cable to your UPS and the C14 socket on the rear panel of the Channel Module. Turn the switch ON. Once powered, the RESET switch on the front panel illuminates. The RESET functions to reboot the temperature controller and temperature relays. Use this as required during troubleshooting.

Temperature Controller. The Thermal Chamber temperature is controlled by a Watlow EZ-Zone integrated temperature controller, accessed on the front panel. Some older Thermal Chamber models used an Omega controller, now legacy (See 9 Appendix B: Omega Controllers (Legacy)). Both models provide similar levels of accuracy and response.

Temperature setpoints must be entered directly on the device. Software-controlled programming of the setpoint is not supported at this time.

Set Temperature Setpoint - Watlow

Selecting your temperature setpoint is straightforward:

1. Power on Thermal Chamber.
2. Enter desired setpoint using ▲ and ▼

Troubleshooting - Watlow

If the Thermal Chamber does not reach the desired set-point after more than 1 hour or the auto-shutoff is triggered, please [contact us](#) for advice.

Symptom	Cause	Solution
Controller displays Limit Error, Low or High <i>Li.E1, Li.L1, Li.h1</i>	Chamber temperature sensor damaged, or wiring damaged	Do not attempt to repair a damaged temperature sensor or wire. Contact us.
No Display	Controller is not receiving power	Check that device is plugged in and that UPS is able to supply sufficient power. Check that breakers are not tripped or fuses are not blown (where applicable)
Chamber does not reach setpoint or is unstable	Tuning incorrect or setpoint not entered	Verify that setpoint is correct. Follow the programming steps in 8 Appendix A: Programming Watlow Controllers or contact us
Condensation forming on inside of chamber walls when operating at colder temperatures	Significant humidity in ambient air while operating chamber below ambient	This is normal; NOVONIX Thermal Chambers are not sealed environments and air is passively exchanged with the ambient air during operation. Dry with a lint-free cloth or open doors and allow to dry naturally. Operate the chamber in a low, stable humidity (<60%RH) environment where possible.

3.5 Uninterruptible Power Supply (UPS)

NOVONIX UHPC systems use an uninterruptible power supply (UPS) to power and protect equipment. The UPS provides a brief battery backup in the event of a power loss. This backup is not meant to provide extended power through a prolonged power outage, but rather to allow a user to stop all tests and shutdown the system safely.



In the event of a power loss, where possible, stop any running tests via the software safely, save data and snapshots, and shut down each module in your system at its switch. The UPS is not intended or designed to run the system through a prolonged loss of mains power.



Using a UPS is critical for protecting the sensitive electronics found in NOVONIX equipment. If you are a user who has purchased a partial system or individual components, ensure that you have discussed a UPS implementation strategy with your NOVONIX Sales rep.

The UPS NOVONIX provides come from APC Canada, and the precise model depends on the configuration of original system provided. All UPS units will input/output either 100, 120 or 220 VAC at 50/60 Hz, configured for input based on country. Replacement battery styles and OEM documentation for your UPS will be provided with the unit itself



In the event of a UPS failure or error, contact the APC Canada customer care team at **1-800-800-4272**. APC will complete diagnostics and replace the unit if required.

3.6 Rack Enclosure

All modules are housed in a standard 19" equipment rack. This rack is equipped with secondary uprights to support the charger modules and Thermal Chambers as well as a smaller set of rear rails to provide rear support for the UPS.

The rack and chassis of all components within the rack must be connected to earth ground via the UPS.

Ensure that when the rack is positioned for final use, all panels are accessible and doors swing freely.



The rack is equipped with an additional ground wire from the rear earth point that must be connected to earth ground. See the 'Getting started with UHPC: Uncrating and power on' guide for more information.

4 System Peripherals

4.1 Interconnect Cables (ICA-XXX-00-00)



Figure 13: Channel Module to Thermal Chamber interconnect cable

Interconnect cables connect each channel on the front panel of a Channel Module to each channel of a Thermal Chamber.

Cables will be labeled on both ends to indicate which channel they are connected to and are all varying length. In general, these cables never need to be disconnected from their Channel Module host, but may be relocated on a Thermal Chamber(s) depending on experimental needs.

Interconnect cables are 9-pin configuration for the current source (+/-), cell voltage sense (+/-), RTD current drive (+/-), RTD voltage sense (+/-) and cable shield.

20A and 10A Interconnect cables are interchangeable, while 2A cables use a different pin configuration and will not physically mate with a 10A or 20A chamber or Channel Module.

4.2 Cell Holders (CHA-XXX-00-00)

NOVONIX offers different cell holders, broadly split between Standard Format and Large Format configurations. NOVONIX sales will help you select cell holders appropriate for your application. In some cases, customers with specific needs will opt not to use NOVONIX-built Environmental Chambers. In these cases, NOVONIX supports customers by providing custom connections on a case-by-case basis.

Standard Format Cell Holders.

16-position Thermal Chambers can take advantage of NOVONIX's Standard Format cell holders. These cell holders carry a circuit board hosting an on-board RTD temperature sensor as well as an interface to connect an external RTD (optional). External RTDs are often used if a temperature even closer to the testing cell is desired.

NOVONIX offers two styles of Standard Format Cell Holder.

10A Capable Holders: These connectors use a magnetic latching mechanism and use a poka-yoke design to ensure only one orientation is possible. Cell holders with these connectors are rated for up to 10A of current at 5V and can safely be used with NOVONIX 10A Channel Modules. To disconnect these cell holders once attached, pull gently backwards to overcome the magnetic mating force. 10A holders may be used on 2A Channel Module systems without issue.

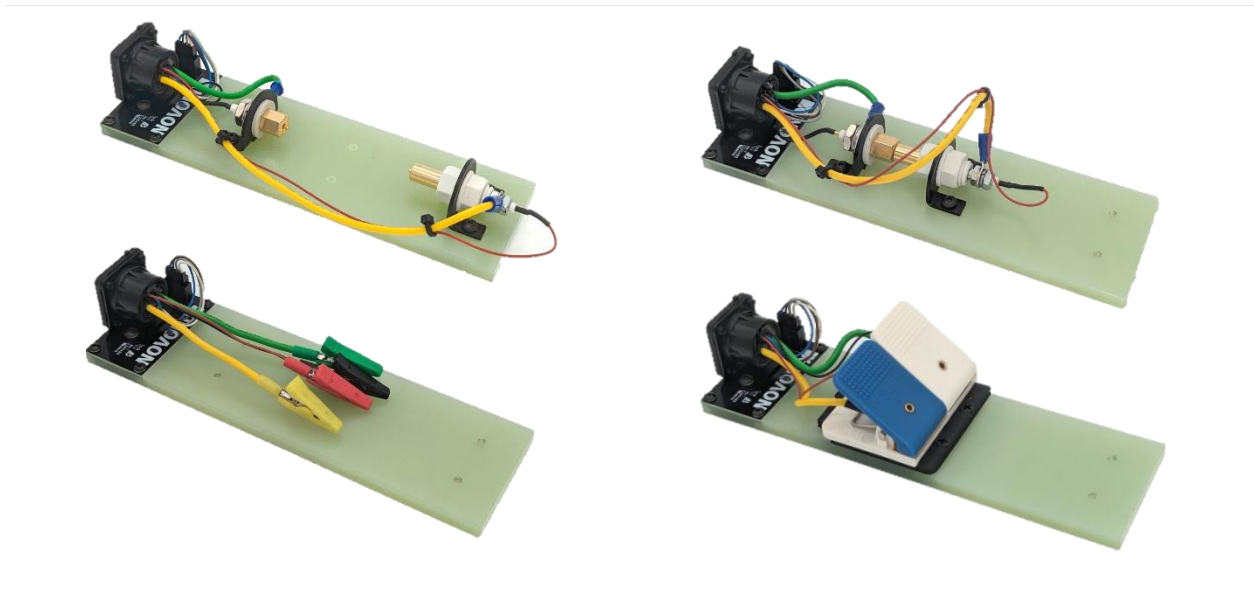


Figure 14: Standard Format Cell Holders with magnetic coupler

To use an external RTD with these connectors, disconnect the 4-pin RTD header (brown, white, grey and blue wires) from the circuit board, and connect your RTD. Otherwise, the onboard RTD will be used for temperature measurements.

2A Capable Holders use traditional press connectors with a poka-yoke design to ensure only one orientation is possible. They may be used in systems with 2A Channel Modules but not systems with 10A Channel Modules, as these connectors are not rated in excess of 5A.

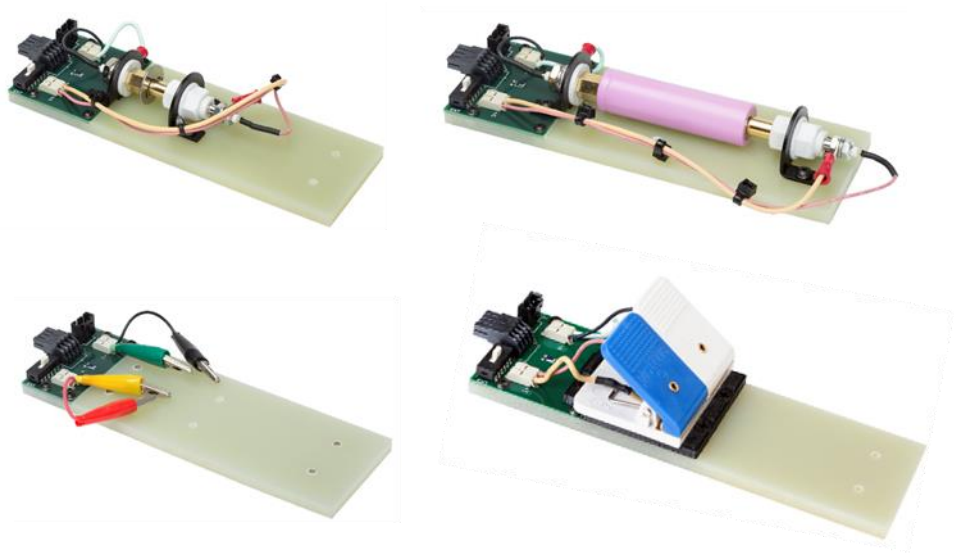


Figure 15: Standard Format Cell Connectors. Clockwise from top left: Coin cell, Cylindrical cell, "Alligator" Pouch cell, "Clip" Pouch cell

These connectors use the pin-out configuration, listed below. Refer to Troubleshooting if you are experiencing connection issues when using these styles of connector.

Pin	Connection	Pin-out Scheme
1	Voltage HI	
2	RTD SENSE HI	
3	RTD DRIVE HI	
4	Current HI	
5	Voltage LO	
6	RTD SENSE LO	
7	RTD DRIVE LO	
8	Current LO	



Large Format Cell Holders.

NOVONIX Large Format Cell Holders are typically made to order and feature custom lead lengths and terminations to accommodate various pouch cell sizes. These connectors may be connected directly to a



10A or 20A Channel Module or to a compatible Thermal Chamber.

Figure 18: Large format cell holders, designed for higher current loads, can be configured in a number of ways, with pouch clips, stripped wire, ring terminals, alligator clips etc

These Cell Holders come wired to accept a separate, external 4-wire RTD, as no on-board RTD is provided. NOVONIX often provides custom cell holders of all styles. Instructions regarding their use is not covered in this manual.

4.3 Communication Cables

Communications cables are used to connect a Control Module to Channel Modules, and to a lab PC running NOVONIX software.



Figure 19: NOVONIX provides custom length cables for new systems to simplify cable management

Each Control Module can connect up to any 8 Channel Modules simultaneously, provided that they are of the same type (2A, 10A or 20A). Channel Modules do not support connecting to mixed Channel Modules at this time.



One Control Module per type of Channel Module! Control Modules do **not** currently support connecting to multiple types of Channel Modules (2A, 10A or 20A) at this time.

All communications cables use an RJ45 connector, with a straight-through Ethernet configuration. Standard, off the shelf Cat 5e/6 cables will work. Crossover style Ethernet cables, which are less common, will not work. Ensure the cables you are using are straight-through Ethernet, available from most computer or office supply stores.



Use straight-through Ethernet cables only! Crossover cables will not work and may damage your system.

NOVONIX supplies all necessary cables with new systems cut to a custom length and labeled. Channel Module cables are coloured **green**, while the PC cable is **black**. Some legacy communications cables are **blue**.

5 Safety Limits

NOVONIX UHPC channels have several safety limits in place to minimize the risk of over-charge or over-discharge of cells.

The Protocol Designer software package, UHPC-Protocol, includes operating and emergency limits; global settings for a given protocol and the option of individual settings for each step in the protocol. A channel will shut down if these limits are exceeded. These limits can be based on channel current, cell voltage, cell temperature or run time. These safety limits are stored locally with each saved protocol, with default values stored locally on the control PC.

The Control Software, UHPC-Control also uses built-in safety limits. If a user attempts to run a protocol that contains values that exceed UHPC-Control's default limits, it will throw an error and prevent the protocol file from being loaded.

During operation, the software continuously monitors the data returned from each channel and compares this to both the system limits and the limits contained in the protocol file. These limits are integrated in the control software.

The channel boards, located in all UHPC Channel Modules, employ hard current and voltage limits that will prevent these values exceeding the system limits. These limits are inherent to the board and cannot be changed. In the case of constant current testing, channels' voltage limits are slightly above (charge) or below (discharge) the step voltage limit.

Finally, all channel boards employ a hardware timeout; all current is cut if no heartbeat signal is received after a certain period of time. The default value is 60s, but can be changed via software settings to a minimum of 10s. See the Software Manual for further information.

6 Software

Three software programs are supplied with each system:

UHPC Control: this program starts and runs tests dictated by protocol files. It controls the Control Module, its communication with connected channels and controlling charge/discharge profiles etc.

UHPC Protocol: this program is used to generate the test sequence protocol files that dictate how a charger channel will operate for a given cell. It allows the user to configure currents, voltage limits, data collection intervals etc.

UHPC Plot: this program allows the user to analyze data files generated by the UHPC Control software. It provides both a graphical interface for viewing of data and a data export section that allows the user to export simple text files for subsequent graphing and further analysis



The UHPC software (UHPC-Protocol, UHPC-Control, UHPC-Plot) are pre-installed on the included PC. However, it is worth checking the [NOVONIX Customer Area](#) to verify that your software is operating with the latest version of each software package.



If there is an issue with an existing installation, each piece of software may be removed using the native Windows “Add or remove programs” in System settings.

Remove the problematic installation and reinstall by downloading the latest version from the NOVONIX Customer Area, extracting the folder and running the Setup application.



A Software Manual that covers detailed use of the UHPC Software suite is available in the NOVONIX Customer Area and is outside the scope of this document.

7 Contact Us

Thank you for using NOVONIX products. We hope that you’ve found this manual concise, clear and easy to read.

We care very deeply about Ultra High Precision Coulometry and want to do everything we can to help you get the most out of your system, wherever you fit in the battery ecosystem. We want to hear from you if you think that any part of your UHPC journey could be improved.

The latest software and notes are always available in the NOVONIX customer area:

<https://www.novonixgroup.com/customer-area>

Please contact us with any support requests, questions or suggestions at:

NOVONIX Battery Testing Solutions
110 Simmonds Drive, Dartmouth
Nova Scotia B3B 1N9 CANADA

bts-support@novonixgroup.com





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8 Appendix A: Programming Watlow Controllers







More detailed instruction on use of the temperature controller is provided in the hardware manual for your specific controller - [Watlow EZ- Zone PM controller](#).

Basic Watlow controller operation:

1. Left Display (**red**): In the Home Page, displays the process value, otherwise displays the value of the parameter in the Right Display (**green**)
2. Right Display (**green**): Indicates the set point value during operation, or the parameter whose value appears in the Left Display (**red**).
3. The four keys are as follows:
 1. : Advances through parameter prompts.
 2. : Press to back up one level or press and hold for two seconds to return to the Home Page.
 3.  : In the Home Page, adjusts the set point in the Right Display (**green**). In other pages, changes the Left Display (**red**) to a higher or lower value, or changes a parameter selection.

Programming the Watlow temperature controller:

Prior to delivery, NOVONIX will program Watlow models following the steps listed below.

1. Enter desired set point in the **red** display using  and .
2. Press and hold  and  together for 6 seconds until the display reads **Ai SEt** and press .
3. Display will read **SEn**. Use  and  until display reads **ro.1H** and press .
4. Display will read **rt.L**. Use  and  until display reads **3**.
5. Press  until display reads **dEC**. Use  and  until display reads **o.o** and press .
6. Display will read **i.CA**. Use  and  until display reads **o.o** and press .
7. Press  to back out to **Ai SEt**.
8. Use  and  until display reads **gLbL SEt** and press .
9. Display will read **C_F**. Use  and  until display reads **C** and press .
10. Press  to back out to **gLbL SEt**.
11. Use  and  until display reads **otPt SEt** and press .
12. Display will read **otPt**. Use  and  until display reads **1** and press .
13. Display will read **Fn**. Use  and  until display reads **Cool**.
14. Press  until display reads **o.tb**. Use  and  until display reads **7.0** and press .
15. Press  to back out to **otPt**.
16. Use  and  until display reads **2** and press .
17. Display will read **Fn**. Use  and  until display reads **hEAt**.
18. Press  until display reads **o.tb**. Use  and  until display reads **10.0** and press .
19. Press  twice to back out to **otPt SEt**.
20. Use  and  until display reads **LooP SEt** and press .
21. Display will read **h.Ag**. Use  and  until display reads **Pid** and press .
22. Display will read **C.Ag**. Use  and  until display reads **Pid**.
23. Press  until display reads **h.Pb**. Use  and  until display reads **17.6** and press .
24. Display will read **C.Pb**. Use  and  until display reads **8.0(WRC)** or **1.8(PCC)** and press .
25. Display will read **ti**. Use  and  until display reads **900(WRC)** or **341(PCC)** and press .
26. Display will read **td**. Use and until display reads **0** and press .

27. Press  until you get back to the Home Page.

The temperature controller is now programmed for normal operation.

A small **1** illuminated on the right side of the controller indicates the chamber is cooling.

A small **2** illuminated on the right side of the controller indicates the chamber is heating.

9 Appendix B: Omega Controllers (Legacy)
















NOVONIX no longer provides Omega CNI-series controllers on newer Thermal Chambers. Details for programming and troubleshooting can be found from Omega directly at

<https://assets.omega.com/manuals/M3355.pdf>

Some quick reference and troubleshooting instructions are provided here.

Adjust Temperature Setpoint - Omega

To adjust the temperature setpoint:

1. Press  until display reads 'SP1' and press .
2. Select desired set point using  and  and press .
3. Press  until display reads 'CNFG' and press .
4. Press  until display reads 'OUT1' and press .
5. Press  until display reads 'OOHI' and press .
6. Select desired %HI, according to the table below, using  and  and press .
7. Press  until display reads 'VR.3.2', followed by 'RUN', then return to the temperature display screen.

The temperature will often stabilize within 30 minutes, but can take up to 2 hours depending on the temperature and thermal mass loaded within.

This table offers typical settings. You may find they need to vary slightly based on ambient conditions and actual desired set point.

Setpoint Temperature (°C)	%HI
30	5 – 10
40	30
50	50
60	70

Troubleshooting- Omega

Symptom	Cause	Solution
Thermal Chamber does not reach temperature setpoint	Insufficient ϕ HI	Use recommended ϕ HI settings from table above
	Temporary error in controller	Use RESET, or power cycle chamber
Thermal Chamber stabilizes below the setpoint	Controller issue; mismatch of control temperature and proportional band	Set proportional band (PROP) value in controller to 1 to return to heating. Once temperature has stabilized, reset the proportional band to 4.
Condensation forming on inside of chamber walls when operating at colder temperatures	Significant humidity in ambient air	<p>This is normal; NOVONIX Thermal Chambers are not sealed environments and air is passively exchanged with the ambient air during operation. Dry with a lint-free cloth or open doors and allow to dry naturally.</p> <p>Operate the chamber in a low humidity (<60%RH) environment where possible.</p>

10 Appendix C: Fused Devices (Legacy)

NOVONIX no longer uses fuses in system modules, but several early models of Thermal Chamber, Channel Module and Controller Module used a double fuse switch alongside a C13 “Kettle Cord” AC power connection.



Figure 20: Fused Switches on several legacy devices

Fused modules are be clearly labeled with the fuse size and capacity (Figure 17). These are typically standard 5x20 6.3A Time Delay fuses. Verify the size and capacity on the label.

The fusebox is located in a small, textured press-fit panel between the C13 socket and the switch. Use only new fuses when replacing a burnt-out fuse.

To change a burnt fuse, ensure the switch is OFF and all power is disconnected. Use a terminal screwdriver to pop out the panel (Figure 18) and replace the spent fuse in the carriage. Press the panel securely shut before reconnecting power.



11 Appendix D: Troubleshooting

11.1 Check Cell Holder Health

Before plugging cell holders into a Thermal Chamber, we recommend checking the following to ensure a smooth test.

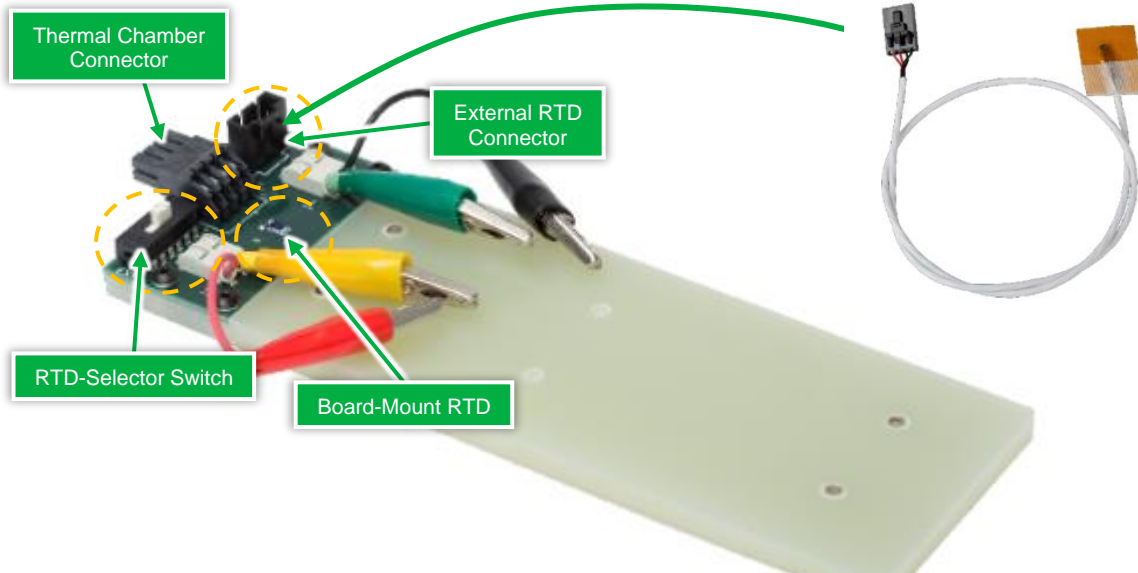


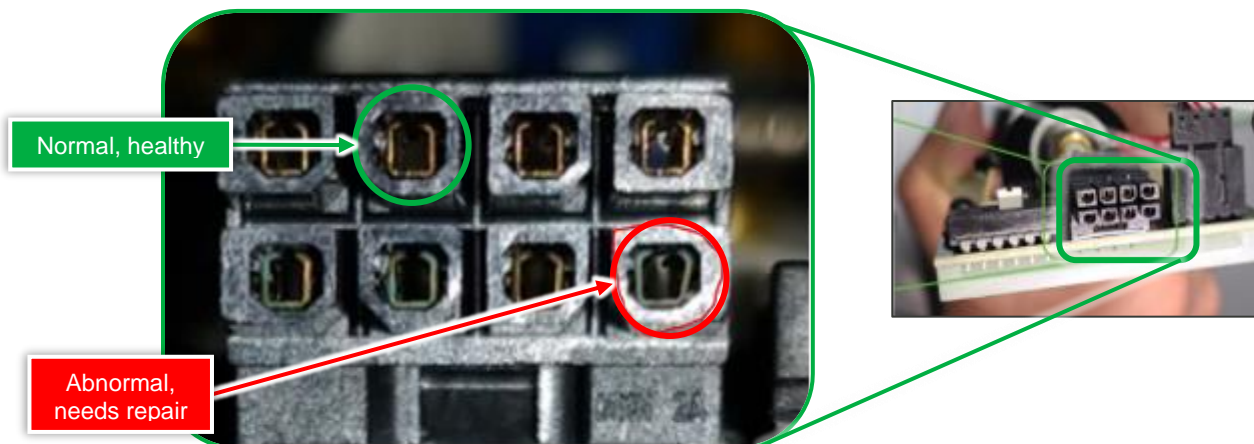
Figure 21 Use a terminal screwdriver to pop out the panel when replacing a spent fuse.

Check RTD set up

The white switch on the cell holder should be toggled **right** (near the plug) if no external holder RTD is applied.

✓ Check cell holder connection

All cell holder pins should be in a normal square shape, as shown above. If any pins appear deformed, skip to [Cell Holder Pin Repair](#).



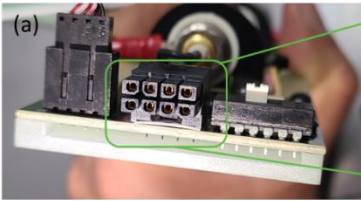
Cell holder pin repair

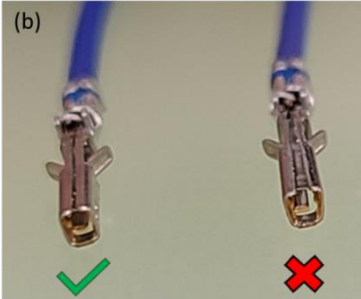
All Cell Holder pins should be in a normal square shape. Occasionally, during routine use, some pins may be opened by the mating stresses, causing them to lose continuity.


NOVONIX is aware of this issue and is actively working to improve the connector.


Good pin connection

View from back, top of cell holder plug

(a) 

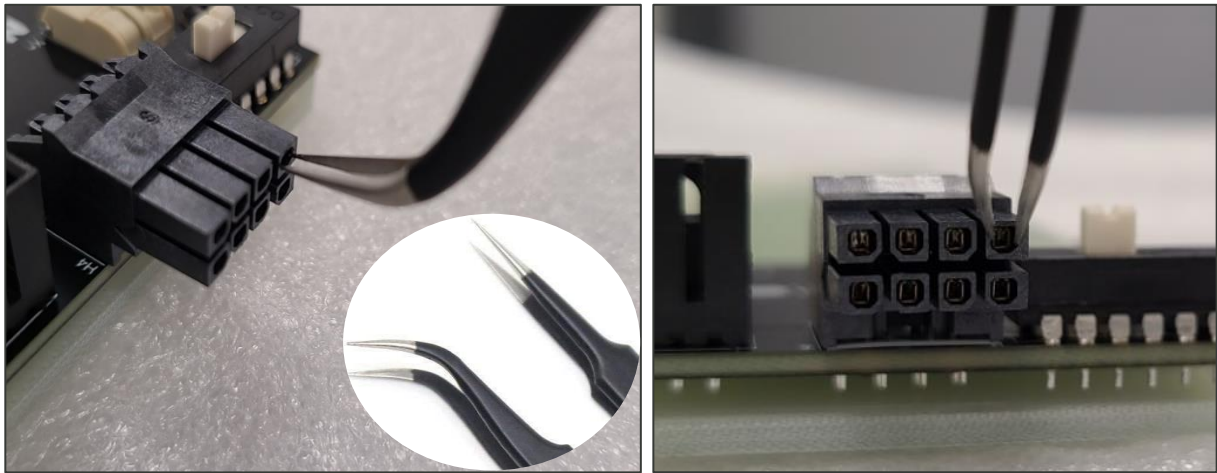
(b) 

(c) 

(d) **Abnormal** **Bad pin connection** 

Pin	Connection
1	Voltage HI
2	RTD SENSE HI
3	RTD DRIVE HI
4	Current HI
5	Voltage LO
6	RTD SENSE LO
7	RTD DRIVE LO
8	Current LO

To fix the issue, we use fine, sharp-tipped tweezers. Insert the tips to the connector, between the pin and housing, and gently squeeze to tighten the gap back to a square shape.



Please [contact us](#) about replacement if you are unsure about the pin adjustment.

11.2 Channel cannot maintain current or voltage

This issue might be caused by a bad connection at any of the equipment interfaces, between:

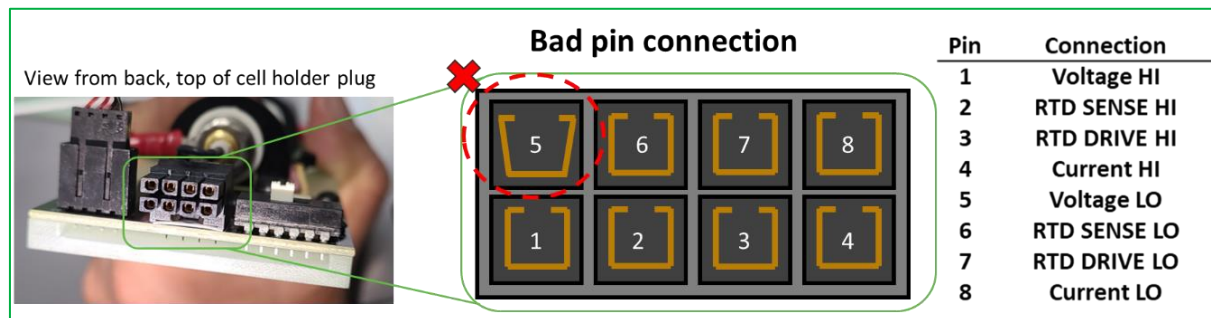
- Cell and Cell Holder
- Cell Holder and Thermal Chamber
- Thermal Chamber with Channel Module
- Channel Module and Control Module

Before connecting or disconnecting ANY cables, verify that no tests are running and power to the system is OFF.

✓ Check Cell Holder connection

Check that Cell Holder pins are a normal, square shape.

- Refer to [Cell Holder Pin Repair](#) if any are deformed.



Methodically investigate each remaining connection

If the Cell Holder connector appears healthy, investigate each interface to isolate the issue.
Reminder: ensure no tests are running and power to the system is OFF

- Verify that the cell is well seated on its Cell Holder. Pogo pins (if applicable) should make a firm contact with the cell terminals.
- Move the Cell Holder to a new position in the Thermal Chamber see if the problem persists.
- Ensure Interconnect Cables connecting the Channel Module to Thermal Chamber are solidly connected.
 - Swap Interconnect Cables or replace the Interconnect Cable with a spare.
- Swap or replace the Ethernet comms cable on the back of the Channel Module. Ensure it is a straight-through Ethernet configuration and not a crossover cable. Try to connect again.
 - Move the Channel Module to a new port on the back of Control Modules. Note: The channel number of the channels will change if their Communication Module position is changed.

Please [contact us](#) if the step above doesn't fix the issue.

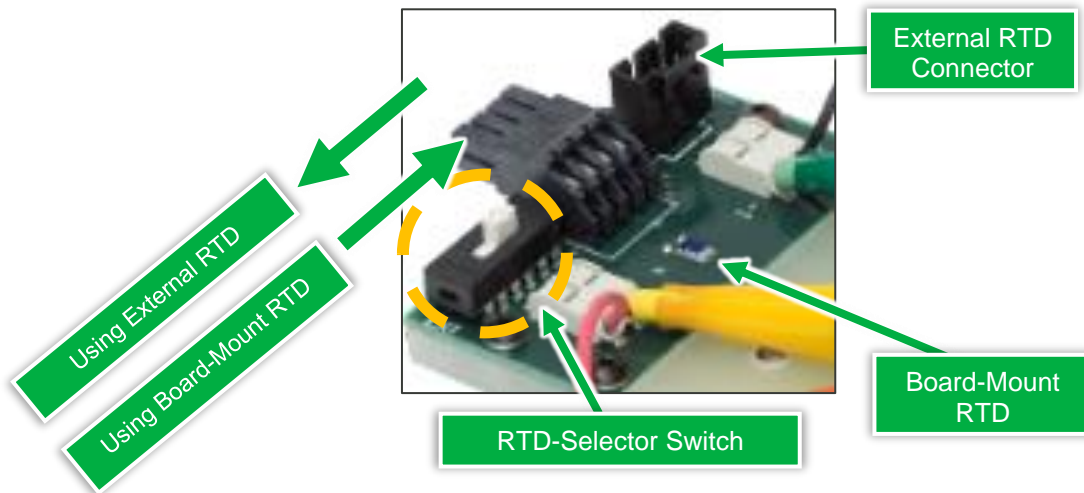
Our service team may ask to connect to your system remotely. Please ensure the newest version of TeamViewer is installed on your UHPC computer here: <https://www.teamviewer.com/en-us/>

11.3 Temperature is out of range

This might be caused by the RTD setup, or a bad connection.

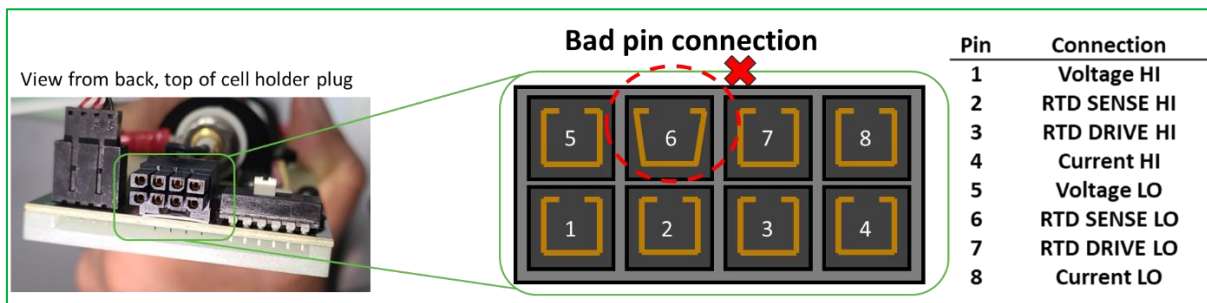
✓ Check cell holder RTD set up and connection

The white switch on cell holder should be toggled to RIGHT side (near the plug) if no external holder RTD is applied:



Check that Cell Holder pins are a normal, square shape.

- Refer to [Cell Holder Pin Repair](#) if any are deformed.



Try swapping Cells, Thermal Chamber positions and Cell Holders with each channel.

✓ **Methodically investigate each remaining connection**

If the Cell Holder connector appears healthy, investigate each interface to isolate the issue.
Reminder: ensure no tests are running and power to the system is OFF

- Verify that the cell is well seated on its Cell Holder. Pogo pins (if applicable) should make a firm contact with the cell terminals.
- Move the Cell Holder to a new position in the Thermal Chamber see if the problem persists.
- Ensure Interconnect Cables connecting the Channel Module to Thermal Chamber are solidly connected.
 - Swap Interconnect Cables or replace the Interconnect Cable with a spare.
- Swap or replace the Ethernet comms cable on the back of the Channel Module. Ensure it is a straight-through Ethernet configuration and not a crossover cable. Try to connect again.
 - Move the Channel Module to a new port on the back of Control Modules. Note: The channel number of the channels will change if their Communication Module position is changed.

✓ **Disable Temperature Limits**

If temperature is not critical for your experiment, you can disable temperature limits. In the UHPC Control software:

- Settings >> Features >> Disable Temperature Limits

Please [contact us](#) if any of your issue persists.

11.4 Cell Holder Temperature Measurements

Standard format Cell Holders have an RTD mounted directly to their circuit boards. An external RTD can also be plugged onto it, thus allowing temperature measurement of another desired surface (e.g., cell surface).

The white RTD-Selector switch on the board selects whether the Board-Mount RTD or an External RTD Connector is to be used, as shown in picture below:

✓ Board-Mounted Temperature Measurement

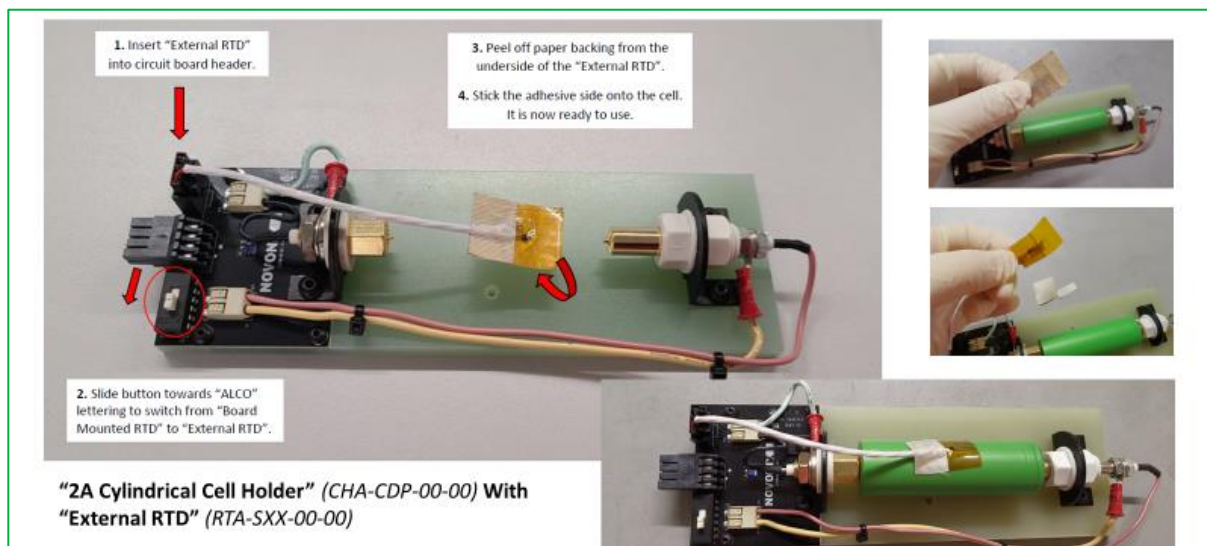
Toggle the RTD-Selector Switch RIGHT, as shown above. That's all! Temperatures will automatically be measured and logged from the board mounted RTD.

✓ External RTD Measurements

To use an External RTD, toggle the switch to the LEFT (see image above). Plug in your external 4-wire RTD allow temperature test with an external RTD.

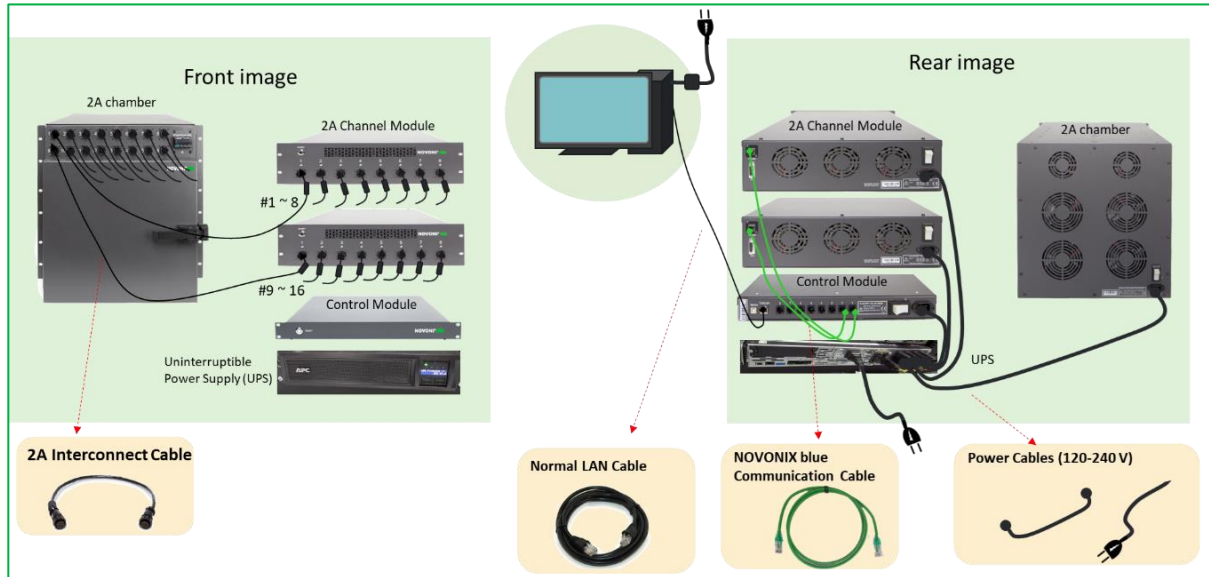
- Plug your 4-wire “external RTD” into circuit board header.
- Toggle the RTD Selector Switch LEFT to switch from “Board-Mount RTD” to “External RTD”.
- Peel off the paper backing from the underside of the “External RTD”
- Stick the adhesive side onto the cell. It is now ready to use.

Note: Other heat tape like Kapton could be used if the original stick tape fades after repeatable usage.



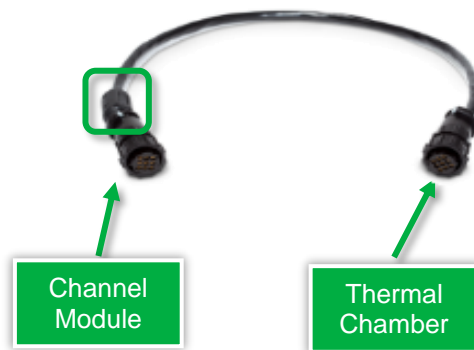
11.5 Cable connections of a UHPC system

The cable connection of an example 2A UHPC system is shown below.



✓ To set up or check cable connection

- Make sure **interconnect cables** are correctly installed between the Channel Module and the Thermal Chamber. Identify the Channel Module end by looking for additional RF shielding on the cable (see image below).



Make sure a **standard, straight-through Ethernet cable** connects Control Module “computer” port to your PC. Additionally, **standard, straight-through Ethernet cables** should connect Control Module to Channel Modules. Verify that crossover style cables are not being used.

- **Power cables** of all modules should be connected via a UPS. Please refer to the specific device’s [specification sheet](#) for power draw information if using a 3rd party UPS or have another power solution.
- Make sure that all cables are connected and seated securely.

✓ Plug type

The plug requirements by region and by product can be found in the table below.

Thermal Chamber Voltage	Plug
-------------------------	------

100-120V	NEMA 5-15p
220-240V	IEC 320 C14

<i>UPS Model #</i>	<i>UK</i>	<i>Rest of Europe</i>	<i>North America (Low Voltage)</i>	<i>North America (High Voltage)</i>
<u>SMT3000RM2UC</u>	NEMA L5-30P			
<u>SMX3000RMHV2U</u>	BS 1363A	CEE 7/7		IEC 60320 C20
<u>SRT5KRMXLT-IEC</u>				NEMA L6-30

11.6 Channels cannot be recognized / connected

This may be caused by cable connection, software version or IP address. To detect its possible cause, follow the steps below.

✓ Check cable connections

- Make sure that all power and communication cables are connected and seated fully.
- Make sure a standard, straight-through Ethernet cable connects Control Module “computer” port to your PC. Additionally, standard, straight-through Ethernet cables should connect Control Module to Channel Modules. Verify that crossover style cables are not being used.
- Control Modules can only connect to a single Channel Module type at a time – one Control Module cannot connect simultaneously to 2A and 20A (for e.g.) Channel Modules.

✓ Update Control software

Make sure you have the most up to date version of our UHPC Control installed. You can access this from the [NOVONIX Customer Area](#).

✓ Check the list of applications running

Make sure that only 1 instance of HPC Control is running on the computer. Restart Control software and try to connect again.

✓ Check IP addresses of the PC's Ethernet port

Click “change adapter options” from “Network & Internet settings”. Manually change the IP address in the IPV4 adaptor settings and try to connect with each of the following IP addresses

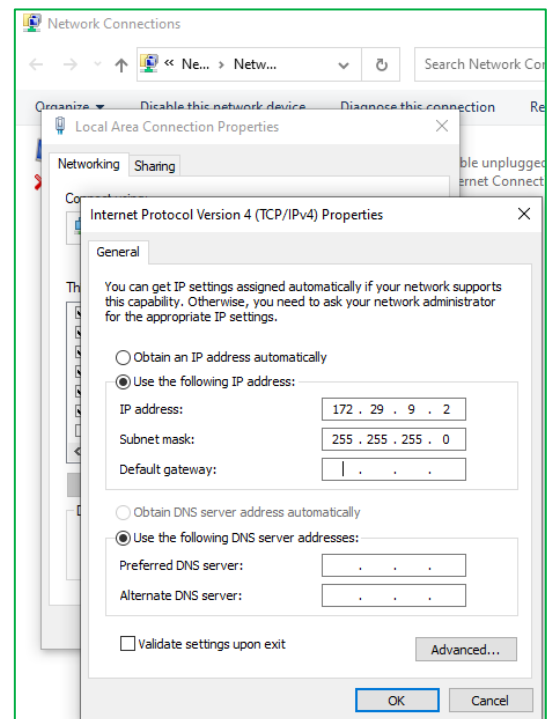
- 172.29.9.2 and 192.168.1.2.
- After switching the IP address wait for 1 minute for the connection to establish. If still not successful, carry on to next step.

✓ Reset Control module

- Hit the reset button of the Control module and wait for 30 seconds. If still not successful, carry on to next step.

✓ Reset Channel modules

- Right click on the channel and select Reset Selected Rows from the dropdown.
- If still not successful, restart the power of Channel modules (make sure to stop any tests first). Try to connect again.



11.7 Test Stopped – Ping not received

Ping not received is likely a communication problem. Check cable connections, software settings and module functions separately to detect the root cause.

✓ Check cable connections

- Make sure that all power and communication cables are connected and seated fully.

- Make sure a standard, straight-through Ethernet cable connects Control Module “computer” port to your PC. Additionally, standard, straight-through Ethernet cables should connect Control Module to Channel Modules.
- Control Modules can only connect to a single Channel Module type at a time – one Control Module cannot connect simultaneously to 2A and 20A (for e.g.) Channel Modules.
- Move the Cell Holder to a new position in the Thermal Chamber see if the problem persists.
- Ensure Interconnect Cables connecting the Channel Module to Thermal Chamber are solidly connected.
 - Swap Interconnect Cables or replace the Interconnect Cable with a spare.
- Swap or replace the green Communication Cable on the back of the Channel Module. Try to connect again.
- Move the Channel Module to a new port on the back of Control Modules.

Note: The channel number of the channels will change if their Communication Module position is changed. Update Control software

✓ **Update Control software:**

- Make sure you have the most up to date version of our UHPC Control installed. You can access this from the [NOVONIX Customer Area](#).
- Check the list of applications running to make sure that only 1 instance of HPC Control is running on the computer. Restart Control software and try to connect again.

✓ **Check IP addresses of the PC's Ethernet port**

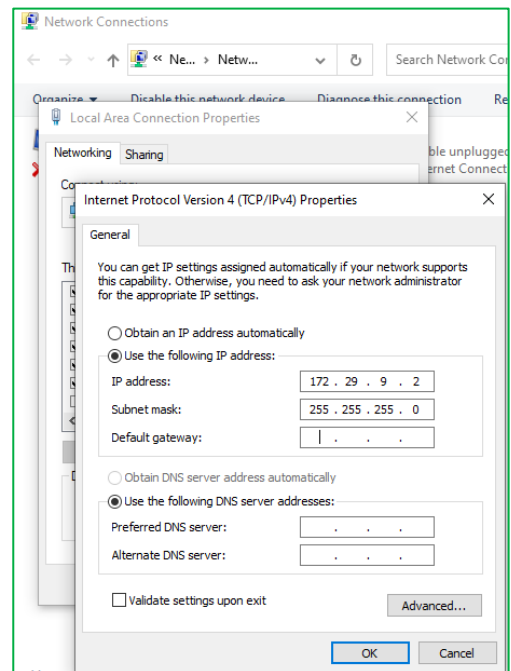
Click “change adapter options” from “Network & Internet settings”. Manually change the IP address in the IPV4 adapter settings and try to connect with each of the following IP addresses

- 172.29.9.2, 192.168.1.2.
- After switching the IP address wait for 1 minute for the connection to establish.

✓ **Reset Control module**

- Hit the reset button of the Control module and wait for 30 seconds. If still not successful, carry on to next step.

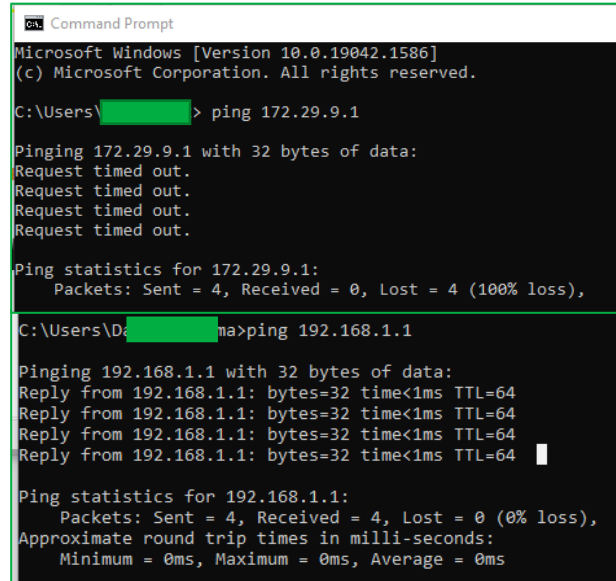
✓ **Reset Channel modules**



- Right click on the channel and select Reset Selected Rows from the dropdown. If still not successful, restart the power of Channel Modules (make sure to stop any tests first). Try to connect again.

✓ **Check the Control module connections**

- Open the command prompt (cmd) and type “ping 172.29.9.1” or “ping 192.168.1.1”. These should be the IPs of the Control Module.
- If the request times out, then it's not communicating with the system and there is a connection issue.
- Recheck the communication cables. Try to connect again. If still not successful, there may be a problem with the Control Module itself. [Contact us](#) for next steps.
- If the ping is sent back, the Control Module and its connections should be healthy.



```
Command Prompt
Microsoft Windows [Version 10.0.19042.1586]
(c) Microsoft Corporation. All rights reserved.

C:\Users\> ping 172.29.9.1

Pinging 172.29.9.1 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 172.29.9.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\De>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64

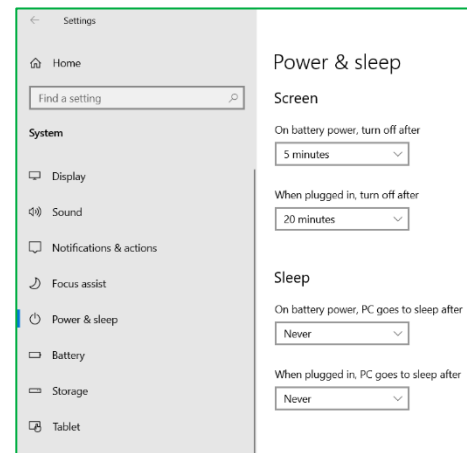
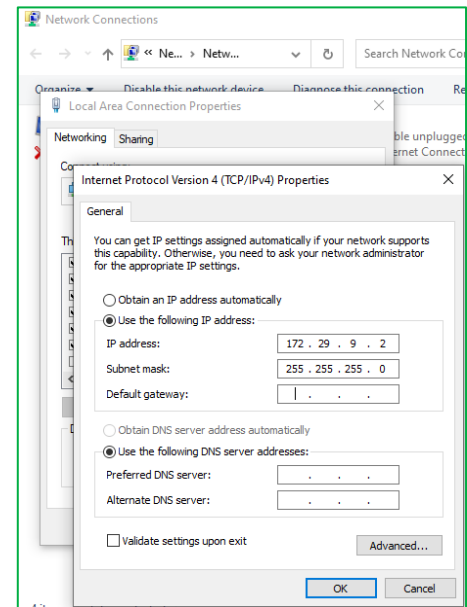
Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

11.8 Migrating to a new PC with Windows 10

Migrating NOVONIX UHPC Software to a new PC running Windows 10 is straightforward. We recommend following these steps:

- ✓ Make sure that all tests on all connected UHPC channels are stopped
- ✓ Backup all important files and configurations
- ✓ Get the latest UHPC software
 - You will need UHPC-Control, UHPC-Protocol and UHPC-Plot, which are available in [NOVONIX Customer Area](#).

- Download the latest available version for each software package and install per the instructions provided.
- ✓ Move the communication cable from your old PC to the new oneOpen UHPC-Control and confirm that all channels appear.
- ✓ If channels cannot be identified/do not appear:
 - Check the IP address of the PC's Ethernet port by clicking "change adapter options" from "Network & Internet settings".
 - Manually change the IP address in the IPV4 adapter settings and try to connect with each of the following IP addresses:
 - 172.29.9.2, 192.168.1.2.
 - After switching the IP address, allow up to 1 minute for the adapter to reset the connection.
- ✓ Verify that old data files can be read with the new software
- ✓ In certain cases, protocols written with previous versions of the software may not work with the latest UHPC-Control. In this case, re-write them using the latest version of UHPC-Protocol on the new machine.
- ✓ Disable Sleep on the new PC
 - Go to Windows Start >> Settings >> Power & Sleep >> Sleep >> Never
- ✓ Run a brief test to check that every channel is responding properly



12 Appendix E: NOVONIX TERMS AND CONDITIONS OF SALE

NOVONIX TERMS AND CONDITIONS OF SALE

NOTWITHSTANDING ANY CONTRARY LANGUAGE PROPOSED BY BUYER IN ANY OTHER DOCUMENT THAT STATES THAT ANY OTHER DOCUMENT, ACT, OR FAILURE TO ACT BY SELLER CONSTITUTES ACCEPTANCE OF ANY DIFFERENT OR ADDITIONAL TERMS OR CONDITIONS, ANY OFFER OR ACCEPTANCE BY SELLER IS MADE SUBJECT TO THESE TERMS AND CONDITIONS, AND THESE TERMS AND CONDITIONS EXPRESSLY LIMIT ACCEPTANCE TO THE TERMS AND CONDITIONS STATED HEREIN. ANY ADDITIONAL OR DIFFERENT TERMS OR CONDITIONS IN ANY BUYER DOCUMENT, WHETHER IN A PURCHASE ORDER, SHIPPING INSTRUCTION, OR OTHERWISE, ARE REJECTED, ARE OF NO FORCE OR EFFECT, AND SHALL NOT APPLY UNLESS SPECIFICALLY AND EXPRESSLY ASSENTED TO IN WRITING BY AN AUTHORIZED REPRESENTATIVE OF SELLER, AND FULFILLMENT OF BUYER'S ORDER DOES NOT CONSTITUTE ACCEPTANCE OF ANY OF BUYER'S TERMS OR CONDITIONS.

1. COMPLETE AGREEMENT: If this document has been issued by Seller in conjunction with a quote ("**Quote**") or acknowledgement ("**Acknowledgement**") in response to a written offer made by Buyer, Seller rejects Buyer's offer and Seller makes this offer expressly limited to the terms hereof, and Seller reserves the right to withdraw this offer at any time before its acceptance by Buyer. If these Terms and Conditions are not acceptable, Buyer is to notify Seller in writing at once. Buyer's action in (a) accepting any products delivered by Seller ("**Products**"), or (b) issuing a purchase order against or otherwise accepting a Quote referencing or incorporating these Terms and Conditions, will constitute an unqualified acceptance by Buyer of these Terms and Conditions. Each applicable accepted Quote or Acknowledgement as governed by these Terms and Conditions may be referred to herein as the "**Agreement**."

The Agreement, together with the specifications, drawings and any other documentation referred to herein and therein, which by this reference are all made a part hereof, constitutes the entire agreement between **Novonix Battery Technology Solutions Inc.**, a Canadian corporation, with a principal place of business located at 177 Bluewater Road, Bedford, Nova Scotia B4B 1H1, Canada ("**Seller**"), and the buyer of the Products set forth in the Agreement (the "**Buyer**"). The Agreement between the parties supersedes all prior negotiations, proposals, writings, trade customs and trade usage pertaining to the subject matter of the Agreement.

2. DELIVERY OF PRODUCTS; RISK OF LOSS: Unless otherwise provided in the Agreement, (a) delivery of the Products shall be made ExWorks, Seller's designated facility located at 110 Simmonds Drive, Dartmouth, NS (Incoterms® 2020); (b) Buyer shall bear the risk of loss or damage to the Products covered by the Agreement after they are made available for Buyer's disposal at Seller's designated facility; and (c) title to the Products shall pass to Buyer after the Products are made available for Buyer's disposal at Seller's designated facility.

3. DELAYS; FORCE MAJEURE: All Delivery Dates are estimates only and are not guaranteed by Seller; provided that Seller will exercise its commercially reasonable efforts to meet the Delivery Dates specified in the Agreement. "**Delivery Date**" means when Products ordered pursuant to the Agreement are delivered to Buyer. Products ordered under an Agreement are usually made available for shipment within the lead time specified in the applicable Quote, which does not commence until execution of such Agreement. Seller shall notify Buyer of any delay in delivery of Products and take commercially reasonable steps to minimize the length of any such delay.

If prevention of Seller's performance or a delay in delivery is caused by (a) an event of *force majeure*, including but not limited to, acts of God or public enemy; terrorism; war; civil commotion; riot; blockage or embargo; work stoppage; strike or other labor dispute or industrial disturbance, slowdowns or interruption, lockout; fire; flood; earthquake; explosion; drought; the elements; casualty; epidemic; pandemic; default by any common carrier; which are due to any law, order, proclamation, regulation, ordinance, demand, requisition or requirement or any other act of governmental authority, agency or entity, whether foreign, national, state or local, including court orders, judgments, or decrees; or any other similar or dissimilar contingency, delay, failure or cause beyond the Seller's reasonable control, irrespective of whether such contingency is specified herein or is presently occurring or anticipated by Seller; or (b) the inability or refusal of Buyer or its customers to accept or receive shipment when due (whether or not valid), then Seller will be entitled, at its sole option, to

(i) extend the time for performance and delivery for a period, or periods, of time that, in Seller's sole discretion, appears to be reasonable, or (ii) cancel the sale, in either case without liability on the part of Seller. If prevention of Seller's performance or a delay in delivery is due to an event described in clause (b) above, Buyer will reimburse Seller for the reasonable costs and expenses incurred by Seller in connection with such delay, including, without limitation, Seller's cost and expense to

store the Products.

4. SECURITY INTERESTS: Buyer hereby grants Seller a continuing first priority purchase money security interest in and to the Products sold hereby and all replacements, substitutions and accessions thereto and all proceeds thereof, including insurance proceeds, to secure payment of all obligations and indebtedness of Buyer to Seller hereunder. Buyer agrees that Seller will have the right to take such actions with respect to the Products as Seller may reasonably determine is necessary in order to create a first lien perfected security interest in the Products, including filing UCC-1 financing statements (or the equivalent thereof if the Products are located outside the United States) evidencing the Products as collateral; and Buyer further agrees to take such actions as Seller may reasonably request in order to perfect Seller's first-lien security interest in the Products. Buyer specifically agrees and acknowledges that the security interest herein granted has attached. Upon the occurrence of an Event of Default, Seller will have all the rights and remedies of a secured party under the Uniform Commercial Code, or if the Products are located outside the United States, then the equivalent thereof. The security interests granted to Seller under this Agreement will automatically terminate upon payment in full of the purchase price for the Products, and Buyer will be entitled to file a UCC-3 termination statement (or the equivalent thereof if the Products are located outside the United States) evidencing such termination.

5. INSPECTION OF PRODUCTS: Buyer will perform acceptance testing of the Products against Seller's "Customer Acceptance Form," and if the acceptance testing demonstrates that the applicable Products function according to the specifications in Seller's "Customer Acceptance Form," those Products will be deemed accepted. Buyer will communicate acceptance or reasons for non-acceptance to Seller in writing without unreasonable delay and no later than 30 days from the Delivery Date. If Seller has not received Buyer's communication of acceptance or non-acceptance before this deadline, acceptance of the applicable Products will be deemed given. If Seller determines that Buyer's communication of non-acceptance is valid, Seller will, at its option, as the exclusive remedy of Buyer, within a reasonable period of time, repair or replace the nonconforming Products.

6. PRICE: In consideration of the provision of the Products, Buyer agrees to pay to Seller the prices specified in the Agreement ("**Prices**"). Prices are listed in the Agreement in United States Dollars. Prices are exclusive of all taxes, fees, tariffs and duties, shipping and handling fees, insurance, and any other similar financial contributions imposed by law on or on account of the purchase and delivery of the Products (collectively, "**Taxes and Shipping Fees**"). Buyer agrees to pay all Taxes and Shipping Fees assessed in connection with each shipment of Products.

7. PAYMENT TERMS: Unless otherwise provided in the body of the Agreement, Seller may invoice Buyer on, or at any time after, the date of each Product shipment for the Prices and Taxes and Shipping Fees associated with the Products Shipped. Unless otherwise agreed upon by the parties in writing or stated elsewhere in the Agreement, terms of payment for Products is due net thirty (30) days from the date of the applicable invoice. Failure of Buyer to make any payment when due will constitute an Event of Default (as hereinafter defined) and will entitle the Seller to treat the entire balance owing to Seller under the Agreement as immediately due and owing and to withhold further deliveries without liability until such Event of Default is cured, and/or entitle Seller to cancel the unperformed part of the Agreement. Further, Seller will have the right to interest on all balances not paid when due at a rate of interest equal one and one half percent (1.5%) per month (or such lesser amount as may be the maximum permitted by applicable law). Upon Seller's request, Buyer will submit to a credit check for Seller to determine Buyer's creditworthiness. In the event Buyer's financial condition, payment history, or any other circumstance occurs that results in Seller reasonably deeming itself insecure as to the payment of any and all amounts due to Seller from Buyer under the Agreement, Seller may, do any one or more of the following: (a) change or otherwise modify the payment and/or credit terms set forth in this Agreement, including by way of example, but not of limitation, change the terms of payment to payment in full or in part in advance of shipment of the entire undelivered balance of Products, (b) delay or postpone delivery of the Products and/or suspend any outstanding orders for Products, and/or (c) require financial data from Buyer for verification of Buyer's creditworthiness. Buyer shall not be entitled to deduct from, or set off against, any sums due and owing to Seller any sums owed by Seller to Buyer.

8. WARRANTY; DISCLAIMER: For 12 months following acceptance of the Products as set out in Section 5, for the Product contained in such shipment, Seller warrants that the Products ordered will conform to any applicable specifications and will be free from defects in materials and workmanship. If Buyer makes a warranty breach claim against any Product, and if Seller determines that Buyer's claim is valid, Seller will, at its option, as the sole and exclusive remedy of Buyer, within a reasonable period of time, repair or replace the non-conforming Products or provide a refund or credit to Buyer for the price of such Products (in which case, Buyer will return the non-conforming Products to Seller as instructed by Seller). Seller's limited warranty with respect to products is voided if any breach thereof results directly or indirectly from (a) the applicable products being subjected to operating, usage, storage, and/or environmental conditions outside of the conditions set forth in any applicable specifications or documentation; (b) the applicable Products being subjected to abuse,

misuse, neglect, negligence, accident, acts of God or other peril, improper installation or hardware or software configuration, improper calibration or failure to routinely calibrate, improper storage, improper handling, improper disposal, or abnormal physical, electrical or environmental stress; (c) normal wear and tear; (d) the applicable Products being used with any other hardware, devices, or other products other than as provided in any applicable specifications or documentation; (e) any non-conformity relating to the design or manufacture of any hardware, devices, or other products in which the applicable products are incorporated; or (f) the applicable products being reconstructed, reconfigured, repaired, tampered with, modified or altered at any time by persons or parties after Seller delivers them, including without limitation by Buyer or any of its representatives or personnel, agents or customers (clauses (a)-(f), collectively, the “Exclusions”).

EXCEPT FOR THE LIMITED WARRANTY IN THIS SECTION 10, THE PRODUCTS ARE SOLD “AS-IS”, AND SELLER HEREBY DISCLAIMS TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY EXPRESS OR IMPLIED WARRANTIES OR CONDITIONS OF TITLE, DESIGN, NON-INFRINGEMENT, WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SELLER FURTHER DISCLAIMS ANY LIABILITY OR RESPONSIBILITY WHATSOEVER TO BUYER OR TO ANY OTHER PERSON FOR INJURY TO PERSON OR DAMAGE TO OR LOSS OF PROPERTY OR VALUE CAUSED BY ANY PRODUCTS TO THE EXTENT SUCH INJURY, DAMAGE OR LOSS RESULTS FROM ANY OF THE EXCLUSIONS.

9. CANCELLATION: If the Seller breaches any material provision of any Agreement, and such breach is not cured by the Seller within 30 days after the Seller’s receipt of notice of such breach, Buyer may, by written notice to Seller, cancel further performance by Seller under the Agreement. Otherwise, the Agreement may not be canceled, in whole or in part, by Buyer without both (a) Seller’s prior written consent and (b) prior payment to Seller of a sum equal to the total of the out-of-pocket expenses incurred by Seller in connection with the Agreement, including, but not limited to, finished Products, work in process, raw materials that are non-returnable to Seller’s suppliers and any supplier cancellation/return fees, plus a reasonable sum for overhead expenses and lost profits, as reasonably determined by Seller.

With respect to Buyer, each of the following constitutes an event of default by Buyer hereunder (each an “Event of Default”): (a) failure to pay any sum due Seller under the Agreement, as and when the same is due, (b) breach of any material provision in any Agreement by Buyer that is not cured by Buyer within 30 days after the Buyer’s receipt of notice of such breach, or (c) Buyer is unable to pay its debts when due, is adjudged bankrupt, makes a general assignment for the benefit of its creditors, or a receiver is appointed on account of Buyer’s insolvency. If any Event of Default should occur, Seller may: (i) terminate this Agreement effective immediately and demand a return of the Products for which payment has not been made to the destination specified by Seller, freight prepaid by Buyer, and/or (ii) take possession of all Products from Buyer, and for that purpose, enter upon any premises owned or leased by Buyer, and/or (iii) file for arbitration pursuant to Section 15(i) (Dispute Resolution), and/or (iv) take any and all other actions specified herein or otherwise permitted by applicable law.

10. INTELLECTUAL PROPERTY: Buyer acknowledges and agrees that Seller (or its licensors) will retain all intellectual property rights in and to the Products, all Product specifications and Product documentation, including, without limitation, all patents, patent applications, and other patent rights and any other governmental authority-issued indicia of invention ownership; all trademarks, service marks, trade dress, trade names, brand names, logos, corporate names and domain names and other similar designations of source, sponsorship, association or origin, together with the goodwill symbolized by any of the foregoing; trade secrets, including all inventions, discoveries, trade secrets, business and technical information and know-how, databases, data collections, patent disclosures and other confidential and proprietary information and all rights therein; and all other industrial and intellectual property rights, and all rights, interests and protections that are associated with, equivalent or similar to, or required for the exercise of, any of the foregoing, however arising, in each case whether registered or unregistered and including all registrations and applications for, and renewals or extensions of, such rights or forms of protection pursuant to the laws of any jurisdiction throughout in any part of the world (collectively, “Seller IPR”). Buyer has a limited, non-exclusive right to use any Product software solely in connection with the use of the Product on which it is installed for Buyer’s internal business operations and subject in all cases to use in accordance with any applicable Product specifications or documentation. Except for the foregoing limited right of use, the sale of Products hereunder does not convey any license or other rights under any Seller IPR, and Seller expressly reserves all of its rights in and to the Seller IPR.

11. CONFIDENTIALITY: Each party shall protect and safeguard the confidentiality of all confidential and proprietary information disclosed to it by the other party (“Confidential Information”) with at least the same degree of care as the receiving party would protect its own confidential and proprietary information, but in no event with less than a

commercially reasonable degree of care. A receiving party shall not publish, disclose or use Confidential Information for any purpose other than such party's performance of its obligations, and exercise of its rights, pursuant to the Agreement and, then, only to those persons with a need to know for such limited purpose. This obligation of non-disclosure shall not apply to the following: (a) information that is or becomes publicly available through no act or fault of a receiving party or its agents; (b) information that is already in the receiving party's possession and is not subject to any confidentiality obligation; or (c) information that is obtained by the receiving party from a third-party who is rightfully in possession of the information. If the receiving party of Confidential Information is requested or required by any legal process to disclose any Confidential Information of the other party, the receiving party will promptly notify the disclosing party unless prohibited from doing so by applicable law or by a governmental agency so that the disclosing party may seek an appropriate protective order and/or waive the receiving party's obligation to comply with these confidentiality obligations. Upon the earlier of the termination or expiration of the Agreement or the request of the disclosing party, the receiving party will promptly return or destroy the disclosing party's Confidential Information, except that a party may retain electronic files consistent with customary backup and retention procedures, provided that any Confidential Information therein will remain subject to the confidentiality obligations provided herein until the same are destroyed as part of such procedures.

12. INDEMNIFICATION: Buyer will defend, indemnify, and hold harmless Seller and its affiliates, and its and their respective directors, officers, members, managers, shareholders, employees, agents, representatives, successors, and assigns from and against all third-party claims, suits, demands, actions, and allegations and all resulting damages, losses, liabilities, judgments, settlements, penalties, fines, costs, and expenses (including all reasonable attorneys' fees and costs of dispute resolution) (collectively, "**Claims**") arising from or relating to (a) Buyer's breach of any provision of the Agreement or (b) any Exclusions. Seller will promptly notify Buyer of any Claims; provided, however, that if Seller fails to so promptly notify Buyer, Buyer's indemnity obligations will not be excused, except to the extent Buyer is actually and materially prejudiced thereby. The indemnified parties will cooperate with Buyer in the course of Buyer's indemnification of them, at Buyer's sole cost and expense. Each indemnified party may participate in Buyer's defense of a Claim with counsel of their own choosing, at their sole cost and expense. Buyer will not settle any Claim without the prior written consent of each indemnified party.

LIMITATION OF LIABILITY: IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY LOSS OF USE, REVENUE OR PROFIT OR DIMINUTION IN VALUE, OR FOR ANY CONSEQUENTIAL, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR PUNITIVE DAMAGES WHETHER ARISING OUT OF BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, REGARDLESS OF WHETHER SUCH DAMAGES WERE FORESEEABLE AND WHETHER OR NOT SELLER WAS ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, AND NOTWITHSTANDING THE FAILURE OF ANY AGREED OR OTHER REMEDY OF ITS ESSENTIAL PURPOSE. IN NO EVENT SHALL SELLER'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THE APPLICABLE AGREEMENT, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, EXCEED THE AMOUNTS PAID BY BUYER UNDER THE APPLICABLE AGREEMENT FOR THE PRODUCTS SOLD. THE FOREGOING LIMITATIONS APPLY WHETHER OR NOT SUCH DAMAGES WERE FORESEEABLE AND WHETHER OR NOT SELLER WAS ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, AND NOTWITHSTANDING THE FAILURE OF ANY AGREED OR OTHER REMEDY OF ITS ESSENTIAL PURPOSE.

13. COMPLIANCE WITH LAWS: Each party shall take all actions reasonably necessary to ensure, that its performance of obligations under the Agreement will be in full compliance with all applicable laws, including without limitation those related to anti-bribery and anti-corruption. Each party shall obtain all permits, certificates and licenses which may be required for the performance of the Agreement and with respect to Buyer, its purchase, import, export and use of the Products.

14. GENERAL PROVISIONS:

(a) **CUMULATIVE REMEDIES:** Except as otherwise provided for herein, all remedies available to a party for breach of the Agreement are cumulative and may be exercised concurrently or separately, and the exercise of any one remedy shall not be deemed an election of such remedy to the exclusion of other remedies. Seller specifically reserves the right, in its sole discretion, to set off any amounts to be paid by Seller to Buyer under this Agreement against any amounts that Buyer may owe to Seller, whether pursuant to this Agreement or

any other agreement between Buyer and Seller.

(b) **INDEPENDENT CONTRACTOR:** The relationship of Buyer and Seller established by the Agreement is that of independent contractors. Nothing in the Agreement shall create between the parties a partnership, joint venture, employer-employee relationship or principal-agent relationship, and neither party has the authority to bind the other to any third person or otherwise to act in any way as the representative of the other.

(c) **ASSIGNMENT:** Neither the Agreement nor any portion thereof may be assigned or subcontracted by the Buyer without Seller's prior written consent, and any such assignment or subcontract without consent will be null and void. Seller reserves the right to freely assign the Agreement. Any permitted assignment shall be binding upon any permitted successors and assigns.

(d) **SEVERABILITY:** If any term or provision of the Agreement shall for any reason be held invalid, illegal or unenforceable in any respect, such invalidity, illegality or unenforceability shall not affect any other term or provision hereof and the remainder of the Agreement shall remain valid and enforceable according to its terms and the Agreement shall be interpreted and construed as if such term or provision, to the extent the same shall have been held to be invalid, illegal or unenforceable, had never been contained herein.

(e) **WAIVER:** No term or provision hereof shall be deemed waived and no breach excused unless such waiver or consent shall be in writing and signed by the party claimed to have waived or consented. The failure by a party to insist, in any one or more instances, upon the performance of any of the terms or conditions of the Agreement, or to exercise any right hereunder, shall not be construed as a waiver of the future performance of any such terms or conditions or the future exercise of such right.

(f) **SURVIVAL:** Any provision of the Agreement, which, by its nature or express terms is intended to survive termination or expiration, shall survive termination or expiration of the Agreement regardless of the reason for such termination or expiration.

(g) **NOTICES:** Any notice required to be given hereunder shall be in writing and addressed to the applicable party at the addresses set forth in the body of the Agreement (or to such other address that may be designated by the receiving party from time to time in accordance with this Section). All notices shall be delivered by personal delivery, internationally recognized overnight courier (with all fees pre-paid) or certified or registered mail (in each case, return receipt requested, postage prepaid). A notice will be deemed given upon receipt by the receiving party if delivered by personal delivery or courier or, five (5) days after mailing if mailed in accordance with the terms hereof.

(h) **GOVERNING LAW:** The Agreement shall be governed by and construed in accordance with the laws of the State of New York, USA, without regard to the conflict of laws provisions thereof. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to these Terms and Conditions or any Agreement, and the parties hereby disclaim the application thereof.

(i) **DISPUTE RESOLUTION:** Except as otherwise provided in this Section 15(i), each party agrees that all disputes arising under the Agreement will be submitted to binding arbitration under the applicable rules of the American Arbitration Association then in effect (the "**Rules**"). Either party may commence the arbitration by delivering a request for arbitration as specified in the Rules. The arbitration will be conducted before a sole neutral arbitrator, selected as provided in the Rules. The arbitration will be conducted in the English language at a site specified by Seller in New York, New York, USA. The arbitrator will apply the law set forth in Section 15(h) (Governing Law) to any such arbitration and shall have the power to award any remedy available at law or in equity; provided, however, that the arbitrator shall have no jurisdiction to amend this Agreement or grant any relief not permitted herein or beyond the relief permitted herein. The award of the arbitrator will be the exclusive remedy of the parties for all claims, counterclaims, issues or accountings presented or plead to the arbitrator. The

award of the arbitrator will require the non-prevailing party to pay the prevailing party's costs, fees and expenses (including attorneys' fees). Judgment upon the award may be entered in any court or governmental body having jurisdiction thereof. Any additional costs, fees or expenses incurred in enforcing the award may be charged against the party that resists its enforcement. Each party agrees that if the other party reasonably believes that the former has, in any manner, breached its confidentiality obligations to the other party or has damaged the other party in such a way where monetary relief would not be a sufficient remedy, then the other party may seek emergency, preliminary or other appropriate interim relief in the federal or state courts whose district encompasses New York, New York, USA, and any actions to enforce the arbitration provisions hereof will be brought exclusively in such courts.