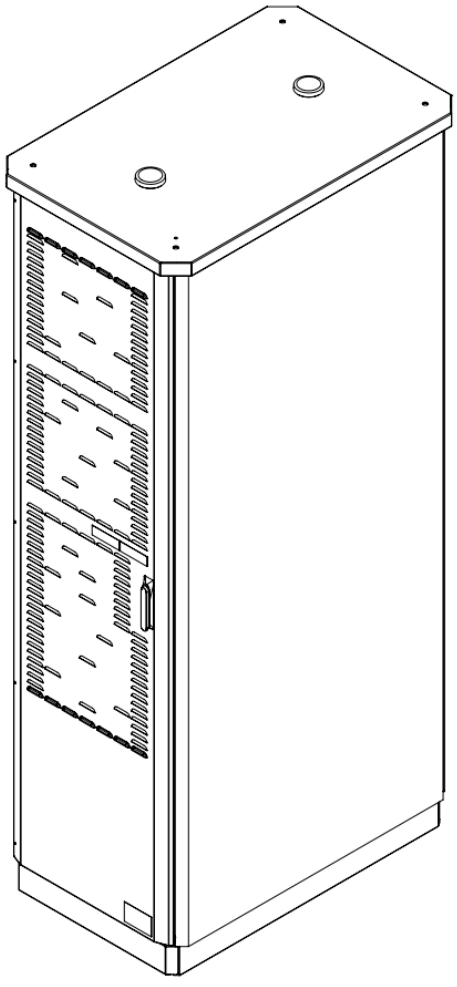
PKM150 Rectifier Unit
User Manual



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Revision record

Rev	Date	TC #	Change	Author
1	0/Jun/2022	3010	Initial document	S. Caddaye C. Walsh S. Taylor
2	20/Dec/2022	4249	Updated Earth Fault Protection; updated content to new template; reviewed/edited	N Palmer

Contents

1 Introduction

1.1 Document maintenance

This manual is a dynamic document and updated as changes occur. Tritium intends to update this manual periodically, as new procedures and technologies are developed and deployed. The manual is subject to updates without notification.

1.2 Definitions

Acronym	Definition
AC	Alternating Current
CAN	Controller Area Network
CCS	Combined Charging System
CPO	Charge Point Operator
CSL	Comma Separated List
CU	Control Unit
DC	Direct Current
DCP	DC Port
DMM	Digital Multimeter
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HMI	Human Machine Interface
HPC	High Power Charging
IMD	Insulation Monitoring Device
MV	Megavolt
OCPP	Open Charge Point Protocol
RU	Rectifier Unit
RCBO	Residual Current Circuit Breaker with Overcurrent Protection
R	Read Only
R/W	Read/Write
SSH	Secure Socket Shell
CS	Charge Station
UV	Undervoltage

2 Identifying symbols

Symbol	Description
	CRITICAL
	CAUTION
	RISK OF ELECTRIC SHOCK
	Equipment grounding conductor symbol
	Phase symbol
	Alternating current supply symbol

3 General safety and hazard instructions

CAUTION

1. Do not use the PKM150 RU, and contact the Charge Point Operator (CPO), if:
   - cabinet is damaged, doors do not close, or cabinet seal is compromised
   - There is fire, smoke, or odor in or near the PKM150 RU.
   - Any cables appear to be damaged or compromised.
   - The PKM150 RU is immersed in water or any other fluid.
   - The PKM150 RU looks vandalized.
2. Members of the public should never interact with the PKM150 RU. Keep the cabinet locked and the key in a safe location. Never direct users or untrained personnel to operate the DC Port switches.
3. Do not operate the RU DC Ports if there is any sign of damage, moisture, contaminants, overheating or if parts do not appear to be working correctly. Do not apply excessive force to the DC Port switch handles.
4. There are no user serviceable parts in the PKM150 RU.

RISK OF ELECTRIC SHOCK

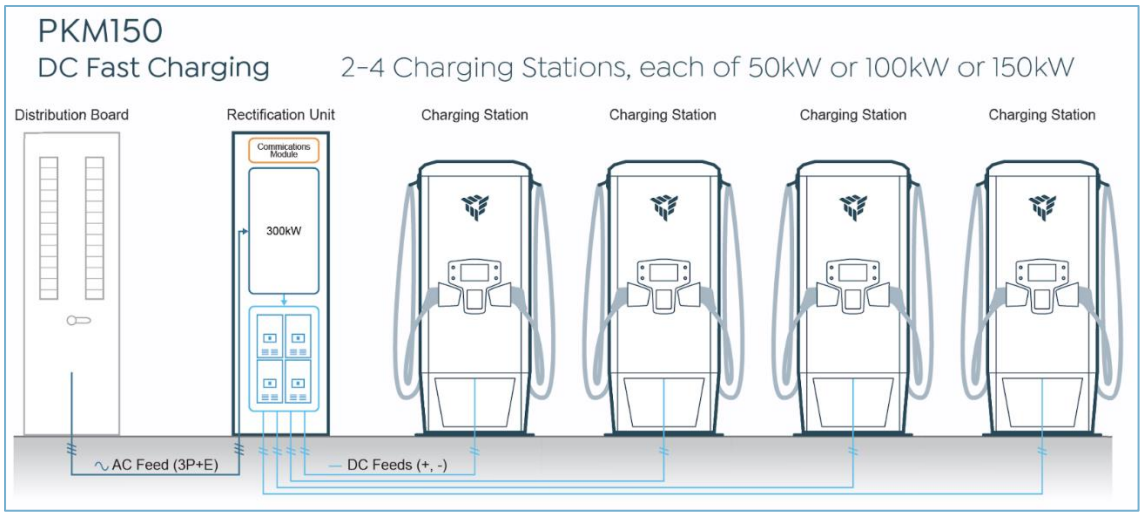
Attention: Cold weather servicing

When servicing the unit in extreme cold temperatures below -20C, there is a remote possibility of cold weather or ice interfering with circuit breaker isolation and trip systems. Multiple trained electrical technicians should work together on the same task and pay particular attention to Lock-Out-Tag-Out procedures and test for voltage before working on the unit.

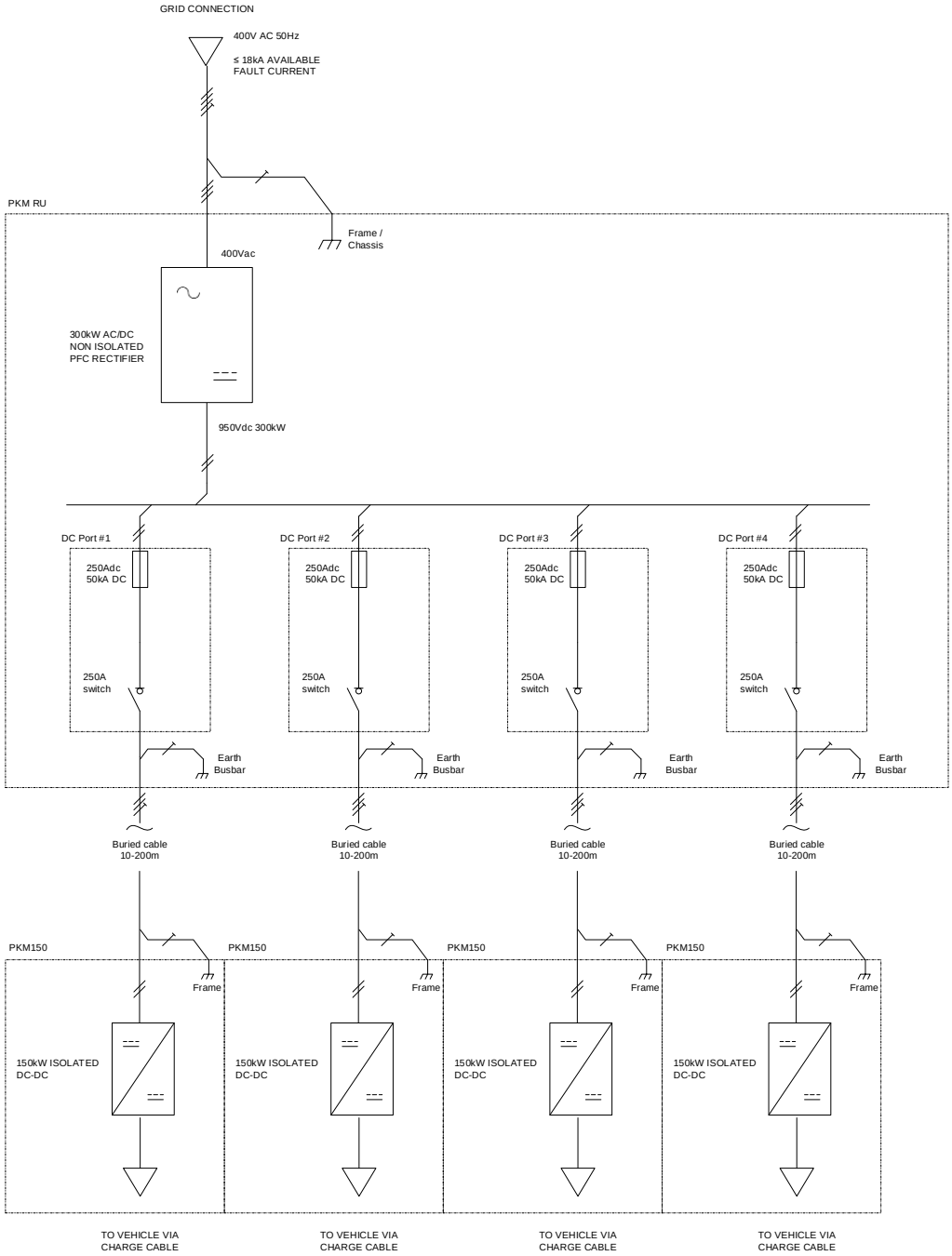
Failure to do so may result in injury or death.

4 PKM150 RU system overview

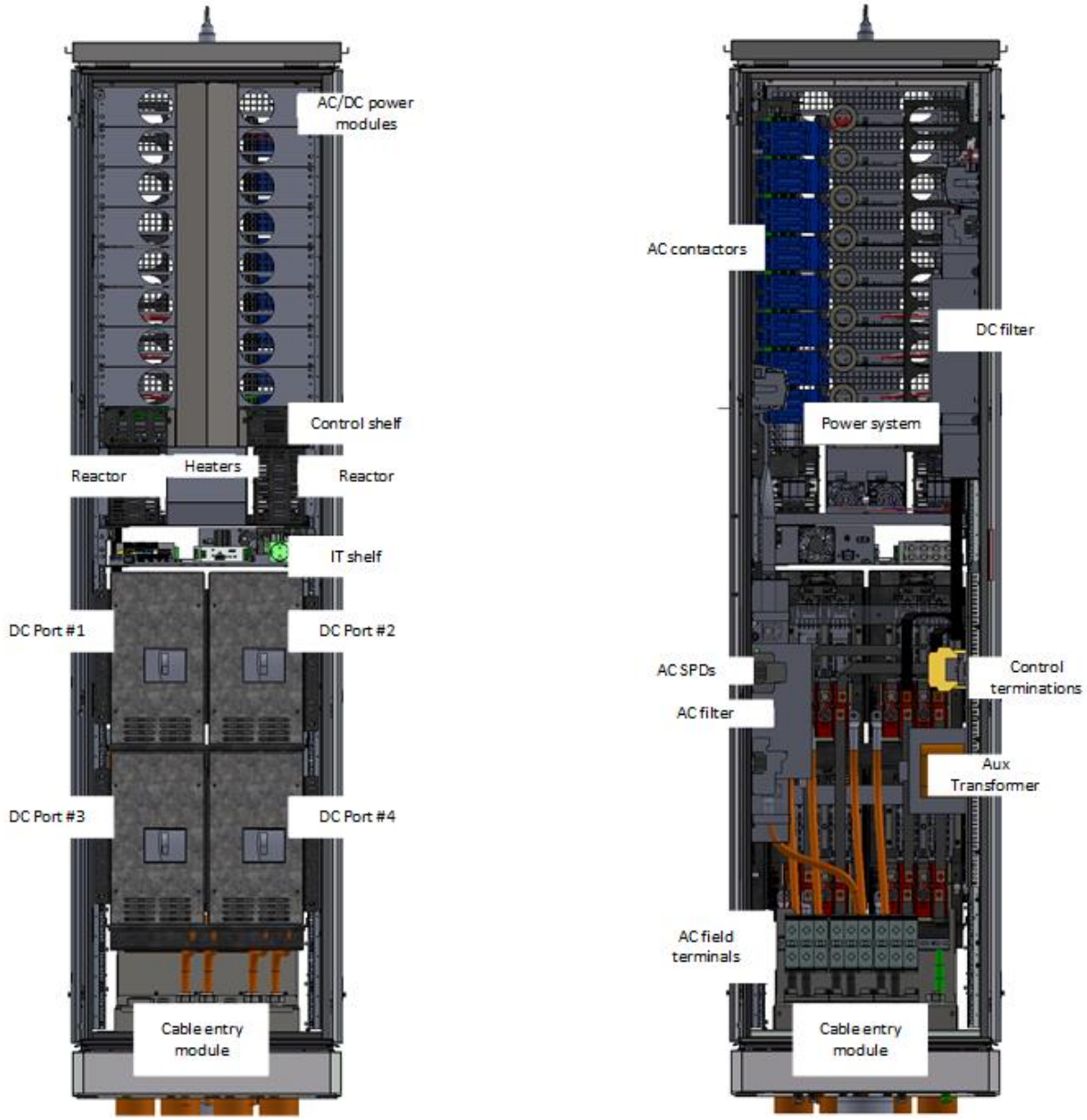
4.1 Site conceptual overview

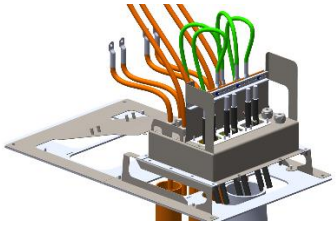
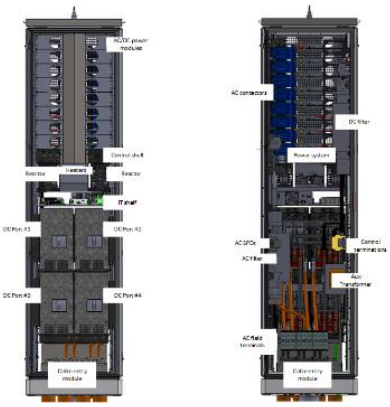
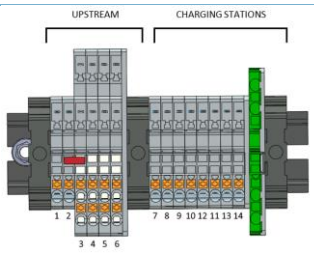
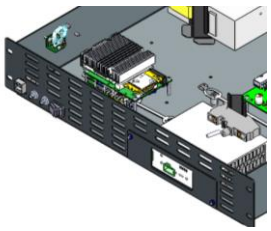


4.2 Site electrical diagram



5 The PKM150 RU Cabinet



Subsystem	Image	Purpose
Cable connection module		• The cable connection module facilitates streamlined installation of the RU. • Cables can be installed and terminated prior to the cabinet's delivery to site. This allows better access to the terminals while working, and a quicker commissioning process once the cabinet arrives. • Cable connection module can be fully covered with a weatherproof cover. • Consult the TRI155.INS.2023 PKM150 Site Installation Manual. for full details.
Power system		Supplies power to the PKM150 Charging Stations (CS) on the site. 
DC Port		• Connection point for a PKM Charge Station. • Charge stations can be isolated, locked-out and tagged-out from this location using the DC switch, accessed from the cabinet's front. • Cabinet may be fitted with 2, 3 or 4 DC Ports. It is possible to upgrade the cabinet by fitting new DC Ports to support new PKM Charge Stations
Control wiring terminations		• For wiring control signals to the upstream distribution unit, and to the PKM150 CS. • Consult *TRI155.INS.2023 PKM150 Site Installation Manual* for connection details.
IT shelf		• Termination points for external networking (if applicable). • Housing for modem and SIM card.

6 PKM150 RU Operation – DC Ports

The DC ports in the PKM150 RU cabinet are accessed when energizing and de-energizing the individual CS for service, troubleshooting or removal.

DC ports are correctly rated for isolation.

6.1 Accessing DC port

Locate the front door of the PKM150 RU cabinet. The front door is not labelled with a hazardous voltage warning as there is no access to live parts through the front door.

Opening the front door does not trip the power feed. The site remains powered and charging sessions will continue.

Note: The site power is reduced and charging sessions may be noticeably lower power while the door is open. Close the door as soon as possible.

CRITICAL

Do not approach the cabinet or use the DC Port if there is an emergency on site, in either the CS or RU. Instead, isolate the entire RU at the upstream distribution point or the site emergency stop, if fitted.

RISK OF ELECTRIC SHOCK

Never open the front door in the energized state when the following conditions are present:

- precipitation or spray
- dust storm
- airborne conductive particles
- insect swarm

Doing so may lead to death or injury.

CAUTION

- Never leave the front door open.
- Only open the front door for as long as required to use the switch on the DC Port.
- If temperatures are colder than -25C, reconsider the need to open the front door. There is a chance the product may be damaged.

6.2 Turning on a DC port

Step	Action
1	Call a meeting with all representatives present on site to notify all parties that power is going to be turned on to a CS
2	Ensure to have the appropriate approval or permission to turn on power to the CS.
3	Ensure it is safe to proceed - follow the steps in the *RISK OF ELECTRIC SHOCK* below.
4	a. Identify the correct DC port. b. Turn on the switch. c. If the PKM150 RU is energized, this supplies 950V to the CS connected to the DC port. The CS becomes active, and the display turns on.

RISK OF ELECTRIC SHOCK

Before turning on a DC port, follow these important safety steps:

1. Ensure the correct DC port is going to be activated, corresponding to the CS to be energize.
2. Using a multimeter on continuity test, double-check that there is no short circuit in the CS on the 950V input (where the cables terminate inside the unit).
3. Check the door is closed off the DC port and personnel are clear from the area.
4. Position your body at arms-length from the cabinet when throwing the DC switch.

RISK OF ELECTRIC SHOCK

- Check all CS units on site before energizing any DC port.
- Ensure no one is working on any charger when switching on any DC port.

6.3 Turning off a DC port

Step	Action
1	a. Identify the correct DC port. b. Ensure it is safe to proceed - follow the steps in the *RISK OF ELECTRIC SHOCK* below. c. Turn off the switch. The CS power cuts immediately.
2	If intending to open the CS, follow *Lock-out Tag-out for DC port* procedures immediately after turning off the DC Port.

RISK OF ELECTRIC SHOCK

Before turning off a DC port, follow these important safety steps:

1. Ensure the correct DC port is going to be turned off, corresponding to the CS that you intend to de-energize.
2. Check that the CS is not coupled to a vehicle and is not charging. Do not turn off the DC Port while the CS is charging.

CRITICAL

Never de-energize a CS by opening the door. The correct procedure is de-energize the unit at the DC port, lock-out, tag-out, and test-for-dead before accessing the cabinet.

6.4 Lock-out Tag-out for DC port

Obtain the DC Port locking kit from where the kit is stored on site, which includes:

- Red locking device
- Padlock
- Key
- Tag

RISK OF ELECTRIC SHOCK

- Follow the site *Lock-out Tag-out* procedure.
- Steps in this section are intended only as a guideline.

Step	Action
1	Place the locking device over the switch actuator. 
2	a. Tighten the grub screw. b. Pull firmly to check that the locking device cannot be removed. 

Step	Action
3	Snap the cover in place over the grub screw to reveal the locking feature. 
4	a. Place the tag on the padlock. b. Thread the padlock through the locking feature. c. Lock the padlock and remove the key. d. Add details to the tag, as required. **Note:** Always keep the key with you while servicing the Charge Station.

6.5 DC port trip

6.5.1 Tripped state

The DC port switch is tripped when the actuator is in the centre position.

Note: The DC port switch will not trip due to overcurrent (there are fuses for this protection). A tripped switch is always an indication that the CS interlocks have caused a trip:

- Door sensors
- Tilt sensor
- CS Emergency-Stop input, if used.

6.5.2 Resetting the trip

Step	Action
1	Eliminate all possible reasons for a trip and ensure it is safe to proceed (see *Turning On a DC port* in this manual's section).
2	Check the doors are not open and no-one is working in the charger.
3	Check the charger is not tilted, impacted, or damaged: a. Firmly press down on the switch until switch latches in the OFF position. b. The switch is now ready to be turned back on. c. Ensure it is safe to proceed. Follow the steps in section *Turning on a DC port* of this manual before turning on.

6.5.3 Debugging the trip

- Because the CS is completely unpowered immediately after the DC Port trips, there may not be an opportunity to transmit an error message if the trip occurs instantly on power-up.
- Follow the debugging steps in this section to identify the cause of a trip.

Step	Action
1	If the switch cannot be turned ON – either the bottom door sensor is in the open position or the CS trip wiring pair from the CS to the RU may be shorted: a. check the door is closed b. bottom door switch may be faulty or mis-wired c. wiring pair from the CS to the RU may be short circuited.
2	If the switch closes but 1-2 second later the trip occurs: a. top or bottom door sensor wiring may be faulty, or the door sensor is broken b. tilt sensor is tripped, or wiring is broken.
3	If the above debugging steps do not work: a. disconnect the trip wire between the CS and the RU. b. The CS sends a descriptive error message to the backend, to describe the cause of the trip.

RISK OF ELECTRIC SHOCK

- If using *Step 3*, the EPO interlocks are bypassed for the entire CS.
- Be extremely vigilant and take precautions to reconnect the trip wire when finished. The CS monitors for the presence of the trip wire and logs show that the trip wire was not reconnected.

6.6 PKM150 RU Emergency-Power-Off circuit

6.6.1 EPO circuit functionality

The EPO sub-system is a 0-20mA current loop which runs through the entire system and triggers an event in the case of disruption to the measured current in the loop; and can be triggered by the following:

- door sensors on the RU
- tilt sensor in the RU
- CS trip via the DC Port (only in special cases, see below)
- Fault encountered while attempting to pre-charge the DC output

RU communicates to the backend that a trip occurred and includes the reason for the trip.

6.6.2 EPO trips upstream breaker

In all cases, the EPO of the RU should be interfaced to the trip/release coil of an upstream circuit breaker, in the customer distribution panel. This can be an Undervoltage or Shunt trip coil.

For more information about selecting and designing the circuit, refer to *TRI155.INS.2023 PKM150 Site Installation Manual.*

6.6.3 Resetting a tripped upstream breaker

The upstream breaker should only be reset by a qualified and authorized representative.

The breaker can trip due to overcurrent or short circuit, and EPO trip. A qualified person must assess the risk of re-energizing the circuit breaker by inspecting the internals of equipment on site and checking for electrical faults before proceeding.

6.6.4 External emergency stop

The PKM RU is only fed from a single source of power. This indicates that site emergency stop can easily be implemented at the upstream distribution point. An e-stop button can be connected directly to the trip coil of the upstream circuit breaker.

Note that if using a 230V or 24V EPO trip interface to the RU, also disconnect this by the e-stop, if the requirement is to isolate the cabinet from all energy sources.

6.6.5 DCP / CS causes an RU cabinet EPO trip

The DC port provides an extra level of trip assurance by commanding the entire RU cabinet to de-energize (EPO trip) if the DC port switch fails to open in response to a CS trip.

Step	Action
Following is the preferred order of trips:	
1	CS experiences a trip (i.e., door of the CS is opened).
2	DC port switch should trip (other CS on site should keep running).
3	If the DC port switch does not trip, the entire RU should trip at the upstream MCCB

If an RU cabinet trip occurs (the breaker for the RU is tripped), first check the backend comms for the RU. It should report the reason for trip. If the DCP is reported as a reason, refer to *Tritium Technical Support* for help debugging.

7 Protection

Type	Explanation
Over-voltage protection	• RU is equipped with hardware over-voltage protection on the AC input and DC output. A voltage of 990VDC or greater on the 950VDC output instantly shuts down the AC/DC converter. Similarly, an AC voltage of 530VL-L or greater instantly shuts down the power unit AC/DC converter. • CS is also equipped with over-voltage protection on both the 950VDC input and the 200V-920VDC output.
Under-voltage protection	• Undervoltage shutdown occurs in the RU at 340 Vac. • Contact Tritium to determine if this feature is provided on the 950V dc bus input for the CS.
Short circuit protection	• RU uses fusing to protect the DC link between the RU and CS. • RU relies on the upstream MCCB on the incoming feed to protect the unit from short circuit.
Earth fault protection (CS ungrounded output circuit)	• In the CS vehicle charging output circuit, an insulation monitoring device (IMD) detects ground faults between the charging circuit and enclosure of the charger and between the charging circuit and the vehicle chassis. • When a ground fault is detected in the vehicle charging circuit, the charger stops charging and further charging sessions are prevented until the IMD confirms the ground fault is no longer present. For example, when the vehicle with a ground fault between the charging circuit and the vehicle chassis is disconnected from the CS.
Earth fault protection (RU - personnel protection)	The RU is incompatible with earth leakage devices set for personnel protection, as false trips will be frequent due to the power level of the equipment.
Earth fault protection (RU – equipment protection)	Earth fault protection for high impedance earth faults (equipment protection) is not provided internally with the product. In most jurisdictions earth leakage protection is not compulsory (unless employing TT earthing) but the site engineer should consult local regulations and provide earth fault protection if required upstream of the RU at the incoming feed. If provided, Tritium recommends a Type B/B+ with the trip current and time selectivity to be set based on the regulatory requirements for the protection scheme (i.e., in a TT system). Tritium recommends that the trip current not be set below 200mA, otherwise, false trips may occur. Nominal earth leakage current through the charger AC filter circuits can be as high as 50mA, excluding transient events. Trip settings may need to be adjusted (within regulatory limits) to reduce the likelihood of nuisance trips. Upstream earth fault protection may lessen the damage caused by some equipment faults and reduce the possibility of a fire under some circumstances.
Reverse power flow from EV	Each CS is equipped with a reverse current prevention diode in the output circuit to prevent reverse current flowing from the traction battery to the CS.
Surge protection	• (EU, AU) The AC input to the RU is protected by EN 61643-11 Type 2 SPD with In = 20kA 8/20us, SCCR = 150kA, including backup fuse.

Type	Explanation
	• (US) The AC input to the RU is protected by a UL Listed Type 1 SPD In = 20kA, SCCR = 200kA, including backup fuse. • AC SPD is monitored, and telemetry error is raised to indicate if they need to be serviced.
Galvanic isolation	Galvanic isolation is provided by a double/reinforced spec high frequency transformer in the CS.
Earth reference	• The 950Vdc link between RU and CS is ungrounded but is earth referenced by the AC/DC converters, which are non-isolated. This DC system may be referred to as a "functional grounded" system (NEC) or "non-separated" system. • The 950Vdc circuit MUST NOT be tied to earth at the positive, negative, or at any midpoint. • Low impedance earth faults on the 950Vdc circuit will cause a large fault current which will clear protective fuses in the RU.
Unauthorized access/direct contact with charged electrical components	• Tritium's charging system is compliant with clause 5.2.3 IEC 61140 for protective barriers. • Barriers have an adequate IP level for low voltage installations to prevent someone inserting their fingers through the barriers. • Protective barriers have adequate mechanical strength for the application. • Removal of barriers requires either the use of a tool or a key. • Tritium's RU and CS include an EPO cut-out switch on the doors.
Vehicular impact	The RU and CS are all equipped with tilt sensors to monitor vehicular impact/vandalism. This sensor is triggered if the unit is: • tilted by more than 10 degrees. • detached from its concrete foundation by the impact (>10 degrees tilt expected).
Over current protection	• When a short circuit is detected between the positive and negative of the output circuit, the CS turns off the devices in the DC-DC converter to interrupt the output short circuit. • Multiple over-current trip thresholds have been implemented to trigger a converter shutdown. This is implemented both in software and directly in hardware as a software-overcurrent-shutdown and a hardware-overcurrent-shutdown. • CS is also protected against overload conditions by fast-blow current-limiting fuse in the DC output circuit of the charger. • RU uses fusing to protect the DC link between the RU and CS. • RU has an electronic trip unit integrated into the MCCB on the incoming feed to protect the unit from short circuit.
Over temperature protection	The thermal management of the charging system is designed to take care of both cold and hot climate conditions. This is applied to all components with possible human touch points temperature requirements according to IEC 61851-23.

8 Energize and de-energize the RU

The order in which the various circuits are energised or deenergised is pre-determined so that the charging site operates normally. Otherwise, the 3-phase load not turning on due to the EPO-loop circuit principle of operation.

8.1 Energize the charging system (Undervoltage trip fitted)

Step	Action
1	A start button or other method of starting should be provided. Press the start button, which may require holding down for several seconds.
2	**IF …** / **THEN …** it is safe to start / the circuit breaker can be closed, energizing the unit it is not safe to start (i.e., door open at the cabinet) / the circuit breaker may remain in the tripped state

8.2 Energize the charging system (Shunt trip fitted)

Step	Action
1	Ensure the shunt trip circuit is powered before approaching the main circuit breaker. Loss of power to the shunt trip circuit (e.g., RCD trip or blown fuse) may disable the entire site EPO system.
3	**IF …** / **THEN …** it is safe to start / the circuit breaker can be closed, energizing the unit it is not safe to start (i.e., door open at the cabinet) / the circuit breaker may remain in the tripped state

8.3 De-energize the charging system

Step	Action
1	Turn off the three-phase power.
2	a. Identify any additional sources of power into the cabinet (trip circuits if running from hazardous voltage), and de-energize if necessary. b. The charging system should be de-energized.
3	Follow all procedures in *TRI155.FSP.1991 PKM150 Service* Manual, including: a. Lock-out the circuit breaker, by following standard procedures. b. Verifying that the system is completely unpowered by testing for absence of voltage, by following standard procedures.

CRITICAL

Never de-energize the system by opening the door of any cabinet to trip the circuit breaker. The correct procedure for de-energizing is to isolate first, before approaching the cabinet.

9 Recommended preventative maintenance intervals

Refer to the *TRI155.INS.1972v1_PKM150CS - Preventative Maintenance Schedule*.

10 Telemetry

Step	Action
1	Customers to communicate to Tritium the preferred WebSocket's URL prior to shipping. This is so the charger arrives and connects immediately to the correct server when powered on.
2	Customers can change the WebSocket's URL after installation, by using the *changeConfigurationRequest* packet that is part of the OCPP 1.6 protocol. Particularly, customers need to set the *CentralURL* configuration parameter.
3	Passwords and security recommendations are outlined in *Tritium's Technical White Papers*: • *Staying Ahead: OCPP 1.6* • *OCPP 1.6 Deployment Procedures for Tritium Veefil Charge Points*