



# Troubleshooting the REVOLUTION Charger

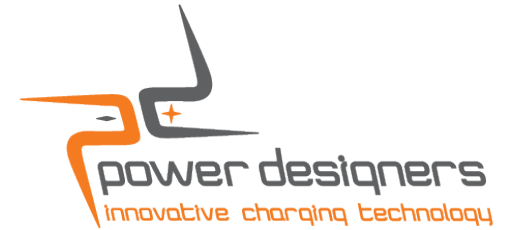
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# Revolution Series

## Charger Overview



- + 3 Basic models
  - RV05 5 module wide chassis
  - RV08 8 module wide chassis
  - RV12 12 module wide chassis
- + 2 Stacked models
  - RV16 Stacks 2 RV08s
  - RV24 Stacks 2 RV12s
- + 3 Major Assemblies
- + Chassis
- + Master Control Unit (MCU)
- + Battery Power Unit (BPU)

RV05



RV08



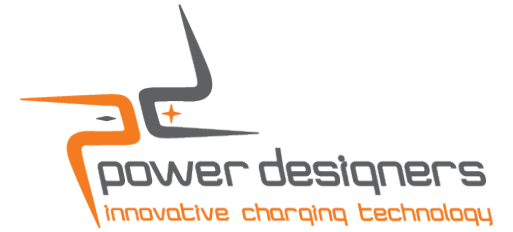
RV12



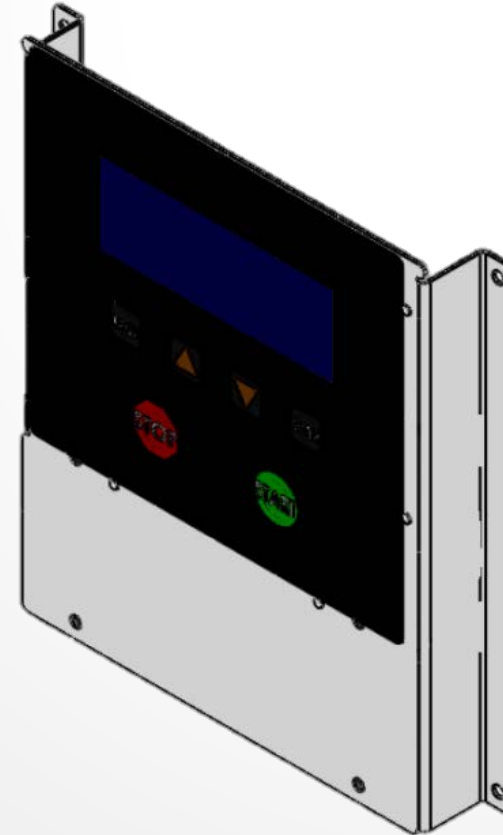
# Revolution Series

## Major Assemblies

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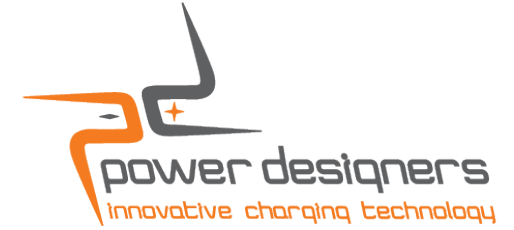


- + MCU Assembly
  - Controls charger operation
  - Stores charger settings
  - Contains
    - LCD display
    - Keypad

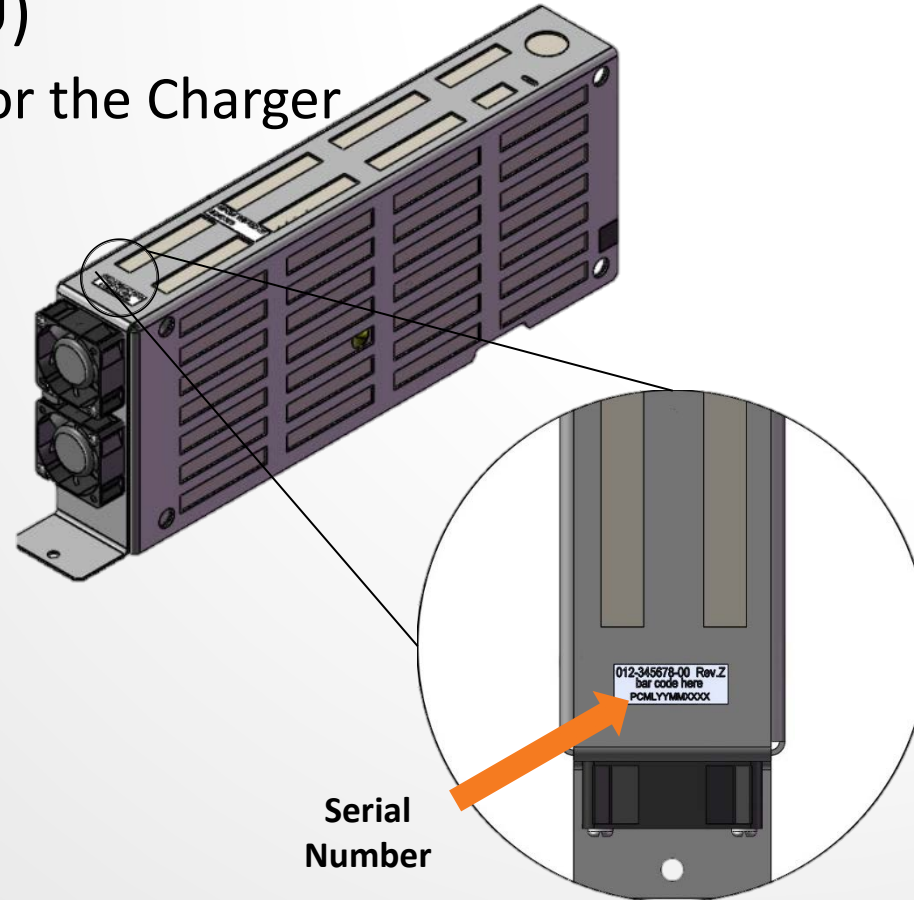


# Revolution Series

## Major Assemblies

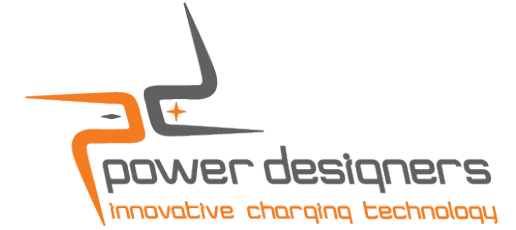


- + Battery Power Module (BPU)
  - Generates the actual output for the Charger
  - Two versions
    - 36V 30A, 1.3kW
    - 48V 25A, 1.3kW

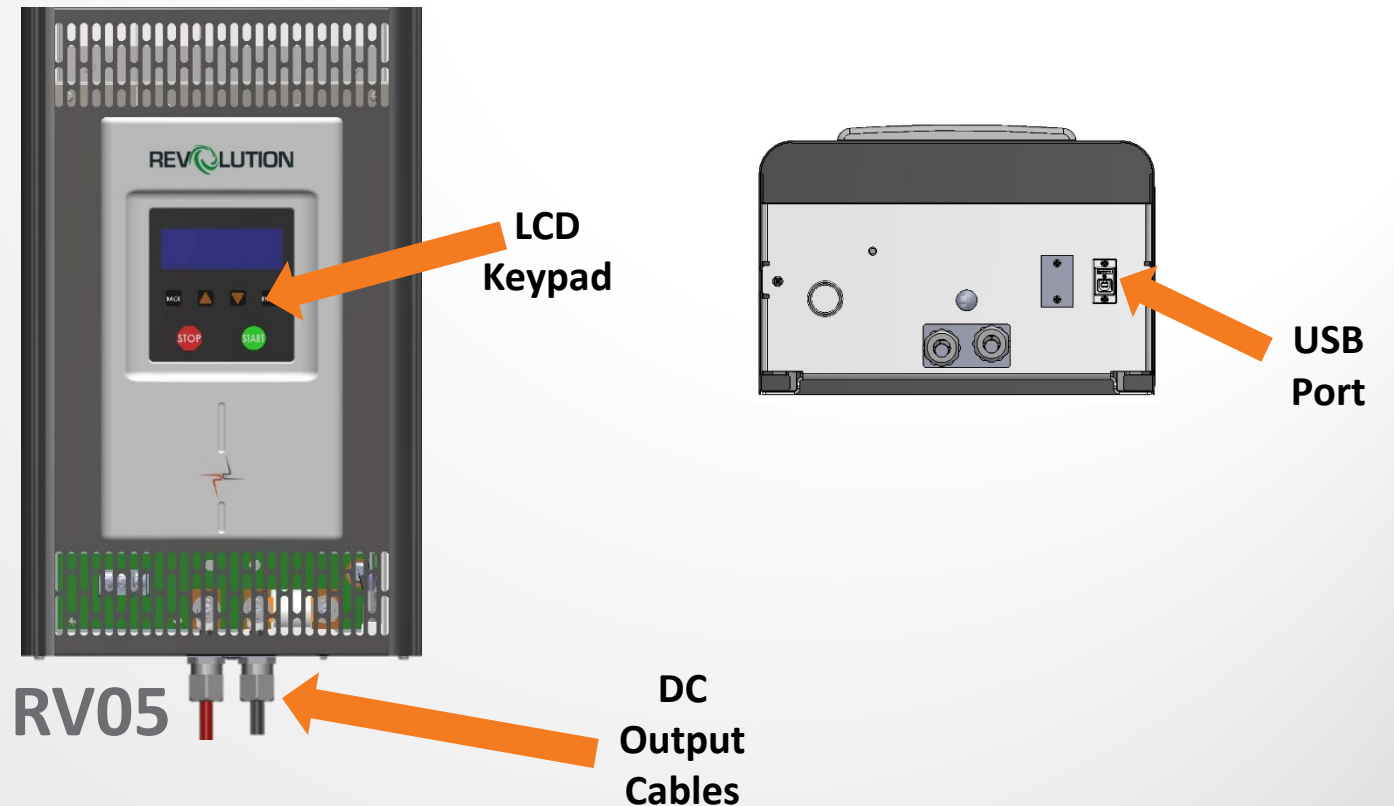


# Revolution Series

## Physical Attributes



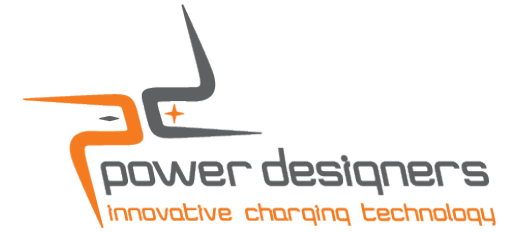
- + All Revolution chargers share the same physical attributes with respect to the;
- + Keypad and display
- + USB Programming Port
- + AC Input wiring from the bottom,
- + DC cable output from the bottom



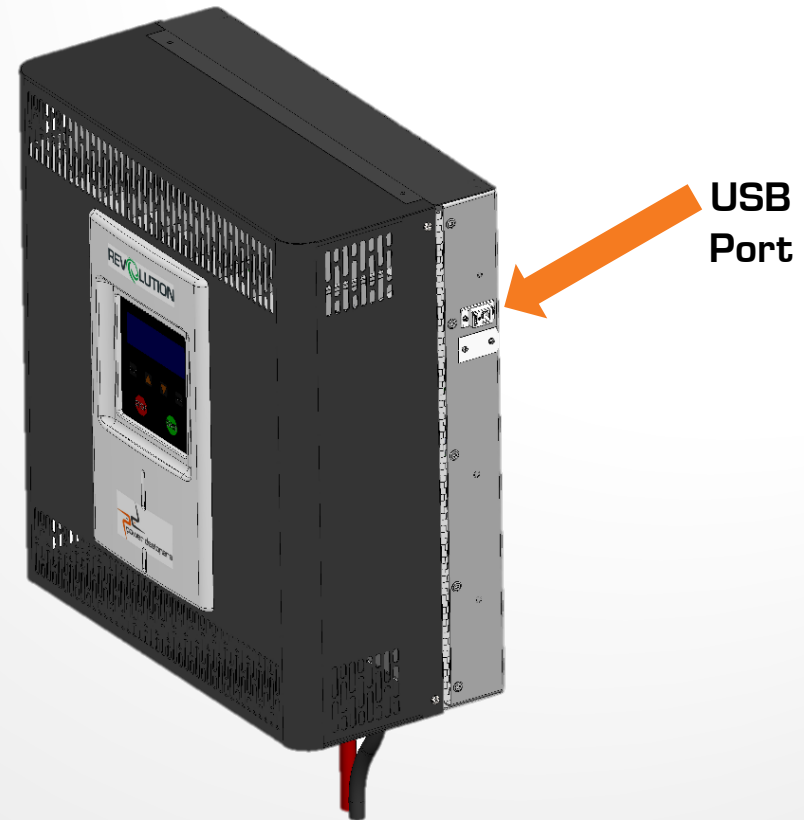
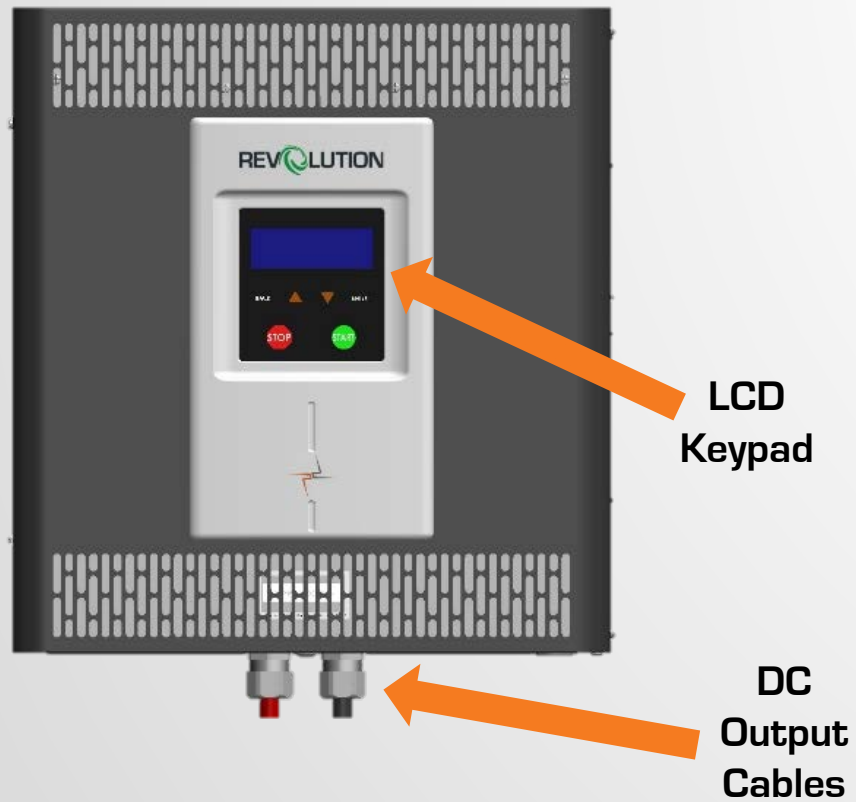


# Revolution Series

## Physical Attributes



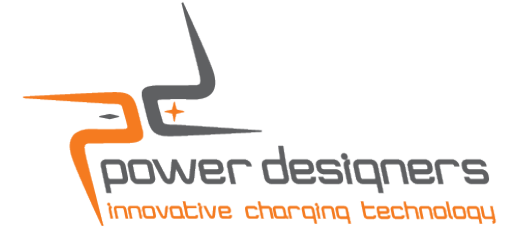
## RV08 & RV12



# Revolution Series

## Quiz Time

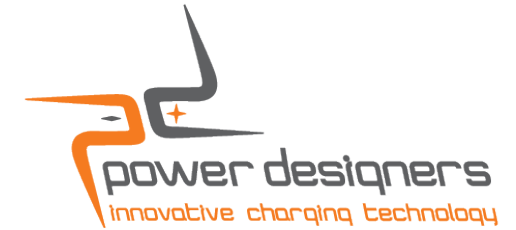
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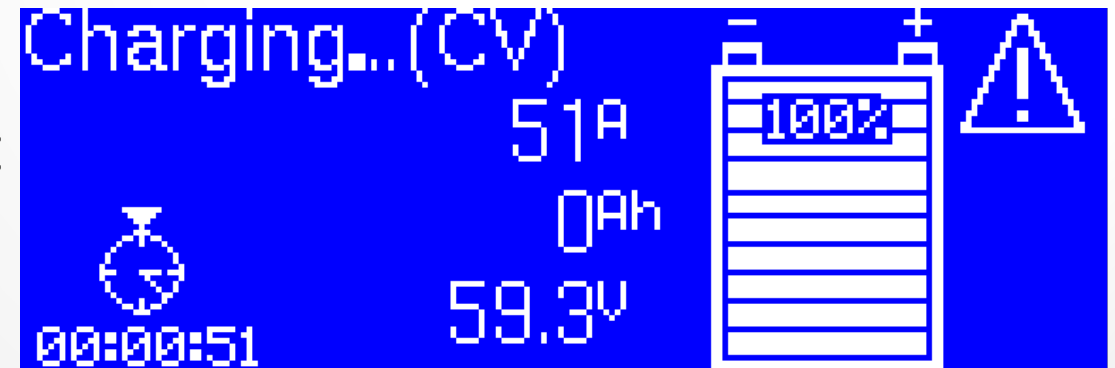
- + Revolution chargers have how many basic chassis sizes?  
Three, a 5 module, 8 module and 12 module chassis
  
- + What are the common attributes to the chargers
  - + Keypad display
  - + USB Port
  - + DC Output location on the bottom
  - + AC input location on the bottom
  
- + The 5 module chassis can be stacked True or False  
False only the 8 and 12 module unit can be stacked

# Revolution Series

## Redundancy and Faults



- + The Revolution charger is designed to continue to operate at reduced output as long as 60% of the installed modules continue to function.
- + In the event that the charger has fault independent of the nature of the fault
  - The Fault icon appears on the display while charging.
  - The Fault is recorded in the charge history.

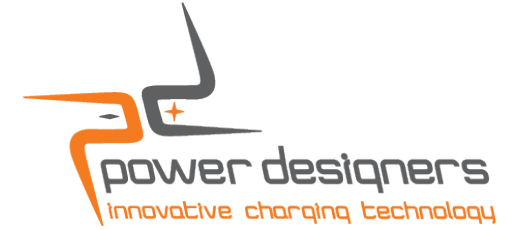




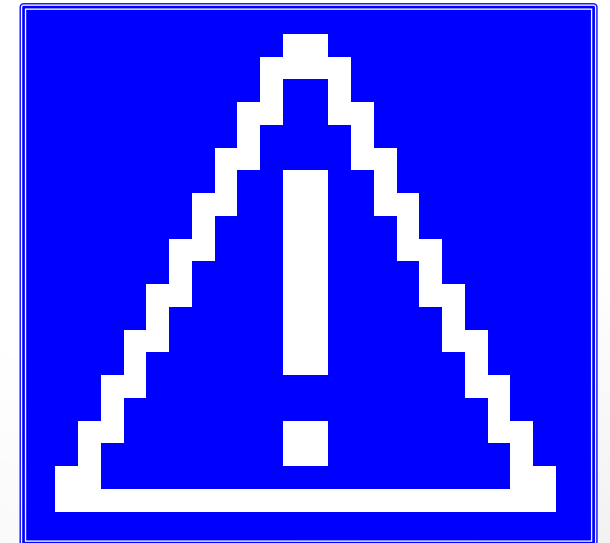
# Revolution Series

## Revolution Faults

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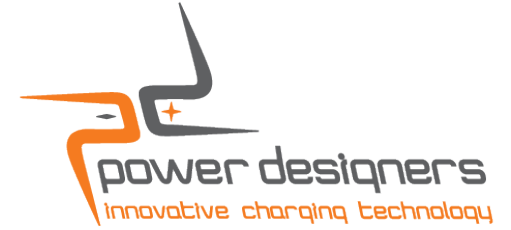
- + The Revolution charger reports a number of faults
  - AC Fault
  - Output OV
  - Output OC
  - Primary OC
  - Time Out
  - Battery OT
  - Fan
- + Each of these is described in detail in this section, along with some troubleshooting tips and techniques.



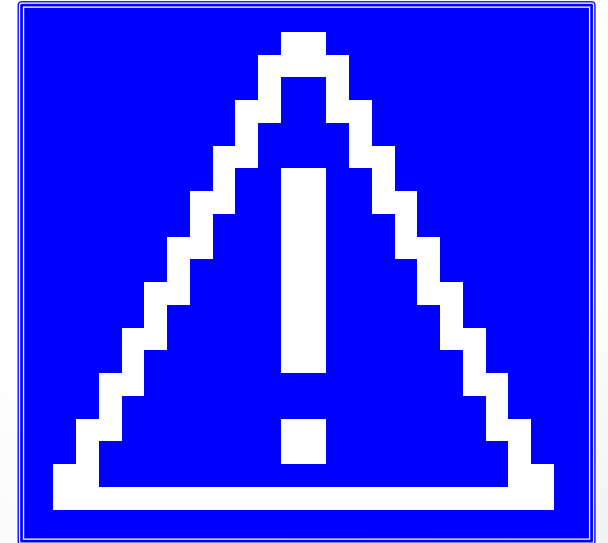
# Revolution Series

## Safety

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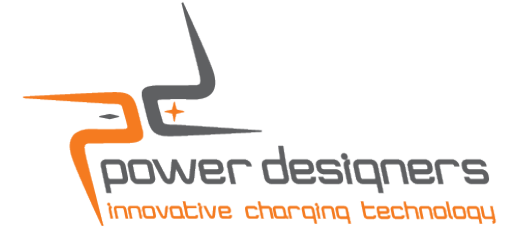
- + Before troubleshooting or attempting any repairs
- + Be sure to review the recommended troubleshooting and repair steps
- + Be sure to identify and have qualified personnel available to perform the repair
- + Follow all facility recommendations for personal protective equipment
- + Follow all facility recommendations for lock out and tag out processes



# Revolution Series

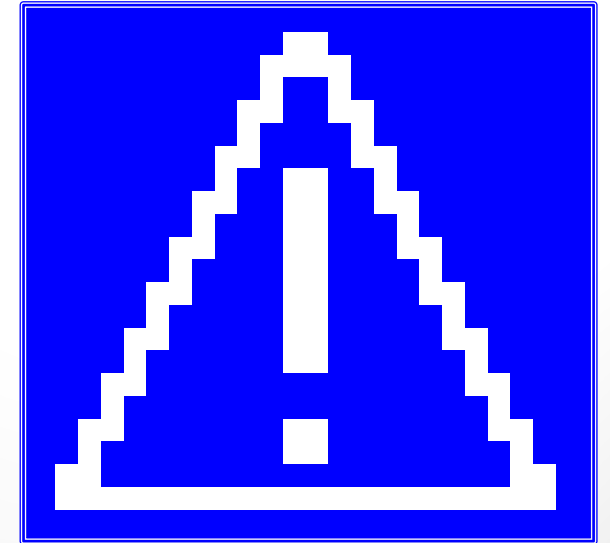
## Quiz Time

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Before trouble shooting or attempting any repairs you should do what 4 things?

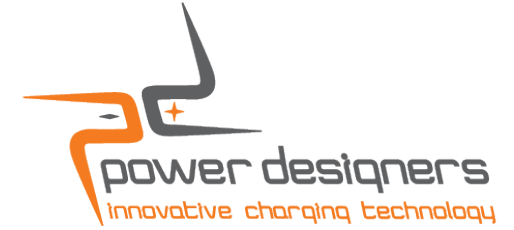
1. Be sure to review the recommended trouble shooting and repair steps
2. Be sure to identify and have qualified personnel available to perform the repair
3. Follow all facility recommendations for personal protective equipment
4. Follow all facility recommendations for lock out and tag out processes



# Revolution Series

## AC Fault

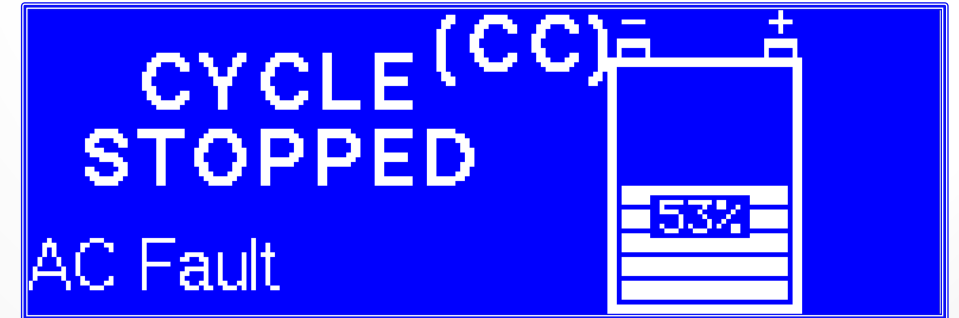
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The AC fault indicates an out of tolerance condition for the incoming power to the charger.

Possible causes are;

- + AC line voltage outside of allowable limits of 432VAC-528VAC
- + AC phases unbalanced or not matched within 10V
- + AC fuse has opened in the incoming service supply



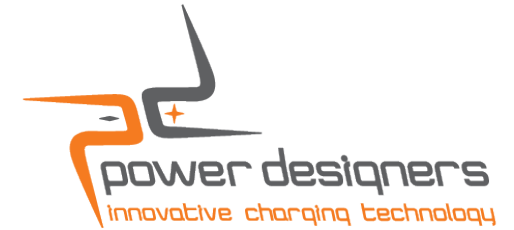
Troubleshooting step include

- + Identify and correct the AC line if not within specified range
- + Inspect and replace any damaged AC wiring or connections
- + Replace any faulty modules

# Revolution Series

## Output Over Voltage Fault

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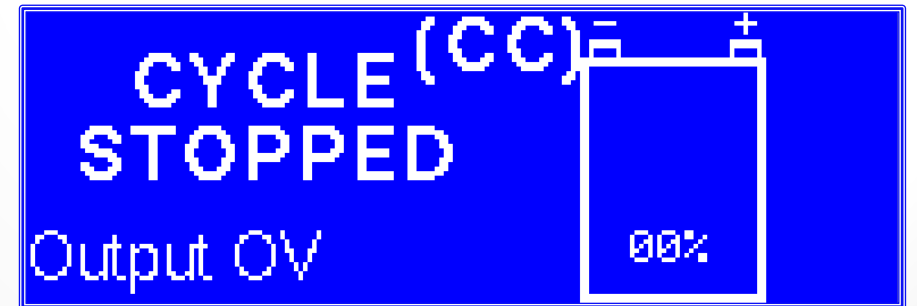
The output over voltage fault is generally caused by one of two items causing the sensed DC voltage to be above the expected value, or to have risen sharply in a short period of time above the maximum DC output threshold.

Possible causes are;

- + Battery disconnected while charging
- + Damaged DC cable or connector, creating an open or high impedance path

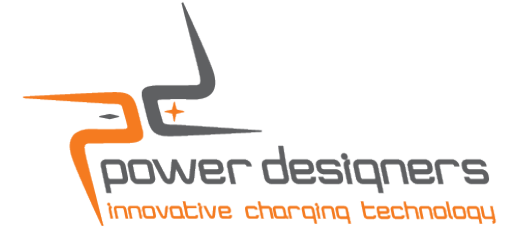
Troubleshooting step include;

- + Restart the charge cycle to verify the fault, the charger might have been unplugged while charging
- + Inspect and repair any damage to the output harness or loose connections



# Revolution Series

## Over Current Faults



The Revolution chargers sense current on both the DC output of the modules and on the input side where the AC line has been converted to a high voltage DC. This provides two levels of detection and protection against damage from over current events

These faults are;

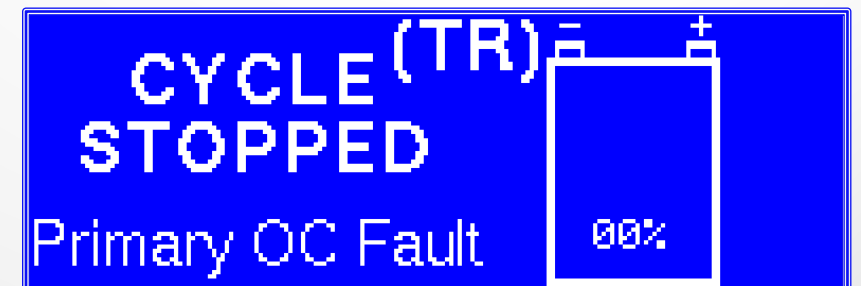
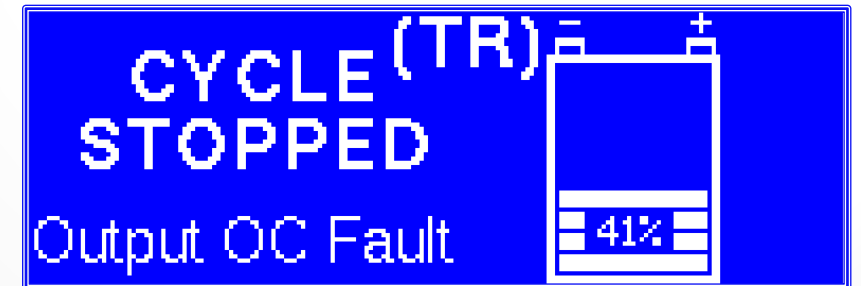
- + Output Over Current
- + Primary Over Current

Possible causes;

- + Damaged and shorted output cable
- + Damaged output connector
- + Failure internal to the BPU

Troubleshooting step include;

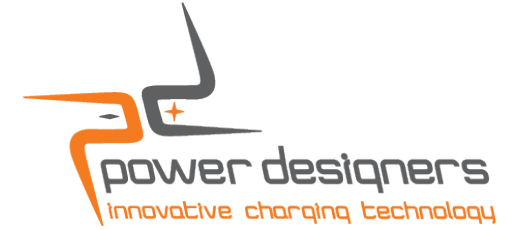
- + Inspect the cable and connector repairing as necessary
- + Replace any faulty modules





# Revolution Series

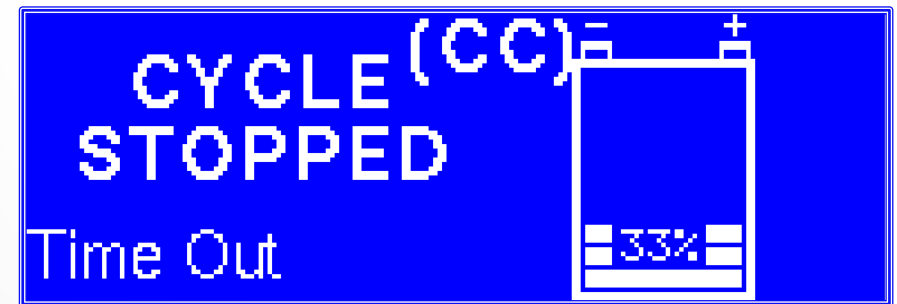
## Timer Faults



There are three timers which may cause the charger to stop prematurely. The screen indicates which timer has been exceeded resulting in a fault: Trickle, Constant Current, or Constant Voltage.

Possible causes;

- + Aging or damaged battery
- + Charge timers are set shorter than required for the battery needs
- + Charge parameters for the transition voltages between modes are too high, or the output current is too low for the batteries needs

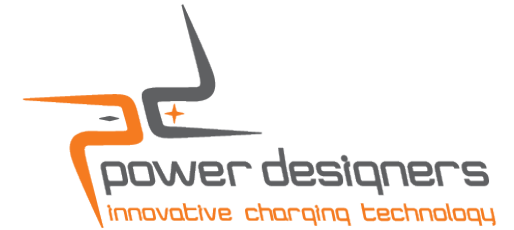


Troubleshooting step include;

- + Identify any bad battery cells and replace as needed
- + Recover a sulfated battery using the recovery cycle of the Revolution charger
- + Adjust timers, voltages and / or currents to adapt the charger to the batteries changing needs

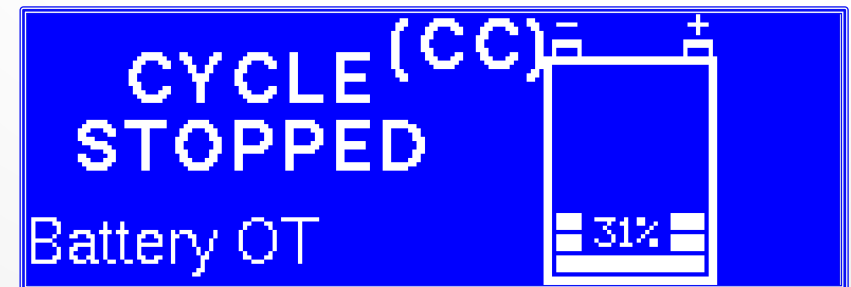
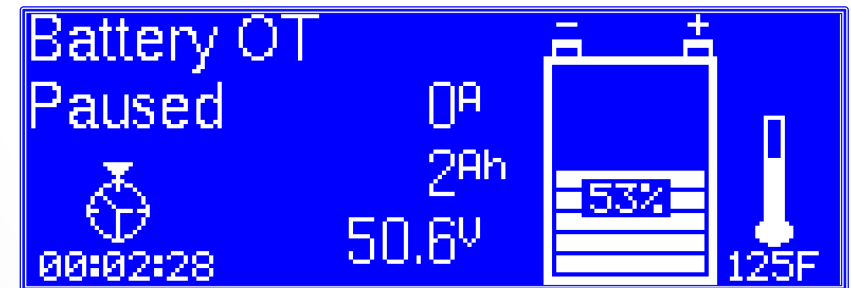
# Revolution Series

## Battery Over Temperature Faults



When a battery is equipped with either a Thermistor or a PowerTrac, the charger is able to sense the temperature of the battery, and react to the battery Over Temperature condition by:

- + Initially and for a total of 5 times the battery OT limit is exceeded the charge cycle is paused
- + Waiting in the paused state until the temperature drops 7°C, at which time the cycle is restarted. Each pause increases the hysteretic temperature by 1°C.  
Following the 5<sup>th</sup> attempt the charge cycle remains stopped.

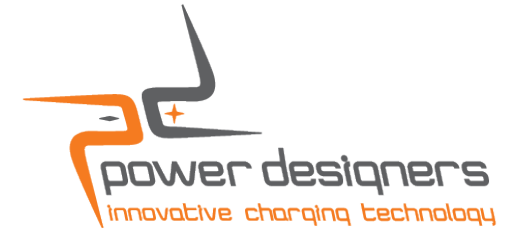


Possible causes;

- + Excessive charge or discharge rates heating the battery
- + High ambient temperatures
- + Running Constant Voltage and Finish modes too often; resulting in lack of cool down time for the battery following a charge
- + Broken or damaged Thermistor or PowerTrac

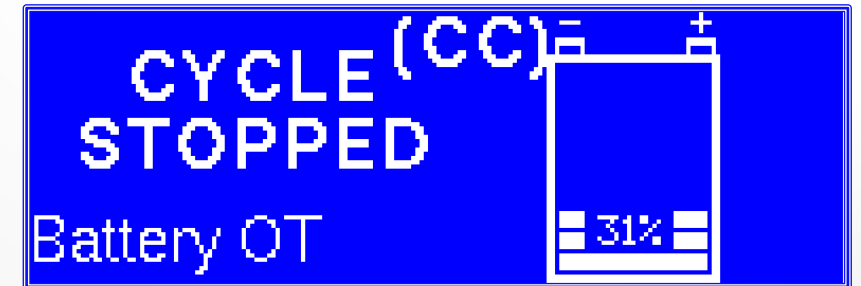
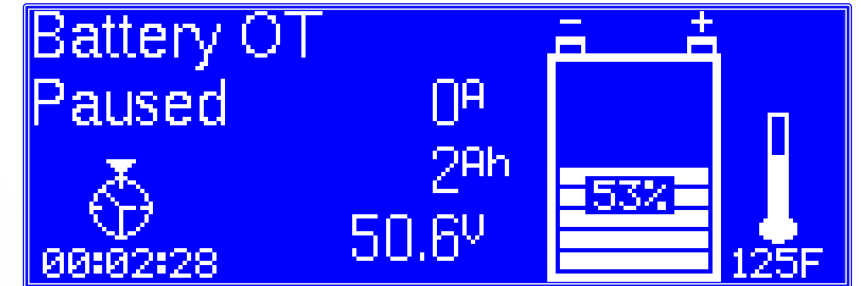
# Revolution Series

## Battery Over Temperature Faults



Troubleshooting step include;

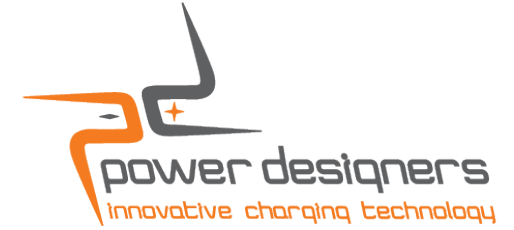
- + Note ambient temperature, if needed reduce either truck usage or charging current to allow less rise above the ambient on hot days or in hot locations
- + Inspect thermistor and PowerTrac, repair or replace if damaged
- + Observe the operation and reduce truck usage, or allow resting periods between use and charge; and between charge and use when possible



# Revolution Series

## Fan Faults

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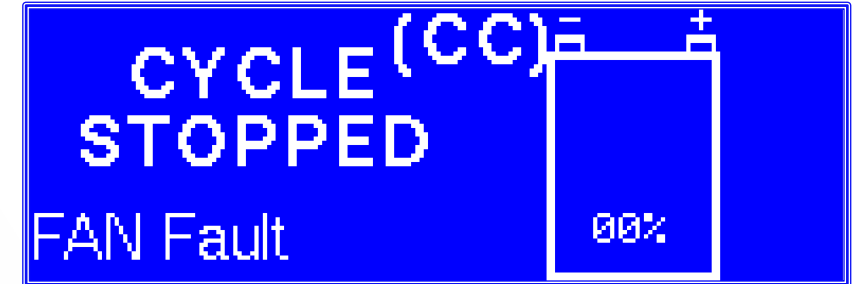
Should the BPU detect an issue with its' cooling fans, a fan fault is active.

### Possible Causes

- + Blocked fan
- + Damaged fan

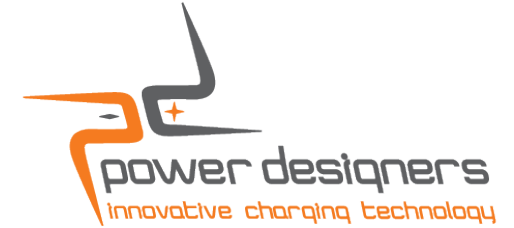
Troubleshooting step include;

- + Inspect fan for blockage and clear blockage
- + Inspect fan for damage and replace module
- + If neither inspection shows blockage or damage replace module




# Revolution Series

## Fault Identification Using the Charge History



Access the Charge History

From the idle screen, press the  key.

Press the Down arrow  until Charge History is displayed.



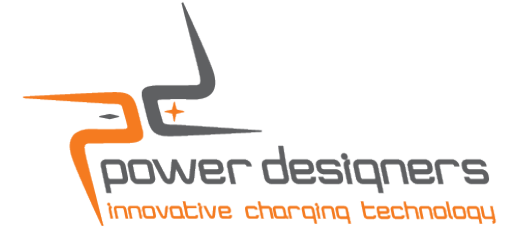
Press  to access the Charge History.

```
Charge:020 12/12/14 10:33  
Duration:00:00:57  
Volt: 59.5  AHS:0000  
Status: Completed
```

# Revolution Series

## Fault Identification Using the Charge History

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The Charge History for a single charge cycle, includes:

- + Charge Number
- + Start Date & Time
- + Charge Duration
- + End voltage
- + Total AHRs
- + Charger Status

```
Charge:020 12/12/14 10:33
Duration:00:00:57
Volt: 59.5   AHRs:0000
Status: Completed
```

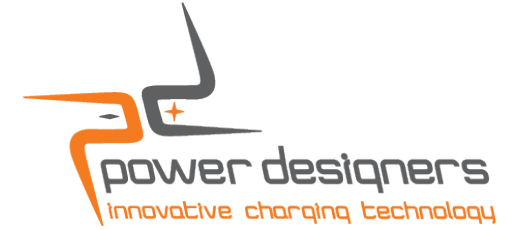
**STATUS** indicates whether the cycle was:

- + Completed successfully (**COMPLETED**),
- + Interrupted by the user (**STOPPED**),
- + Interrupted due to a power outage or disconnection (**TURNED OFF**),
- + Interrupted due to a fault (e.g., **OV FAULT** for an over voltage fault).



# Revolution Series

## Fault Identification Using the Charge History



Press  to display:

- + Charge Number
- + Start Date & Time
- + Charge Duration
- + Charge Profiles activated during the charge cycle
- + Serial number of faulted module and fault code

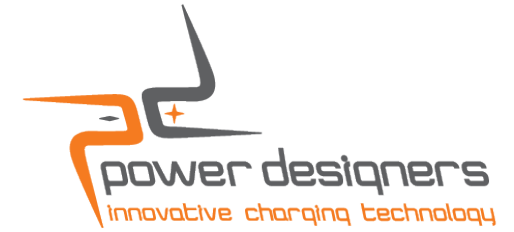
```
Charge:020 12/12/14 10:33
Profiles: TR CC CV
13120104 FN
```

**Note:** Record the serial number listed in the charge history for replacement of the faulty module.

# Revolution Series

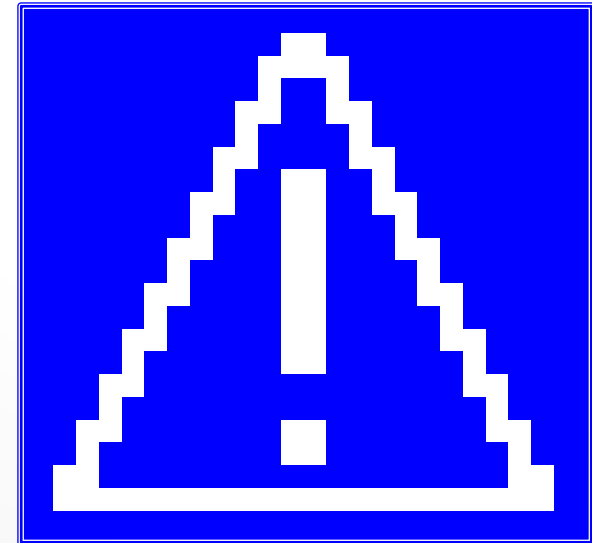
## Safety Service and Repair

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Before trouble shooting or attempting any repairs

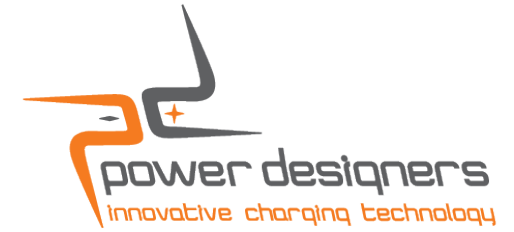
1. Be sure to review the recommended trouble shooting and repair steps
2. Be sure to identify and have qualified personnel available to perform the repair
3. Follow all facility recommendations for personal protective equipment
4. Follow all facility recommendations for lock out and tag out processes



# Revolution Series

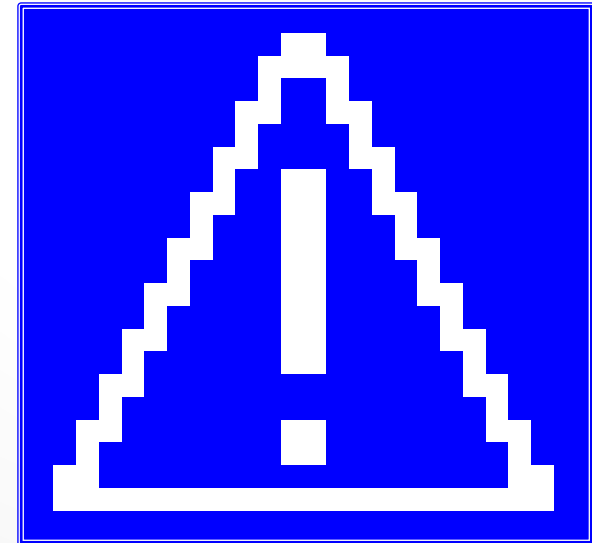
## Quiz Time Repeat Important

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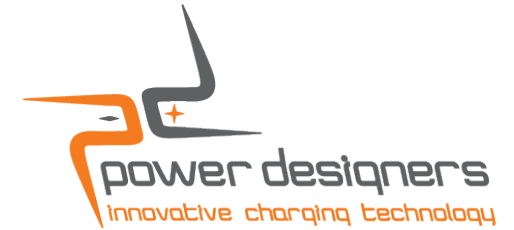
Before trouble shooting or attempting any repairs you should do what 4 things?

1. Be sure to review the recommended trouble shooting and repair steps
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4. Follow all facility recommendations for lock out and tag out processes

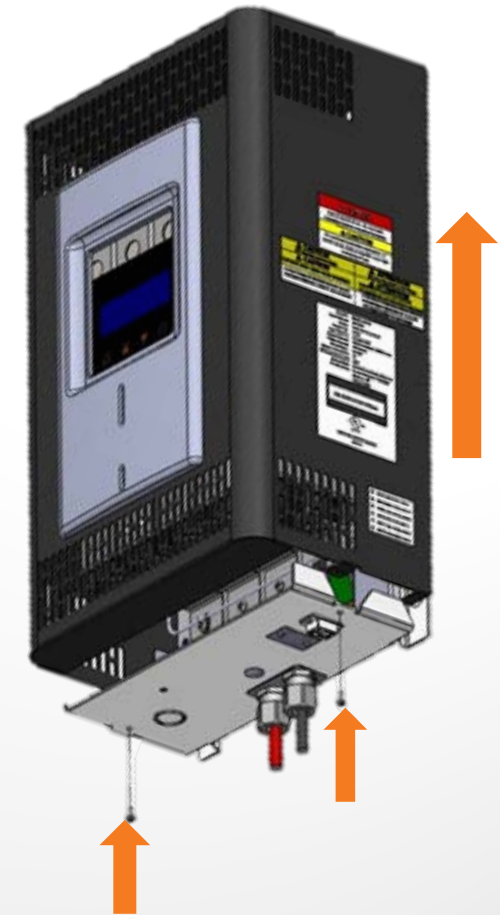


# Revolution Series

## RV05 Repair

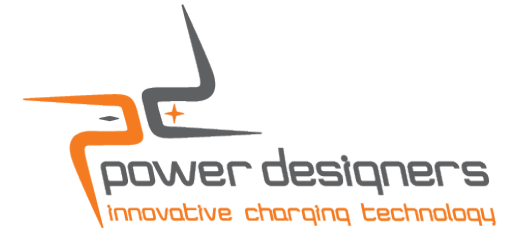


- + Follow Facility Best Practices Do Not Service with the AC Power energized or Battery Connected
- + Follow Lock Out Tag Out and other facility procedures to remove power from the charger
- + Remove the cover
  - Remove the (2) 8-32 screws from the bottom
  - Lift the cover up about 1.5"
  - Pull the cover away from the charger

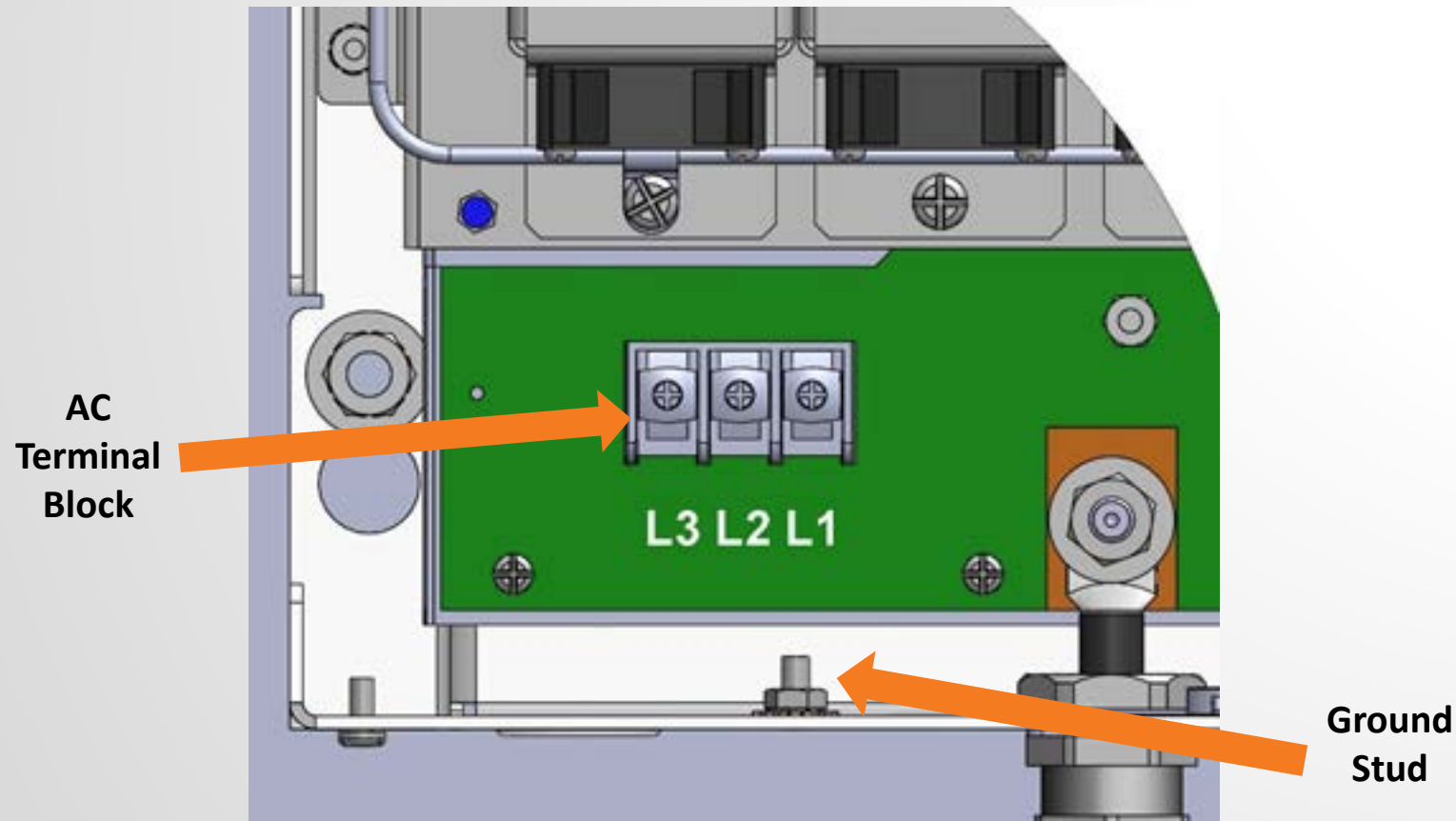


# Revolution Series

## RV05 Repair



- + At the AC input terminals verify that there is no AC applied to the charger

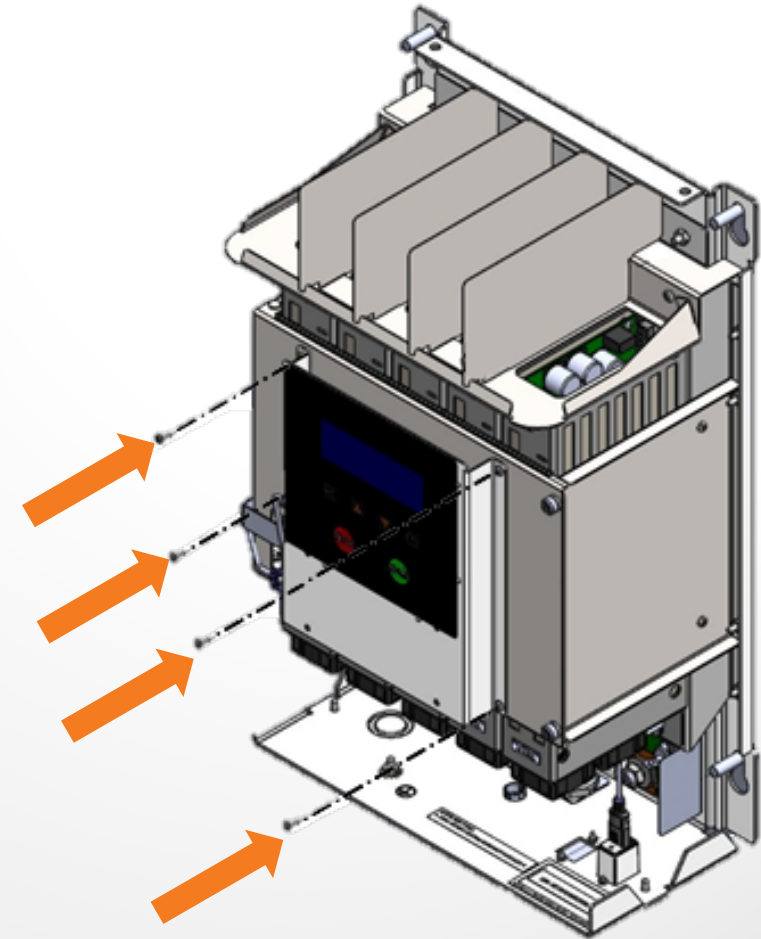


# Revolution Series

## RV05 Repair Replacing the MCU



1. Remove the (4) 6-32 screws from chassis
2. Unplug the ribbon cable and harnesses
3. Install the new MCU in reverse order making sure the ribbon cable and harnesses are connected correctly
4. Replace the screws

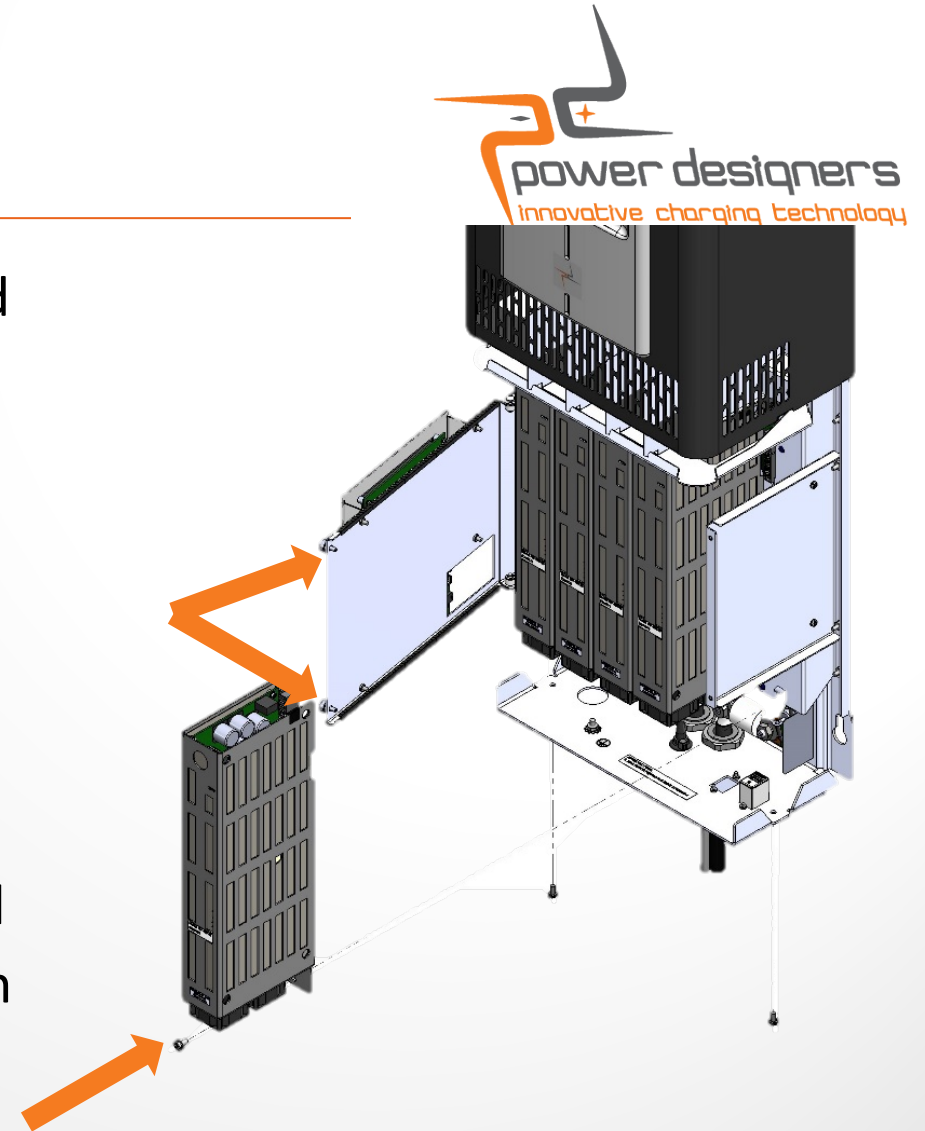




# Revolution Series

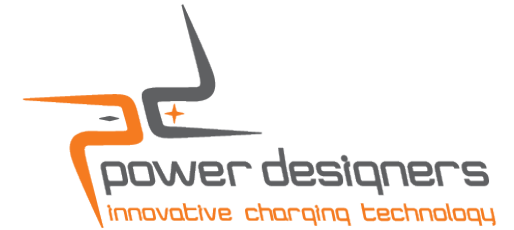
## RV05 Repair Replacing the BPU

1. Loosen the (2) captive screws holding the door closed
2. Locate the BPU to be removed by serial number label on the lower front
3. Remove the (1) 10-32 screw from the bottom tab of the BPU
4. Carefully pull the BPU straight out of the socket
  - + Use your thumb or forefinger to grab the round hole at the top of the BPU.
  - + Grab the bottom of the BPU with your other hand
5. Install the new module and reassemble the charger in reverse order.
6. Enumerate the installed modules



# Revolution Series

## RV08 and RV12 Repair

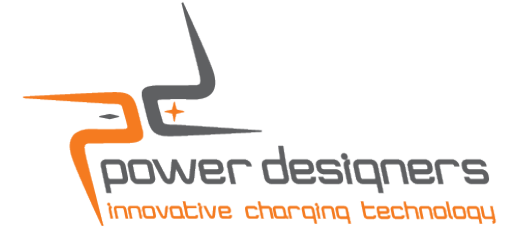


- + Follow Facility Best Practices Do Not Service with the AC Power energized or Battery Connected
- + Following Lock Out Tag Out and other facility procedures remove power from the charger
- + Access the AC terminal block
  - On the left side of the Charger, remove the (2) 10-32 screws securing the Charger door.
  - Swing the Charger open



# Revolution Series

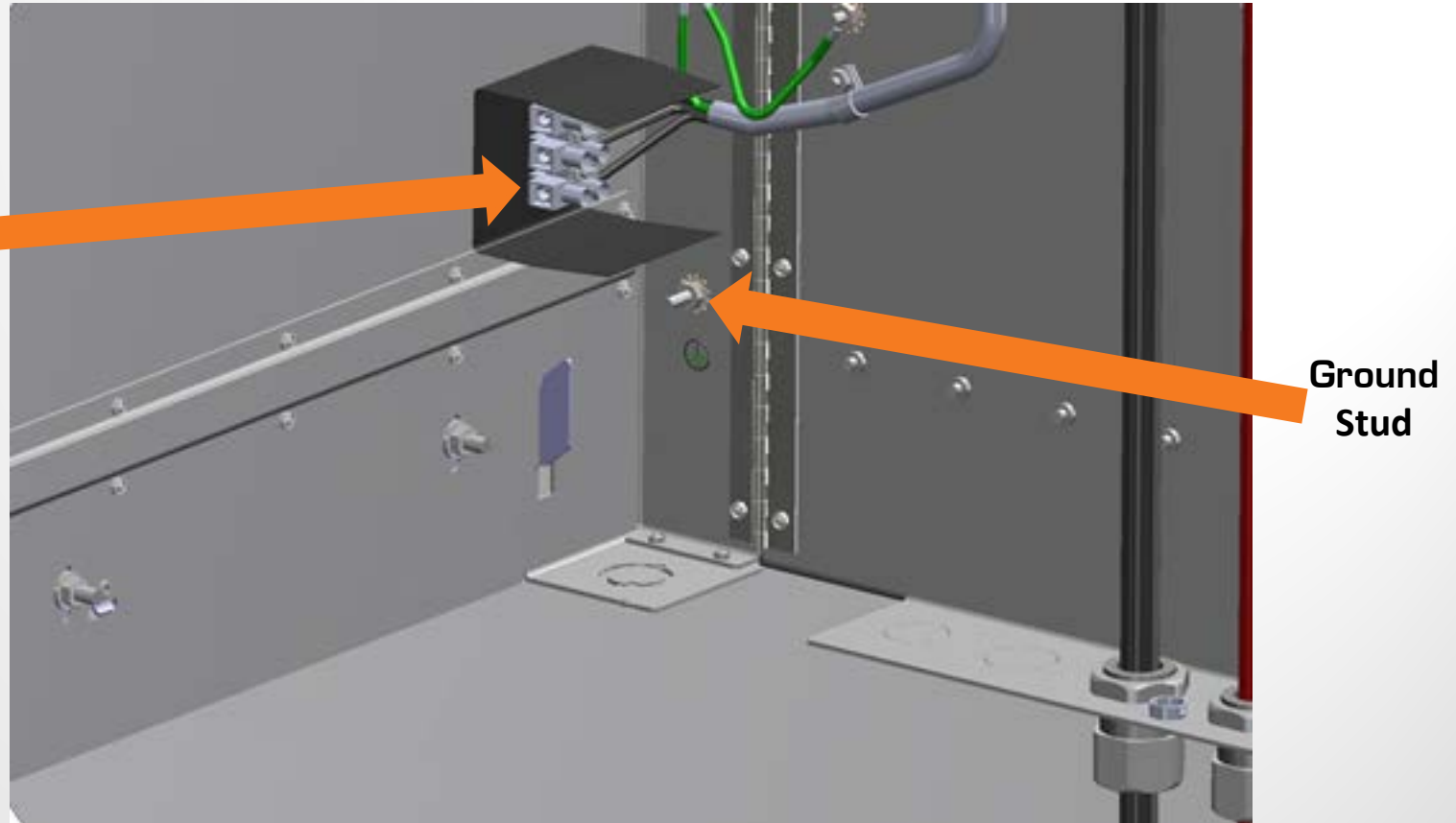
## RV08 and RV12 Repair



- + At the AC input terminals verify that there is no AC applied to the charger

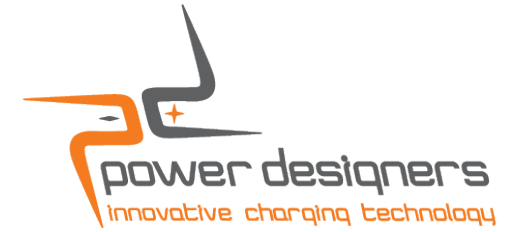
AC  
Terminal  
Block

- + Swing charger closed to proceed



# Revolution Series

## RV08 and RV12 Repair



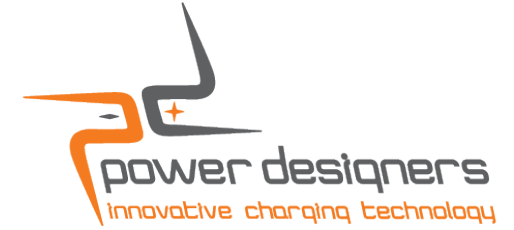
### Remove the Cover

1. Remove the (4) 8-32 screws, (2) from each side
2. Pull the cover out and away from the charger

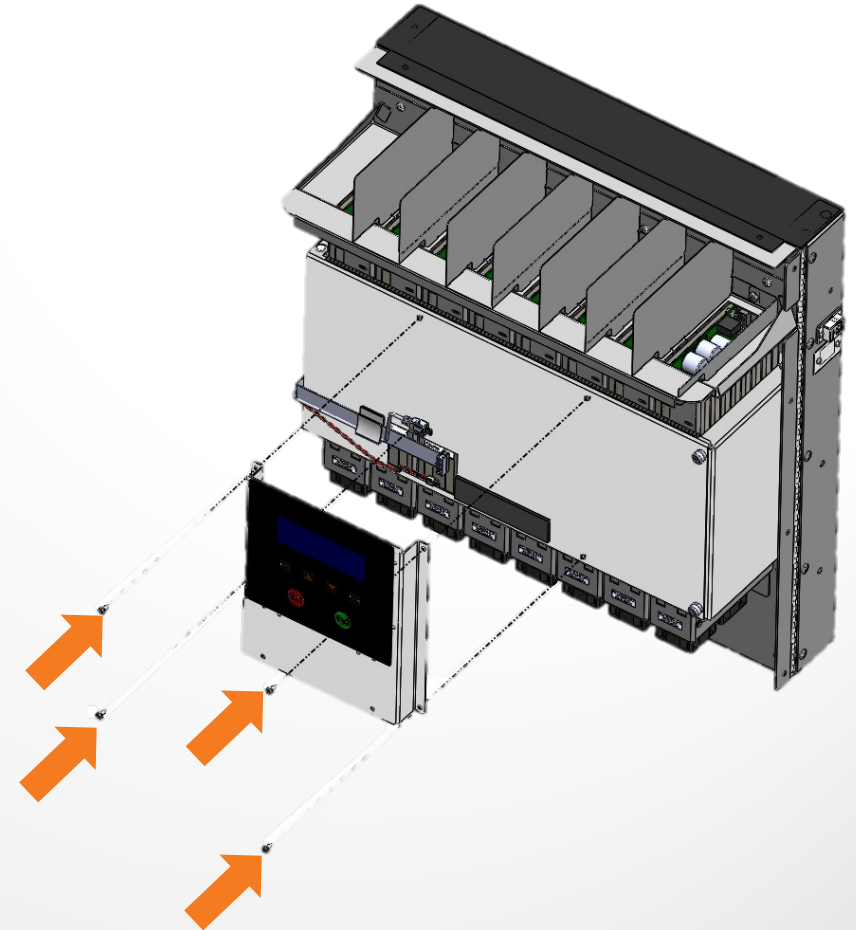


# Revolution Series

## RV08 & RV12 Repair Replacing the MCU

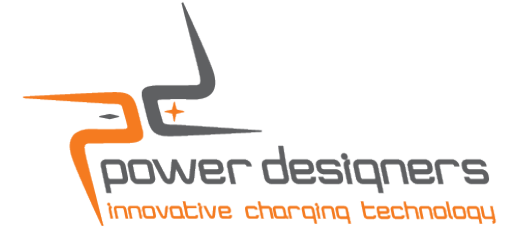


1. Remove the (4) 6-32 screws from chassis
2. Unplug the ribbon cable and harnesses
3. Install the new MCU in reverse order making sure the ribbon cable and harnesses are connected correctly

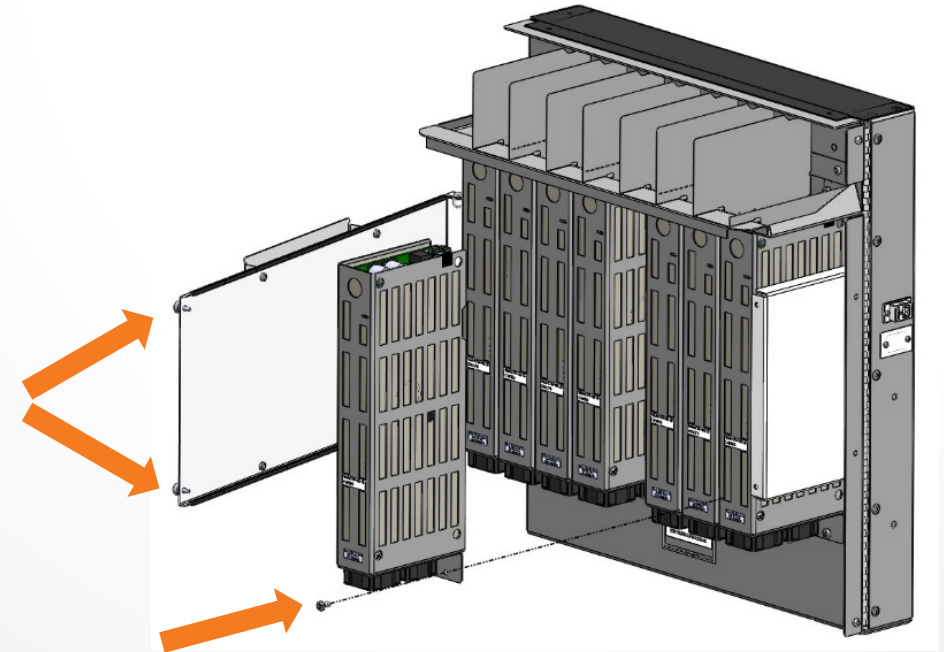


# Revolution Series

## RV08 & RV12 Repair Replacing the BPU



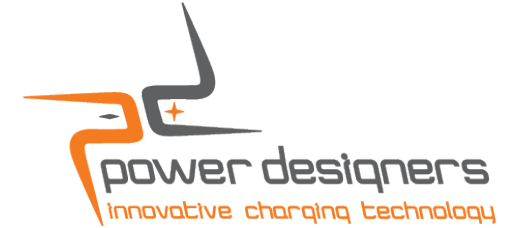
1. Loosen the (2) captive screws holding the door closed
2. Locate the BPU to be removed by serial number label on the lower front
3. Remove the (1) 10-32 screw from the bottom tab of the BPU
4. Carefully pull the BPU straight out of the socket
  - Use your thumb or forefinger to grab the round hole at the top of the BPU.
  - Grab the bottom of the BPU with your other hand
5. Install the new module and reassemble the charger in reverse order.
6. Enumerate the installed modules








# Revolution Series

## Enumerating Installed Modules




After a Power Module is replaced, and the charger is fully reassembled, apply AC power to the charger.

The chargers MCU must be programmed with the serial number of the new module.


- + From the idle screen, press the  key to enter the menu
- + Press the Down Arrow  to scroll to “Model & SN”
- + Press the  key
- + The Model and Serial number will be displayed along with the firmware revision.



Connect  
Battery



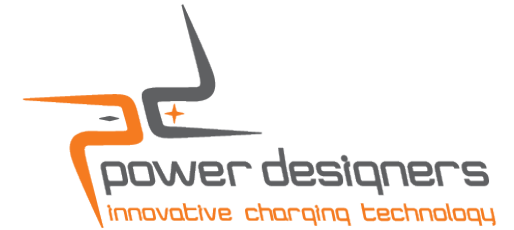
Model  
& SN



Model & SN:  
RV-10.4-240-36V  
R08361406P100018  
Rev: 2.29

# Revolution Series

## Enumerating Installed Modules



Press the  key again.

- + The serial numbers of the installed modules will be displayed. There will be an “!” next to the module that was removed.

Press  key.

- + The display will show “Save Installed Modules?” with “NO” as the default selection.

Press the Up Arrow  to select “YES”.

```
13120286 13120108!  
13120256 13120259  
13120288 13120291  
13120316 13120328
```

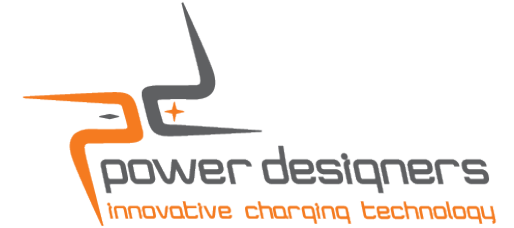
```
Save Installed  
Modules?  
▲ NO ▼
```


```
Save Installed  
Modules?  
▲ YES ▼
```

# Revolution Series

## Enumerating Installed Modules

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Press the  key to enumerate the modules.

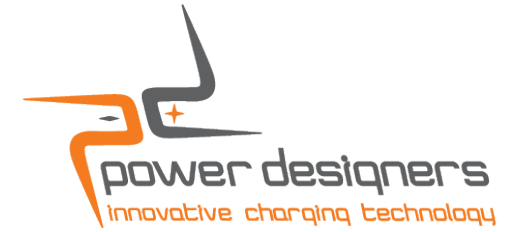
- + The serial numbers of the modules will be displayed, the new serial number should be listed.

Press  key to exit the menu.

```
13120286 13120256
13120259 13120288
13120291 13120294
13120316 13120328
```

# Revolution Series

## Trouble Shooting and Repair Additional Assistance



For additional assistance or to order parts please contact

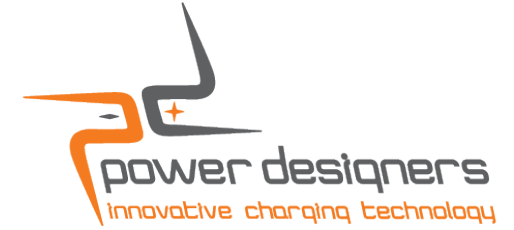
+ [service@powerdesigners.com](mailto:service@powerdesigners.com)

+ 608 231-0450 Ext 404

# Revolution Series

## Final Quiz

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After replacing a BPU the MCU need to identify the BPU True or False

True

Identification is called what?

Enumeration

How do I contact Powe Designers for parts or additional help?

E-mail to [service@powerdesigners.com](mailto:service@powerdesigners.com)

Phone 608 231-0450 Ext 404

Thank You  
On Behalf of  
Power Designers  
For Your  
Participation