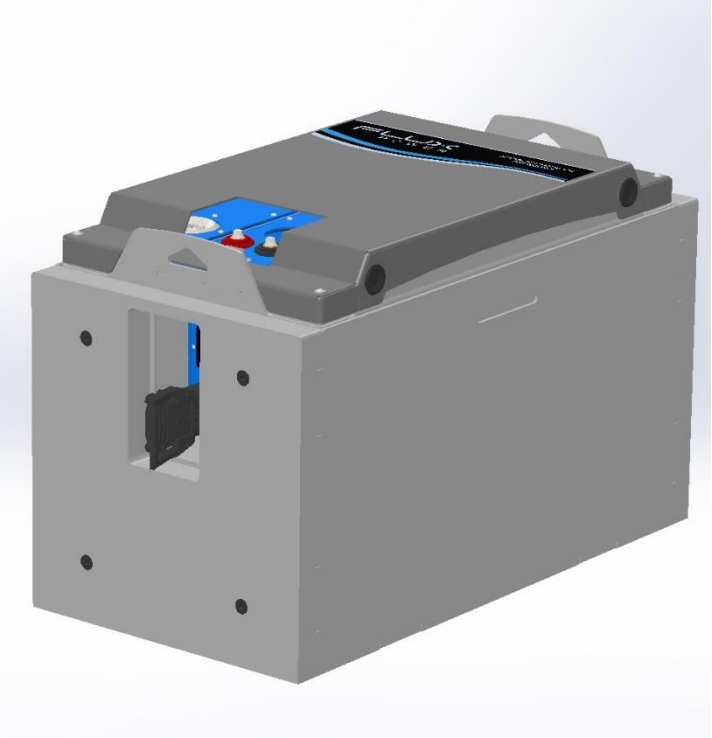
Training

# L-Series First Level Training



FLUX POWER

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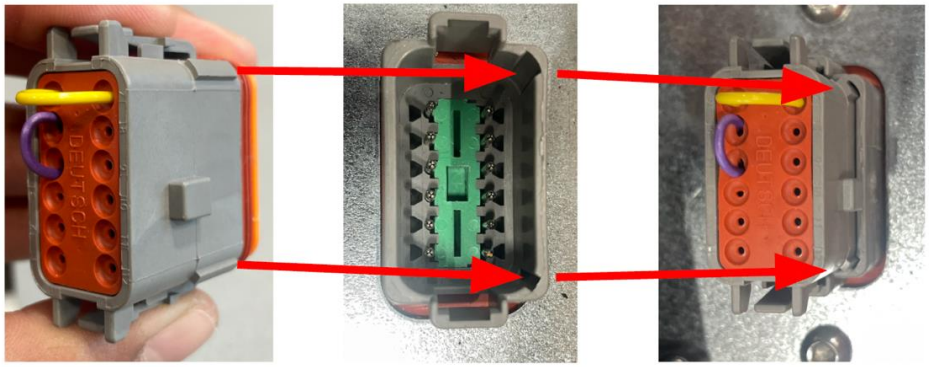
# 1 Introduction

This document is intended to serve as a training template and a first level reference for troubleshooting Flux Power batteries. Specific troubleshooting will not be covered in this document; however there already exist online tools and documents for specific troubleshooting for each battery. Those tools and their locations will also be referenced in this document. Different versions of batteries will also be referenced by their Battery Management System (BMS) versions and serial numbers.

# 2 External Harnesses

All M-Series batteries require an external harness connected to their communications port to operate. The communications port on each M-Series battery varies location, but they all follow the same pin out. Each external harness may have different connections such as to the truck, external SOC gauge, and telematics, but all external harnesses with have the same 12-pin connector and orientation used to plug into a battery's communications port.

Notice that the connector has 2 ridges only on one side which allow it to only be inserted into the communication port through one way. Use this orientation to view the pin numbering. The column of pins on the side with the 2 ridges consist of pins 7-12. Pin 7 is populated with the yellow loop back wire in the picture below. The column of pins on the opposite side of the 2 ridges consist of pins 1-6. Pins 4 and 5 are populated with a purple loop back wire. Pin 6 will be populated with the yellow loop back with pin 7.



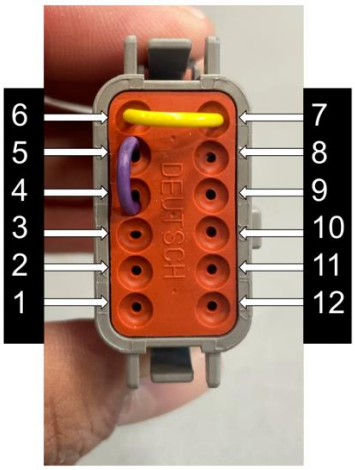



Figure 1: External harness pin out numbering

The battery sends out a signal into the external harness and looks for its return to close the discharge contactor and turn on the truck. If this signal is disrupted anywhere along the external harness, then the external SOC gauge will sound an alarm for 10 seconds to indicate that battery will open its discharge contactor and the truck will turn off.

# 3 L-Series

The L-Series batteries out in the field can be of two different blade encasing colors and Battery Discharge Indicator (BDI) systems. The older version of the battery will have blue encased blades, a set of 6 LEDs which are used to display the battery's current SOC % and any Device Trouble Codes (DTCs) that may be present, and a mechanical turn switch on the front face of the battery. This will be referred to as the L48 with the mechanical power switch. The currently newer version of the L-Series battery will have gray metal encased blades, a blue capacitive internal BDI used to display the battery's current SOC % and any Device Trouble Codes (DTCs) that may be present, and that same internal BDI is used to turn the battery ON and OFF. This will be referred to as the L48 with the capacitive touch power button.

## 3.1 L48 (Capacitive Touch Power Button)

### 3.1.1 First Level Components

The figure below is of the outside of a fully assembled L48 battery.


Figure 2: First Level Components of L48

The first level components are found on the outside of the battery. Below is a brief description of each component and their function.

- Internal BDI: A blue capacitate touch BDI that is used to display the battery's current SOC % and any Device Trouble Codes (DTCs) that may be present.

- Battery's Power Cables: Connect to the truck and provide power to it. These are equipped with SB XXX connectors.
- Communications Port: Battery's 12-pin connector used to communicate with the battery through a device with the appropriate software. Not all pins of the 12-pin connector are populated. Pins are numbered 1-12 in a clockwise manner. Use the image below as a reference.

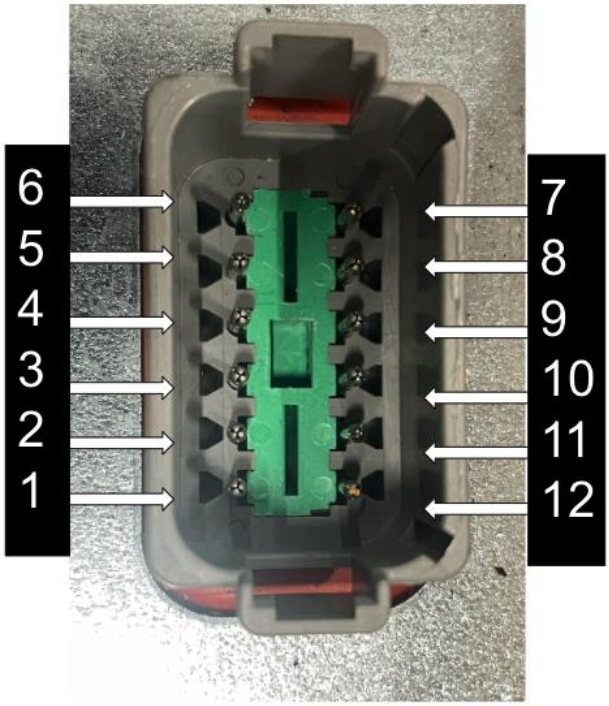



Figure 3: Communications Port's pin numbering with cap on

- Charge Port: The charge port of this battery can be populated with up to 3 sets of pins.
  - X-Large Pins: Positive and negative cables from the battery.
  - Bottom Pair Large Pins: Hot disconnect loop back.
  - Top Pair Small Pins: Drive away protect loop back.

Figure 4: Charge Port's pin sets

### 3.1.2 Reading Device Trouble Codes (DTC)s

The battery's internal BDI will flash DTCs in increasing numerical order. It is important to note that not all DTCs mean that there is an issue with the battery. The DTCs are used to force open both the charge and discharge contactors in the battery to protect the cells.

| Fault Description | Cause and Required Duration to Trigger | Fault Protection | DTC Number | Service Required? | Fault Resolution |
|---|---|---|---|---|---|
| Low SOC % | Cause: the SOC % has reached 5% or lower<br><br>Duration to trigger: 10 seconds | Buzzer Sounds Periodically | 1 | No | Plug the battery in to charge. If the battery is allowed to remain in this overdischarged state for long, then service will be required to be able to charge it. A loose cell tap connection can also present a false SOC percentage reading and cause a false DTC. |
| Exceed Temperature Range | Cause: the cell temperatures have either gotten too high or too low. The upper and lower thresholds vary for charging and discharging states. They can be seen below<br><br>Charging: 33F (lowest) and 123F (highest)<br><br>Discharging: -4F (lowest) and 131F (highest)<br><br>Duration to trigger: 10 seconds | Contactor Opens | 2 | No | Allow the pack to either cool down or warm up. A warmer ambient temperature and heavy use can increase the cells' temperature. The quickest way to cool down the battery is to turn it off through the circuit breaker. A colder ambient temperature and lack of use (leaving pack off in cold warehouse overnight) can lower the cell's temperature. The quickest way to warm up the battery is to leave it turned on and charging. A loose connection on the thermistors can also present a false cell temperature reading and cause a false DTC. |

| | | | | | |
|---|---|---|---|---|---|
| High Cell | Cause: at least one cell has reached 3.60V. This will occur when charging. This will also trigger DTC 11 and 12.<br><br>Duration to trigger: 10 seconds | Contactor Opens | 3 | No | The contactor will remain open. In order to close the contactor, the battery will need to be power cycled through its internal BDI. If the SOC percentage is still low, then an authorized technician will need to connect to the battery. |
| Exceed Current Range | Cause: the current going through the battery has exceeded the thresholds for charging and discharging states. They can be seen below.<br><br>Charging: 1000A (highest)<br><br>Discharging: -1000A (lowest)<br><br>Duration to trigger: 10 seconds | Contactor Opens | 4 | No | Connect the appropriate charger and cycle internal BDI. |
| Electronics Hardware Failure | Cause: an issue with the BMS has prevented the battery from charging and discharging<br><br>Duration to trigger: 10 seconds | Contactor Opens | 6 | Yes | An authorized technician will need to connect to the battery in order to resolve the DTC. |
| Low Cell Imminent | Cause: at least one cell has reached a voltage value of 2.95V.<br><br>Duration to trigger: immediate | None | 9 | No | Plug the battery in to charge. If the battery is allowed to remain in this overdischarged state for long, then service will be required to be able to charge it. A loose cell tap connection can also present a false cell voltage reading and cause a false DTC. |
| Integrity Signal | Cause: if another DTC less than 11 is present, then it will trigger DTC 11. If there is an issue with the external harness then it will also trigger this DTC.<br><br>Duration to trigger: 10 seconds | Contactor Opens | 11 | Yes | Ensure that the communications port has a proper loop-back. If an external harness is connected, then ensure that all components of the harness are properly connected and functioning. Cycling the power through the internal BDI can resolve the DTC. If the DTC is still present afterwards, then an authorized technician will need to connect to the battery. |
| EWS Latched | Cause: this comes grouped with DTC 11.<br><br>Duration to trigger: 10 seconds | Contactor Opens | 12 | Yes | Ensure that the communications port has a proper loop-back. If an external harness is connected, then ensure that all components of the harness are properly connected and functioning. Cycling the power through the internal BDI can resolve the DTC. If the DTC is still present afterwards, then an authorized technician will need to connect to the battery. |

### 3.1.3 Discharging the Battery

The battery is discharged through its power cables. This battery is equipped with a charge and discharge contactor. The discharge contactor is in line with the red positive power cable. Therefore, the black negative power cable is always grounded. The color of the plastic connector on the power cables must match the color of the connector on the truck.

If there are no DTCs present, no problems with the external harness, then the contactor should be closed, and the truck will turn ON. If the truck still does not turn ON, then an authorized technician will need to connect to the battery. A voltmeter will display the battery's voltage at the power cables.

### 3.1.4 Charging the Battery

The battery is charged through its charge port. The charge contactor is in line with the positive x-large pin of the charge port. The external charger's lithium profile should not exceed a charge current of XXA. A charge current profile exceeding this threshold can imbalance the pack and make the charger cables hot to the touch. There is also no CAN communication between the battery and the external charger, but there are some loop backs required through the charge port's auxiliary pins. In these loop backs, the battery will send out a signal and will wait to close the charge contactor once it sees the signal return. The simplest method to ensure that the external charger and the battery's charge port are properly equipped with all required loop backs is to ensure their auxiliary pins match as seen in the figure below.

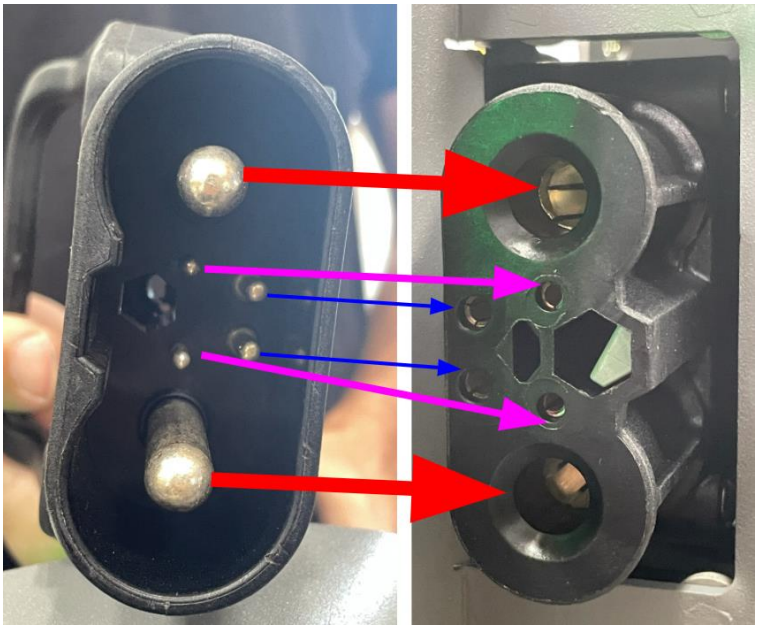


Figure 5: Charger's connector (left) and charge port (right)

The small battery display on the internal BDI will indicate charging by filling up through an animation. Once all cells reach 3.45V, then the battery's SOC percentage will reset to 100%. Once at least one cell reaches 3.60V both contactors will open to stop charging as a safety measure. If there are no DTCs present, and the battery does not charge, then an authorized technician will need to work on the battery.

## 3.2 L48 (Mechanical Power Switch)

### 3.2.1 First Level Components

The figure below is of the outside of a fully assembled L48 battery.

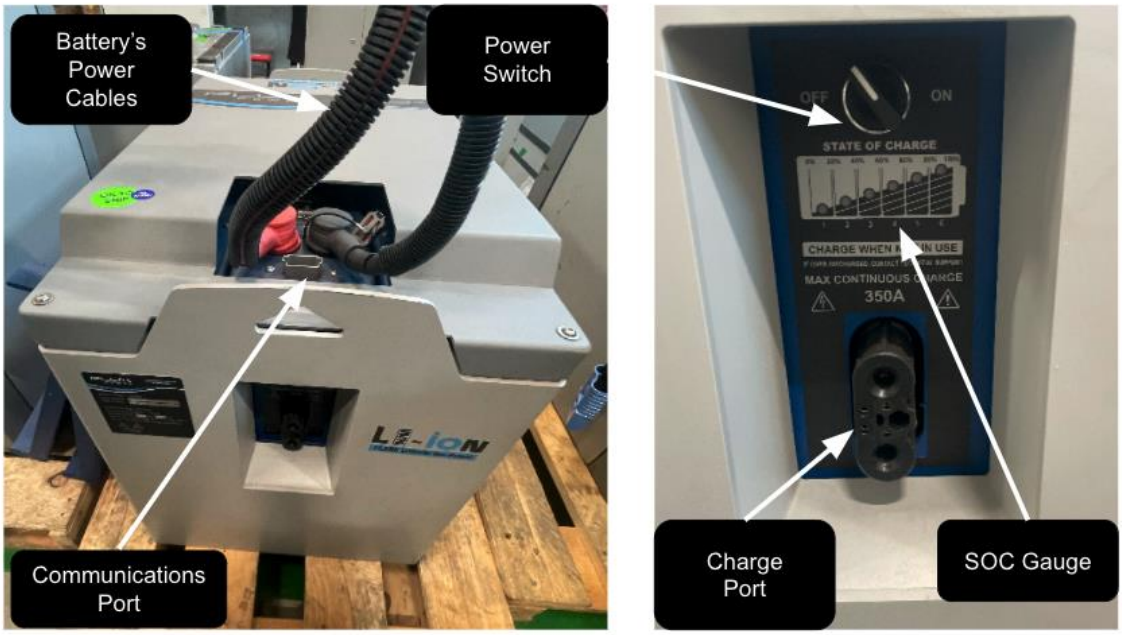



Figure 6: First Level Components of L48

The first level components are found on the outside of the battery. Below is a brief description of each component and their function.

- Power Switch: A black power switch used to turn the battery ON and OFF. It is also labeled to indicate which orientation to turn it to turn the battery ON and OFF.
- State of Charge (SOC) Gauge: A set of 6 LEDs which are used to display the battery's current SOC % and any Device Trouble Codes (DTCs) that may be present. The SOC is shown by the solid set of lights. Any DTC present is shown by that LED light flashing.
- Battery's Power Cables: Connect to the truck and provide power to it. These are equipped with SB XXX connectors.
- Communications Port: Battery's 12-pin connector used to communicate with the battery through a device with the appropriate software. Not all pins of the 12-pin connector are populated. Pins are numbered 1-12 in a clockwise manner. Use the image below as a reference.

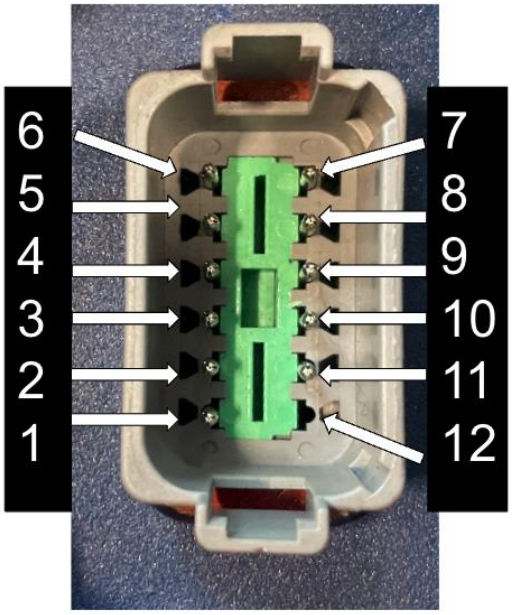



Figure 7: Communications Port's pin numbering with cap on

- Charge Port: The charge port of this battery can be populated with up to 3 sets of pins.
  - X-Large Pins: Positive and negative cables from the battery.
  - Bottom Pair Large Pins: Hot disconnect loop back.
  - Top Pair Small Pins: Drive away protect loop back.

Figure 8: Charge Port's pin sets

### 3.2.2 Reading Device Trouble Codes (DTC)s

The 6 LEDs on the front of the battery will indicate the SOC percentage of the battery and any DTCs that may be present.

The SOC percentage of the battery is represented by solid LEDs. For reference, the SOC gauge numbers the LEDs 1-6 and assigns each number a SOC percentage. Flux Power recommends that the battery not be allowed to go below 30%, or LED 2.

When a DTC is present, the LED associated with that DTC will flash multiple times. Each DTC is described below.

| Fault Description | Cause and Required Duration to Trigger | Fault Protection | LED Indicator | Service Required? | Fault Resolution |
|---|---|---|---|---|---|
| Low Cell | Cause: at least one cell has reached a voltage value at or below 2.80V<br><br>Duration to trigger: immediate | Contactor Opens | LED 1 | No | Plug the battery in to charge. If the battery is allowed to remain in this overdischarged state for long, then service will be required to be able to charge it. A loose cell tap connection can also present a false cell voltage reading and cause a false DTC. |
| Low SOC % | Cause: the SOC % has reached 5% or lower<br><br>Duration to trigger: immediate | Buzzer Sounds Periodically | LED 1 | No | Plug the battery in to charge. If the battery is allowed to remain in this overdischarged state for long, then service will be required to be able to charge it. A loose cell tap connection can also present a false SOC percentage reading and cause a false DTC. |
| Electronics Hardware Failure | Cause: an issue with the BMS has prevented the battery from charging and discharging<br><br>Duration to trigger: immediate | Contactor Opens | LED 3 | Yes | An authorized technician will need to connect to the battery in order to resolve the DTC. |
| Exceed Temperature Range | Cause: the cell temperatures have either gotten too high or too low. The upper and lower thresholds vary for charging and discharging states. They can be seen below<br><br>Charging: 33F (lowest) and 123F (highest)<br><br>Discharging: -4F (lowest) and 131F (highest)<br><br>Duration to trigger: immediate | Contactor Opens | LED 4 | No | Allow the pack to either cool down or warm up. A warmer ambient temperature and heavy use can increase the cells' temperature. The quickest way to cool down the battery is to turn it off through the circuit breaker. A colder ambient temperature and lack of use (leaving pack off in cold warehouse overnight) can lower the cell's temperature. The quickest way to warm up the battery is to leave it turned on and charging. A loose connection on the thermistors can also present a false cell temperature reading and cause a false DTC. |
| Exceed Current Range | Cause: the current going through the battery has exceeded the thresholds for charging and discharging | Contactor Opens | LED 5 | No | Connect the appropriate charger and cycle the circuit breaker OFF, then ON |

| | | | | | |
|---|---|---|---|---|---|
| | states. They can be seen below.<br><br>Charging: 1000A (highest)<br><br>Discharging: -1000A (lowest)<br><br>Duration to trigger: immediate | | | | |
| Low Cell Imminent | Cause: at least one cell has reached a voltage value of 2.95V.<br><br>Duration to trigger: immediate | None | LED 6 | No | Plug the battery in to charge. If the battery is allowed to remain in this overdischarged state for long, then service will be required to be able to charge it. A loose cell tap connection can also present a false cell voltage reading and cause a false DTC. |

### 3.2.3 Discharging the Battery

The battery is discharged through its power cables. This battery is equipped with a charge and discharge contactor. The discharge contactor is in line with the red positive power cable. Therefore, the black negative power cable is always grounded. The color of the plastic connector on the power cables must match the color of the connector on the truck.

If there are no DTCs present, no problems with the external harness, then the contactor should be closed and the truck will turn ON. If the truck still does not turn ON, then an authorized technician will need to connect to the battery. A voltmeter will display the battery's voltage at the power cables.

### 3.2.4 Charging the Battery

The battery is charged through its charge port. The charge contactor is in line with the positive x-large pin of the charge port. The external charger's lithium profile should not exceed a charge current of XXA. A charge current profile exceeding this threshold can imbalance the pack and make the charger cables hot to the touch. There is also no CAN communication between the battery and the external charger, but there are some loop backs required through the charge port's auxiliary pins. In these loop backs, the battery will send out a signal and will wait to close the charge contactor once it sees the signal return. The simplest method to ensure that the external charger and the battery's charge port are properly equipped with all required loop backs is to ensure their auxiliary pins match as seen in the figure below.

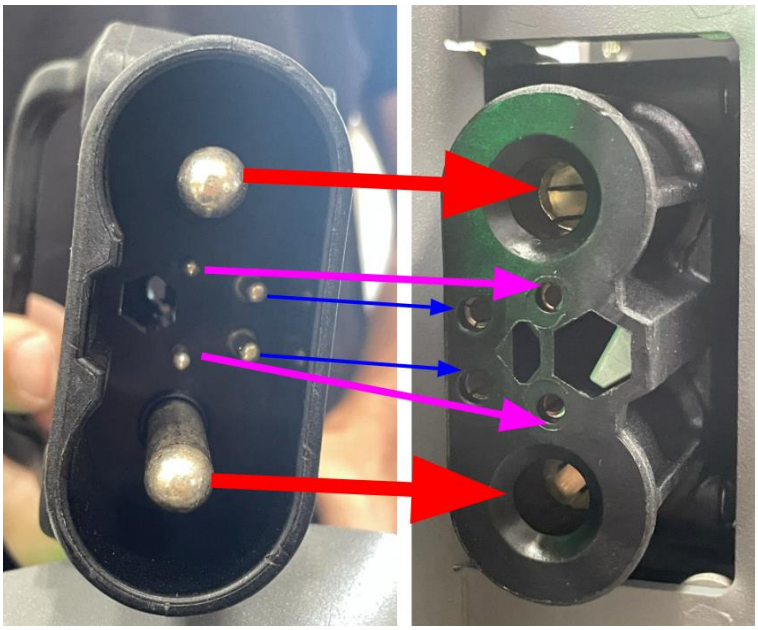


Figure 9: Charger's connector (left) and charge port (right)

The small battery display on the internal BDI will indicate charging by filling up through an animation. Once all cells reach 3.45V, then the battery's SOC percentage will reset to 100%. Once at least one cell reaches 3.60V both contactors will open to stop charging as a safety measure. If there are no DTCs present, and the battery does not charge, then an authorized technician will need to work on the battery.

# 4 Flux Power Contact Details

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