

M-Series First Level Training



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1 Introduction

This document is intended to serve as a first level training for 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 will 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.

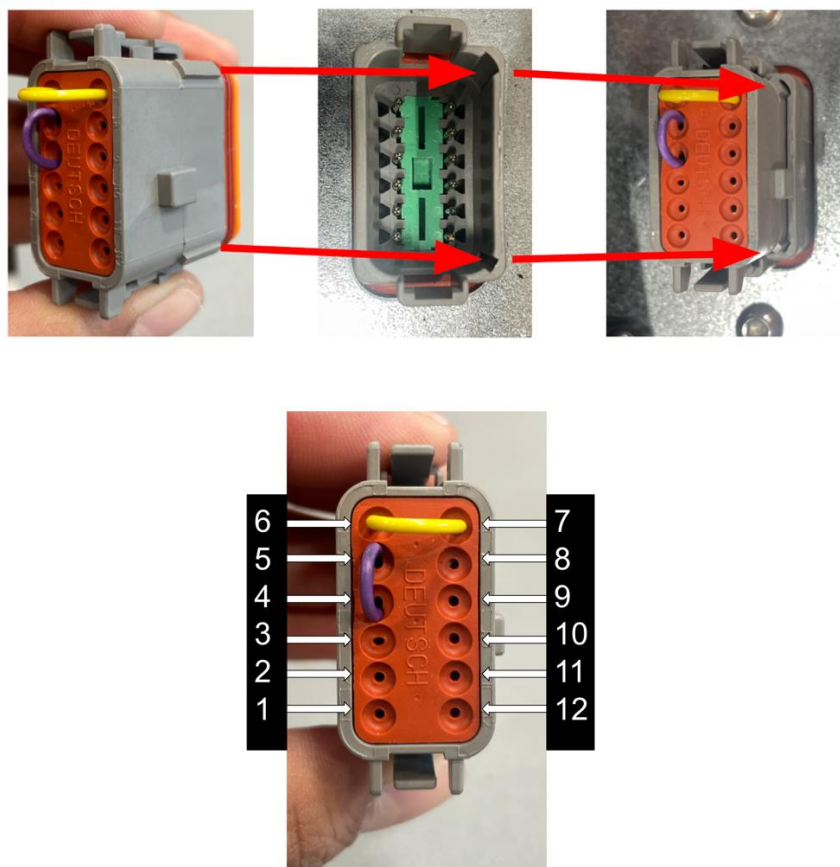


Figure 1: External harness pin out numbering

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 M-Series

The M-Series batteries consist of the following: M24 Legacy, M24 New Generation, and M36. These batteries are currently operating in electric stand-on pallet jacks.

3.1 M24 Legacy

The main difference between some M24 Legacy batteries is the presence of internal chargers. A M24 Legacy battery with internal chargers will come equipped with an A.C. inlet on the front face. However, M24 Legacy batteries can be charged through the battery's power cables despite whether it has internal chargers or not. The A.C. inlet can be seen on the images following.

3.1.1 First Level Components

The figure below is of the outside of a fully assembled M24 Legacy battery.

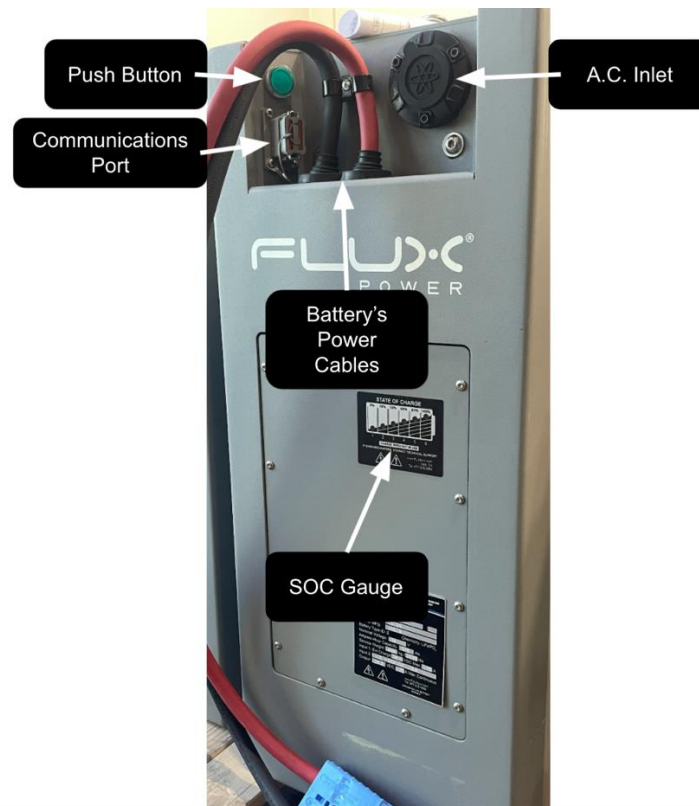


Figure 2: First Level Components of M24 Legacy

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

- 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. The color of the connector is dependent on the color of the connector on the truck.
- 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.

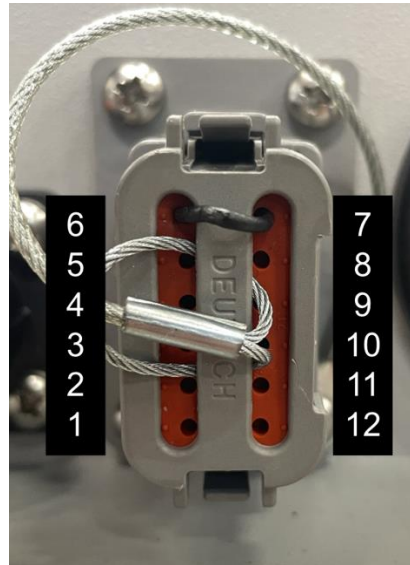


Figure 3: Communications Port's pin numbering with cap on

- Green Push Button: Used to turn the battery ON and OFF. To turn the battery ON push the green button inside. To turn the battery OFF press on the green button again.
- A.C. Inlet (if present): Plug the female end of an extension cable in to charge the battery.

3.1.2 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 Duration to trigger: immediate	Contactors 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 %	<p>Cause: the SOC % has reached 5% or lower</p> <p>Duration to trigger: immediate</p>	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	<p>Cause: an issue with the BMS has prevented the battery from charging and discharging</p> <p>Duration to trigger: immediate</p>	Contactors Opens	LED 3	Yes	An authorized technician will need to connect to the battery in order to resolve the DTC.
Exceed Temperature Range	<p>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</p> <p>Charging: 33F (lowest) and 115F (highest)</p> <p>Discharging: -4F (lowest) and 133F (highest)</p> <p>Duration to trigger: immediate</p>	Contactors 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	<p>Cause: the current going through the battery has exceeded the thresholds for charging and discharging states. They can be seen below.</p> <p>Charging: 1000A (highest)</p> <p>Discharging: -1000A (lowest)</p> <p>Duration to trigger: immediate</p>	Contactors Opens	LED 5	No	Connect the appropriate charger and cycle the circuit breaker OFF, then ON
Low Cell Imminent	<p>Cause: at least one cell has reached a voltage value of 2.95V.</p> <p>Duration to trigger: immediate</p>	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.

3.1.3 Discharging the Battery

The battery is discharged through its power cables. This battery is equipped with a single contactor that is in line with the red positive power cable. Therefore, the black negative 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 A.C. inlet or power cables. The external charger's lithium profile should not exceed a charge current of 280A. A charge current profile exceeding this threshold can imbalance the pack and make the power cables hot to the touch. There is also no CAN communication between the battery and the external charger; therefore, the only communication the battery sends to the external charger is its pack voltage. If the battery's voltage is high enough, then the charger won't charge the pack because of the logic of its lithium profile.

If there are no DTCs present, no problems with the external harness, then the battery should charge when plugged into an A.C. power source. If the battery still does not charge, then an authorized technician will need to connect to the battery. The LEDs on the SOC gauge will indicate charging through a scrolling sequence. The LEDs will light up and stay on one by one from LED 1-6. They will all then stay solid for a second, flash to the current SOC percentage, and the scrolling sequence will start over. Once all 8 cells reach 3.45V, then the battery's SOC percentage will reset to 100%. Once at least one cell reaches 3.60V the contactor will open to stop charging as a safety measure.

3.2 M24 New Generation

All M24 New Generation batteries require an external harness to be plugged into the battery to turn ON. This modification is a simple loop-back between pins 6 and 7 that should already be inserted into the external harness.

3.2.1 First Level Components

The figure below is of a fully assembled M24 New Generation battery without the external harness connected for reference.

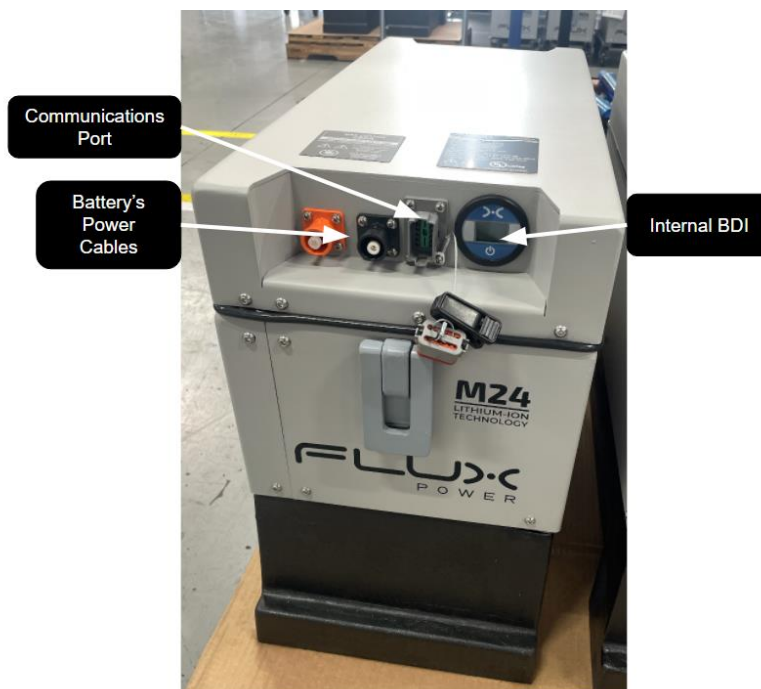


Figure 4: First level components of an M24 New Generation battery

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

- Internal Battery Discharge Indicator (BDI): A blue circular BDI with a display used to display the battery’s current SOC % and any Device Trouble Codes (DTCs) that may be present. To turn the battery ON, there is a push power button on the Internal BDI. Press and hold this power button for 3 seconds.
- Battery’s Power Cables: Connect to the truck and provide power to it. The color of the connector is dependent on the color of the connector on the truck.
- 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.

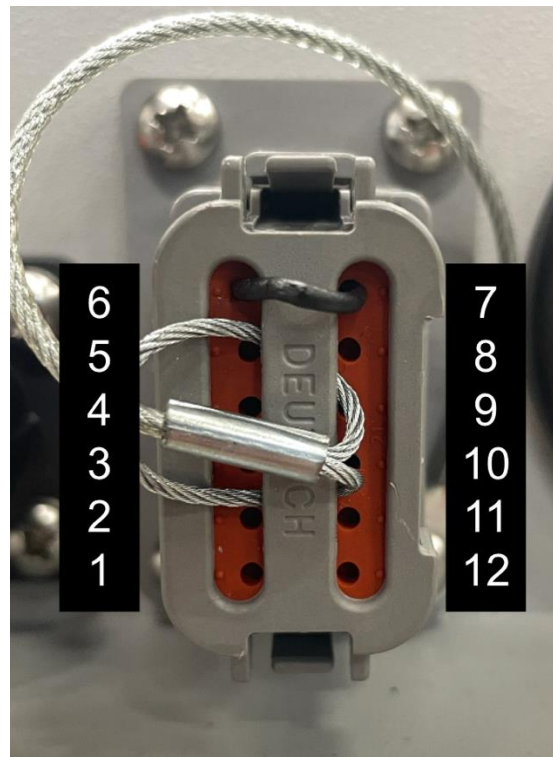


Figure 5: Communications Port’s pin numbering

3.2.2 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 %	<p>Cause: the SOC % has reached 5% or lower</p> <p>Duration to trigger: 10 seconds</p>	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	<p>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</p> <p>Charging: 33F (lowest) and 115F (highest)</p> <p>Discharging: -4F (lowest) and 133F (highest)</p> <p>Duration to trigger: 10 seconds</p>	Contactors 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	<p>Cause: at least one cell has reached 3.60V. This will occur when charging. This will also trigger DTC 11 and 12.</p> <p>Duration to trigger: 10 seconds</p>	Contactors 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	<p>Cause: the current going through the battery has exceeded the thresholds for charging and discharging states. They can be seen below.</p> <p>Charging: 1000A (highest)</p> <p>Discharging: -1000A (lowest)</p> <p>Duration to trigger: 10 seconds</p>	Contactors Opens	4	No	Connect the appropriate charger and cycle internal BDI.
Electronics Hardware Failure	<p>Cause: an issue with the BMS has prevented the battery from charging and discharging</p> <p>Duration to trigger: 10 seconds</p>	Contactors Opens	6	Yes	An authorized technician will need to connect to the battery in order to resolve the DTC.
Low Cell Imminent	<p>Cause: at least one cell has reached a voltage value of 2.95V.</p> <p>Duration to trigger: immediate</p>	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	<p>Cause: if another DTC less than 11 is present, then it will trigger DTC 11. If there is an issue with the external</p>	Contactors 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

	harness then it will also trigger this DTC. Duration to trigger: 10 seconds				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. Duration to trigger: 10 seconds	Contactors 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.

3.2.3 Discharging the Battery

The battery is discharged through its power cables. This battery is equipped with a single contactor that is in line with the red positive power cable. Therefore, the black negative 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 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 power cables. The external charger's lithium profile should not exceed a charge current of 280A. A charge current profile exceeding this threshold can imbalance the pack and make the power cables hot to the touch. There is also no CAN communication between the battery and the external charger; therefore, the only communication the battery sends to the external charger is its pack voltage. If the battery's voltage is high enough, then the charger won't charge the pack because of the logic of its lithium profile.

The small battery display on the internal BDI will indicate charging by filling up through an animation. Once all 8 cells reach 3.45V, then the battery's SOC percentage will reset to 100%. Once at least one cell reaches 3.60V the contactor 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.

3.3 M36

There have been a few different iterations on the electronics tray of this battery in terms of component placement, however they all have the same components. These batteries are different in terms of their charge ports. This will be explained below.

3.3.1 First Level Components

The figure below is of the outside of a fully assembled M36 battery.

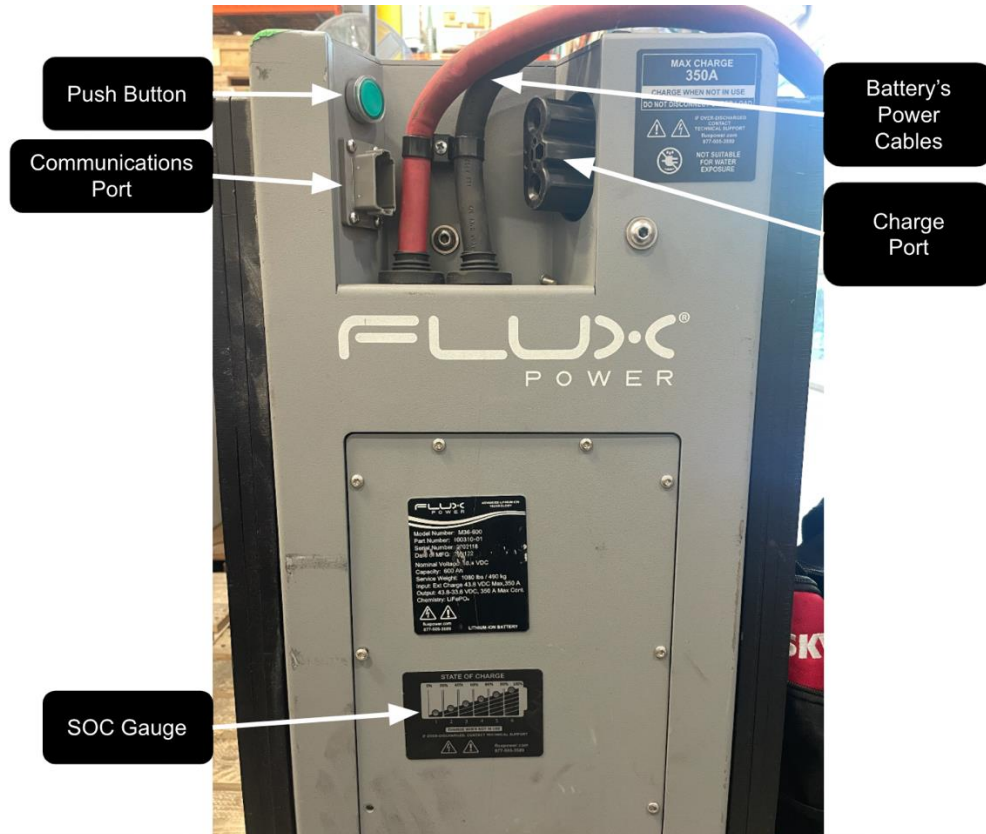


Figure 6: First Level Components of M36

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

- 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. The color of the connector is dependent on the color of the connector on the truck.
- 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.

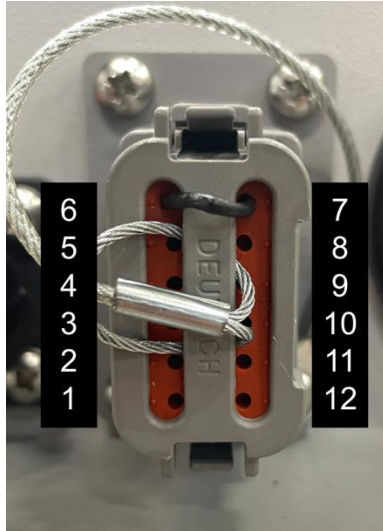


Figure 7: Communications Port's pin numbering

- Green Push Button: Used to turn the battery ON and OFF. To turn the battery ON push the green button inside. To turn the battery OFF press on the green button again.
- 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.
 - Right Pair Large Pins: Hot disconnect loop back required on model batteries 100310-01 and 100310-04.
 - Left Pair Small Pins: Drive away protect loop back required on all model batteries.



Figure 8: Charge Port's pin sets

3.3.2 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	<p>Cause: at least one cell has reached a voltage value at or below 2.80V</p> <p>Duration to trigger: immediate</p>	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 %	<p>Cause: the SOC % has reached 5% or lower</p> <p>Duration to trigger: immediate</p>	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 cell voltage reading and cause a false DTC.
Electronics Hardware Failure	<p>Cause: an issue with the BMS has prevented the battery from charging and discharging</p> <p>Duration to trigger: immediate</p>	Contactor Opens	LED 3	Yes	An authorized technician will need to connect to the battery in order to resolve the DTC.
Exceed Temperature Range	<p>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</p> <p>Charging: 33F (lowest) and 115F (highest)</p> <p>Discharging: -4F (lowest) and 133F (highest)</p> <p>Duration to trigger: immediate</p>	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	<p>Cause: the current going through the battery has exceeded the thresholds for charging and discharging states. They can be seen below.</p>	Contactor Opens	LED 5	No	Connect the appropriate charger and cycle the circuit breaker OFF, then ON

	Charging: 1000A (highest) Discharging: -1000A (lowest) Duration to trigger: immediate				
Low Cell Imminent	Cause: at least one cell has reached a voltage value of 2.95V. 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.

3.3.3 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.

3.3.4 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 350A. 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 type of loop backs present in the charge port of your battery will depend on the model type displayed on the battery's I.D. plate. Use the chart below for charge port auxiliary pins assistance.

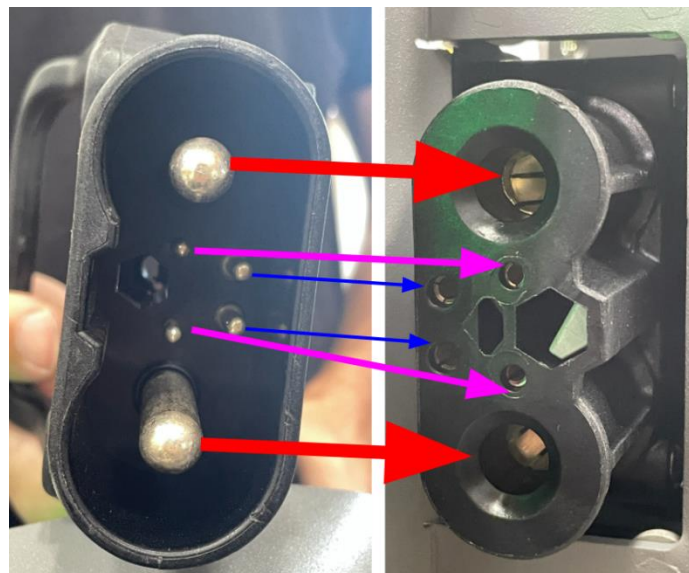


Figure 9: Charger's connector (left) and charge port (right)

Legend:

- Red: X-L pins for the positive and negative cables.
- Purple: Small pins.
- Blue: Large pins.

Model Type	Populated Auxiliary Pins
-01	<p>Large Pins: Populated, requires a loop back from the charger's connector</p> <p>Small Pins: Populated, requires a loop back from the charger's connector</p>
-02	<p>Large Pins: Not populated, no loop back required from the charger's connector</p> <p>Small Pins: Populated, requires a loop back from the charger's connector</p>
-03	<p>Large Pins: Not populated, no loop back required from the charger's connector</p> <p>Small Pins: Populated, requires a loop back from the charger's connector</p>
-04	<p>Large Pins: Populated, but serves as a loop back for the charger</p> <p>Small Pins: Populated, requires a loop back from the charger's connector</p>
-05	<p>Large Pins: Not populated, no loop back required from the charger's connector</p> <p>Small Pins: Populated, requires a loop back from the charger's connector</p>

The only communication the battery sends to the external charger is its pack voltage. If the battery's voltage is high enough, then the charger won't charge the pack because of the logic of its lithium profile.

If there are no DTCs present, no problems with the external harness, then the battery should charge when plugged into an A.C. power source. The LEDs on the SOC gauge will indicate charging through a scrolling sequence. The LEDs will light up and stay on one by one from LED 1-6. They will all then stay solid for a second, flash to the current SOC percentage, and the scrolling sequence will start over. If the battery still does not charge, then an authorized technician will need to connect to the battery. Once all 8 cells reach 3.45V, then the battery's SOC percentage will reset to 100%. Once at least one cell reaches 3.60V the contactor will open to stop charging as a safety measure.

4 Flux Power Contact Details

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WARNING – Risk of Fire – No User Serviceable Parts

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