

RQ-SERIES BATTERY CHARGER

INSTALLATION AND DESIGN GUIDE

VERSION 1.0, DECEMBER 2022



RQ350



RQ700



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Table of Contents

1	Safety Notes	4
1.1	High Voltage Safety	4
1.2	Electrical Safety Information	4
1.3	Battery Safety Information.....	4
1.4	Precautions	4
2	Safety and Regulatory	4
2.1	General Safety	4
2.2	Regional Regulatory Compliance.....	5
3	Model Listing.....	5
4	Charger Operations	6
4.1	Normal Operation.....	6
4.2	Minimum/Maximum Battery Capacity.....	7
4.3	Adverse Operations	7
5	LED Display	9
6	Installation.....	11
6.1	Cooling	11
6.2	Mechanical Installation.....	13
7	Electrical Installation	15
7.1	General Considerations for Machine Wiring	15
7.2	AC Input	15
7.3	DC Output	17
7.4	Signals & Control Connectors.....	18
7.5	Interlock.....	20
8	Software.....	22
8.1	Algorithms	22
8.2	CAN Features.....	22
9	Service and Troubleshooting	22
9.1	Charging Algorithms.....	22
9.2	Troubleshooting Guide.....	22
9.3	Faults and Error Codes	22
10	Drawings	23

1 Safety Notes

This section provides important safety information when using the RQ Series battery chargers. Read and comprehend this document fully before handling or working with RQ Series battery chargers. Important safety, operation, and installation instructions are included.

1.1 High Voltage Safety

WARNING: This product can contain potentially lethal levels of voltage. Exercise extreme care when working with the equipment.

WARNING: DO NOT open the case of the charger. No serviceable parts are contained inside the unit.

1.2 Electrical Safety Information



Danger: Risk of electric shock. Connect charger power cord to an AC outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded AC outlet is required to reduce the risk of electric shock—do not use ground adapters or modify the plug. Do not touch uninsulated portions of the output connector or uninsulated battery terminals. Disconnect the AC supply before making or breaking the connections to the battery. Do not open or disassemble the charger. Do not operate the charger if the AC supply cord or DC output cord is damaged or if the charger has received a sharp blow, been dropped, or is damaged in any way. Refer all repair work to the manufacturer, or qualified personnel. This charger is not intended for use by persons with reduced physical, sensory or mental capabilities, or lack of experience and knowledge on electrical systems and battery charging, unless they have been given supervision or instruction concerning use of the charger by a person responsible for their safety. The charger should be kept out of the reach of children.

1.3 Battery Safety Information



WARNING: Only use the charger with a charging profile that is appropriate to the specific battery type. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal charging. Keep sparks, flames, and smoking materials away from batteries. Do not operate charger in a closed-in area or an area with restricted ventilation. Never charge a frozen or non-rechargeable battery. Observe all battery manufacturers' precautions (eg. maximum charge rates and temperature compensation).

1.4 Precautions



Hot Surfaces: During charging, the surface of the charger may become hot to the touch, especially in higher ambient temperatures. This is normal. Avoid touching the surface of the charger.

Extension Cord Rating: Extension cords used with the charger must have appropriate safety approvals for the country in which it is used (e.g., Nationally Recognized Testing Laboratories (NRTL) approval in the United States). Wire gauge must be appropriate for the input current of the charger.

2 Safety and Regulatory

2.1 General Safety

2.1.1 Shock Hazards

- DO NOT open the case of the charger. Hazardous voltages inside
- DO NOT use ground adapters or remove AC ground pin

2.1.2 Hot Surfaces

Caution: While the charger handle is rated to be “touch-safe”, the chassis can reach temperatures of 90°C (>190°F) in extreme circumstances. Avoid contact with the chassis during operation.

2.2 Regional Regulatory Compliance

2.2.1 United States and Canada

- 949-XXXX (RQ350) and 961-XXXX (RQ700) chargers are UL recognized and 959-XXXX (RQ350) and 971-XXXX (RQ700) chargers are UL listed. Look for these logos on the charger:



2.2.2 Outside North America

- All chargers are CE certified and carry this logo:



3 Model Listing

Basic information is detailed below. See the appropriate specification sheet or extended specification sheet (if available) for more details. See *Section 10*: for illustrations.

Table 1: RQ-Series Model Details

Product Description	Nominal Lead-Acid Voltage	Maximum Voltage	Maximum Current	Output Power (at 25°C)
RQ350 350W 12V	12V	18V	15A	220W
RQ350 350W 24V	24V	36V	13A	350W
RQ350 350W 36V	36V	60V	10A	350W
RQ350 350W 48V	48V	72V	7.5A	350W
RQ700 700W 24V	24V	36V	30A	700W
RQ700 700W 36V	36V	60V	19.5A	700W
RQ700 700W 48V	48V	72V	15A	700W

4 Charger Operations

RQ-series battery chargers are normally operated either on-board or off-board of the machine. This section describes both normal and adverse operating modes.

4.1 Normal Operation

The normal operating sequence of the RQ-series battery charger is as follows:

1. The charger is connected to AC power and a battery pack.
2. Charging starts if the battery pack is within the starting range of the algorithm.
3. Charging completes normally.
4. The charger enters “monitor/maintain mode” (see section 4.1.3 : *Monitor/Maintain Mode* for more information).

The following sections illustrate and describe these normal operating conditions.

4.1.1 On-Board Configuration: Charge on AC Detect

The charger is permanently connected to the battery pack. Charging begins when AC power is applied to the charger and will continue until the batteries are fully charged. Once charging is complete, the charger will enter “monitor/maintain mode” for as long as the charger remains connected to AC power.

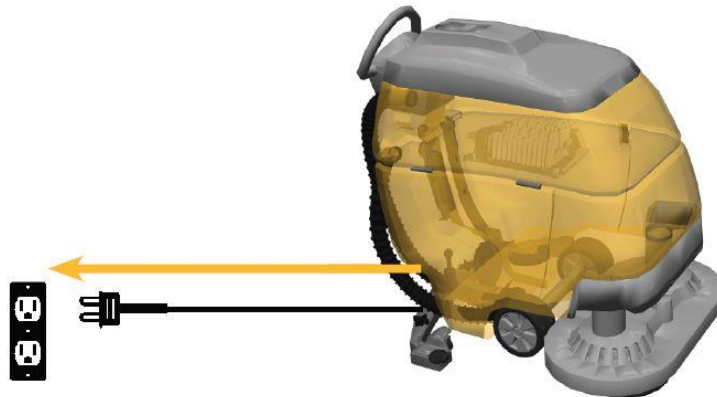


Figure 1: On-Board Configuration

4.1.2 Off-Board Configuration: Charge on DC (Battery) Detect

The charger is permanently connected to AC power. Charging begins when the battery pack is connected to the charger and will continue until charging is complete. Once charging is complete, the charger will enter “monitor/maintain mode” for as long as the charger remains connected to the battery pack.

NOTE: Ensure the charge algorithm supports battery-disconnect detection for this mode.

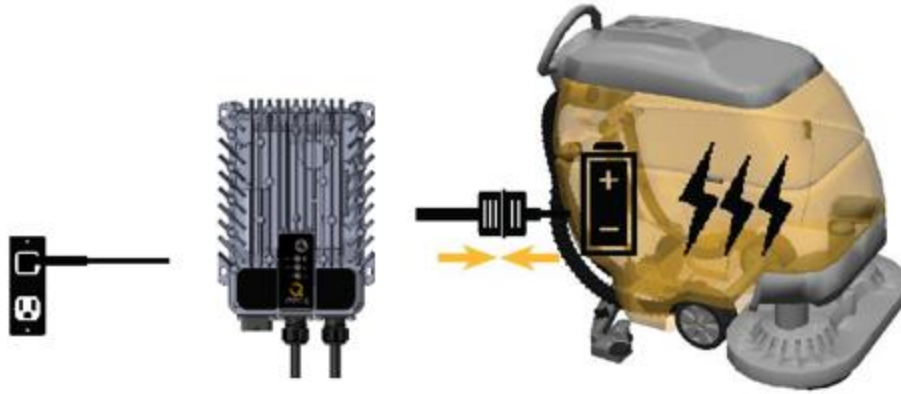


Figure 2: Off-Board Configuration

4.1.3 Monitor/Maintain Mode

This mode becomes active when charging is complete, AC power is present, and the battery pack is left connected. The charger will cease current output and begin monitoring the batteries. If the battery voltage falls below a set threshold or if enough time passes, the charger will start a new charge cycle to maintain the capacity and health of the batteries. The voltage threshold and time limit at which the charger will resume charging are algorithm-dependent.

4.2 Minimum/Maximum Battery Capacity

The minimum battery capacity to meet California Energy Commission (CEC) regulation for each model is as follows:

Table 2: Minimum Battery Capacity (C/20 Rates Shown)

Product Description	Minimum Capacity (C/20)	Maximum Capacity (C/20)
RQ350 12V	150 Ah*	250 Ah
RQ350 24V	75 Ah*	250 Ah
RQ350 36V	50 Ah*	250 Ah
RQ350 48V	40 Ah*	250 Ah
RQ700 24V	100 Ah*	400 Ah
RQ700 36V	70 Ah*	400 Ah
RQ700 48V	50 Ah*	400 Ah

***Note:** Smaller battery pack sizes can be accommodated. Special testing or configuration may be required to ensure efficiency regulation compliance. Contact your Delta-Q Technologies application engineer if you are planning to charge smaller battery packs.

4.3 Adverse Operations

See Section 5: LED Display for a list of error codes.

- Operating the machine while charging: Doing so may result in the reduction of battery capacity and life due to severe under/over-charge. It may also cause undesired Electromagnetic Interference (EMI).
- AC/DC Interruption Factors: Disconnection of the AC/DC cable, tripping of AC breakers, blowing of DC fuses will cause the charger to shut down or display an error on the LED display and cease any current output from the charger.
- AC Voltage Extremes: Output power will de-rate at AC voltages below 110VAC and will shut down completely below 80VAC.

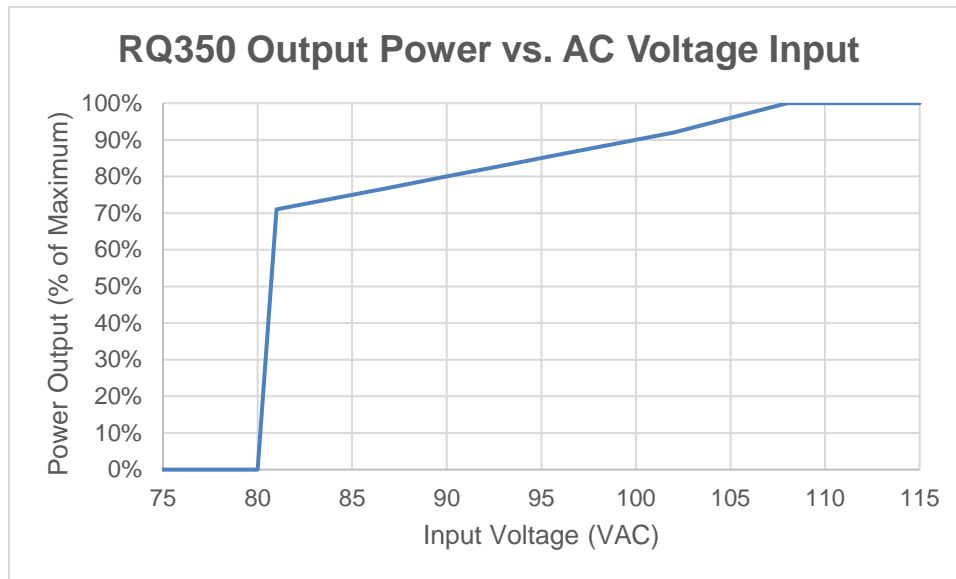


Figure 3: RQ350 (All Models) Output Power as Affected by AC Voltage Input

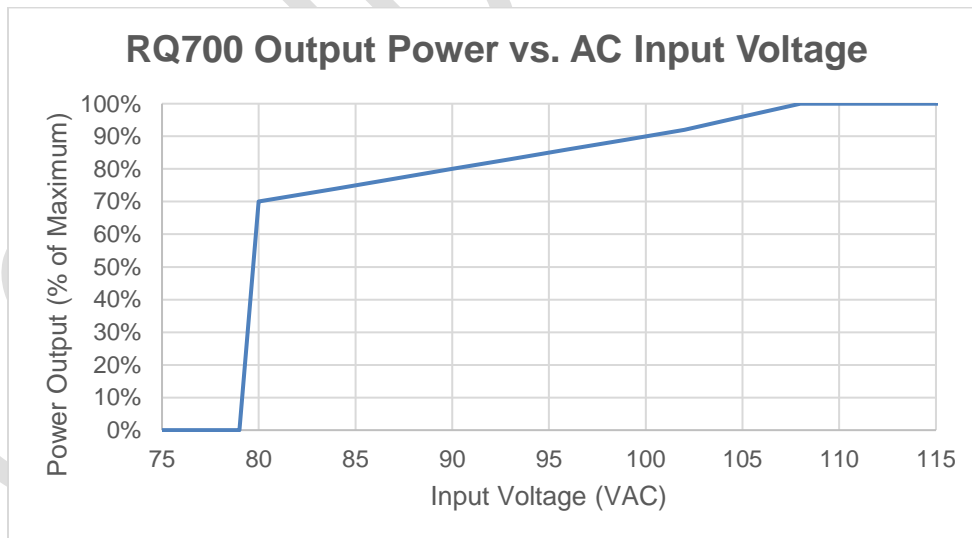


Figure 4: RQ700 (All Models) Output Power as Affected by AC Voltage Input

- DC Voltage Extremes: Connecting a voltage source outside of the specified range of the charger will result in a charger error on the LED display and no output from the charger.
- Temperature Extremes: RQ-series chargers will reduce current output at extreme ambient temperatures: (*Note: these results are recorded from a charger in still air. Any amount of airflow will change the effect on the charger. Data was taken from chargers connected to a 120VAC source.*)

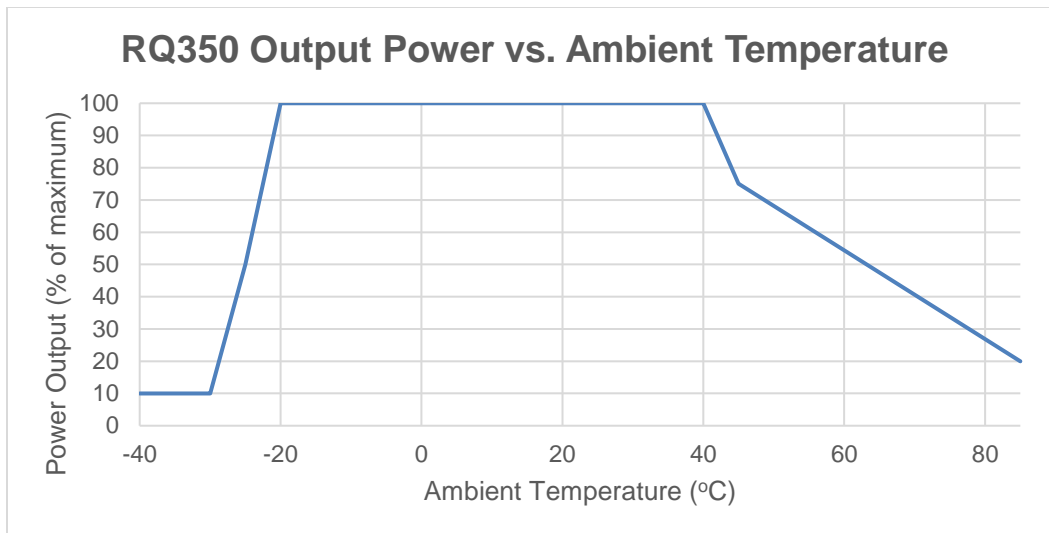


Figure 5: RQ350 (All Models) Output % as Affected by Ambient Temperature

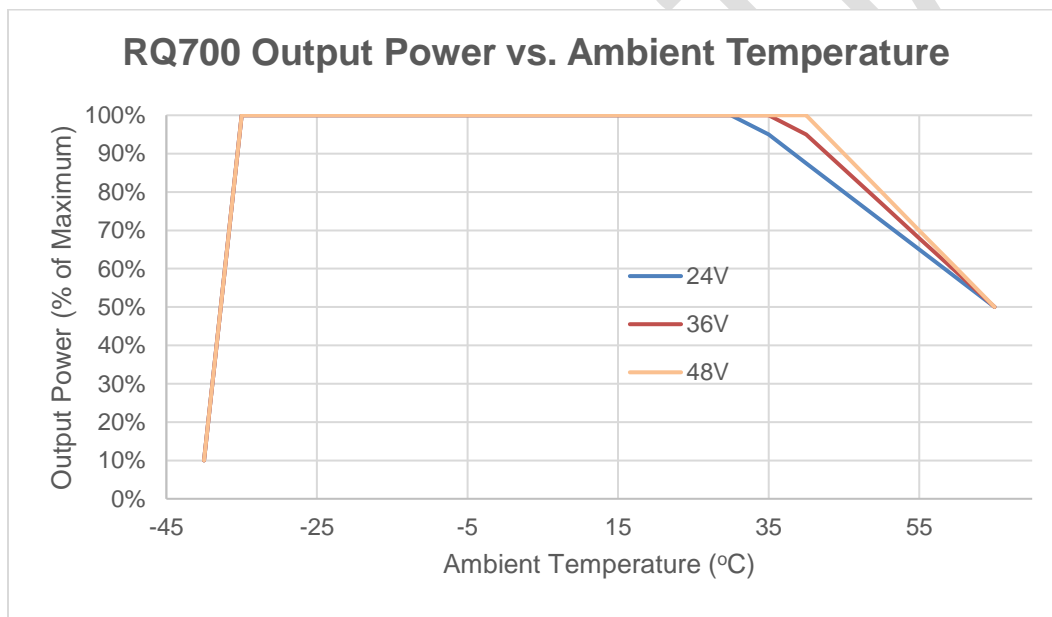


Figure 6: RQ700 Output % as Affected by Ambient Temperature

- External Control Mechanisms: external charge controllers (ie. battery management systems (BMS), CANBUS controllers) that cut off the charger from the battery or prevent the charger from communicating properly with the vehicle/batteries may result in the charger shutting down and displaying an error code.

5 LED Display

The LED display has the following indicators:

- Battery Charging Indicator (GREEN)
- Fault/Error Indicator (RED)
- AC Power Indicator (BLUE)

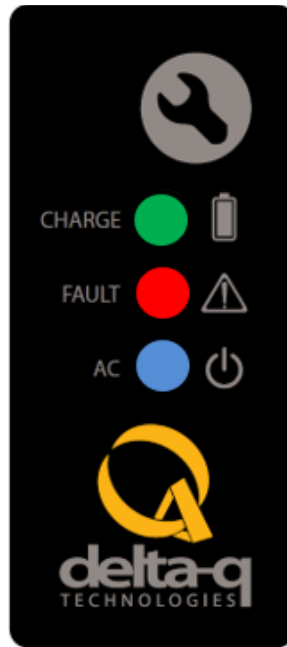


Figure 7: LED Display

Table 3: LED Display Definitions




Name	Display	Definition
Battery Charging Indicator		Slow flashing (every 0.5s) = Low state of charge Fast flashing (every 0.2s) = High state of charge Solid = Charge complete
Fault/Error Indicator		Flashes 1-6 times depending on the error/fault occurring – See Table 4: RQ Series Error Codes
AC Power Indicator		Solid Blue = AC power connected

Table 4: RQ Series Error Codes

Number of Flashes	Error/Fault Description
1	Battery voltage too high
2	Battery voltage too low
3	Battery charge timeout
4	Battery fault
5	CAN communication error
6	Internal charger fault
7	Temperature sensor error

6 Installation

6.1 Cooling

RQ-series chargers rely on convection cooling which depends on the natural tendency of warm air to move upward and away from the surfaces of the charger while colder air flows in.

- Fins are designed to bring in air from any direction and exhaust upwards. A minimum 5cm (2") air gap is recommended around the sides, back, and top of the charger to allow for air movement through the fins.
- Designs should allow about 10% of the charger's maximum power to be exhausted (eg. 10% of 350W is 35W). The thermal image below shows hotspots during charging.

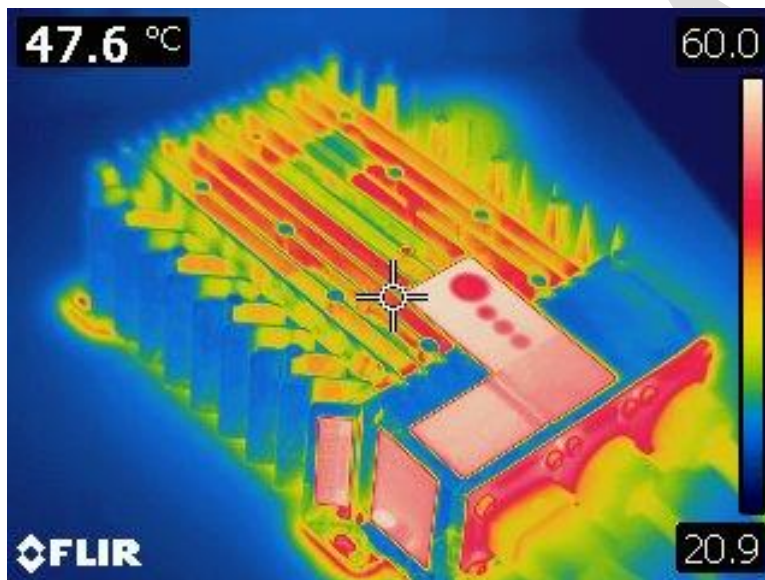


Figure 8: RQ350 Thermogram Detailing Heat Distribution During Charge

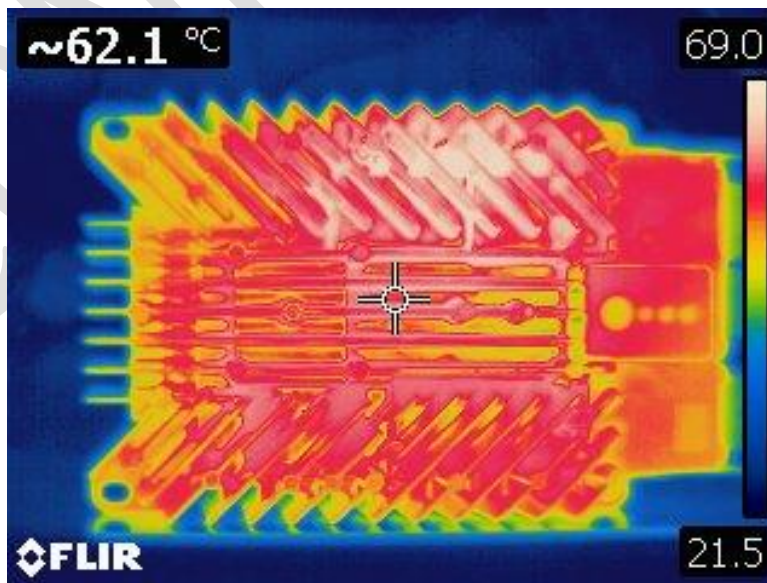








Figure 9: RQ700 Thermogram Detailing Heat Distribution During Charge

Table 5: Cooling Performance for Various Charger Orientations

Orientation	Cooling Performance	Illustration
Horizontal	Ideal overall performance.	
Vertical (Connectors at the bottom)	Best vertical mounting performance.	
Side (AC connector at the top)	RQ350: Best side-mount performance. RQ700: May de-rate sooner below 120VAC.	
Side (AC connector at the bottom)	RQ350: May de-rate sooner below 120VAC. RQ700: Best side-mount performance.	
Vertical (Connectors at the top)	Worst performance, may de-rate power sooner, may heat cables.	
Downward	Not recommended as hot air can be trapped.	

6.2 Mechanical Installation

Robust mounting points are cast in each corner of the charger's aluminum enclosure. They are designed to support M4 or #8 hardware.

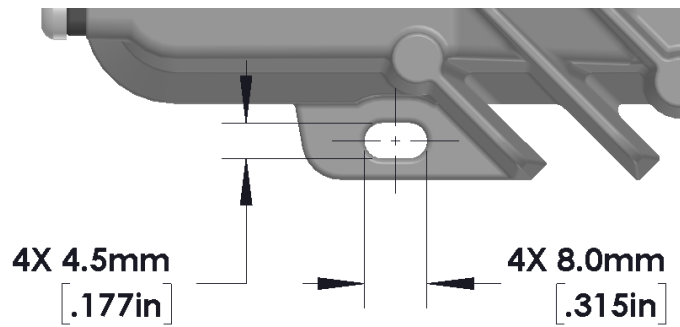


Figure 10: RQ350 Detailed Mounting Point

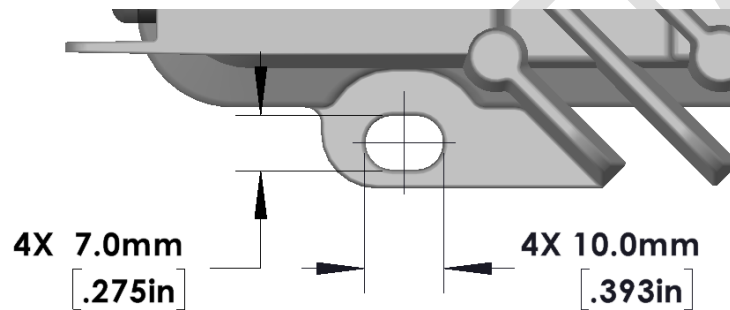


Figure 11: RQ700 Detailed Mounting Point

- The mounting detail dimensions are in millimeters (mm).
- Use only three mounting points to prevent the charger being stressed due to frame-flexing.
- Do not drill holes in the charger as internal components may be damaged and/or the charger's ingress-protection may be compromised.

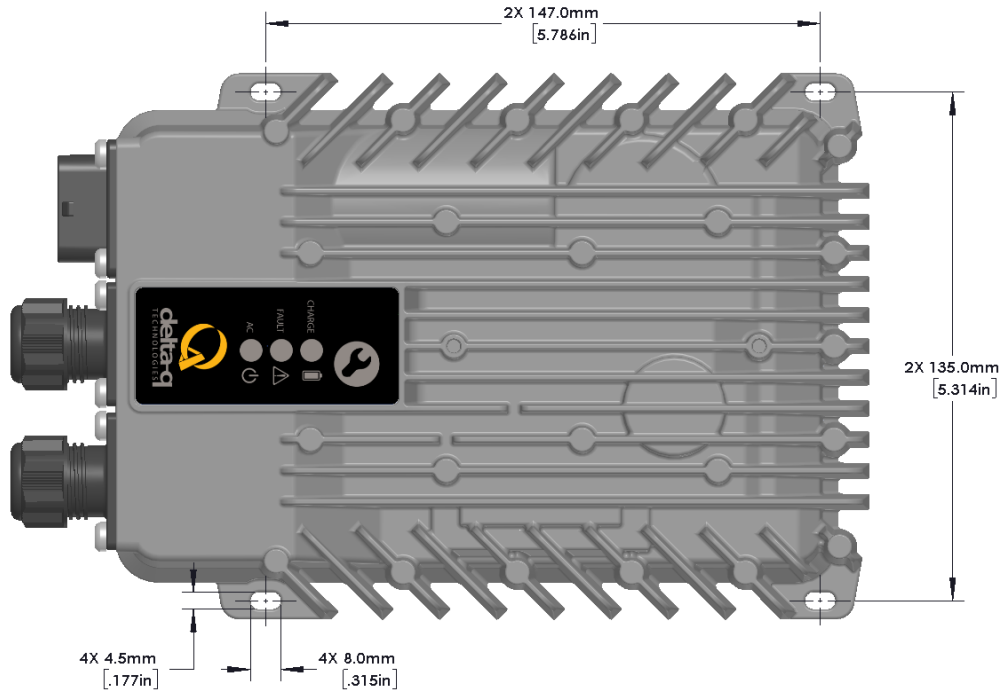


Figure 12: RQ350 Mounting Points

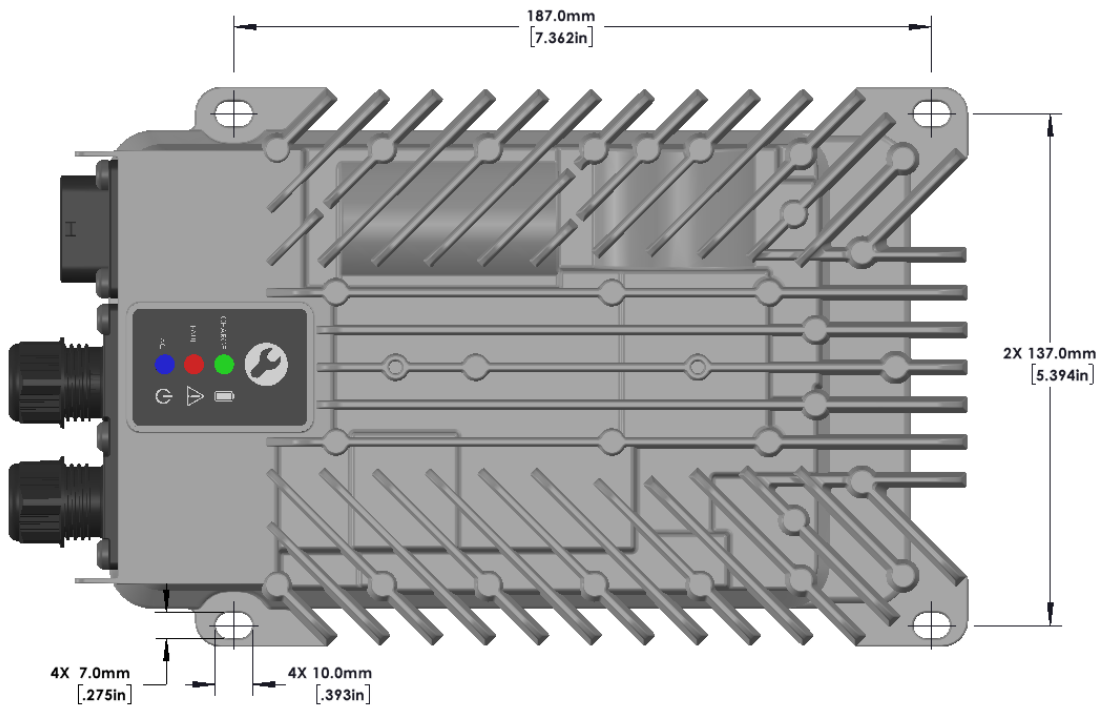


Figure 13: RQ700 Mounting Points

7 Electrical Installation

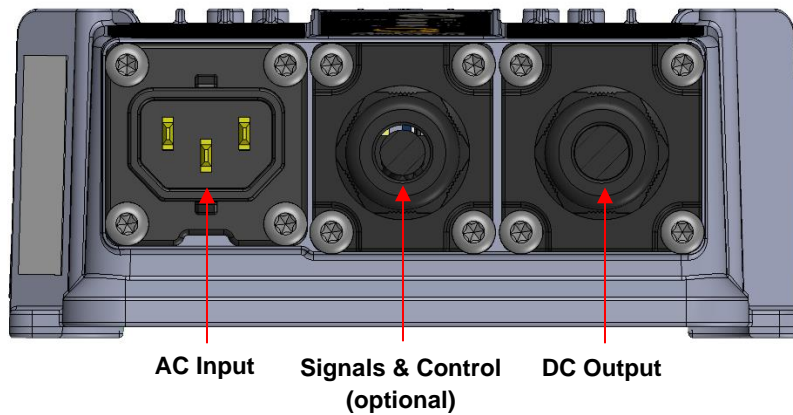


Figure 14: RQ350/700 Cable Diagram

7.1 General Considerations for Machine Wiring

- Battery overcurrent protection is highly recommended, even if it is not required by the specific safety regulations for the vehicle or equipment. Install the overcurrent protection as close to the battery as possible to provide adequate protection.
- Fuses and disconnects should be sized to protect the wiring in the system and break worst-case fault currents. Install the overcurrent protection as close to the battery as possible to provide adequate protection.
- RQ-series battery chargers have built-in overcurrent protection on both the AC input and the DC output.
- For tips on reducing Electromagnetic Interference (EMI), see the Delta-Q Application Note *Reducing Electromagnetic Interference* – ask your Delta-Q representative for a copy.

7.2 AC Input

7.2.1 AC Cable Requirements

Connector Type: IEC60320/C13 with IP66 locking feature

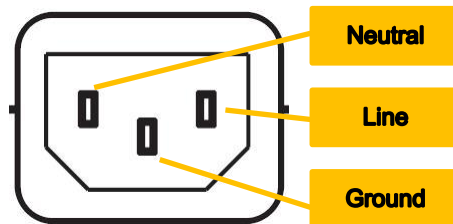


Figure 15: AC Input Connector

Table 6: AC Input Connector Pin Configuration

Pin	IEC Wire Colour	North American Wire Colour	Description
L	Brown	Black	AC Line
G	Green/Yellow	Green	AC Ground
N	Blue	White	AC Neutral

- In North America (and other 120V AC regions), the AC cord must be a 3-conductor UL Listed/CSA approved detachable cord set at least 1.8m in length (≥ 6 feet); minimum 16AWG SJT rated 105C, 300V; terminated with 120V or 240V, 13A-or-greater connector. For industrial applications where the AC cord may be exposed to hard usage and moisture, Delta-Q Technologies recommends a heavy-duty S- or SO-type cable, rated for 105°C (221°F) and 600V.
- In Japan, the AC cord must be a 3-conductor PSE approved detachable AC cord set terminated with 100V, 15A or greater connector.
- In 220-240VAC regions, the AC cord must be a 3-conductor safety-approved cord set with 1.0mm² conductors (minimum) rated appropriately for industrial use. The cord must be terminated on one end with a grounding type input plug appropriate for use in the country of destination. Both plug and connector should be rated 250V, 10A or greater.

7.2.2 AC Extension Cords

Use a heavy-gauge extension cord rated for the charger's maximum input current. Do not use a light-duty indoor extension cord. Per UL guidelines: at 120VAC, extension cords must be 3-wire cord no longer than:

- 30m (100ft) at 10 AWG/6.0 mm²
- 7.5m (25ft) at 16 AWG/1.5 mm²

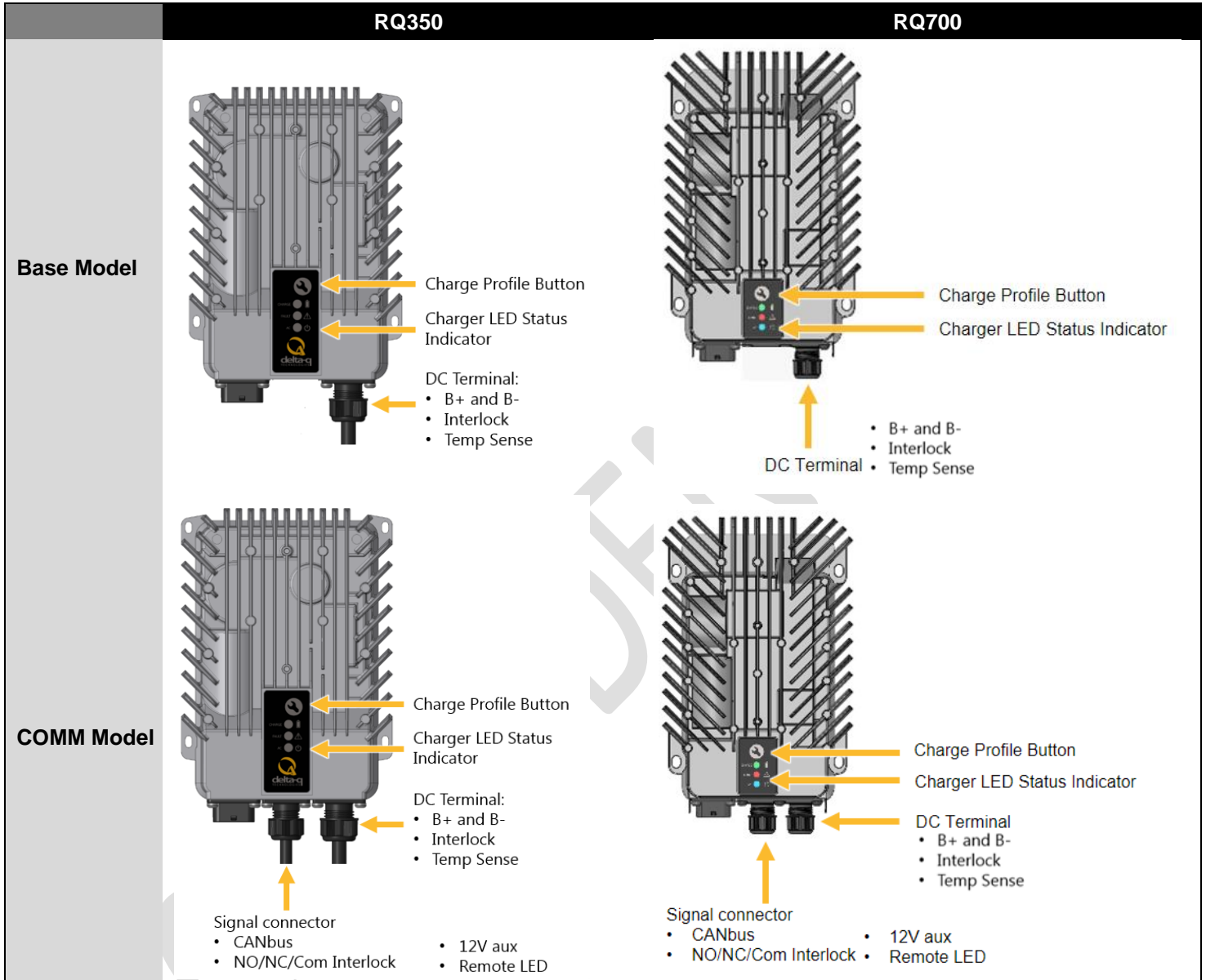
7.2.3 Beaded AC Cables

In order to comply with FCC Class B/CISPR-14 electrical emission standards, the RQ350 requires a beaded AC cable. Contact your Delta-Q account manager to purchase beads or beaded cables.

7.3 DC Output

RQ-series chargers have two standard variations depending on the vehicle requirements, seen below:

Table 7: Output Variants



Other custom variations can be made available on request.

Table 8: DC Terminal Output (Base and COMM Models Only)

Wire Colour	Function
Red	Battery +
Black	Battery -
White	Temperature Sensor
Green	Power Interlock (10A)

7.4 Signals & Control Connectors

7.4.1 RQ350 Signals & Control Connector

The RQ350 uses an 8-pin Deutsch DT06-08SA connector.

Table 9: RQ350 Standard Wire Colours & Signals

Signal Connector Pin	Wire Colour	Description
Pin 1	Yellow	CAN High
Pin 2	Black	CAN Low
Pin 3	White	Signal Interlock NC
Pin 4	Green	Signal Interlock COM
Pin 5	Brown	Signal Interlock NO
Pin 6	Red	Remote LED Red Positive
Pin 7	Orange	Remote LED Green Negative
Pin 8	Blue	AUX – 12V 100mA*

*Pin 8 requires a return path via battery-negative

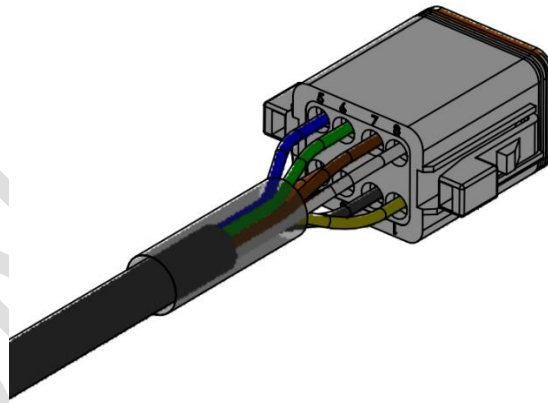


Figure 16: RQ350 COMM Signal Connector

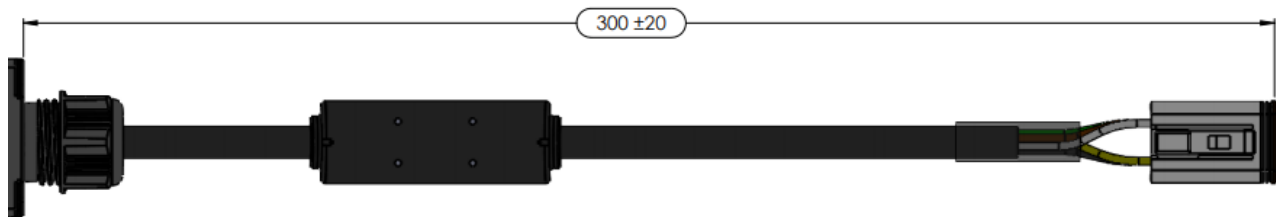


Figure 17: RQ350 COMM Signal Cable

7.4.2 RQ700 Signals & Control Connector

The RQ700 uses a 12-pin Amphenol ATM06-12SA connector.

Table 10: RQ700 Standard Wire Colours & Signals

Signal Connector Pin	Wire Colour	Description
Pin 1	Yellow	CAN-High (isolated, non-terminated)
Pin 2	Black	CAN-Low (isolated, non-terminated)
Pin 3	White	Signal Interlock NC
Pin 4	Green	Signal Interlock COM
Pin 5	Brown	Signal Interlock NO
Pin 6	Red	Remote LED Green Positive
Pin 7	Orange	Remote LED Red Positive
Pin 8	Blue	14V Aux 400mA
Pin 9	Grey	14V Aux Return*
Pin 10	Purple	CAN-Ground
Pin 11	Pink	General Purpose Input/Output
Pin 12	Other	Not connected; factory use only

*Note: Return lines are reference to battery-negative but should not carry charging current.

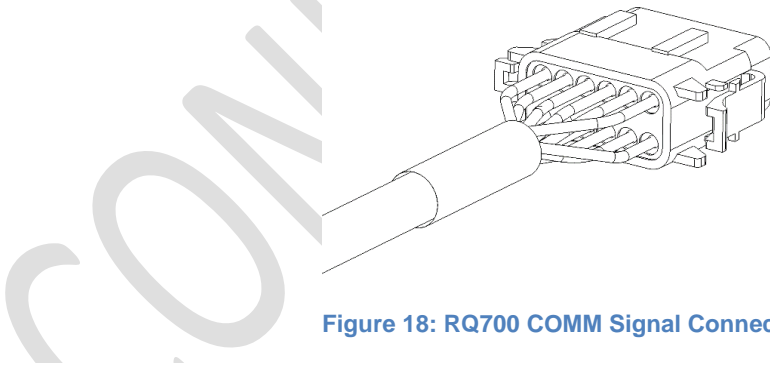


Figure 18: RQ700 COMM Signal Connector

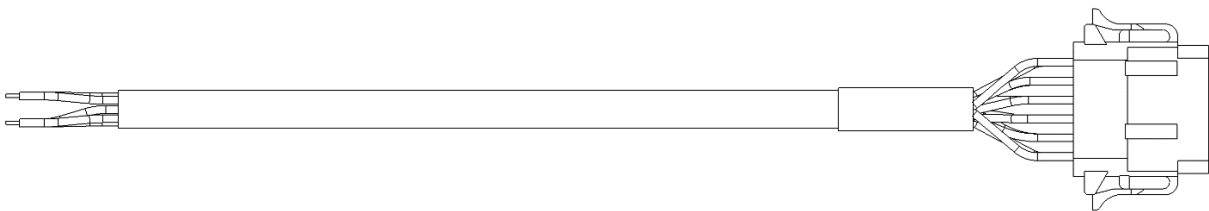


Figure 19: RQ700 COMM Signal Cable

Note: The RQ700 COMM signal cable includes a ferrite bead to reduce electromagnetic emissions (not pictured).

7.5 Interlock

Three different interlock options are available for the interlock relay:

7.5.1 Floating (or Battery-Referenced) Signal Relay (1A max)

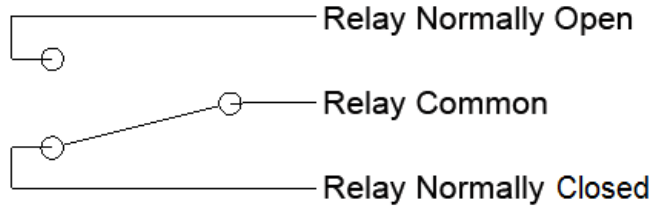


Figure 20: Internal Schematic of Interlock Relay Contacts

The relay's coil is energized when there is AC voltage connected to the charger, connecting the Common and Normally Open (NO) pins and leaving the Normally Closed (NC) pin disconnected. The relay de-energizes when the charger loses AC power, connecting the Common and NC pins and leaving the NO pin disconnected. The contacts are isolated from all other circuits in the charger.

Table 11: Floating Signal Relay Resistive Current Limits

Voltage Range	Min	Max
0 - 30VDC	0.1mA	1,000mA
30 - 110VDC	0.1mA	500mA
110 - 125VDC	0.1mA	300mA

- Available on either signal cable or DC output cord
- 1A fuse recommended to be added in series
- (Optional) Relay common can be tied to Battery Negative internal to the charger

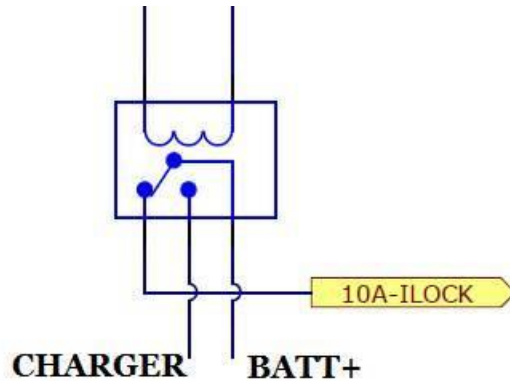
7.5.2 Floating (or Battery-Referenced) Power Relay (5A max)

- Functionally similar to Signal Relay but higher current capability (see *Figure 20: Internal Schematic of Interlock Relay Contacts* for schematic)
- ONLY available on DC output cord
- Minimum wetting current of 10mA is required
- 5A fuse is recommended to be added in series
- (Optional) Relay common can be tied to Battery Negative internal to the charger

Table 12: Floating Power Relay Resistive Current Limits

Voltage Range	Min	Max
0 - 15VDC	10mA	5,000mA (RQ350) 4,000mA (RQ700)
15 - 30VDC	10mA	2,000mA
30 - 60VDC	10mA	1,000mA
60 – 200VDC	10mA	300mA

7.5.3 Battery-Referenced Power Relay (10A max)

**Figure 21: Internal Schematic of Power Relay Contacts**

The relay's coil is controlled by the algorithm and will close the interlock cable to Battery Positive when charging is complete (by default – different configuration options are available).

Table 13: Battery-Referenced Power Relay Resistive Current Limits

Voltage Range	Min	Max
0 - 15VDC	100mA	10,000mA
15 - 30VDC	100mA	7,000mA
30 - 40VDC	100mA	1,000mA
40 – 1000VDC	100mA	300mA

Note: these limits assume resistive loads. For inductive/capacitive loads, contact your Delta-Q representative for further details.

- ONLY available on DC output cord
- Minimum wetting current of 100mA is required
- In series with DC output fuse – no extra fuse is necessary

7.5.4 Protecting Interlock Relays

In addition to fusing for resistive loads at the limits listed above, protection for inductive kickback and surge loads should also be considered.

Inductive Kickback: Voltage spikes (kickbacks) occur if the load is inductive, such as with a relay or motor, and may damage the charger interlock circuits. A free-wheeling diode, metal oxide varistor (MOV), or transient voltage suppressor (TVS) will minimize this kickback.

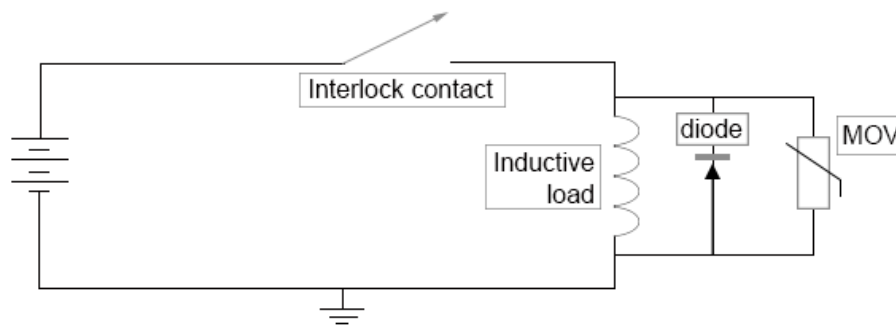


Figure 22: Example Interlock Circuit

Surge Loads: Many loads (e.g., motors, light bulbs, and electronic equipment) often have an inrush or surge current when first connected to power which can weld or severely damage relay contacts. To protect against this, test for surges with an oscilloscope and a current sensor and install a suitable resistor in series to reduce the surge. Contact your Delta-Q application engineer for help selecting this resistor.

8 Software

RQ Series software is based on the well-developed IC, RC, and ICL Series software. Specific details on software are subject to change; contact your Delta-Q representative for the latest documentation.

8.1 Algorithms

A selection of algorithms from our library are available – contact Delta-Q for details.

8.2 CAN Features

Refer to Delta-Q CAN interface documentation

9 Service and Troubleshooting

9.1 Charging Algorithms

A selection of algorithms from our library are available – contact Delta-Q for details.

9.2 Troubleshooting Guide

Available from your Delta-Q representative.

9.3 Faults and Error Codes

See *Section 5, Table 4: RQ Series Error Codes*

10 Drawings

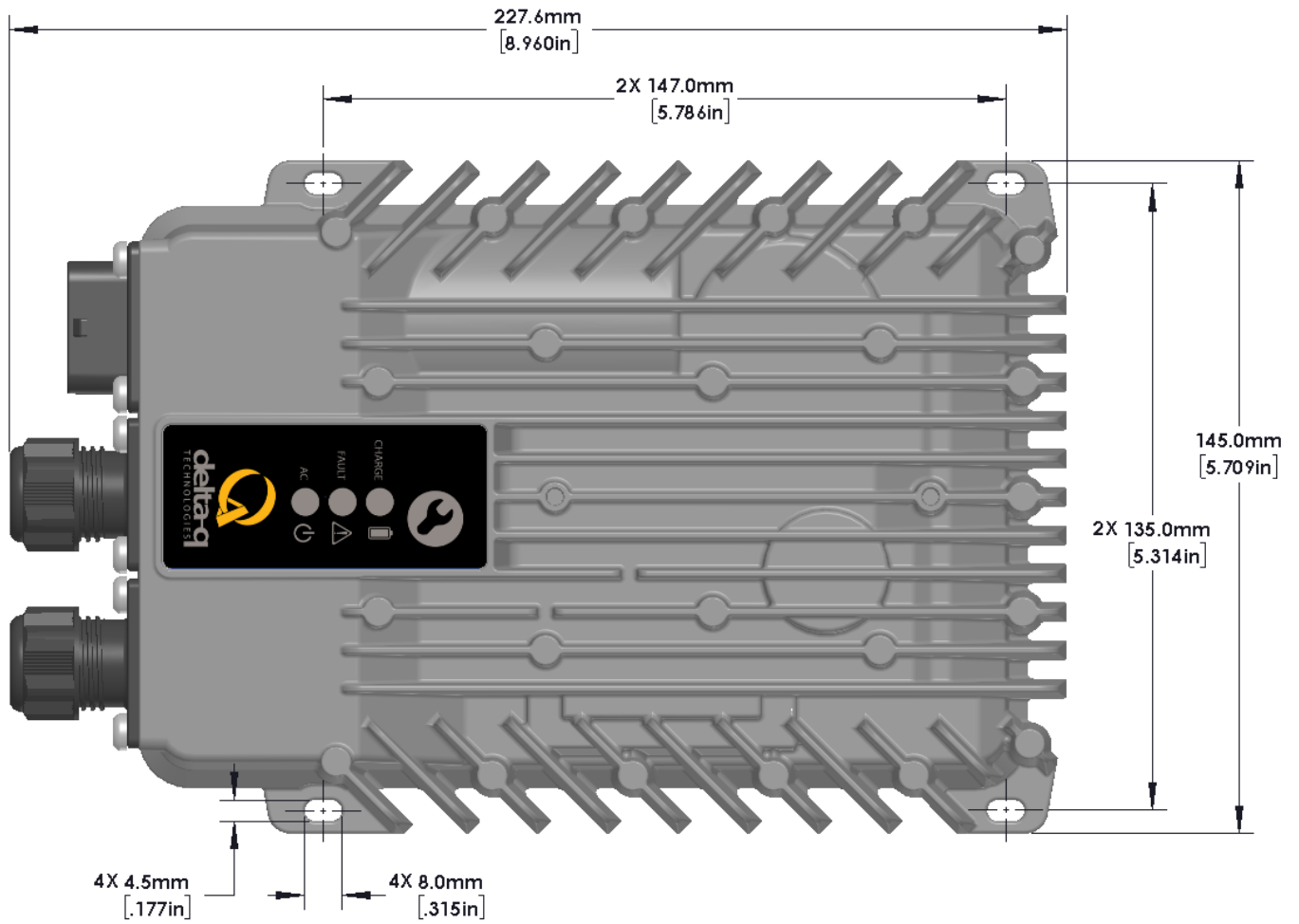


Figure 23: RQ350 Top View and Dimensions

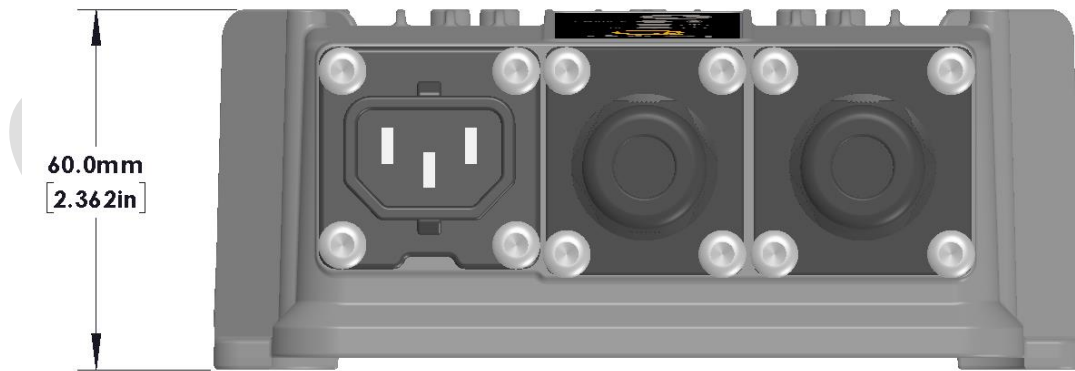


Figure 24: RQ350 Front View and Dimensions

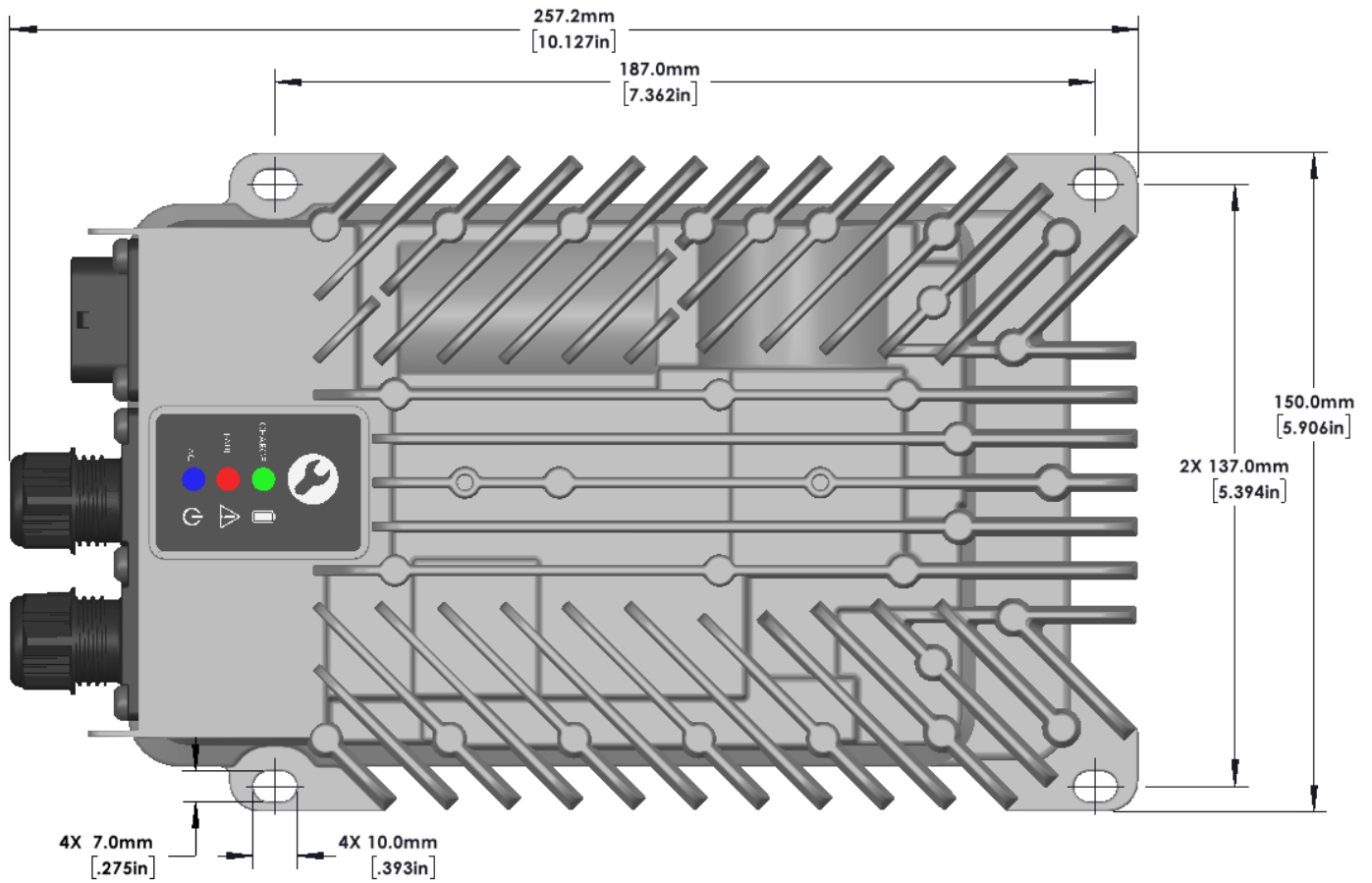


Figure 25: RQ700 Top View and Dimensions

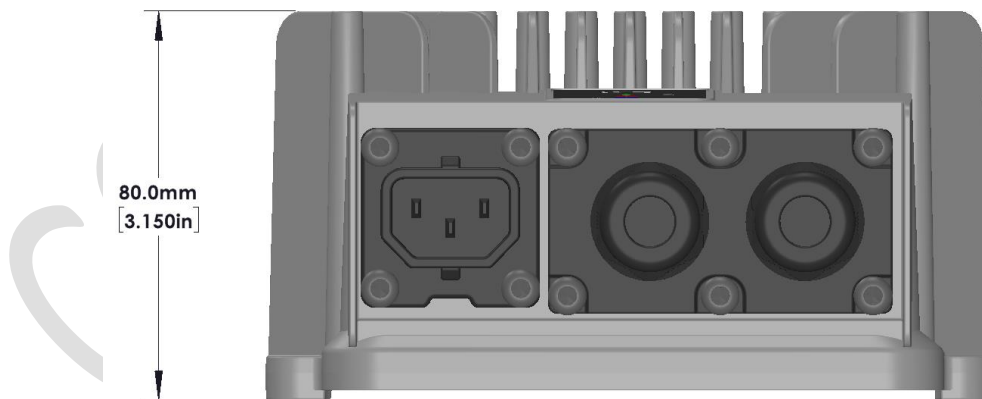


Figure 26: RQ700 Front View and Dimensions