



IC

SERIES

# Delta-Q IC Series Battery Chargers Installation and Design Guide



IC650

IC900

IC1200



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## **Intended Audience**

This document is intended for engineers and technologists of original equipment manufacturers (OEMs) to aid them in incorporating IC Series battery chargers into their products.

## **Delta-Q IC Series Battery Chargers Design Guide: Contents**

**1.0 Safety Notes 1**

**2.0 Regulatory Notes 2**

**3.0 IC Series Model Listing 3**

**4.0 IC Series Charger Operations 4**

**5.0 IC Series Charger Interface 6**

**6.0 Mechanical Installation 8**

**7.0 Electrical Installation 18**

**8.0 Communications 33**

**9.0 IC Series Charger Configuration 36**

**10.0 Troubleshooting 39**

**11.0 IC Series Drawings, Photos, and Specifications 46**

**12.0 Replacement Parts List 64**

**13.0 Glossary 65**

# 1.0 Safety Notes

Read and comprehend this document fully before handling or working with IC Series battery chargers. Important safety, operation, and installation instructions are included.

## 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 user-serviceable parts are contained inside the unit.

## Electrical Safety Information



**Danger:** Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. **A grounded outlet is required to reduce risk of electric shock. Do not use ground adapters or modify plug.** Do not touch uninsulated portion of output connector or uninsulated battery terminal. Disconnect the AC supply before making or breaking the connections to the battery while charging. Do not open or disassemble charger. Do not operate charger if the AC supply cord or DC output cord are damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way—refer all repair work to qualified personnel. Not for use by children.

## Battery Safety Information



**Warning:** Use charger only on appropriate battery systems. Other usage may cause personal injury and damage. Study all battery manufacturers' specific precautions, such as recommended rates of charge and other safety precautions before charging batteries. Do not charge non-rechargeable batteries.

## 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. NRTL approval in the United States).

# 2.0 Regulatory Notes

## North America

This equipment has been tested and found to comply with the limits for Class A digital devices, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in an industrial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their own expense.

All IC Series chargers are fully compliant with safety regulatory requirements in Canada and the United States, as indicated by the "C" before and the "US" after the "UL" or "RU" logo.

Additionally, the IC650 charger also carries the "CSA" logo.

All IC Series chargers are fully compliant with California Energy Commission (CEC) standards for efficiency, and are marked with the CEC compliance symbol.

## Europe, Asia, Middle East, Africa

These products are approved for use in Europe and other countries that accept CE requirements. Each charger has a CE mark, supported by a CB Test Report.

## Japan

24V and 36V IC650 chargers are certified for use in Japan when an appropriately filtered AC cord is installed. Contact Delta-Q Technologies for details on this AC cord.

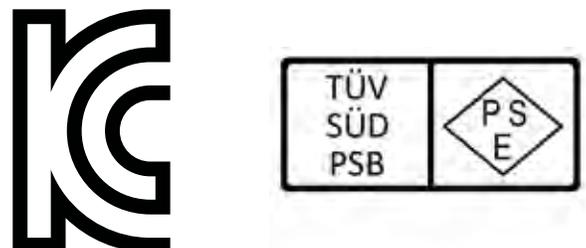
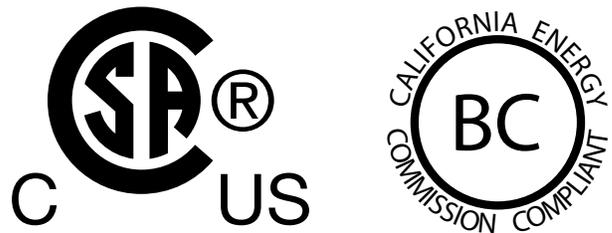
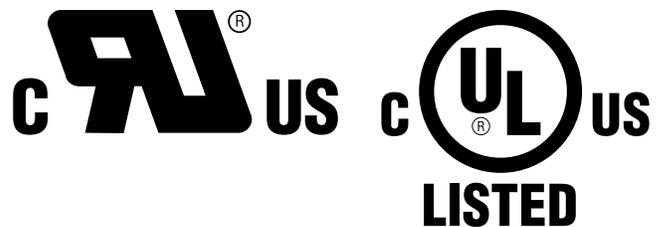
## Australia & New Zealand

IC Series chargers (IC900/IC1200 pending) are certified for use in Australia and New Zealand, and labelled with the Regulatory Compliance Mark (RCM) symbol, which also includes the C-tick mark.

## Other Standards or Geographies

Every effort has been made to ensure IC Series chargers are fully compliant with most worldwide regulations. If a particular region does not accept the regulatory approvals for these products, contact Delta-Q Technologies for further information and assistance.

Copies of all approvals are available upon request.



# 3.0 IC Series Model Listing



IC650



IC900



IC1200

## IC650

Part no.	Product Description	Voltage	Max Current	Power
940-0001	24V IC650 Base	24 V	27.1 A	650 W
940-0002	36V IC650 Base	36 V	18.1 A	650 W
940-0003	48V IC650 Base	48 V	13.5 A	650 W
940-0004	24V IC650 COMM	24 V	27.1 A	650 W
940-0005	36V IC650 COMM	36 V	18.1 A	650 W
940-0006	48V IC650 COMM	48 V	13.5 A	650 W

## IC900

Part no.	Product Description	Voltage	Max Current	Power
942-0001	24V IC900 Base	24 V	37.5 A	900 W
942-0002	36V IC900 Base	36 V	25.0 A	900 W
942-0003	48V IC900 Base	48 V	20.0 A	960 W
942-0008	24V IC900 COMM	24 V	37.5 A	900 W
942-0009	36V IC900 COMM	36 V	25.0 A	900 W
942-0010	48V IC900 COMM	48 V	20.0 A	960 W

## IC1200

Part no.	Product Description	Voltage	Max Current	Power
941-0001	24V IC1200 Base	24 V	50.0 A	1200 W
941-0002	36V IC1200 Base	36 V	33.3 A	1200 W
941-0003	48V IC1200 Base	48 V	25.0 A	1200 W
941-0008	24V IC1200 COMM	24 V	50.0 A	1200 W
941-0009	36V IC1200 COMM	36 V	33.3 A	1200 W
941-0010	48V IC1200 COMM	48 V	25.0 A	1200 W

See [11.0 IC Series Charger Drawings, Photos, and Specifications](#) for detailed product specifications.

# 4.0 IC Series Charger Operations

IC Series battery chargers are intelligent, programmable power devices designed to reliably charge your machine's batteries in the harshest of environments. They are intended to be installed on-board or off-board and, if desired, can be fully controlled by your own machine control module. The charger also provides electrical protection to help maintain the integrity of your vehicle's electrical system and protect your users.

## 4.1 Overview

As advanced power conversion devices, IC Series chargers efficiently provide clean DC output in a very compact package. It does this using a small, light, high-frequency switching transformer, and also includes a utility-friendly power factor correction stage. Each charger's overall design is optimized for maximum ruggedness and reliability to provide many years of service.

### Isolation

Delta-Q has developed an innovative system of isolation boundaries to separate the charger's advanced features into four galvanically-isolated electrical domains:

- i. AC Input: Isolated input to AC source (0-270 VAC). AC input is isolated from chassis ground and other inputs, including communications.
- ii. DC output: Isolated output to batteries (0-3 volts per cell).
- iii. SELV: Isolation for USB and other signals (0-5 volts DC).
- iv. SELV: Isolation for CAN bus (0-5 volts DC).

### Configurations

Two configurations of each model are available. The difference between the models is the inclusion of a communication port on the "COMM" model for advanced control.

1. COMM: Full CAN bus control and other signals available.



IC650 "COMM" model (overhead view)

2. Base: Base model connections to the battery and controller interlock.



IC650 "base" model (overhead view)

Either of the above can be configured for on-board or off-board use. For more details, please see the [7.0 Electrical Installation](#) section of this guide.

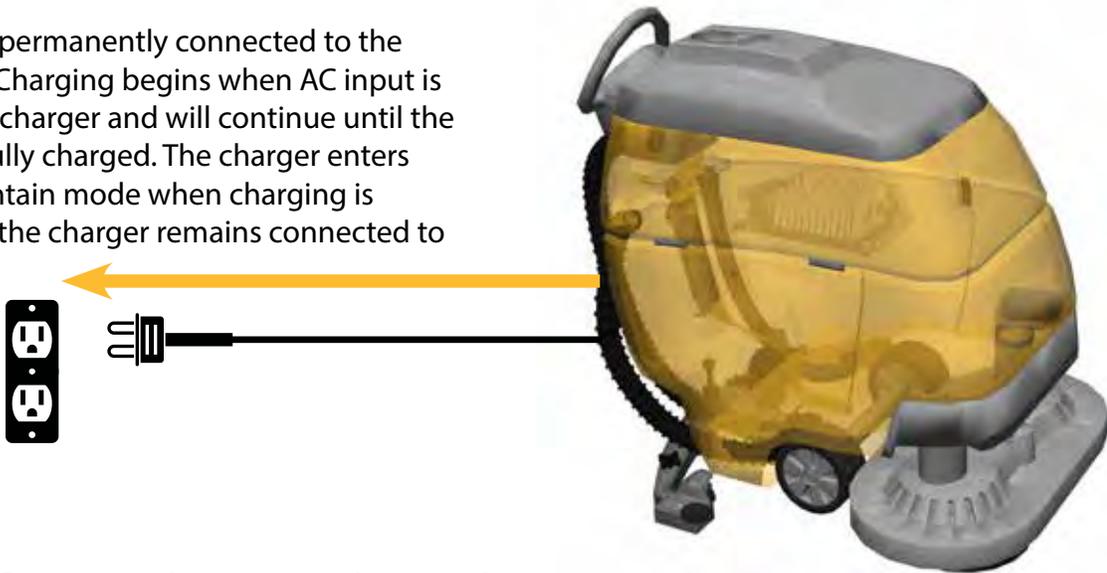
## 4.2 Normal Operation

To begin charging in an on-board or off-board configuration, the battery pack must be within the voltage operation range of the selected charge profile and the AC voltage must be within the specified range for the charger. For details of CAN bus controlled charging, please see the [8.0 Communications](#) section.

The IC Series Charger operates in an on-board configuration (charge on AC detect) or off-board configuration [charge on DC (battery) detect]. Once the battery pack is fully charged, and if the charger, battery pack and AC input remain connected, the charger will continue to monitor and maintain the battery.

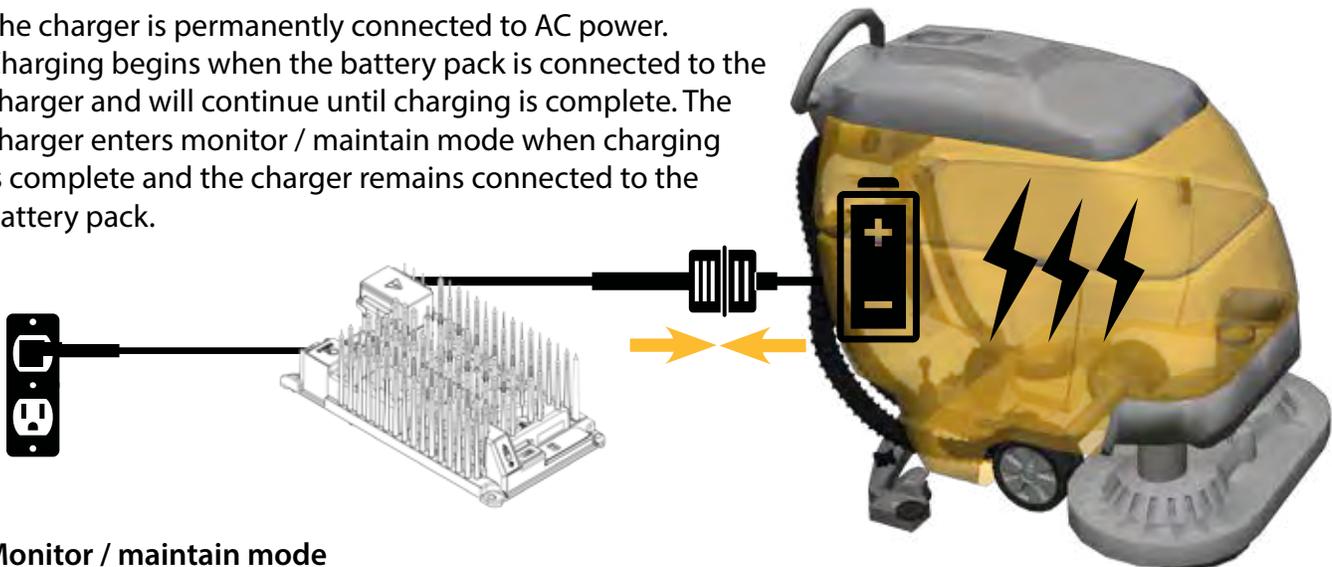
### On-board configuration: Charge on AC detect

The charger is permanently connected to the battery pack. Charging begins when AC input is applied to the charger and will continue until the batteries are fully charged. The charger enters monitor / maintain mode when charging is complete and the charger remains connected to AC input.



### 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. The charger enters monitor / maintain mode when charging is complete and the charger remains connected to the battery pack.

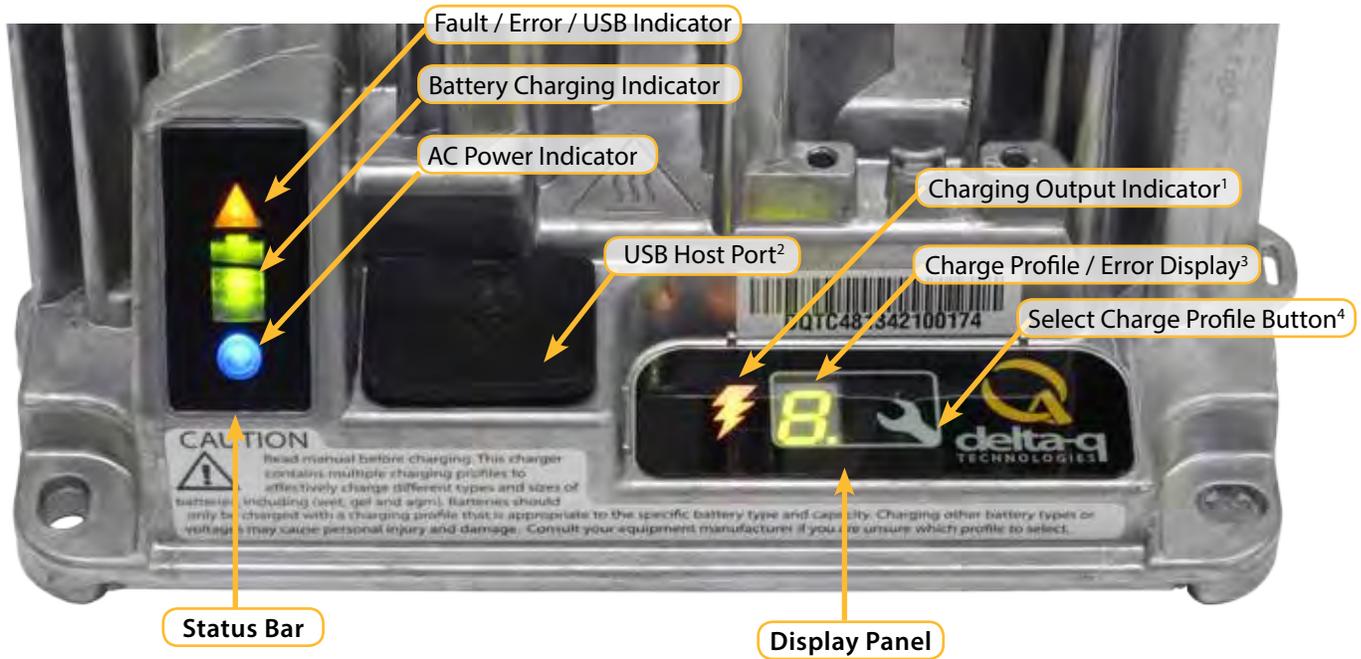


### Monitor / maintain mode

This mode becomes active when charging is complete, AC power is present, and the battery pack is connected. The charger output is disabled and the charger monitors the batteries. If the batteries fall below set thresholds or beyond set time limits for the charge profile, the charger will take action to maintain the capacity and health of the batteries. Depending on the selected algorithm, the charger will restart after 30 days or 2.08 V/cell, or the newer logic after 14 days or 1.80 V/cell.

# 5.0 Charger Interface

All IC Series chargers share the same user interface to improve usability.



	Solid red = Charger fault See display panel for details		Solid blue = AC power available
	Flashing amber = External error condition - caution See display panel for details		Flashing green = Low state of charge Solid green = High state of charge
	Flashing green = USB port active Solid green = Safe to remove USB flash drive		Flashing green = High state of charge Solid green = Charge completed

1. The Charging Output Indicator is solid yellow when the charger output is active. Take appropriate actions while handling the charger, as there is a risk of electric shock. The indicator will flash if the charger is disabled by an external signal (some charge profiles).
2. The USB host port provides read and write functionality. Using a standard USB flash drive, a user can download charge tracking data and update the charger's software and charging profiles. See [5.1 USB Host Port](#), [9.0 Charger Configuration](#), and [9.3 Charge Cycle Tracking Data](#) for more information.
3. The Charge Profile / Error Display shows one of four possible codes to indicate different conditions:
  - + 'F' codes mean that an internal fault condition has caused charging to stop.
  - + 'E' codes mean that an external error condition has caused charging to stop.
  - + 'P' codes mean that the charger programming mode is active.
  - + 'USB' code meaning that the USB port is active and the flash drive should not be removed.

The 'E','F' and 'P' codes are followed by three numbers and a period to indicate different conditions (e.g. E-0-0-4.). See [10.1 Charger Fault Codes](#) or [10.2 Charger Error Codes](#) for details on these conditions and their solutions. 'P' codes indicate the active charging profile number.

4. The Select Charge Profile Button is used to select a charge profile from those stored on the charger. Up to 25 charge profiles can be stored. See [9.1 Selecting A Charge Profile](#) for instructions.

## 5.1 USB Host Port



The Universal Serial Bus (USB) host port on an IC Series Charger is used when configuring or retrieving data from the charger.

The USB host port accepts standard USB flash drives that are available at office supply or electronic stores.

Data that is retrieved from a charger can be transferred to and viewed on a Windows-based computer running the IC Data Analysis tool software.

A USB flash drive can also be configured to program charger settings or update charger software. This enables operators to easily update charger software and/or settings, on a production line or in the field, without a custom handheld diagnostic tool or computer.

A rubber cover seals this USB port against the elements. The port itself is sealed against water and dust ingress to an IP67 rating.

See [9.2 Configuring the charger using a USB Flash Drive](#) for more information.

**IMPORTANT:** Only directly-connected USB flash drives (single partition, FAT formatted) are compatible with the USB host port. Other USB devices may not function.

### USB Port Specifications

IC Series Charger	Max Current Rating
IC650	200 mA
IC900	500 mA
IC1200	500 mA

## 5.2 Display Panel



On the right side of the charger interface is a display panel area containing three items:

1. Charging Output Indicator
2. Charge Profile / Error Display
3. Select Charge Profile Button

The Charging Output Indicator is solid yellow when the charger is outputting power. This is meant to clearly show when the charger is active, so that appropriate safety precautions can be taken if the charger is to be handled. The indicator will flash if the charger is disabled by external signal (some charge profiles).

The Charge Profile / Error Display shows the current charge profile, or the fault or error condition the charger is currently experiencing.

The Select Charge Profile Button is pressed to view the currently active charging profile. It is also used to select a new charge profile from those loaded on the charger. See [9.1 Selecting a Charge Profile](#) for the full procedure.

From charger software version 4.3.3 and later, the button has additional features:

- Long (5 second) Press: Shows software version, checksum, algorithm and algorithm version in the following pattern:

S 4. 3. 3 C a b 1 2 P 0 1 1 r 1. 3 2

**SW:** v4.3.3

**Checksum:** ab12

**Algorithm:** 11 v1.32

- Very Long (10 second) Press: Off mode. This turns off all functions while not charging to save energy while connected only to batteries.

# 6.0 Mechanical Installation

When considering installation space for an IC Series charger, allow space around the charger to maintain maximum performance. It is also important to choose a location that allows for the following:

- + Access to the AC, DC and signal connections
- + Good visibility of the charger interface, or a pathway for the use of a remote LED on the vehicle or machine's control interface
- + Access to the USB host port

See [6.1.3 Charger Touch Temperatures](#) for more information about charger temperatures and thermal images of the charger in operation.

## 6.1 Cooling

As fully sealed power electronics devices, IC Series chargers require different considerations for cooling than open, ventilated or conductively-cooled devices. IC Series chargers employ convection (IC650 and IC900) and active (IC1200) cooling designs.

### 6.1.1 Convection Cooling

The convection-cooled IC650 and IC900 chargers require sufficient airflow across their surface in order to cool the internal components. Delta-Q can assist you in fitting the charger into your vehicle or machine to allow for enough convection airflow over the charger.

Use the following tips as a guide to ensuring the charger receives enough airflow:

- + Allow sufficient space around the charger for cooling air to flow.
- + All orientations are possible, however, if the heat sink is facing directly downward, rising hot air may prevent the charger from operating at its maximum output level. Mounting on a horizontal surface is best.
- + In known high ambient temperature locations (>40°C), a fan may be used to direct air over the charger surface to maximize power.

Charger de-rating statistics are shown in [10.3 Performance Charts](#).



*Convection-cooled IC Series chargers require clearance for airflow around the charger to allow for maximum performance.*

## 6.1.2 Active Cooling

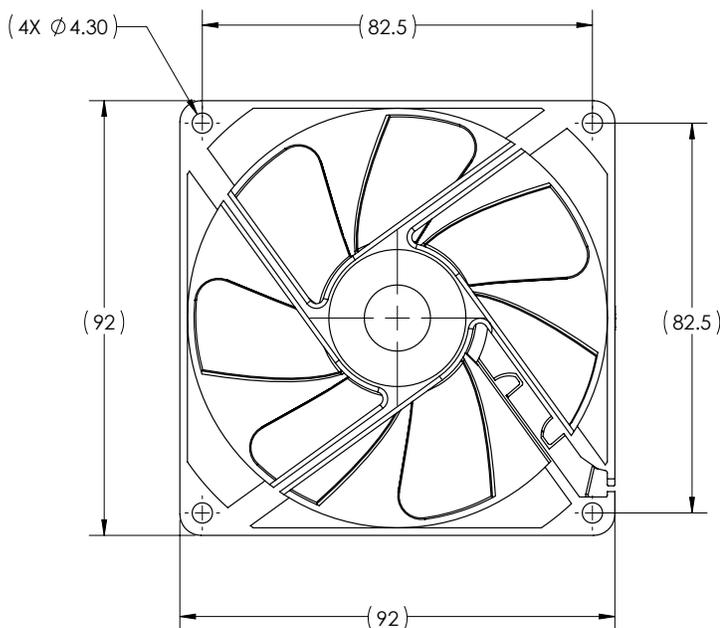
The IC1200 charger has been designed with a fan to provide for high power density. The fan has been carefully selected to ensure trouble-free operation for the life of the charger.

The charger's active cooling and thermal management design features include:

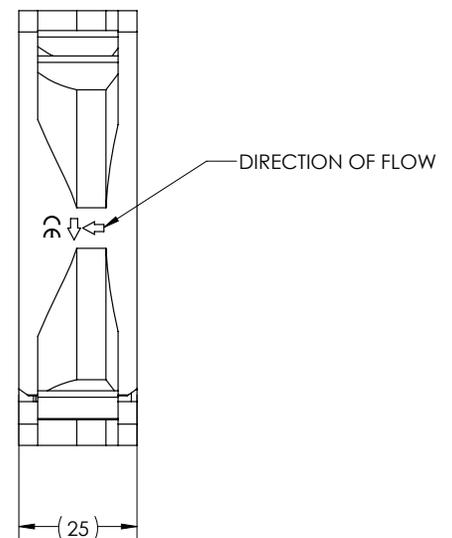
- ✦ Charger-controlled fan speed to regulate internal temperatures. The fan only turns on when needed, at much less than maximum speed. Only ~30 cubic feet per minute (CFM) is required to cool the charger at 40°C (104°F) ambient.
- ✦ Features have been molded into the die-cast enclosure and the plastic fan shroud to ensure optimum airflow to the critical areas.
- ✦ The fan has ball-bearings (vs. a bushing) and is sealed to IP67 so dirt and debris can be washed out with a hose or pressure washer.
- ✦ A carry handle has been integrated into the fan shroud for user convenience when handling the charger.
- ✦ The fan is quiet, producing acoustic noise of less than 50 dB at 3m (9.8 ft).
- ✦ As with convection-cooled IC Series chargers, mounting on a horizontal surface is best.

Description	Specification
Type	DC Brushless Fan
Rated Voltage	12 V DC
Max Flow Rate	73 CFM
IP Rating	IP67
Electrical Protections	<ul style="list-style-type: none"> <li>✦ Locked Rotor</li> <li>✦ Reverse Polarity</li> </ul>
Life Expectancy (L10)*	65,000 hours at 40°C (104°F)

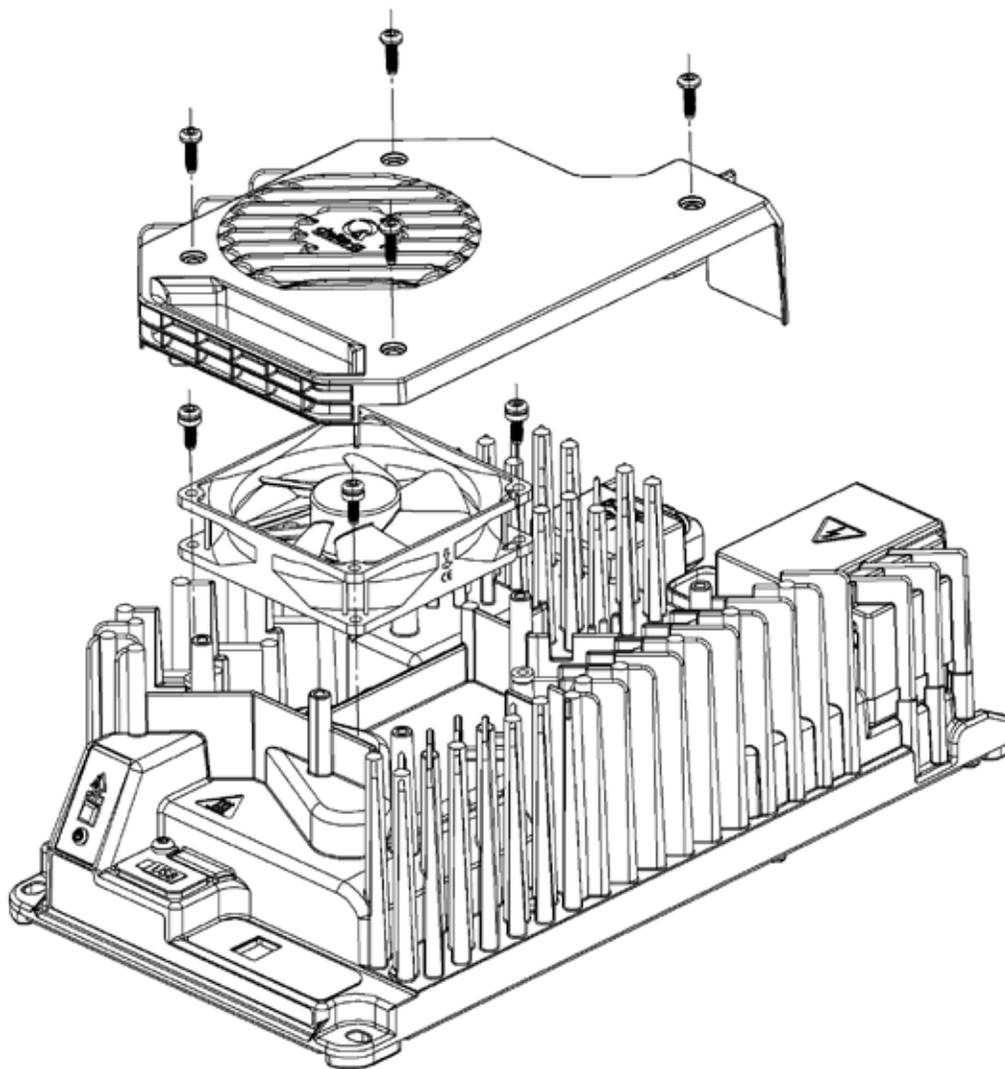
\* After 65,000 hours at 40°C (104°F), a mean of 10%, are expected to fail



IC1200 fan dimensions



If the IC1200 charger fan fails, or is accidentally disconnected, the charger will display a Fan Error on its status display. Under this condition, the charger will continue to operate but at reduced output, within limits of its internal components. The fan and/or fan shroud can be easily replaced. See [6.1.2.1 Fan Replacement](#) for instructions.



*Active cooling fan assembly on the IC1200 Charger*

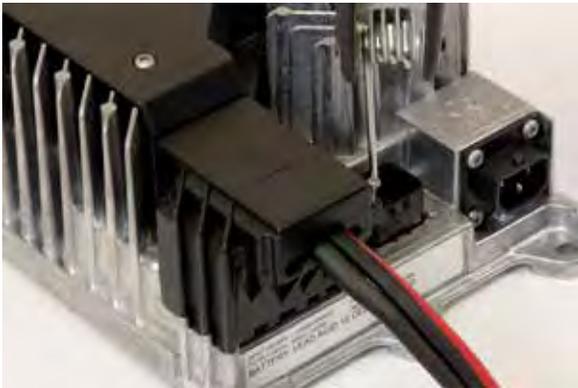
### 6.1.2.1 Fan Replacement Instructions (IC1200 Charger Only)

To replace the fan and/or fan shroud, you will need the following tools:

- + 3mm Hex key (Allen key)
- + Torx T10 screwdriver

#### Removal of existing fan

1. Disconnect charger from AC power and DC output ends to the battery.
2. Remove 2 DC cover screws (T10 Torx) and DC cover.



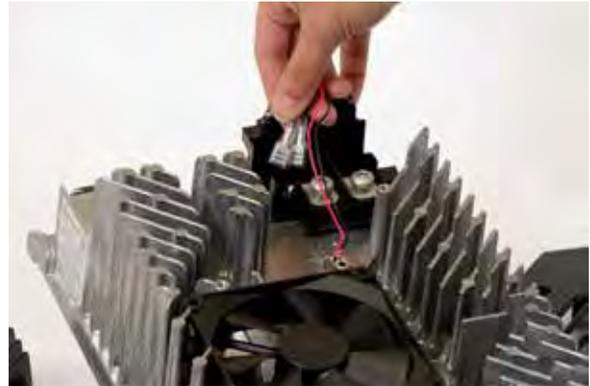
3. Using the Hex key (3 mm Allen key), remove 4 fan shroud screws.



4. With the 4 screws removed, lift up the fan shroud to detach from the charger.



5. Disconnect + (red) and - (black) fan harness fastons.



6. Remove 4 fan screws (3mm Allen key) and fan.



7. Ensure all rubber isolation washers are removed.

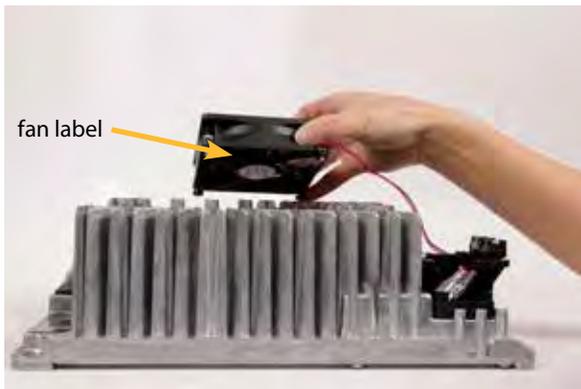


## Installation of new fan

1. During assembly, ensure all fasteners are fully seated but not overtightened.
2. Pre-assemble fan, fan screws, and isolation washers per illustration.



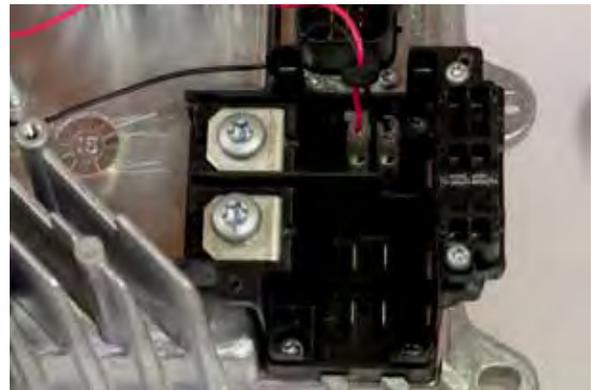
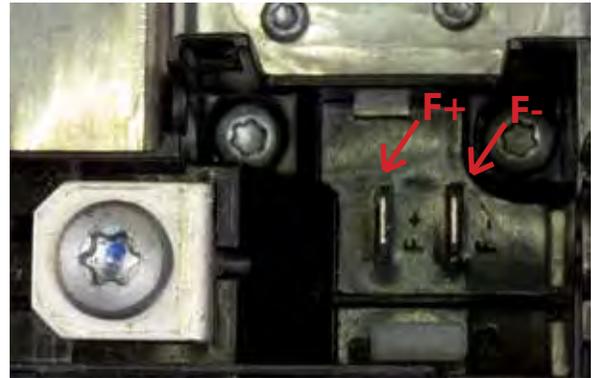
3. Install fan assembly onto charger with fan label down and with leads oriented and routed per illustration.



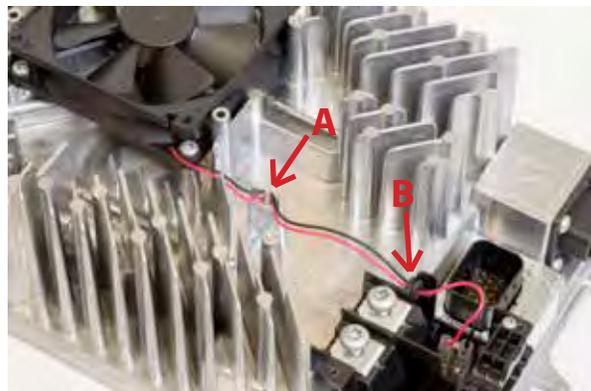
4. Tighten fan screws.



5. Connect fan fastons per illustration. Red wire to positive blade (F+) terminal and black wire to negative (F-) blade terminal. Install rubber strain relief in as shown.



6. (A) Weave the two wires around the three pins to provide strain relief. (B) Ensure the rubber grommet is placed in the plastic holder of the DC block.



7. Install fan shroud and 4 fan shroud screws.
8. Install DC cover and DC cover screws.
9. Reconnect DC output ends and finally AC power.

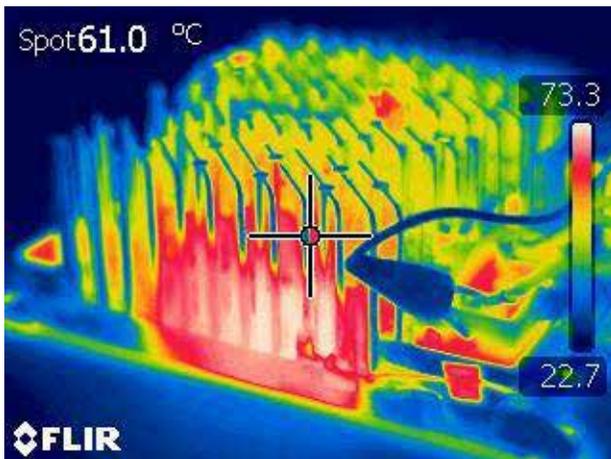
### 6.1.3 Charger Touch Temperatures

*NOTE: Touch temperature testing is still to be completed for the IC900 and IC1200 chargers. This document will be updated when that data is available. All of the information below is for the IC650 charger.*

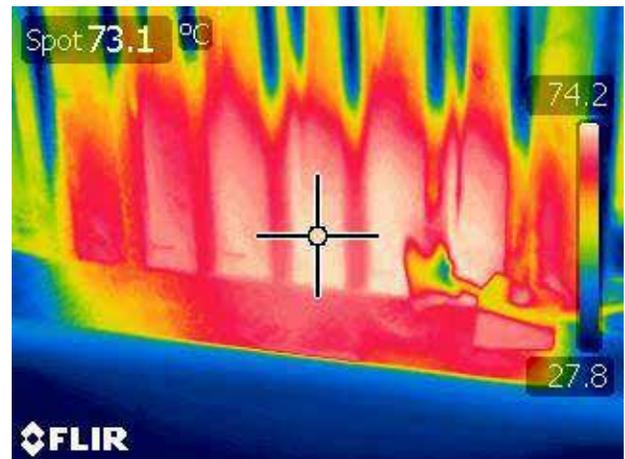
IC Series Chargers will feel hot to the touch while charging, especially during the bulk phase. These temperatures do not pose a risk to the charger, and are a sign of the effectiveness of the heat-sinking fins in keeping internal component temperatures low. The two hottest spots while the charger is actively charging a battery pack are on the left and right sides of the charger.

The maximum allowable touch temperature to meet safety approval requirements is 95°C (203°F). At an ambient room temperature of 21°C (70°F), expected touch temperatures will be 73°-76°C (163°-169°F).

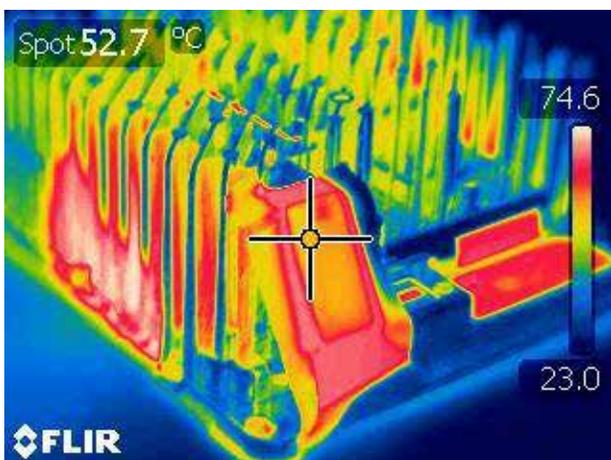
If thermocouples are placed at the base of the cooling fins near these peak temperature areas, well within the edge of the charger, you may measure temperatures that exceed 95°C (203°F). However, the charger will regulate its output to ensure any surface that can be casually touched does not exceed the 95°C limit. The temperature on the bottom of the charger is typically approximately 8°C (15°F) lower than the hottest temperatures on the charger sides when operating at maximum output.



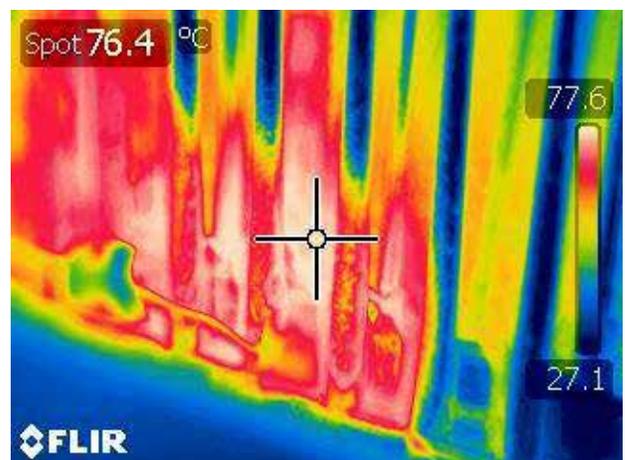
*IC650 right side. The highest temperatures occur between the cooling fins.*



*IC650 right side close-up. The highest measured temperature in this area is 74°C (165°F).*



*IC650 left side. The highest touch temperatures occur between the cooling fins, on the left side of this picture.*



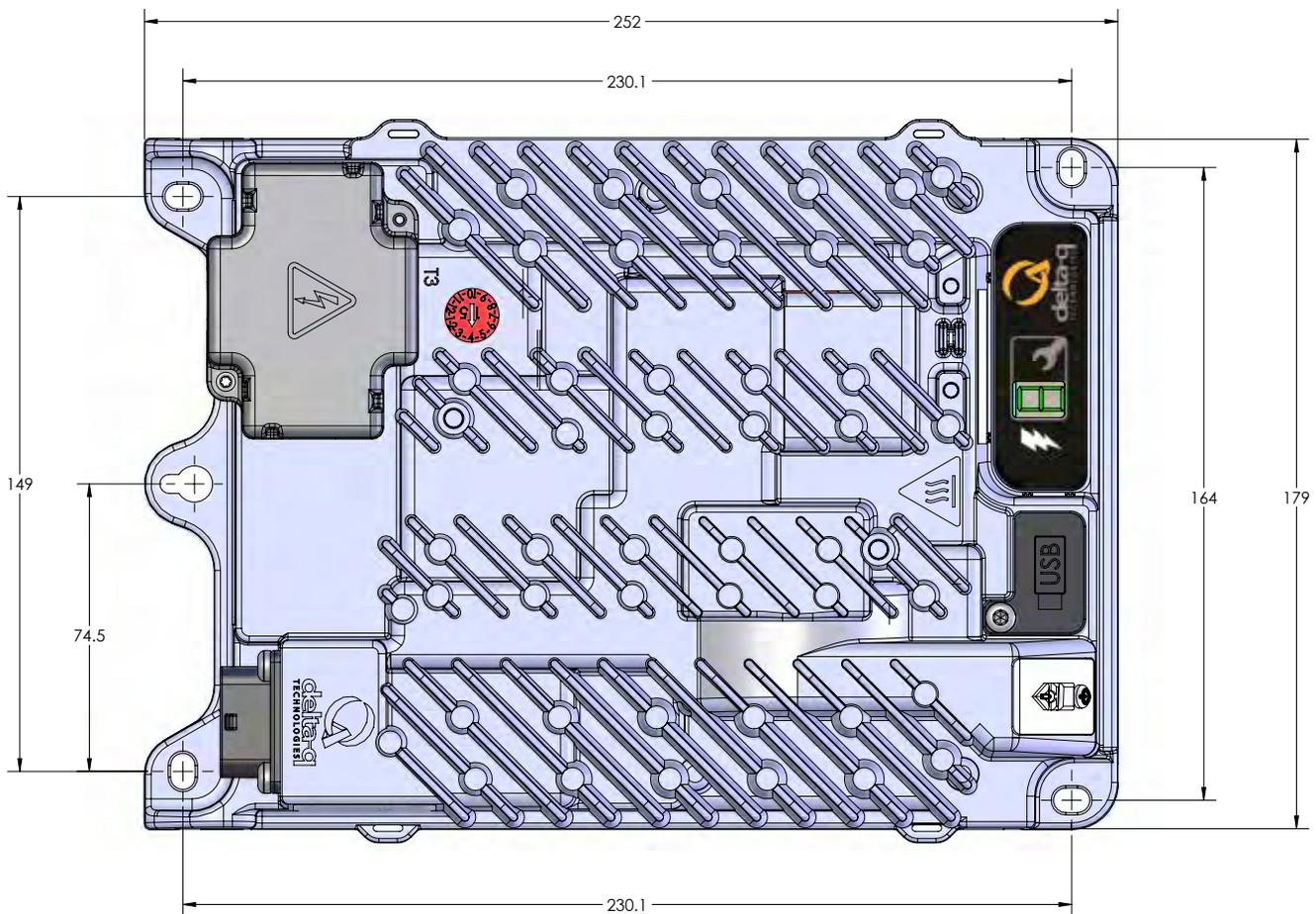
*IC650 left side close-up. The highest measured temperature in this area is 77°C (170°F).*

## 6.2 Mounting Points

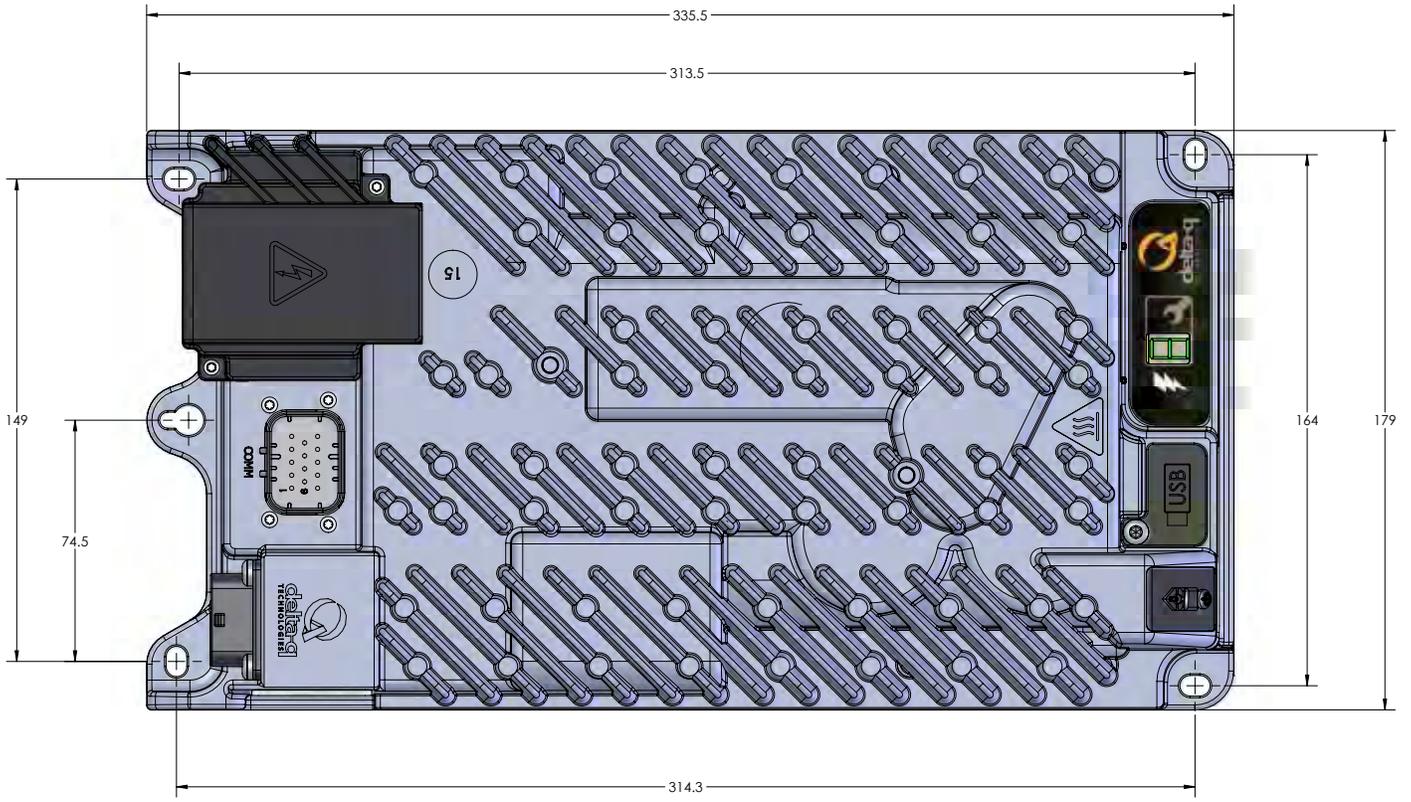
Robust mounting points are cast into the charger's aluminum enclosure. At each corner are 6.3mm (1/4") diameter slots, arranged to allow ample tolerance when mating with standoffs or pre-drilled holes in a machine. In addition, a keyhole slot has been provided in the back of the charger so that it can be hung vertically on a wall or secured to a shelf.

If mounting the charger on a vehicle or machine frame that may be prone to flexing, it is recommended to mount the charger using only three of the mounting points to prevent the charger case and internal components from being subjected to undue stress and torsional loads.

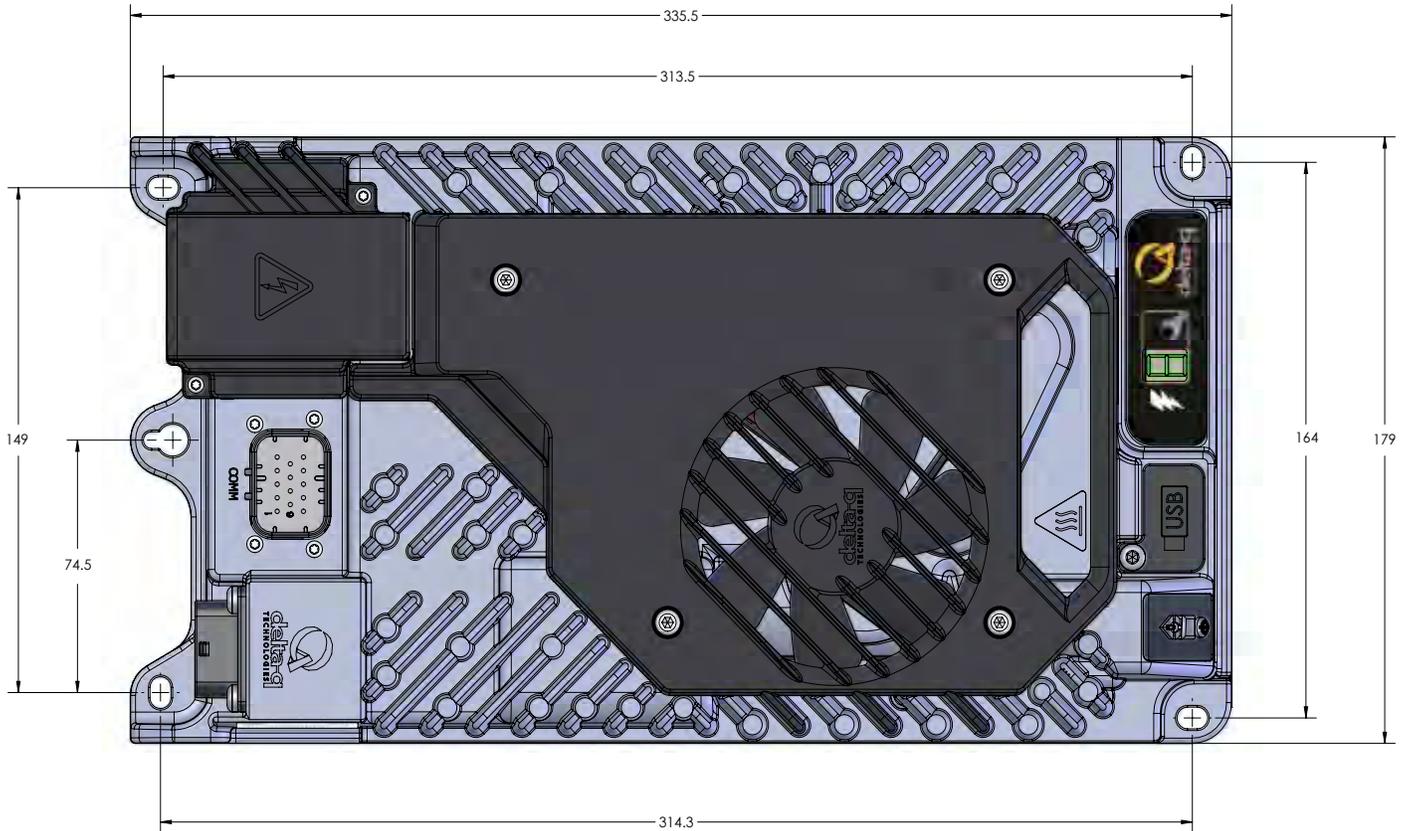
- ✦ Mount the charger securely using the mounting points shown in this section.
- ✦ A bracket may need to be fabricated, particularly if there is insufficient cooling air flow.
- ✦ Do not drill holes in the unit for mounting.



*IC650 charger mounting points*



IC900 Charger mounting points



IC1200 Charger mounting points

## 6.3 Cable Dressing

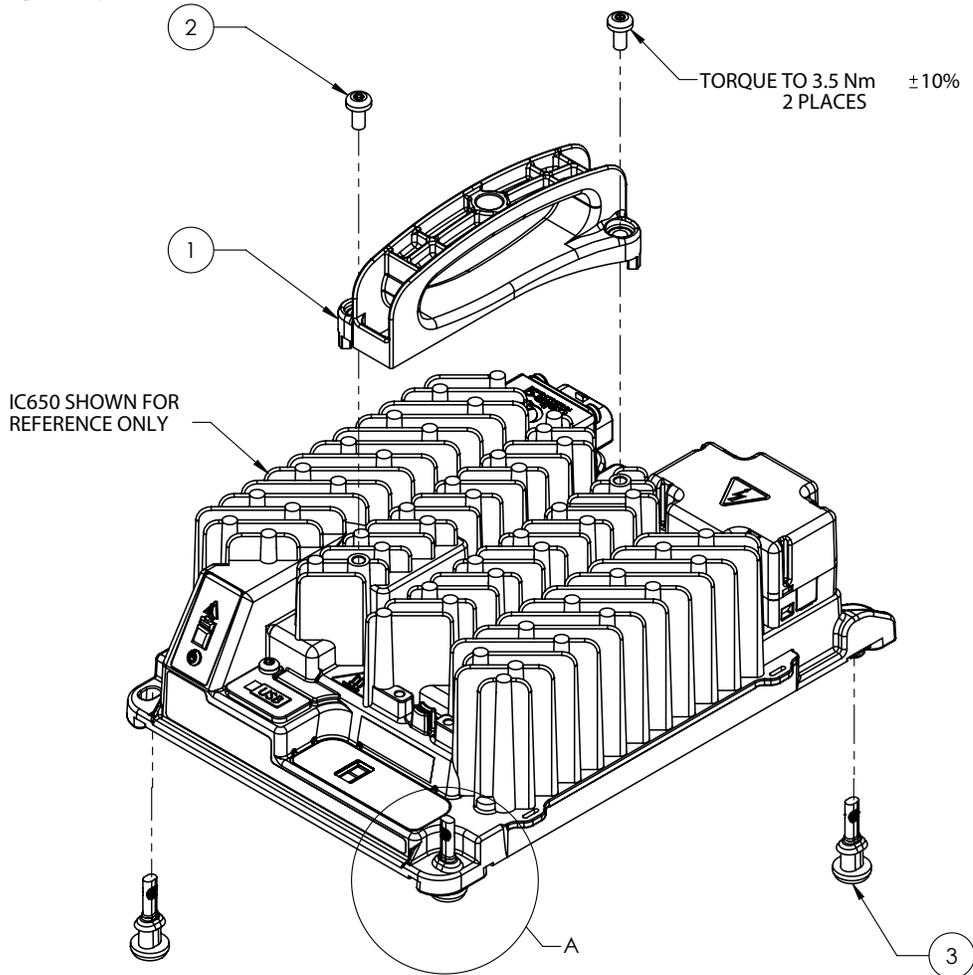
It is recommended that AC, DC and signal cables be secured, especially in applications where there are high vibration and shock loads. Cables and cords used to secure cables should be rated to at least 105°C (221°F). Delta-Q offers cable clamps and sealed, locking AC cables to provide improved system robustness.



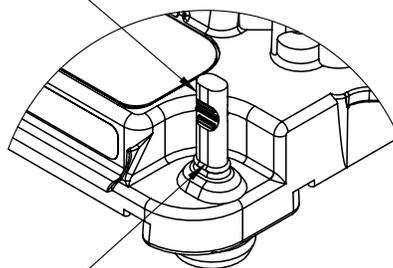
*The IC650 Charger provides a channel between the heat sink fins to thread the DC cabling through the front side of the charger, and clamp the cable in place. The example shown is made for Club Car.*

## 6.4 Off-board Configuration for the IC650 / IC900 Chargers

The diagram below shows how kit 900-0111, which includes a handle and rubber feet for the IC650 and IC900 chargers. This kit provides portability, safe charger handling and prevents scratches to surfaces on which the charger is placed.



**PULL-THROUGH FEATURE:**  
USE THIS FEATURE TO STRETCH AND PULL THROUGH THE MOUNTING HOLE UNTIL THE SHOULDERS PULL THROUGH THE SLOT FULLY



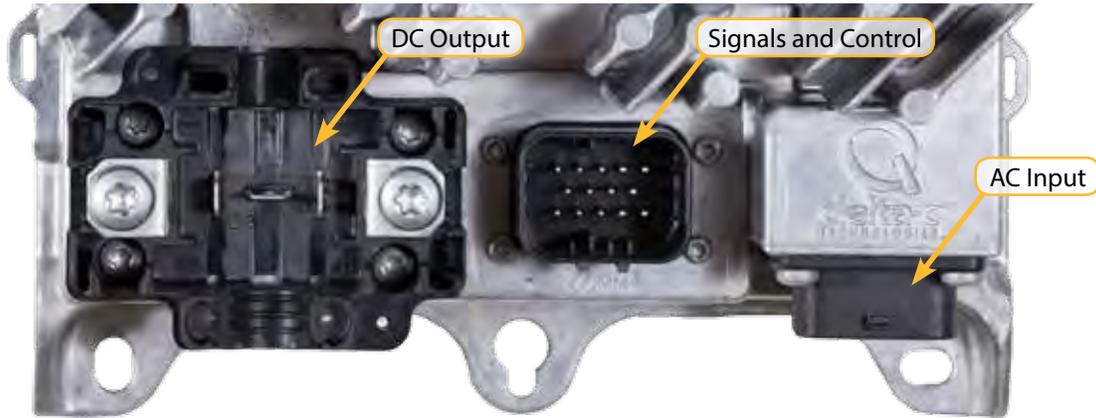
THIS VIEW ILLUSTRATES THAT THE PULL-THROUGH FEATURE ON THE RUBBER FOOT HAS BEEN CUT

**NOTE:** CUT THE PULL THROUGH FEATURE WITH AT THE EMBOSSED RING AFTER THE RUBBER FOOT IS PULLED THROUGH. THIS VIEW SHOWS THE RUBBER FOOT BEFORE THE PULL THROUGH FEATURE IS CUT.

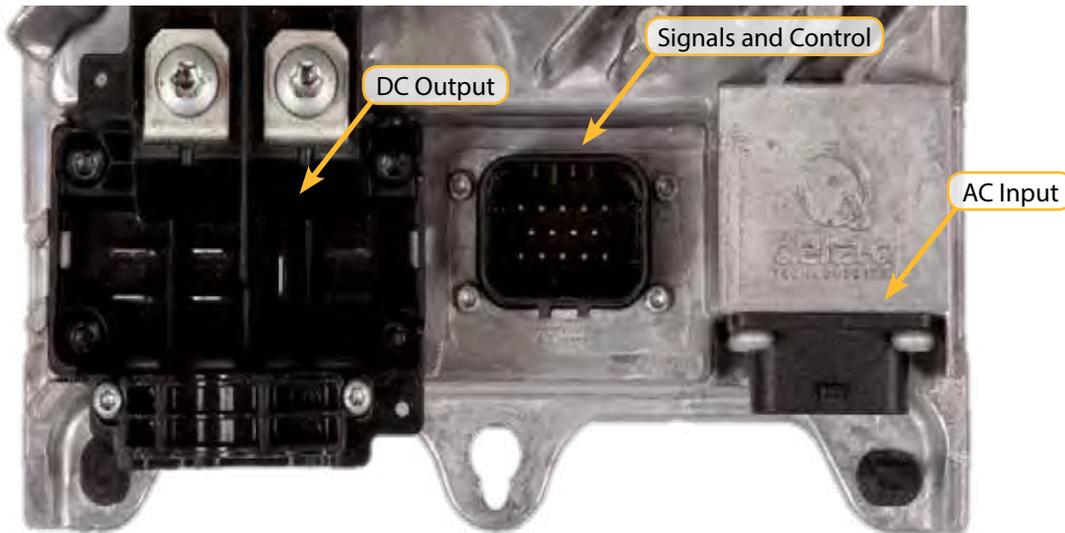
ITEM NO.	QTY	DESCRIPTION
1	1	HANDLE IC SERIES
2	2	SCREW M5 x 16 TAPTITE TORX
3	4	FEET IC SERIES

# 7.0 Electrical Installation

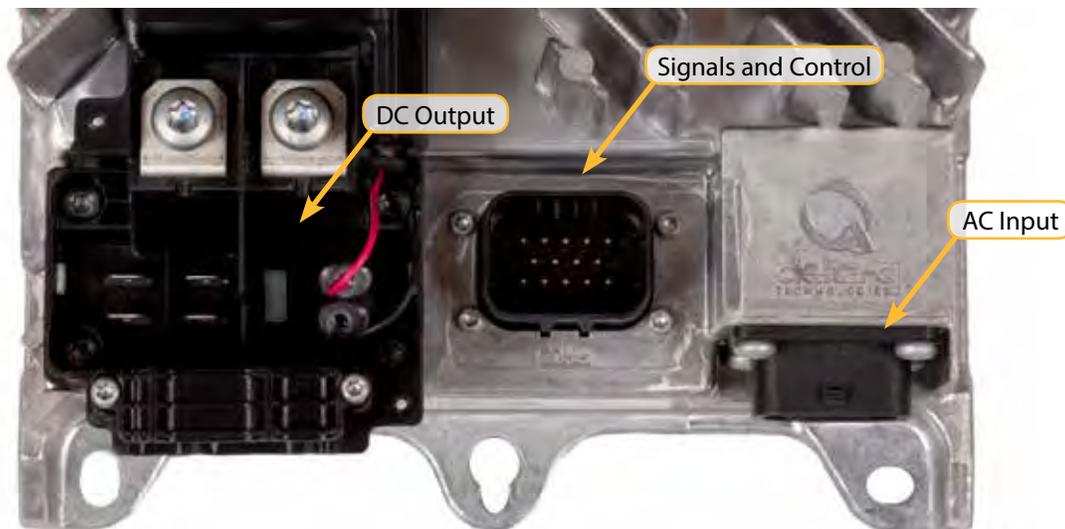
The charger has either two or three connectors on the rear panel depending on its configuration. The COMM model with all connectors is shown below. The BASE model does not have a signals and control connector.



*IC650 COMM model rear panel: DC output, signals and control, and AC input.*



*IC900 COMM model rear panel: DC output, signals and control, and AC input.*



*IC1200 COMM model rear panel: DC output, signals and control, and AC input.*

## 7.1 AC and DC Cabling Instructions

AC and DC cabling for the charger can be completely customized during installation. Cables can easily be attached into the DC block and the IEC320 AC receptacle.

The modular design of IC Series Chargers has several benefits:

- ✦ Customers only have to manage a single charger part number for each power or voltage level (e.g. 24V / 36V / 48V).
- ✦ Units can be customized at the time of installation based on demand for specific DC connectors or AC cords for different countries.
- ✦ AC and DC cables are field replaceable, saving the time and expense of sending units for repair.

### General considerations for machine wiring

To reduce noise issues, avoid laying power and communications cables together. If they must cross, it should be at right angles. Communications cables should not be run in parallel with power cables since they can pick common-mode noise by inductive coupling – either from the 50/60 Hz alternating current from AC, or from the transients injected by DC switching devices (e.g. charger or motor controller). If these cables must be run in parallel, keep the cable lengths as short as possible. Ideally, communications cables should use twisted pair wiring so that any AC or DC noise coupled to the data cable will be balanced on each wire and will cancel itself in the receiving circuit. Higher quality receiving circuits offer high common-mode noise rejection for this reason.

Communication cables may safely cross power cables at right angles, since this minimizes coupling. The greater the distance between data and power cables, the less the coupling.

For battery cables, see the tables in the following sections for minimum recommended cable sizes. Wire lengths should be kept as short as is practical. For best performance, the positive and negative cables should run alongside each other. Avoid cable loops.

Battery overcurrent protection is highly recommended, even if not required by the specific safety regulations for the vehicle or equipment being designed. Fuses and disconnects must be sized to protect the wiring in the system and are required to open before the wire reaches its maximum current carrying capability. Overcurrent protection between the battery and charger is not required. The charger has built-in electronic overcurrent protection. Additionally, the charger has an internal safety fuse should an internal short occur.

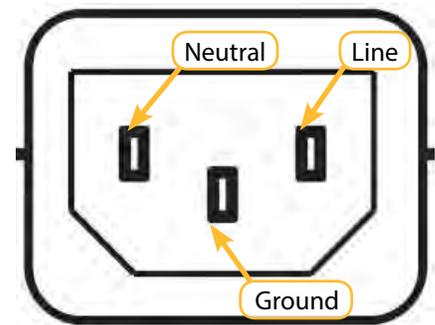
## 7.2 AC Input

Connector Type: Standard IEC60320/C14

Recommended connector type: Delta-Q IP66 sealed AC cord

Alternate Mating Connector: Standard IEC60320/C13

For industrial applications where the AC cord may be exposed to hard usage and moisture, Delta-Q recommends that the cord is UL listed with an SJTW (or SJT) rating, 105°C (221°F), 300 V rating (or equivalent).



AC Input Connector

### Connector Pin Configuration

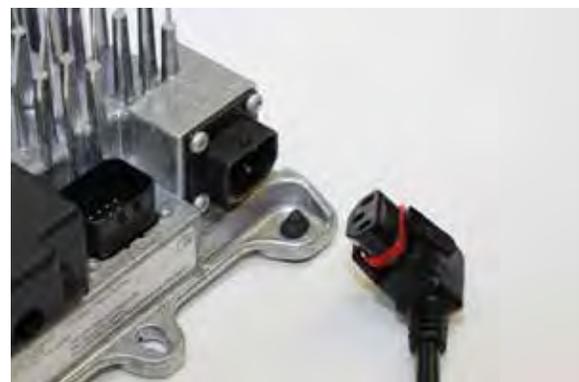
Pin No.	Wire Color Code	Description	Recommended Extension Cords (110 VAC)	Notes
L	Brown	AC Line	10AWG/6.0 mm <sup>2</sup> : max length of 30m (100ft) 14AWG/2.5 mm <sup>2</sup> : max length of 15m (50ft) 16AWG/1.5 mm <sup>2</sup> : max length of 7.5m (25ft)	Use a heavy gauge extension cord rated for the charger's maximum input current. Do not use a light-duty indoor extension cord.
G	Green / yellow	AC Ground		
N	Blue	AC Neutral		

### AC Cabling Installation Instructions

Use of Delta-Q's sealed, locking AC power cable is recommended. It will seal the AC inlet against water and dirt ingress, as well as lock the cable to the charger.

IC Series Chargers also allow any country-specific IEC60320/C14 AC cable to be used with the charger's standard IEC60320/C14 mating connector. This allows an OEM to source AC cables depending on demand in different countries. If a third-party AC cable is used, Delta-Q recommends securing the cable to the charger using cable ties. This will prevent accidental disconnection.

No tools are required for installation.



The Delta-Q sealed, locking AC power cable with its red gasket and locking clips.



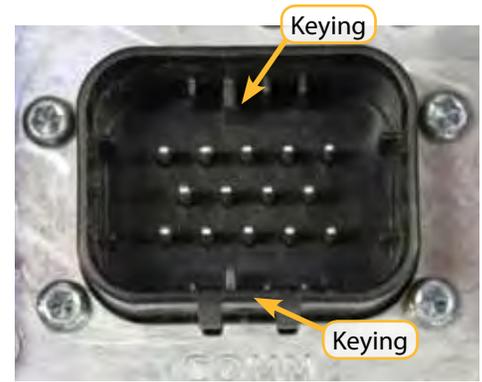
## 7.3 Communications Signals and Control

Connector type: TE Connectivity AmpSeal 776262-1

Mating connector: TE Connectivity AmpSeal 776273-1

This is a heavy-duty, automotive-grade, waterproof signal connection system. When assembled properly, it will provide a long service life.

**Note:** Pin numbers 1, 5, 6, 9, 10, and 14 are labeled on the connector. These numbers are upside-down when the connector is viewed from the back of the charger.

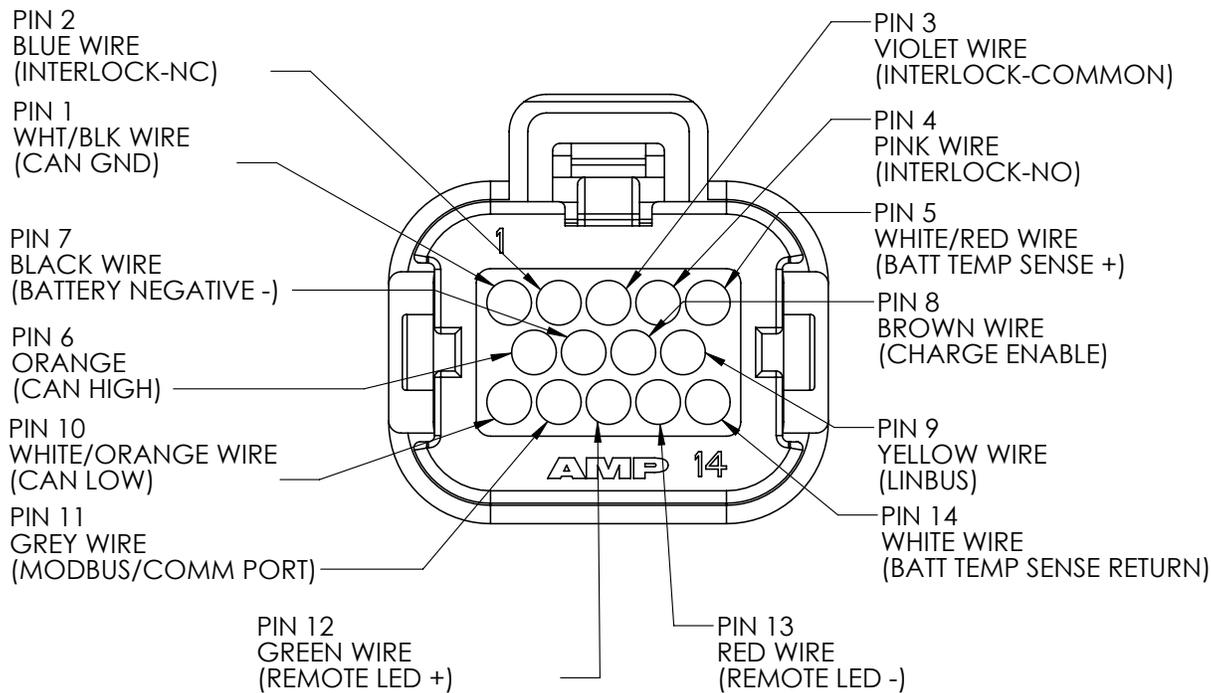


Signals and control connector

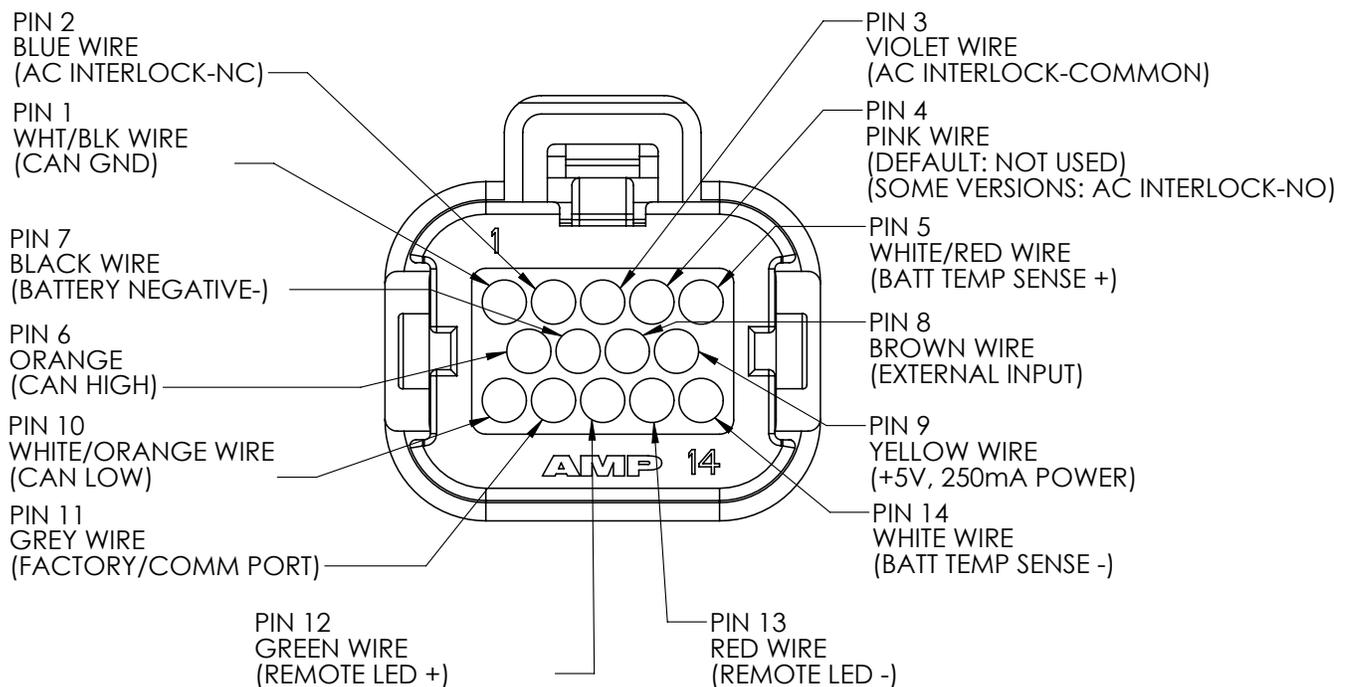
Wire Colour Reference	Pin No.	Recommended Wire Gauge (AWG / mm <sup>2</sup> )	Description	Detail
White/black	1	16-20 / 1.3-0.52	CAN GND	Reference ground for CAN signals
Blue	2		Interlock NC	Interlock relay: Normally closed contact
Purple	3		Interlock COM	Interlock relay: Common contact. Recommend inline fuse (see <a href="#">7.6 Interlock Relay Contacts</a> ) IC900/IC1200 10A relay option: See <a href="#">7.6 Interlock Relay Contacts</a>
Pink	4		Interlock NO	Interlock relay: Normally open contact IC900/IC1200 10A relay option: See <a href="#">7.6 Interlock Relay Contacts</a>
White/red	5		Battery Temp. Sense '+'	Connect to NTC 10k 5% thermistor or Pin No. 14 if a sensor is not used IC900/IC1200 10A relay option: unused
Orange	6		CAN High	See Communications section
Black	7		Battery Negative	Reference ground for battery signals
Brown	8		External Input	IC650: Enable / disable input (for future use) IC900/IC1200: Charger control / current sensor input (for future use)
Yellow	9		IC650: LIN bus IC900/IC1200: APO	IC650: For future use IC900/IC1200: Accessory Power Output (+5V, 250mA, non-isolated output)
White/orange	10		CAN Low	See Communications section
Grey	11		Factory Comm Port	Service use only
Green	12		LED Positive (+)	For remote LED
Red	13		LED Negative (-)	For remote LED
White	14		Battery Temp. Sense Ground	Reference ground for battery temperature sensor signal

### 7.3.1 COMM Connector Pin Configurations

Delta-Q offers standard communication wiring harnesses that mate with the TE Connectivity AmpSeal 776262-1 connector type. The recommended specifications for communication wiring are 20AWG, rated to 300V with a minimum diameter of 1.7mm and a maximum diameter of 2.7mm, OD UL3266.



*IC650 COMM Connector: pin configuration reference for communication port cabling.*



*IC900/IC1200 COMM Connector: pin configuration reference for communication port cabling.*

### 7.3.2 Communications Cabling Instructions

No tools are required to install or remove the TE Connectivity AmpSeal Plug assembly (Part no. 776273) into the COMM receptacle on the charger. See [8.0 Communications](#) for more information about communications capabilities.



*Example communications harness*



*Insert the TE Connectivity AmpSeal Plug into the Comm fixture with the locking mechanism facing toward the outer edge of the charger.*



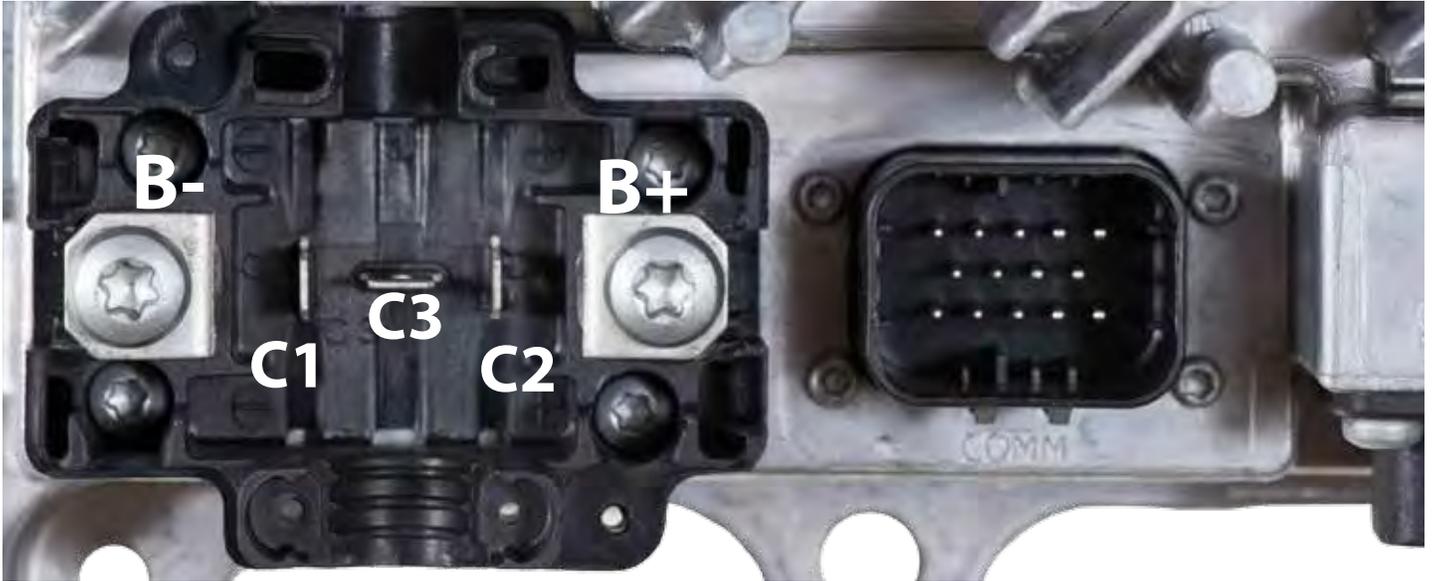
*Apply pressure until you hear an audible “click” as the plug locks into position.*

#### **Disconnecting the communications harness**

To remove the communications harness, pull the plastic catch (plug locking mechanism) out while pulling the harness out of the charger.

## 7.4 DC Output

### 7.4.1 IC650 DC Output



IC650 charger DC output terminals

The DC terminal block on the IC650 charger is designed to allow a DC cable to be attached leading to the front or to the back of the charger. A DC cable clamp secures the DC cord to the terminal block using two Torx T10 screws. The DC cable clamp is designed to provide optimum compression for cable diameters in the 9mm to 11mm range. Care must be taken to prevent overtightening these screws during assembly.

**The recommended torque for the DC cable clamp is 0.6Nm +/-6%.**

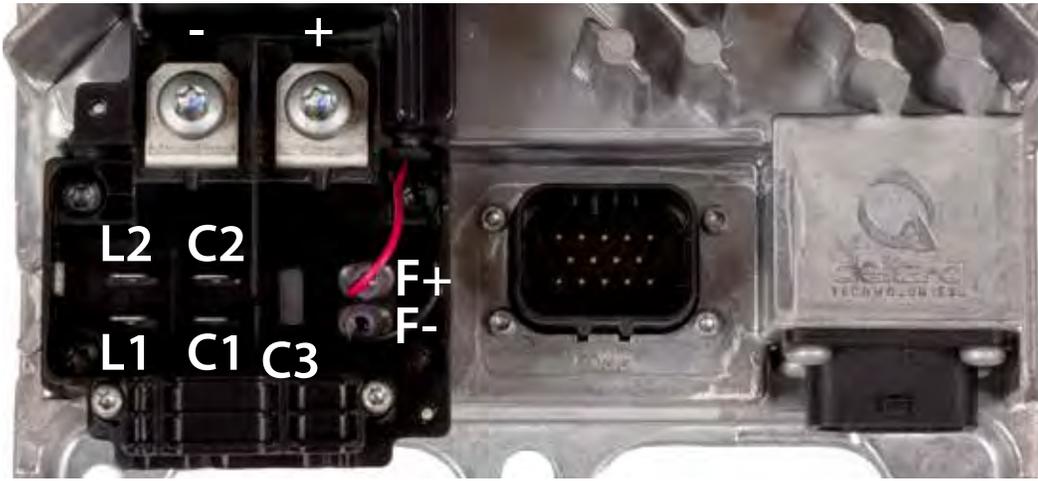
A DC terminal block cover is provided to protect the user from contact with the DC terminals. After final connections are made to the terminals, the cover is snapped into place and secured with one screw.

**WARNING: Be very careful not to allow battery voltage to be applied to the blade terminals (C1, C2, C3), as permanent damage to the charger will result.**

#### Pin Configuration

Pin	Recommended Wire Size (AWG / mm <sup>2</sup> )	Description	Notes
'-'	12 / 3.0	Battery negative	Accepts 1/4" or larger ring terminal Torx T30 / M6 bolts Recommended torque: 4.5Nm +/-5%
'+'	12 / 3.0	Battery positive	
C1	20 / 0.5	Battery temperature sense negative	1/4" blade terminal; connected internally to battery negative
C2	20 / 0.5	Battery temperature sense positive	1/4" blade terminal. <a href="#">See 7.7 Temperature Sensing</a>
C3	20 / 0.5	Interlock	1/4" blade terminal; normally closed to battery positive. Open when charger output may be active. 1.5A maximum. <a href="#">See 7.6.1 Interlock Signal</a>

## 7.4.2 IC900 and 1200 DC Output



DC output terminals for the IC900 and IC1200 charger. The IC1200 includes connection points for positive and negative wires used to control the fan.

The DC terminal block is designed to allow a DC cable to be attached to the back of the charger. A DC cable clamp secures the DC cord to the terminal block using two Torx T10 screws. The DC cable clamp is designed to provide optimum compression for cable diameters from 6.5mm to 12mm. Care must be taken to prevent overtightening these screws. **The recommended torque for the DC cable clamp is 0.6Nm +/-6%.**

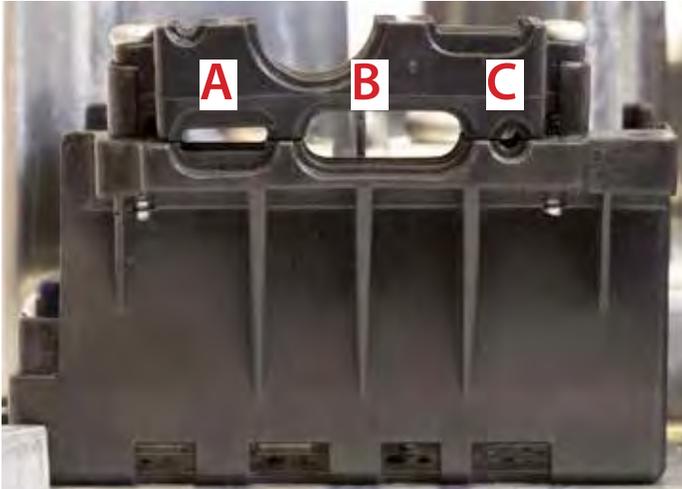
A DC terminal block cover is provided to protect the user from contact with the DC terminals. After final connections are made to the terminals, the cover must be secured with the provided screws.

**WARNING: Be very careful not to allow battery voltage to be applied to the blade terminals (L1, L2, C1, C2, C3), as permanent damage to the charger will result.**

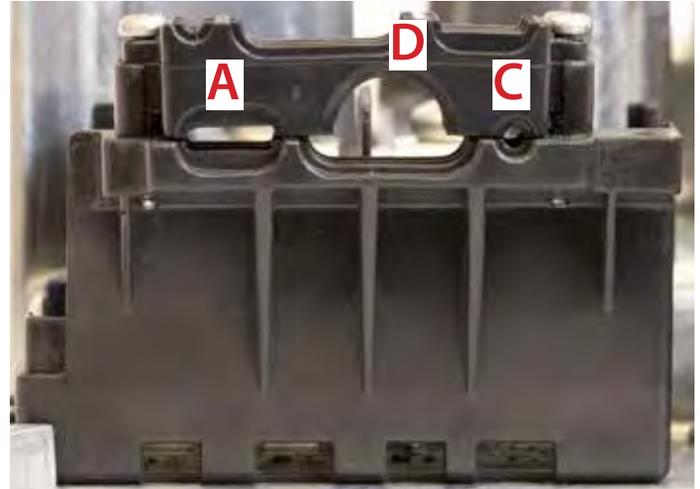
### Pin Configuration

Pin	Recommended Wire Size (AWG / mm <sup>2</sup> )	Description	Notes
'-'	See table	Battery negative	Accepts 1/4" or larger ring terminal Torx T30 / M6 bolts Recommended torque: 4.5Nm +/-5%
'+'		Battery positive	
L1	22 / 0.5 (2 conductor cable)	Remote LED Cathode	1/4" blade terminal. <a href="#">See 7.5 Remote LED</a>
L2		Remote LED Anode	
C1	18 / 0.8 (2 conductor cable)	Battery temperature sense negative	1/4" blade terminal; connected internally to battery negative
C2		Battery temperature sense positive	
C3	12 / 3	Interlock	1/4" blade terminal; normally closed to battery positive. Open when charger output may be active. <a href="#">See 7.6.1 Interlock Signal</a>
F+	N/A	Fan control (IC1200 only)	1/4" blade terminal fan '+'
F-			1/4" blade terminal fan '-'

### 7.4.3 IC900 / IC1200 DC Terminal Blocks



**Cable clamp configuration 1:** Recommended for use with a battery cable - 2x single conductor



**Cable clamp configuration 2:** Recommended for use with a multi-conductor cable

To switch between the two cable clamp configurations, unscrew the screws on either side of the cable clamp and rotate it 180°.

Reference	Description	Minimum Outside Diameter	Maximum Outside Diameter	Minimum/ Maximum AWG
A	Remote LED &/or temperature sensor	3.2 mm	5.2 mm	2 Conductor, 18-22 AWG
B	Battery cable - 2x single conductor	6.5 mm	8.5 mm	6-8 AWG
C	Interlock wire	2.0 mm	3.5 mm	12-18 AWG
D	Multi-conductor cable (battery +/-, temp sensor, interlock)	10.0 mm	12.0 mm	Depends on cord (accepts 4 Conductor, 12AWG cord)

#### Recommended Battery Cable Size Versus Length

IC900 / IC1200 model	Up to 1m (3.3ft) 105°C (221°F) wire	Up to 2m (6.5ft) 105°C (221°F) wire
24V	8 AWG (9 mm <sup>2</sup> )	6 AWG (14 mm <sup>2</sup> )
36V	10 AWG (6 mm <sup>2</sup> )	8 AWG (9 mm <sup>2</sup> )
48V	14 AWG (2.5 mm <sup>2</sup> )	12 AWG (3 mm <sup>2</sup> )

## 7.4.4 DC Cabling Installation Instructions - IC650 Charger

To attach DC cabling to the charger, you will need the following items:

- + 1 - Torx T30 screwdriver
- + 1 - Torx T10 screwdriver
- + 2 - Torx T30 / M6 screws (provided)
- + 3 - Torx T10 screws (provided)
- + 1 - DC cable with ring terminals for attachment into the DC block
- + 1 - DC block cover (provided)
- + 1 - DC cable clamp (provided)

1. Remove the DC block cover by inserting the head of the Torx T30 screwdriver into the gap on the lower left side of the DC block fixture, and apply pressure to trigger the cover's release. It can be removed and put aside.

2. Remove the positive and negative battery fasteners (M6 screws). Fix the DC cable in place using the Delta-Q cable clamp, fastened with Torx T10 screws to a recommended torque of 0.6Nm +/-6%.

3. Proceed by attaching the positive and negative leads to the positive and negative terminals, respectively, using the Torx T30 screwdriver and Torx T30 / M6 screws, with a recommended torque of 4.5Nm +/-5%.

4. Replace the DC terminal block cover and use the third, shorter T10 screw in the kit to fix the cover in place.



Step 1: Removal of the IC650 DC block cover using a screwdriver.



Step 2: Attachment of the DC cable with a Torx T30 screwdriver

## 7.4.4 DC Cabling Installation Instructions - IC900 and IC1200 Chargers

To attach DC cabling to the IC900 and IC1200 charger, you will need the following items:

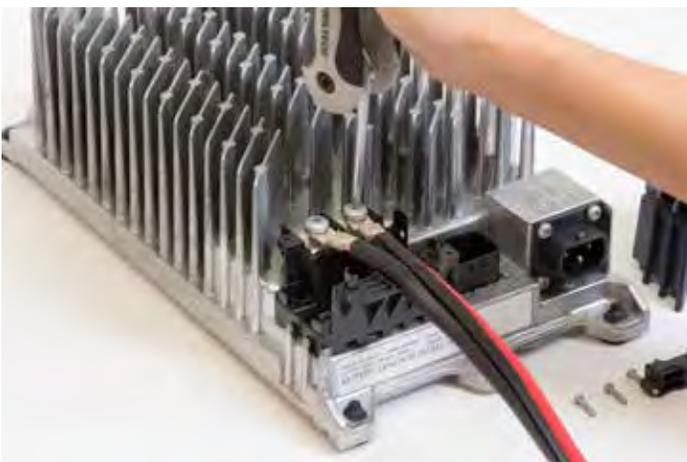
- + 1 - Torx T30 screwdriver
- + 1 - Torx T10 screwdriver
- + 2 - Torx T30 / M6 screws (provided)
- + 2 - long Torx T10 screws (provided)
- + 2 - short Torx T10 screws (provided)
- + 1 - DC cable with ring terminals for attachment into the DC block
- + 1 - DC block cover (provided)
- + 1 - DC cable clamp (provided)

Note that fan replacement instructions for the IC1200 Charger are provided in [6.1.2.1 Fan Replacement Instructions](#).

1. On delivery, first remove the DC block cover by lifting it vertically. Remove the kit that contains the cable clamp, 2 long Torx T10 screws, and 2 short Torx T10 screws.
3. Fix the DC cable in place using the Delta-Q cable clamp (in one of two configurations, see [7.4.3 IC900 / IC1200 DC Terminal Blocks](#) for details) fastened with Torx T10 screws to a recommended torque of 0.6Nm +/-6%.



2. Remove the positive and negative battery fasteners (M6 screws). Secure the DC cable in place, fastened with the Torx T30 / M6 screws to a recommended torque of 4.5Nm +/-5%.
4. Replace the DC terminal block cover and use the 2 short T10 screws in the kit to fix the cover in place.



## 7.5 Remote LED

The remote LED recommended for use with the IC Series Charger's LED outputs is Delta-Q part number 900-0058 - "Remote LED 3m shielded bare wires."



Part 900-0058: 3m (9.8 ft) remote LED indicator

### Operation

Part Type	Recommended Provider / Part Number
Recommended remote LED	Lite-On LTL-293SJW or similar 2.0V bi-color LED, 5mm T1-3/4
Recommended LED holders	Lumex SSH-LX5091 and SSH-LX5090 or similar (maximum 1.5mm panel) Bivar CR-174L for 1.5 - 6.4 mm panel Bivar CR174 for 0.8-3.2 mm panel
Cable	20AWG (0.5mm <sup>2</sup> ) 2-conductor with shield grounded to chassis
Maximum length	7.5m (25') using 22AWG wire

LED polarity:

LED '+' is red cathode / green anode (white wire)

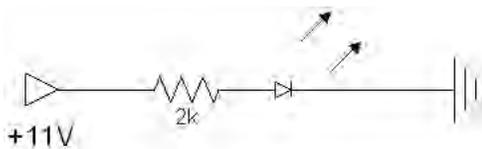
LED '-' is green cathode / red anode (black wire)

### LED signal operation:

Green: LED '-' line low 0%, LED '+' line 1kHz at 90% duty cycle

Red: LED '-' line 1kHz at 90% duty cycle, LED '+' line low 0%

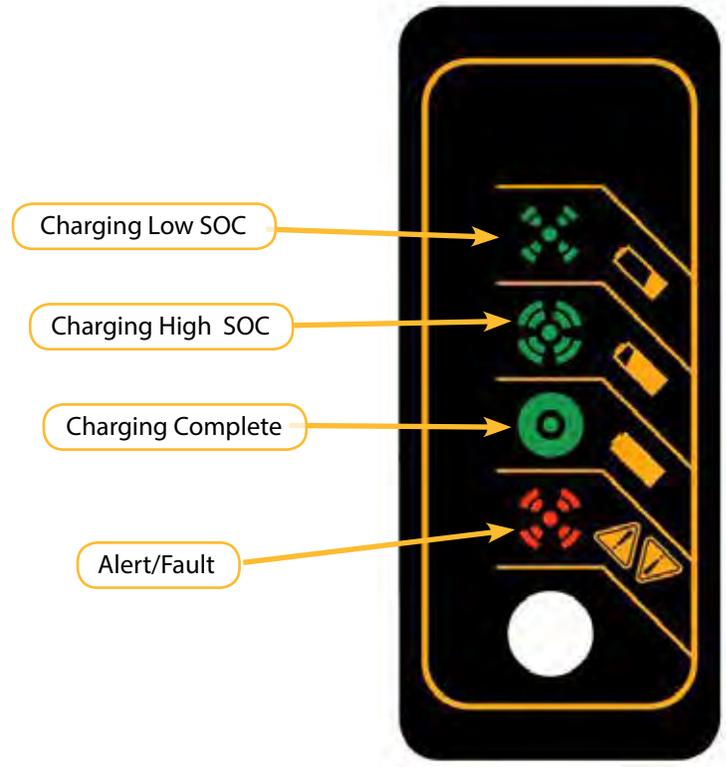
Yellow: Both lines 1kHz at 92% duty (one line inverted from the other so one is low for 92%, while the other is high for the same time).



Simplified internal schematic of remote LED. I: 4.5mA / VL: 2.0V

## IC Series Remote LED Behavior (factory default)

Status	LED Operation
No AC	OFF
Charging - battery still at low state of charge	Slow GREEN flashing (1s on; 0.2s off)
Charging - battery at high state of charge	Fast GREEN flashing (0.4s on; 0.1s off)
Charge complete	Solid GREEN
Error	Rapid AMBER flashing (0.5s on; 0.5s off)
Fault	Solid RED

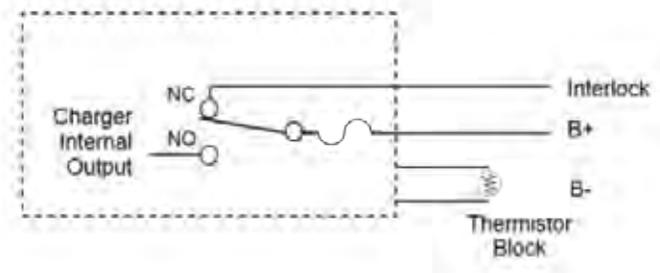


## 7.6 Interlock Relay Options

### 7.6.1 Charging Interlock

IC Series chargers have one blade terminal in the DC Terminal Block, marked "C3", which is internally connected to Battery Positive when the charger is not charging. Below is a simplified internal diagram of the charger's output.

This Interlock Signal can be used to inhibit a vehicle either by connecting it directly to the appropriate signal on a motor controller, or to an external relay.



DC output schematic

**Caution: Do not allow this wire to contact battery negative. Doing so will cause damage to the charger.**

**Important: Install a suitably-rated fuse inline to avoid damage to internal circuitry. See table below for maximum current and also for recommendations for capacitive loads.**

### IC650 C3 Interlock

	Maximum current	Minimum current*	Minimum resistance for capacitive load**
24 V	1.5 A	0.1 A	2 $\Omega$
36 V	1.5 A	1.0 A	3 $\Omega$
48 V	1.5 A	1.0 A	4 $\Omega$

### IC900/IC1200 C3 Interlock

	Maximum current	Minimum current*	Minimum resistance for capacitive load**
24 V	10.0 A	0.1 A	2 $\Omega$
36 V	2.0 A	0.1 A	3 $\Omega$
48 V	0.5 A	0.1 A	4 $\Omega$

\* Observe minimum current to avoid contact oxidation. While it is possible to operate the interlock below these levels, reliable operation cannot be guaranteed. Infrequent use of the charger and low interlock currents contribute to formation of oxidation which will prevent B+ from making contact with the interlock.

\*\* or loads with large inrush currents such as incandescent or halogen headlights.

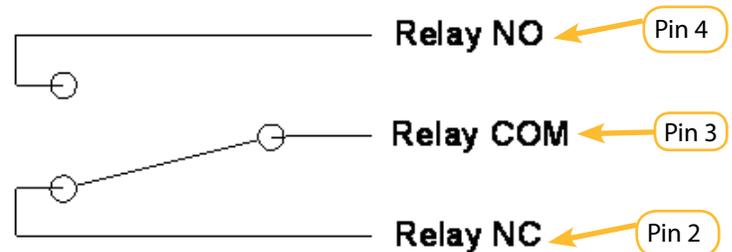
NOTE: A flyback or free-wheeling diode or snubber should be installed with inductive loads to prevent voltage spikes.

NOTE: The interlock will be set to B+ even when the charger is connected to AC power when the charger is a fault state.

## 7.6.2 AC Interlock Relay

In addition to the Interlock Signal provided on “C3”, IC Series COMM models incorporate an additional interlock feature that effectively provides “dry” relay contacts. The term “dry” means there is no power on any of these contacts. The relay itself is driven when the AC Voltage to the charger is in range. For example, when there is AC voltage, the COM and NC pins will be open.

The implementation of this on the IC650 is through a form C (SPDT) electromechanical signal relay that is tied to three pins on the COMM connector for “NC, NO, and COM”. Refer to the figure for the internal schematic of these pins.



Internal schematic of interlock relay contacts

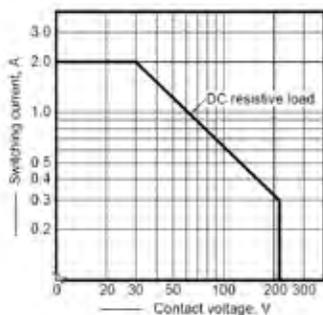
It is recommended that the interlock circuit on Delta-Q’s IC650-COMM model be protected by a fast blow fuse sized to match the switching capacity depending on the operating voltages.

Recommendations are: 24V - 2A, 36V - 1.5A, 48V - 1A. Examples include:

- ✦ 0.25" x 1.25" 3AG and 5 mm x 20 mm M205 glass/ceramic cartridge types.
- ✦ Auto style blade fuses (e.g. ATC-1) may also be an option, though most are rated at only 32 VDC and may not be suitable for your application.

Delta-Q uses a signal relay such as Panasonic (TX2SA-12V).

### 1. Maximum switching capacity



*Panasonic TX2SA-12V*  
*1 A @ 30 VDC*  
*30 W (no VA rating available)*  
*Contact resistance: <100 mΩ*

Important: These contacts cannot support capacitive loads.

Note: Once current over 100mA is switched through these contacts, they will no longer reliably conduct currents under 100mA.

On an optional model of the IC900 and IC1200 COMM, a solid-state relay provides a NC contact that is capable of up to 80V, 10ADC. The NO pin (Pin 4) is not used on these models. It is recommended that this interlock circuit is protected by a maximum 10 A Fast-Blow fuse.

## 7.7 Temperature Sensing

Battery temperature sensors are available to be attached to either the blade terminals, C1 and C2, within the DC terminal block or to Pin 5 and Pin 14 on COMM models with the COMM connector. The other end of the battery temperature sensor is attached to any battery post that is convenient, preferably one at the center of the battery pack. Some, but not all, Delta-Q charging algorithms use temperature compensation. See the DC Output section for more information.

### Hardware

The recommended thermistors for use with the charger's temperature sensor input are:

- + Part 900-0059: Isolated Temp Sensor 140mm Bare Wires
- + Part 900-0028: Isolated Temp Sensor 200mm Bare Wires (250pcs)
- + Part 900-0060: Isolated Temp Sensor 1.2m Bare Wires
- + Part 900-0056: Isolated Temp Sensor 3m Shielded Bare Wires
- + Part 900-0064: Isolated Temp Sensor 140mm Fast-on Tab/Plug
- + Other part numbers may also be available. Check with your OEM Account Manager.

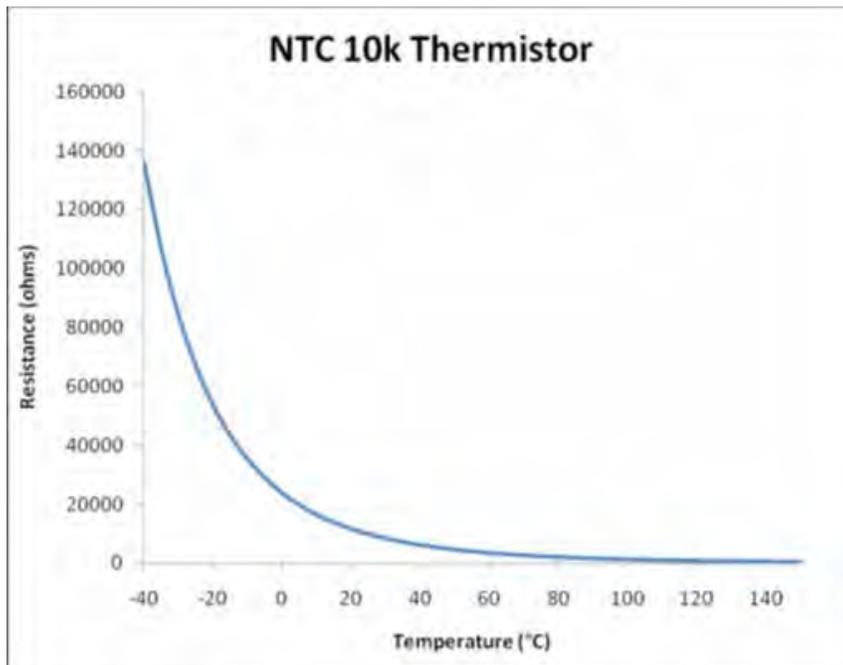
An alternative part number which will be compatible with the Delta-Q chargers is:

- + Vishay BCC 238164063103, NTC 10k 5% Thermistor, B25/85 = 3977K

If using other thermistors in a harness design, it is recommended to use 1mA as the figure to calculate limitations on wire gauge and length.

### Operation

Below is a sample plot of a typical NTC 10k thermistor resistance vs. temperature:



# 8.0 Communications

The COMM version of the IC Series Chargers supports advanced functions accessible via the CAN interface.

For more information, please contact Delta-Q for the most recent version of the IC Series CANopen Interface Specification (Document number 710-0148).

## 8.1 External Interface Design

### 8.1.1. Interface Architecture

IC Series chargers are compliant with the CAN in Automation (CiA) 301, 418 and 419 device profiles. These standards define most of the interface, including all of the first six layers (Physical, Data Link, Network, Transportation, Session, and Presentation) of the OSI model, and most of the seventh layer (Application).

In addition to the standard protocol, the charger has support for:

- + Voltage set point control
- + Algorithm selection
- + Setting an Ah target
- + Reading the sensed current
- + Reading charge cycle status information

## 8.2 On-board and Off-Board Configurations

An IC Series charger using CANbus can operate in both on-board and off-board configurations.

In an on-board configuration, the charger is permanently connected to the batteries and another component, such as a battery management system (BMS) or motor controller. When charging is required, the AC cord from the charger is plugged into an electrical outlet for charging.

In an off-board configuration, the charger is permanently connected to AC power and is connected to the vehicle and its batteries for charging via separate cables for the communications cabling and DC cabling, or a single combined cable.

## 8.3 CAN Bus Configuration

Item	Configuration / Specification
Charger role	Slave of the master / slave model
CAN Termination	Permanent 120 ohm
Number of bits in identifier	11 bits
Bit-rate	125 kbps (configurable)
Node ID of the charger	10 (configurable)
Node ID of the battery node	1 (configurable)
Use Dynamic SDO and SDO Manager	FALSE (configurable)
SDO COB-ID	60B (rx) and 58B (tx); Use Dynamic SDO is FALSE
PDO COB-ID	Always requested from the battery module via SDO

The charger has been configured with a 2-second heartbeat consumer timeout. The charger has been configured with a 1-second heartbeat producer period.

### 8.3.1 Recommended Timeouts

Parameter	Timeout Value	Note
Boot-up	5000 ms	
NMT	2000 ms	
SDO	2000 ms	2000 ms functions correctly, but is being optimized
PDO cycle time	TBD ms	2000 ms functions correctly, but is being optimized
Objects 1010h/1011h	2000 ms	
SYNC cycle time	N/A	Charger does not support SYNC function
Charger monitoring heartbeat timeout	2000 ms	Charger produces HB messages every 1000 ms

### 8.3.2 Default PDO and SDO COB-IDs

The following table shows the default COB-IDs for the charger and battery module.

PDO / SDO	Object Index	Object Sub-Index	Base COB-ID	Charger w/ Node ID COB-ID	Battery Module w/Node ID COB-ID
Server SDO: Client > Server	1200h	1	600h	60Ah	601h
Server SDO: Server > Client	1200h	2	580h	58Ah	581h
Client SDO: Client > Server	1280h	1	580h	58Ah	581h
Client SDO: Server > Client	1280h	2	600h	68Ah	681h
RPDO 0	1400h	1	200h	20Ah	201h
RPDO 1	1401h	1	300h	30Ah	301h
RPDO 2	1402h	1	400h	40Ah	401h
RPDO 3	1403h	1	500h	50Ah	501h
TPDO 0	1800h	1	180h	18Ah	181h
TPDO 1	1801h	1	280h	28Ah	281h
TPDO 2	1802h	1	380h	38Ah	381h
TPDO 3*	1803h	1	480h	48Ah	481h
TPDO 4*	1804h	1	481h	48Ah	482h

See tutorial document "Delta-Q IC-series CANopen Simplified" or "CANOPEN INTERFACE SPECIFICATION IC SERIES" for more details.

# 9.0 Charger Configuration

There are two ways to alter the configuration on the IC Series Charger:

1. Use the Select Charge Profile Button.
2. Use a pre-programmed USB flash drive.

## 9.1 Selecting A Charge Profile Using the 'Select Charge Profile Button'

1. Disconnect AC input from the charger, or from the wall outlet. Wait 30 seconds for the input relay to open.



Disconnect AC input from the charger.

2. While reconnecting AC input, press and hold the Select Charge Profile Button. Hold the button (approx. 20 seconds) through the light check function, until Error Indicator is on (in amber) and Battery Charging Indicator (in green) starts flashing.



Reconnect AC input while holding the Select Charge Profile Button.

3. Press and release the Select Charge Profile Button to advance through charging profiles loaded on the charger. The selected charging profile will be displayed up to three times (e.g. "P-0-1-1" for Profile 11).\*



Press the Select Charge Profile Button to advance through the charge profiles.

\*Process will time out and profile will remain unchanged if there is 15 seconds of inactivity, a profile number is allowed to display three times, or if AC power is cycled.

4. Once the desired charging profile is displayed, press and hold the Select Charge Profile button for 10 seconds to confirm selection and exit Profile Selection Mode. When the charge profile is confirmed, the Error Indicator and Battery Charging Indicator lights will turn off, while the blue AC Power Indicator remains lit. At this point, the button can be released.

5. Press the Select Charge Profile Button to check that the desired profile is selected.

## 9.2 Configuring the IC Series Charger Using a USB Flash Drive

Pre-configured files for use on a USB drive are available from Delta-Q. To use the USB port, follow these steps:

1. Insert the USB flash drive at any time, but preferably not during a charge cycle. Stop the charge cycle by removing AC power or the DC connection to the batteries. The charger can power the USB port from the AC connection (DC disconnected) or from the DC connection (AC disconnected).
2. If there is enough disk space (about 2 MB), the charger will write charge tracking data to the drive. The Fault / Error / USB Indicator will flash green during reading and writing.
3. If the drive contains compatible configuration files, the charger will load them.
4. The IC Series Charger may briefly reset.
5. Remove the drive when the Fault / Error / USB indicator is solid green.



*Insert the USB flash drive to begin the reprogramming process. When complete, the Fault / Error / USB indicator will be solid green as shown.*

### *Troubleshooting*

If the alarm indicator flashes amber, note the error code and retry the update. If there is no response to inserting the USB drive when the charger is being used off-board, check that AC power is available and connected. If the charger is installed on-board, ensure that the charger either has AC power and / or batteries are connected.

### *Confirming a Software Update*

After using a USB flash drive to update the charger firmware, the update can be confirmed by reviewing the .txt file written to the flash drive by the charger. It will be located in the folder labelled 'syslog' (e.g. F:\CHARGER\RESP\serialno\syslog\00000000.txt).

Open this file using a text editing program such as Wordpad or Microsoft Word. If the update has been successful, near the end of the text you will see a description resembling "SM Task: Successful upgrade at Major[001].Minor[001].Build[000] variant[008]."

Alternatively, if you are using the IC Series Data Analysis Tool, you will be able to see which software and charging algorithm were used for each charge cycle in the Charger Cycle Summaries.

As of SW v4.3.3 and later, a long button press also shows the software version. See section 5.2 Display Panel for details.

## 9.3 Charge Cycle Tracking Data

All IC Series Chargers record data such as amp hours returned, charge cycle completion or interruption, and the charge profile being used. This data can be very useful in vehicle or machine diagnostics. It can be viewed using the IC Series Data Analysis Tool, available by contacting Delta-Q.

To retrieve this data, follow these steps:

1. After a charge cycle is complete, or the charger is disconnected from the battery pack, insert a USB flash drive with at least two megabytes of free space into the charger's USB host port. The charger will automatically begin to download the data, shown on the Fault / Error / USB Indicator with a flashing green light.
2. The downloading process is complete when the Fault / Error / USB Indicator is solid green. The USB flash drive can be removed from the charger.

If you plan to download data from a large number of chargers, having more free space on your USB flash drive is recommended. If you want to update the software on only some of your chargers, it is recommended that you use separate a USB flash drive for updating.

## 9.4 Battery Capacity (8-hour recharge - approximate 20-hour battery size)

	12V	24V	36V	48V	72V	96V
IC650	260 Ah	260 Ah	175 Ah	130 Ah	--	--
IC900	--	360 Ah	240 Ah	180 Ah	--	--
IC1200	--	480 Ah	320 Ah	240 Ah	--	--
QuiQ 1000	--	260 Ah	220 Ah	190 Ah	130 Ah	90 Ah
QuiQ 1500 (@ 120 VAC)	--	--	--	260 Ah	175 Ah	--
QuiQ 1500 (@ 230 VAC)	--	--	--	310 Ah	210 Ah	--

# 10.0 Troubleshooting

The IC Series Charger is continuously monitoring itself and its environment for unusual conditions. There are a few indications that may require the user's attention.

Symptom	Recommended Action
No indicator lights	Check AC power and connection to batteries.
Only blue AC light on	Charger has AC and is waiting connection to batteries or CAN remote control commands. Battery voltage must rise over 0.2V /cell before charging will begin.
Solid red Fault / Error / USB Indicator	Read fault code (e.g. F-0-0-1) number on the Charge Profile / Error Display and refer to the fault code table below.
Flashing amber Fault / Error / USB Indicator	Read error code (e.g. E-0-0-1) number on the Charge Profile / Error Display and refer to the error code table below.

## 10.1 Charger Fault Codes

Code	Description	Troubleshooting / Customer Actions
F-0-0-1	DC-DC failure: LLC excessive leakage fault	Internal charger fault. Remove AC and battery for minimum 30 seconds and retry charger. If it fails again, contact the manufacturer of your vehicle or machine / or Delta-Q Technologies.
F-0-0-2	PFC failure: PFC excessive leakage fault	
F-0-0-3	PFC has taken too long to boost	
F-0-0-4	The charger has been unable to calibrate the current offset.	
F-0-0-5	The voltage drop across the DC relay is too high while the relay is closed.	

## 10.2 Charger Error Codes

Code	Description	Solution
E-0-0-1	Battery voltage over limit in software. Typically 2.5V/cell.	<ul style="list-style-type: none"> <li>Check the battery voltage and cable connections.</li> <li>Check charger voltage model is appropriate for batteries.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-0-2	Battery voltage too low to start a charge cycle. Algorithm dependent – typically 0.1V/cell.	<ul style="list-style-type: none"> <li>Check the battery voltage and cable connections.</li> <li>Check battery size and condition. Batteries may be over-discharged. Use another charger to bring the batteries above the minimum voltage.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>

## 10.2 Charger Error Codes

Code	Description	Solution
E-0-0-3	Charge time limit reached. Algorithm dependent.	<ul style="list-style-type: none"> <li>Charger output reduced due to high temperatures. Operate at lower ambient temperature.</li> <li>Charger output reduced due to low AC voltages. Check AC voltage.</li> <li>Check for shorted or damaged cells.</li> <li>Poor battery health. Replace battery.</li> <li>Very deeply discharged battery. Retry charge.</li> <li>Poorly connected battery. Check connections.</li> <li>Extra loads. Turn off other devices running on the battery</li> <li>This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.</li> </ul>
E-0-0-4	Battery could not be trickle charged up to the minimum voltage. May also be used for other battery-related errors depending on the algorithm.	<ul style="list-style-type: none"> <li>Check for shorted or damaged cells.</li> <li>Poor battery health. Replace battery.</li> <li>Check DC connections.</li> <li>This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.</li> </ul>
E-0-0-7	Charge amp-hour Limit reached. Algorithm dependent.	<ul style="list-style-type: none"> <li>Charger output reduced due to high temperatures. Operate at lower ambient temperature</li> <li>Charger output reduced due to low AC voltages. Check AC voltage.</li> <li>Check for shorted or damaged cells.</li> <li>Poor battery health. Replace battery.</li> <li>Very deeply discharged battery. Retry charge.</li> <li>Poorly connected battery. Check connections.</li> <li>Extra loads. Turn off other devices running on the battery</li> <li>This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.</li> </ul>
E-0-0-8	Battery temperature out of range. Algorithm dependent.	<ul style="list-style-type: none"> <li>Cool or warm batteries as needed.</li> <li>Check temperature sensor and connections.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-1-2	Reverse polarity	<ul style="list-style-type: none"> <li>Battery is connected the wrong way around. Check the battery connections.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-1-3	Battery does not take current	<ul style="list-style-type: none"> <li>Check for an electrical device connected between the charger and the battery which passes through voltage but not current (ie. Diode).</li> <li>Some lithium algorithm try to charge without detecting battery voltage and will show this fault if it is not connected. Ensure the charger is properly connected to approved equipment.</li> <li>This error will automatically clear once the charger is reset by cycling DC or AC.</li> </ul>

## 10.2 Charger Error Codes (continued)

Code	Description	Solution
E-0-1-6 E-0-1-8	Software upgrade failed	<ul style="list-style-type: none"> <li>• Ensure the USB flash drive is properly formatted and is not corrupted.</li> <li>• Ensure the USB flash drive does not draw excessive current.</li> <li>• Copy the install files to the USB flash drive again.</li> <li>• Retry the update by reinserting the USB Flash Drive into the charger.</li> <li>• If software updates continue to fail, contact Delta-Q.</li> </ul>
E-0-1-7	USB mount/unmount error	<ul style="list-style-type: none"> <li>• Remove and re-insert the USB Drive.</li> <li>• Ensure the USB flash drive is properly formatted and is not corrupted.</li> <li>• Ensure the USB flash drive does not draw excessive current.</li> <li>• If the condition persists then remove AC and battery for minimum 30 seconds and retry charger.</li> <li>• If the problem persists then contact Delta-Q for further help.</li> </ul>
E-0-1-9	Hardware build does not support software version	<ul style="list-style-type: none"> <li>• The charger hardware does not support the new software version trying to be programmed. Existing SW is left running. Contact Delta-Q.</li> </ul>
E-0-2-0	No active algorithm selected	<ul style="list-style-type: none"> <li>• Reprogram the charger with its original software, algorithms, and settings.</li> <li>• Use the wrench button to select the correct algorithm if still available on the charger.</li> <li>• The problem will clear automatically when an available algorithm is set on the charger as default.</li> </ul>
E-0-2-1	High battery voltage while charging. Algorithm dependent – typically 2.8V/cell	<ul style="list-style-type: none"> <li>• When already full, some new batteries may exhibit this error. Cycle the batteries and see if it reoccurs.</li> <li>• Check battery size and condition. Resistive batteries in poor condition may cause this. Some new batteries if charged when already full will also cause this. Cycle the batteries a few times.</li> <li>• Check the battery voltage and cable connections.</li> <li>• This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-2-2	Low battery voltage while charging. Algorithm dependent – typically 0.1V/cell	<ul style="list-style-type: none"> <li>• Another device may be drawing current from the battery.</li> <li>• Check the battery voltage and cable connections.</li> <li>• Check battery size and condition. Batteries may be over-discharged. Use another charger to bring the batteries above the minimum voltage.</li> <li>• This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-2-3	High AC voltage error (>270VAC)	<ul style="list-style-type: none"> <li>• AC voltage is too high. Connect charger to an AC source that provides stable AC between 85 - 270 VAC / 45-65 Hz. This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-2-4	Charger failed to turn on properly	<ul style="list-style-type: none"> <li>• Disconnect AC input and battery for 30 seconds. If error persists, contact Delta-Q.</li> </ul>
E-0-2-5	AC voltage has dipped below 80VAC 3 times in 30 seconds	<ul style="list-style-type: none"> <li>• AC source is unstable. This could be caused by an undersized generator and/or input cables that are too long or too small. Connect charger to an AC source that provides stable AC between 85 - 270 VAC / 45-65 Hz.</li> <li>• This error will automatically clear once the condition has been corrected.</li> </ul>

## 10.2 Charger Error Codes (continued)

Code	Description	Solution
E-0-2-6	One or more USB script commands failed	<ul style="list-style-type: none"> <li>Ensure the USB flash drive is properly formatted.</li> <li>Ensure the right update package is being used.</li> <li>Copy the install files to the USB flash drive again.</li> <li>Retry the update by reinserting the USB Flash Drive into the charger.</li> <li>If software updates continue to fail, contact Delta-Q.</li> </ul>
E-0-2-7	USB overcurrent fault	<ul style="list-style-type: none"> <li>USB hardware overcurrent protection has been tripped. Remove and reinsert USB flash drive. If condition persists, try using a different USB flash drive.</li> </ul>
E-0-2-8	Attempt to select algorithm incompatible with this software	<ul style="list-style-type: none"> <li>Update charger software, continue to use existing algorithm* or select a different charging algorithm that is compatible.</li> </ul> <p>*Notes:</p> <ul style="list-style-type: none"> <li>If selection of a different algorithm, then the existing algorithm will remain in the charger</li> <li>If upgrading existing algorithm then existing algorithm will be deleted, please contact Delta-Q for a software upgrade to run the new algorithm.</li> </ul>
E-0-2-9	Cannot transmit on CAN bus	<ul style="list-style-type: none"> <li>Check the physical CAN connector, electrical bus conditions and other CAN modules for correct functioning. For example, check termination resistance is approximately 60 ohms.</li> </ul>
E-0-3-0	CAN heartbeat timeout on Battery module	<ul style="list-style-type: none"> <li>May be caused by a missing heartbeat message. Check the CANbus battery module for correct function.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-3-1	The Vref for the ADC measurements has triggered an alarm	<ul style="list-style-type: none"> <li>Internal charger error. Remove AC and battery for minimum 30 seconds and retry charger.</li> <li>If the problem persists, contact Delta-Q.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-3-6	Battery temperature sensor is missing or shorted	<ul style="list-style-type: none"> <li>Check if sensor is connected correctly.</li> <li>The charger behavior when this fault occurs can be configured. OEMs may contact Delta-Q for more information.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-3-7	CANOpen reprogramming failed	<ul style="list-style-type: none"> <li>Re-try CANOpen download or re-program using the USB</li> <li>This error will automatically clear once reprogramming has completed successfully.</li> </ul>
E-0-3-8	Fan will not turn	<p>(Fan-equipped models only)</p> <ul style="list-style-type: none"> <li>Check fan connections for loose wires.</li> <li>Check rotor is not locked, or fan is not obstructed. Inspect the fan and clear the blockage.</li> <li>This error will automatically clear once the condition has been corrected.</li> </ul>
E-0-4-0	Fan voltage pulled low	<p>(Fan-equipped models only)</p> <ul style="list-style-type: none"> <li>Ensure the fan is not stuck, sticking, or otherwise overloaded.</li> </ul>

## 10.3 Adverse Operation and Performance Charts

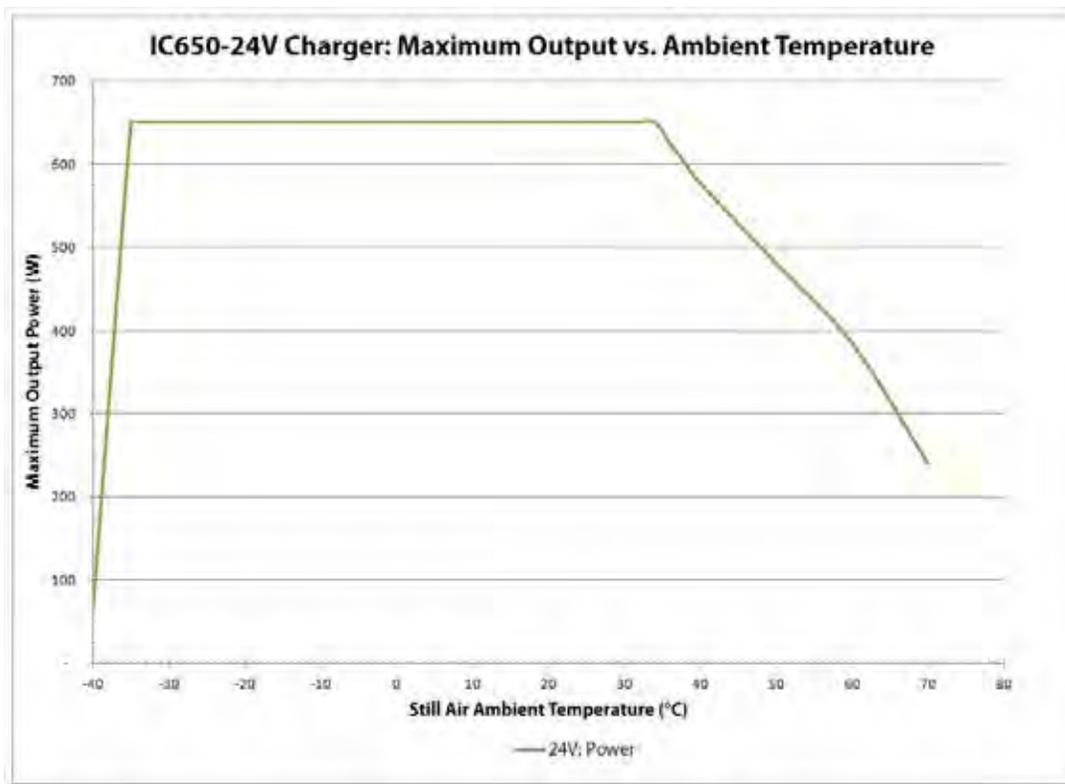
### High Ambient Temperature

At ambient temperatures above approximately 40°C (104°F), the charger will de-rate its output in order to regulate below its maximum internal temperature. This de-rating is approximately linear until 0% output power at over 80°C (176°F) ambient temperature.

As with any thermodynamic system, there are many variables to consider, such as the volume and speed of airflow, ventilation, air currents, and emissivity effects that all influence the thermal performance of the charger. Thorough thermal testing is recommended in the final installation to determine actual performance.

### Low Ambient Temperature

The charger is capable of operating at full power at extremely low ambient temperatures. The chart below illustrates the approximate ambient temperature performance.



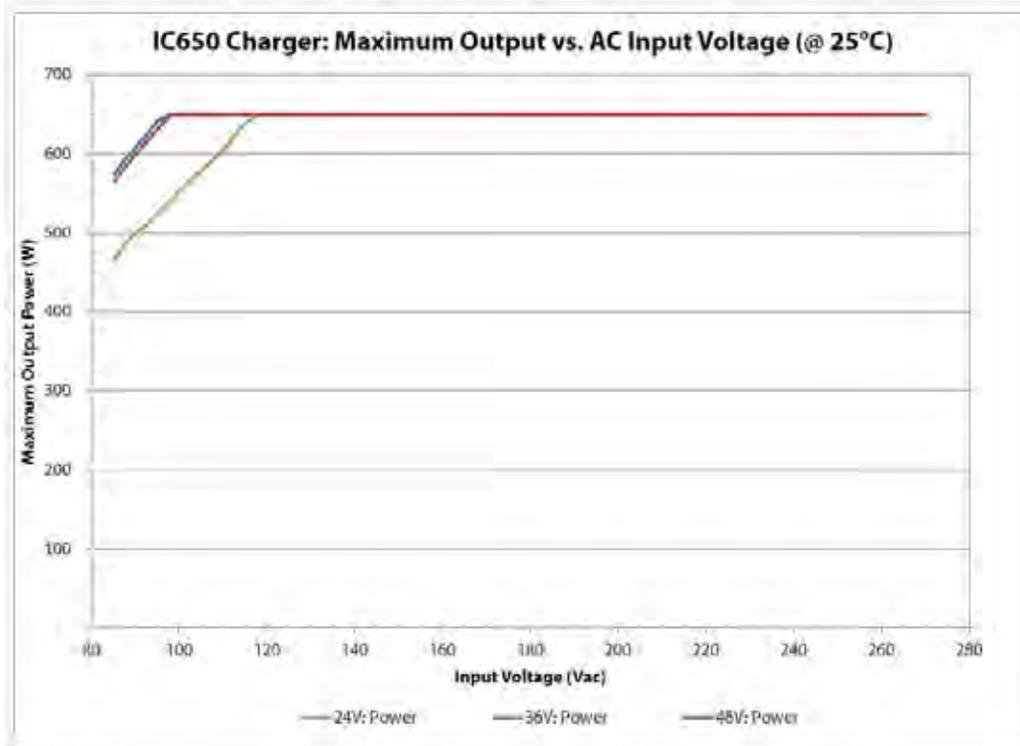
*Ambient temperature derating performance for the IC650 charger.*

### Low AC Voltage

Should input voltage fall below 100V AC, the charger will reduce output power in order to protect itself from damage. The power is reduced 1% per Volt below 100VAC until the charger turns off at 80V AC. Turn-on occurs when the voltage rises above 85V AC. Due to regulatory requirements, the 24V model de-rates at 0.5% per Volt below 120VAC.

## High AC Voltage

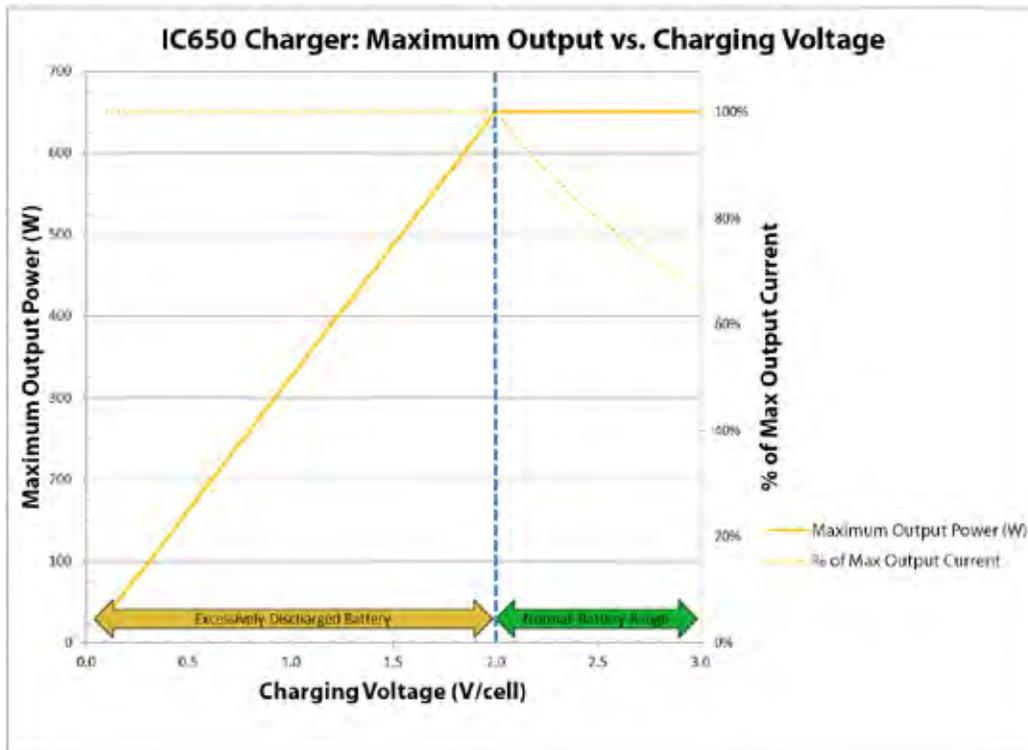
When input voltage rises above 270VAC, the charger will shut off in order to protect itself from damage. It will not turn on until the voltage falls below 265VAC. Figure 4 shows the power across the AC voltage range.



Output power versus AC input voltage for the IC650 charger.

## Power Limited

At charging voltages below 2.0V/cell (24.0V on a 24V charger, 36.0V on a 36V charger, etc.), such as those found on excessively discharged or damaged battery packs, the charger will supply its maximum DC output current at voltages as low as 0.1V/cell. The selected charging profile may restrict this further. While the current is limited at the charger's maximum, the voltage is low, resulting in reduced power output. At normal charging voltages ( $\geq 2.0\text{V/cell}$ ), the charger will charge at its maximum power output continuously.



Maximum output versus charging voltage

## DC Only Operation

IC-series chargers are able to operate on DC voltage from the batteries after being disconnected from AC. CAN and some monitoring functions are active until a pre-set turn-off time or a voltage threshold is reached.

Standard turn-off time: 18 days

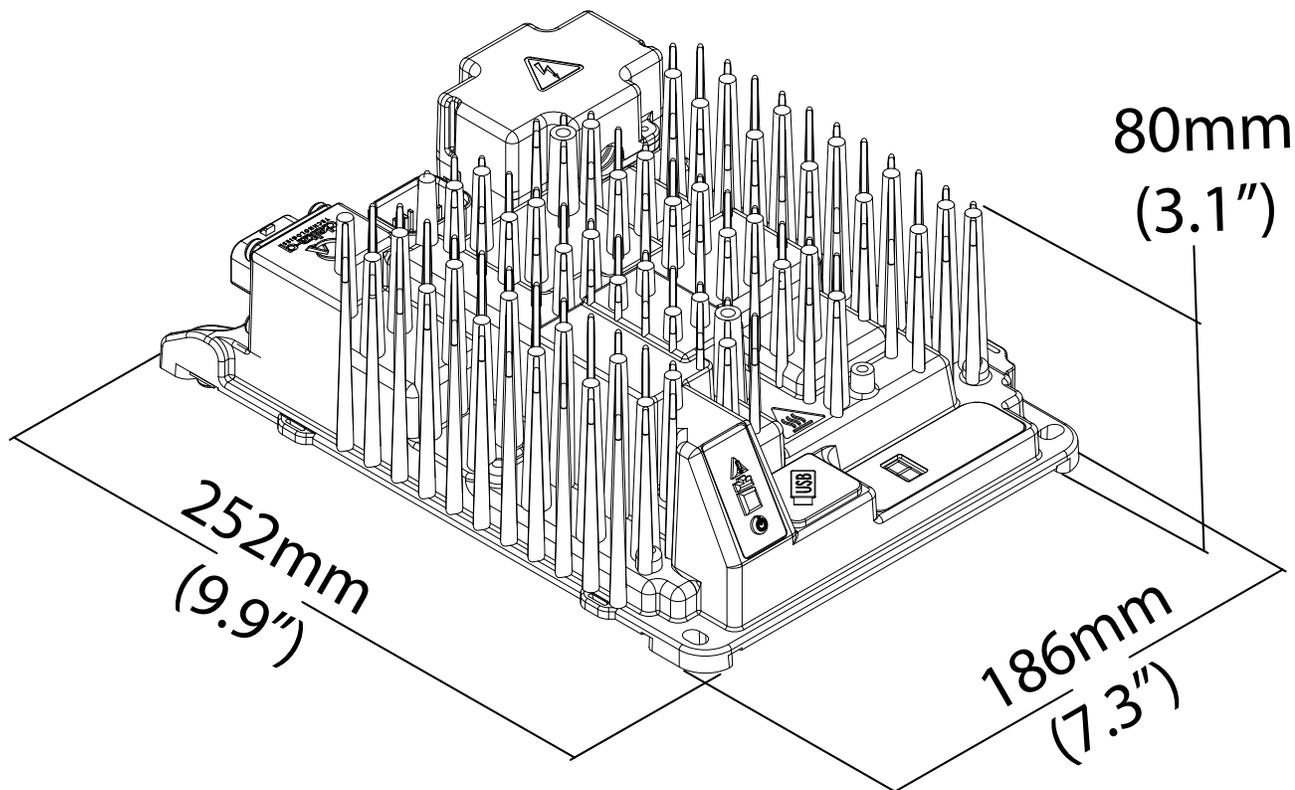
Standard turn-off voltage: 1.75V/cell

When there is no AC power, IC900/1200 will also turn on with DC voltage only. The IC650 requires a hardware modification to turn on with DC.

Minimum DC voltage to turn on: Approx. 25VDC

# 11.0 IC Series Drawings, Photos, and Specifications

## 11.1 IC650 Charger



*IC650 charger isometric view and dimensions*



*IC650 charger front view*

## 11.1 IC650 Charger (continued)



*IC650 charger right side view*



*IC650 charger left side view*

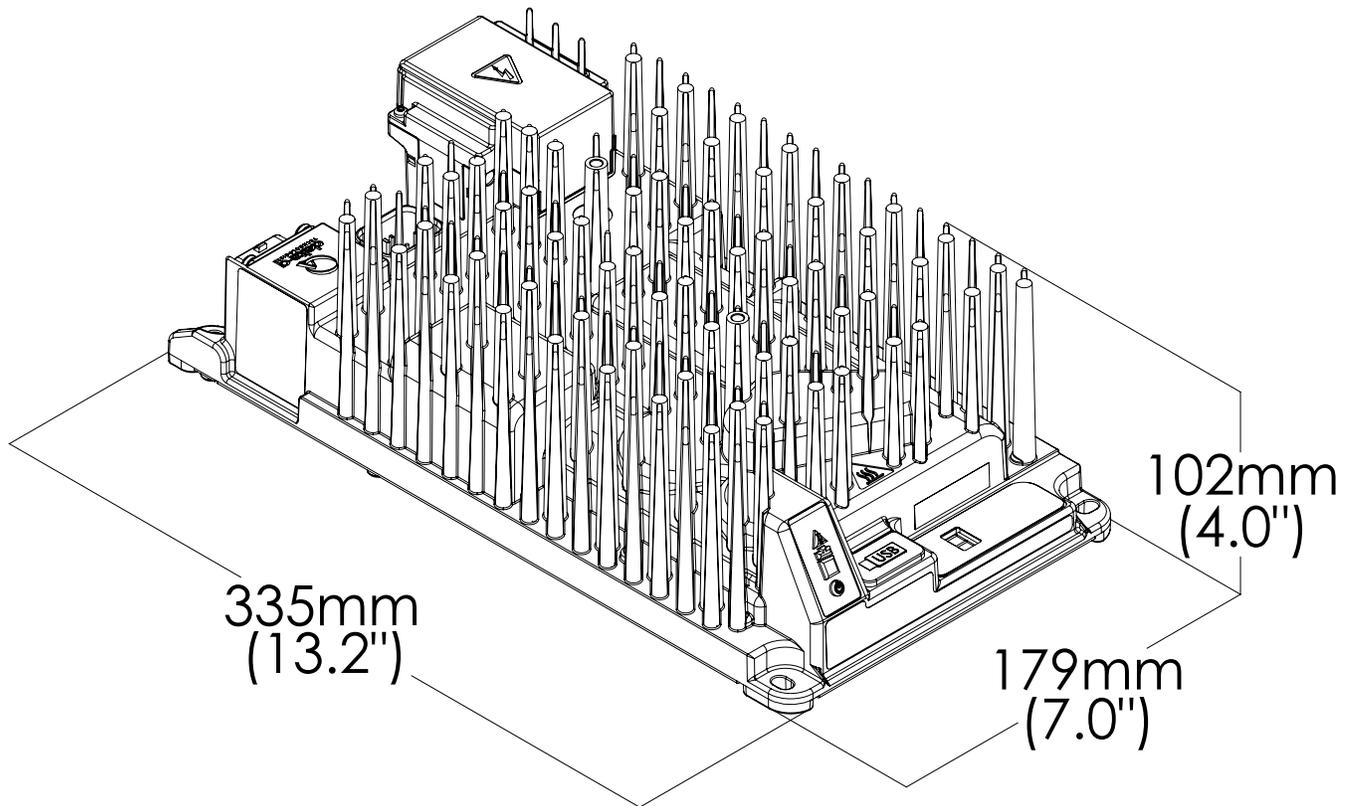


*IC650 charger top view (base version)*



*IC650 charger rear view (base version)*

## 11.2 IC900 Charger



*IC900 isometric view and dimensions*



*IC900 charger front view*

## 11.2 IC900 Charger (continued)



*IC900 charger right side view*



*IC900 charger left side view*

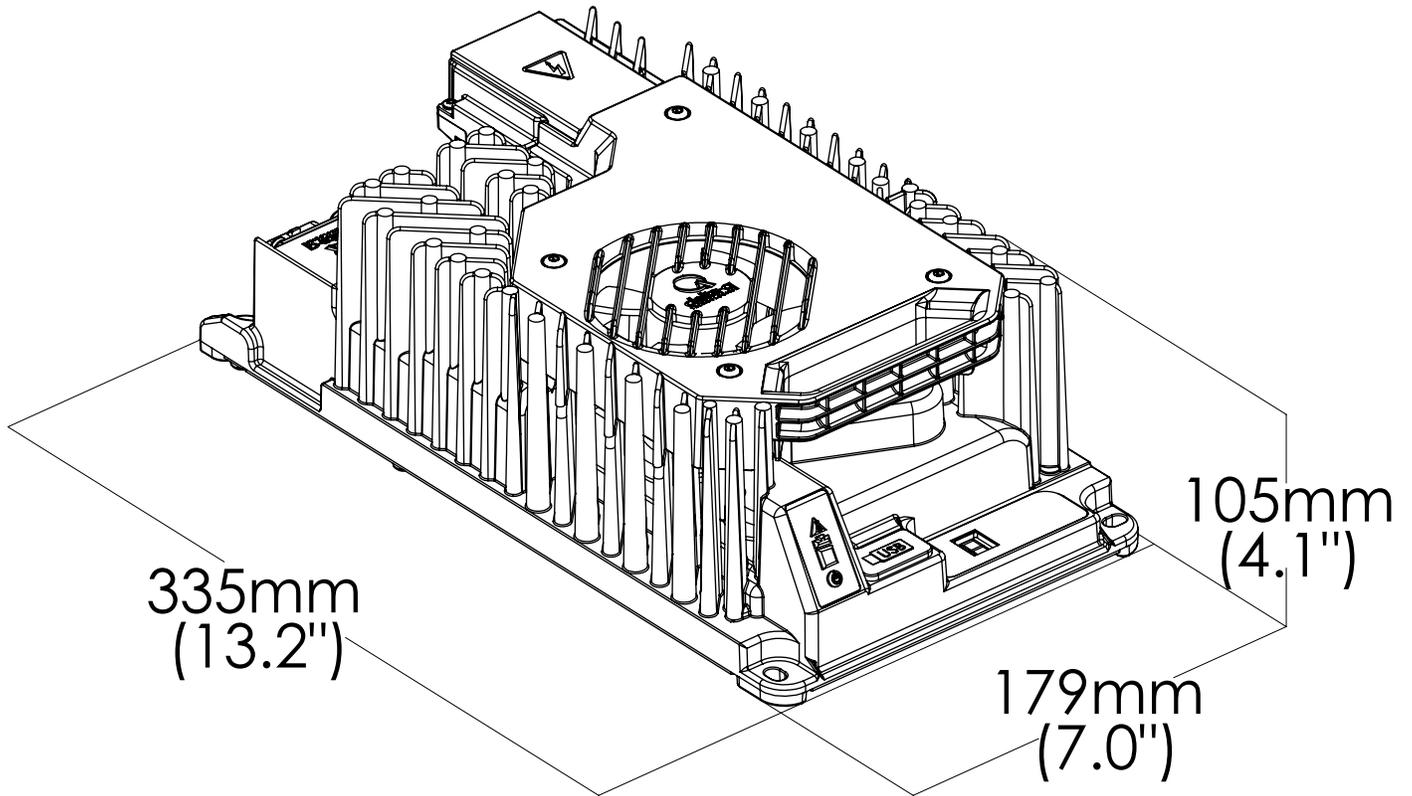


*IC900 charger top view (COMM version)*



*IC900 charger rear view (COMM version)*

### 11.3 IC1200 Charger



*IC1200 charger isometric view and dimensions*



*IC1200 charger front view*

### 11.3 IC1200 Charger (continued)



*IC1200 charger right side view*



*IC1200 charger left side view*



*IC1200 charger top view (COMM version)*



*IC1200 charger rear view (COMM version)*



IC

650



Available models:

24 V / 27 A

36 V / 18 A

48 V / 13.5 A

# Delta-Q IC650

## 650 W Industrial Battery Charger

Capable of charging lead acid (wet, AGM, gel) and lithium battery chemistries, the IC650 Charger is available in on- and off-board configurations. Optional CAN bus communication ensures seamless machine integration and AC/DC cabling is completely customizable. Applications include: scissor lifts, lift trucks, floor care machines, and golf cars.



### High Reliability

Engineered using design for reliability. Validated for long service life in worst-case operating conditions. Manufactured in a world class facility specializing in high reliability solutions.



### Easy to Integrate

Assists machine troubleshooting with built-in charge cycle tracking. Download data / upgrade software through USB host port. Optional CAN bus communication enables deep machine integration, diagnostics and control.



### Charge Quality

Charge profiles to precisely charge deep-cycle lead acid and lithium batteries. Developed in Delta-Q's battery lab to balance charge time, battery life and application requirements.



### Global + Efficient

Capable of operating reliably on any single-phase grid worldwide. High-efficiency performance for electricity savings and shorter charge times.

# IC650 Charger Specifications



## Usability Features

- + Optional CAN bus communication for machine integration or lithium BMS
- + Multi-color LED indicator for AC source, battery status, charging, error, fault
- + Numeric display for charge profile, alarm/fault codes
- + Field programmable with up to 25 charge profiles
- + Auto-recharge in maintenance mode
- + OEM customizable, field replaceable cable design
- + Optional carrying handle

DC Output	24 VDC	36 VDC	48 VDC
Maximum DC output voltage	36 V	54 V	72 V
Maximum DC output current	27.1 A	18.1 A	13.5 A
Maximum DC output power	650 W		
Deep discharge recovery (minimum voltage)	1.2 V	1.8 V	2.4 V
Maximum interlock current	1 A (10 A with external interlock device)		
Battery type	Lead acid (Wet / AGM / GEL), lithium-ion		
Reverse polarity	Electronic protection with auto-reset		
Short circuit	Electronic current limit		

AC Input			
AC input voltage range	85-270 VAC		
Nominal AC input voltage	100-240 VAC		
Nominal AC input frequency	50 / 60 Hz		
Maximum AC input current	7.5 A		
Nominal AC input current	7.3 A @ 100 VAC	6.0 A @ 120 VAC	
	3.1 A @ 230 VAC	2.9 A @ 240 VAC	
Power factor	>0.99 @ 120 VAC	>0.98 @ 230 VAC	

Regulatory	
Efficiency	93.5% peak, California Energy Commission compliant
Safety	UL1564, CSA 107.2, EN 60335-2-29
Emissions	FCC Part 15 / ICES 003 Class A, EN55011
Immunity	EN 61000-3-2, EN 61000-3-3, EN 61000-6-2, EN 61000-6-4, EN55014 available

Environmental		
Operating temperature	-40°C to +65°C (-40°F to 149°F)	Derated output at >40°C (104°F)
Storage temperature	-40°C to +85°C (-40°F to 185°F)	
Ingress protection	Charger rated IP66 (Complete protection against contact, dust, and powerful water jets) with sealed Delta-Q AC cord AC input connector rated to IP20 (protect against dust and water -- keep clean and dry), with a non-Delta-Q AC cord	
Chemical	MIL 810-G, Method 504.1: Withstands exposure to chemicals typically found in application (battery acid, salt, cleaners, fertilizers, etc.)	
Salt	Withstands 720 hours (30 days) salt spray test per GMW 3172 with 5% (w/w) salt solution (pH 6.5-7.2) at 35°C (95°F) without degradation of performance	
Shock / vibration	Infrequent shock: 100g, 11ms half-sine pulse, 3 cycles in each of 3 axes Repetitive shock (bump): 25g, 11ms, 2400 cycles Vibration: Random vibration of 4.55g from 10-1000Hz for 8 hours in each of 3 axes, using the sprung mass profile of GMW 3172	
Humidity	0 to 95% non-condensing	
Altitude	< 15,000 feet derated above 20°C	

USB Host Port	
Required equipment	Standard USB flash drive with FAT formatting
Charge tracking data Points	VAC, IAC, VDC, IDC, temperature (battery & charger) Ahr returned, charge duration, end of charge voltage, fault / error codes logged
Software update	Allows updating of software using USB flash drive, replacing software and / or charge profiles

# IC650 Charger Specifications

Mechanical	
Dimensions	Charger: 25.2 x 18.6 x 8.0 cm (9.9 x 7.3 x 3.1")
	Shipping carton: 32.5 x 30.5 x 12.0 cm (12.8 x 12.0 x 4.5")
Weight	Charger: 2.4 kg (5.3 lbs)
	Shipping carton: 3.0 kg (6.6 lbs)
AC input connector	IEC320/C14 Receptacle with Delta-Q AC cord retention tabs
DC output connector	M6 threaded fasteners for ring terminals, field replaceable in the event of cross-threading or other damage
Signal Connector	IC650 BASE
	6.3 mm (1/4") blade terminals: C1 - Battery temp. sense '-' C2 - Battery temp. sense '+' C3 - Interlock signal
Signal Connector	IC650 COMM
	6.3 mm (1/4") blade terminals: C1 - Battery temp. sense '-' C2 - Battery temp. sense '+' C3 - Interlock signal  TE AmpSeal automotive connector (IP67 rated) mates with TE Connectivity AmpSeal Plug (p/n: 776273): Signals for CAN bus (isolated); Remote status indicators; Battery temperature sense; Interlock; Enable / disable; Modbus
Service port	Sealed (IP66) USB 2.0 Host Port (Type A) with dust cover
Mounting holes	6.3 mm (1/4") diameter slots in each corner for safe installation on shelf, wall or bulkhead
Cooling	Normal operation in any orientation with passive cooling only

Operation	
Status indicators	AC present, charging status (low state-of-charge, high state-of-charge, complete), alarm, fault, USB activity
Numeric display	Displays selected charging profile, alarm and / or fault codes
Long-term storage mode	Automatic restart to maintain battery state-of-charge and prevent sulphation or freezing
Power source	Charge control circuitry powered from AC input. Backup power provided by battery if AC not present.
Standby AC power consumption	2.40 W
Quiescent DC current (connected to battery only)	24 VDC
	27 mA (0.65 W)
Quiescent DC current (connected to battery only)	36 VDC
	18 mA (0.65 W)
Quiescent DC current (connected to battery only)	48 VDC
	15 mA (0.72 W)

Communications / Signals	IC650 BASE	IC650 COMM
Battery temperature input	Isolated temperature sensor signals (mates with Delta-Q isolated battery temperature sensors)	
Charge enable / disable input	Not available	PWM signal
Interlock signal	Standard (Battery positive signal when AC not present)	NO or NC (selectable) dry contact 0.5 A fast-blow fuse (>100 VDC rated) required
Remote status indicator	Not available	Tri-color red / yellow / green
CANbus	Not available	Isolated CAN-H, CAN-L, CAN-GND CANopen CiA 418: Battery and CiA 419: charger CANopen CiA 454: Light electrical vehicles (LEV)
Serial communications	Not available	Modbus RTU

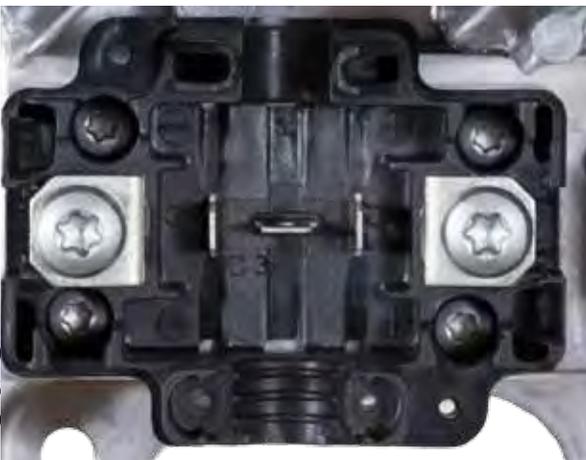
# IC650 Charger Specifications

## Special Features

Charging profile selection	Up to 25 charging profiles stored on the charger. Button and LED numeric display allows default charging profile to be selected.
Datalogging	Flash memory for logging charge cycle parameters (V, I, T, Ah returned, charge duration), events and diagnostic information.
Service	No custom service tools needed. USB flash drive used to update charger software, load charging profiles, select default charge profile and download charge tracking and diagnostic information. Software can be upgraded and logged charge cycle information can be downloaded using CANbus (for OEM handhelds).
External communications	PC-based configuration software for field programmability, analyzing charging performance and troubleshooting issues

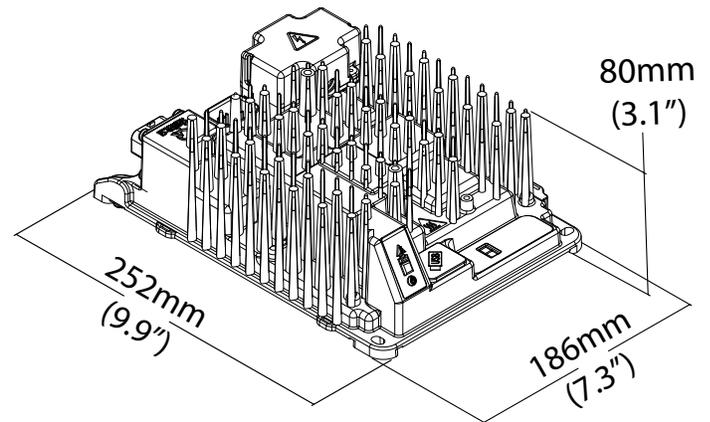
## Options

OEM-specific AC, DC & signal cords	Customized cords to suit OEM requirement, factory-installed for OEM convenience		
AC cord	Delta-Q's custom IEC-compliant AC power cords provide sealed, retained AC connection to the charger. Cords for North America, Europe, Great Britain, China, Japan, and Australia are available. The sealed connection prevents damage from fluids, dirt or acid corrosion, as well as maintaining a firm connection between the power cord and inlet. The charger can also be connected to any off-the-shelf, country-specific AC cord which has a standard IEC320 C13 plug. Contact your Delta-Q Sales Representative for more details.		
Isolated battery temperature sensor	p/n 900-0056 3m (9.8') bare wires	p/n 900-0059 0.14m (5.5") bare wires	p/n 900-0060 1.2m (47.2") bare wires
Tri-color remote status indicator	p/n 900-0058: Remote LED, 3m (9.8') shielded bare wires, tri-color red / yellow / green		
IC series handle & rubber feet kit	p/n 900-0111: Handle, rubber feet and associated mounting hardware		



Close-up view of battery temperature sense and interlock blade terminals within the IC650's DC output block.

## Dimensions





IC

900



Available models:

24 V / 37.5 A

36 V / 25 A

48 V / 20 A

# Delta-Q IC900

## 900 W Industrial Battery Charger

Capable of charging lead acid (wet, AGM, gel) and lithium battery chemistries, the IC900 Charger is available in on- and off-board configurations. Optional CAN bus communication ensures seamless machine integration and AC/DC cabling is completely customizable. Applications include boom lifts, lift trucks, floor care machines, speciality golf vehicles, utility vehicles, motorcycles, and scooters.



### High Reliability

Engineered using design for reliability. Validated for long service life in worst-case operating conditions. Manufactured in a world class facility specializing in high reliability solutions.



### Charge Quality

Charge profiles to precisely charge deep-cycle lead acid and lithium batteries. Developed in Delta-Q's battery lab to balance charge time, battery life and application requirements.



### Easy to Integrate

Assists machine troubleshooting with built-in charge cycle tracking. Download data / upgrade software through USB host port. Optional CAN bus communication enables deep machine integration, diagnostics and control.



### Global + Efficient

Capable of operating reliably on any single-phase grid worldwide. High-efficiency performance for electricity savings and shorter charge times.

# IC900 Charger Specifications

DC Output	24 VDC	36 VDC	48 VDC
Maximum DC output voltage	36 V	54 V	72 V
Maximum DC output current	37.5 A	25.0 A	20.0 A
Maximum DC output power	900 W		960 W
Deep discharge recovery (minimum voltage)	1.2 V	1.8 V	2.4 V
Maximum interlock signal current	10 A		
Maximum solid state relay current rating (COMM models)	10 A		
Battery type	Lead acid (wet / AGM / gel), lithium		
Reverse polarity	Electronic protection with auto-reset		
Short circuit	Electronic current limit		

AC Input		
AC input voltage range	85-270 VAC	
Nominal AC input voltage	100-240 VAC	
Nominal AC input frequency	50 / 60 Hz	
Maximum AC input current	10.5 A	
Nominal AC input current	10.1 A @ 100 VAC	8.4 A @ 120 VAC
	4.4 A @ 230 VAC	4.3 A @ 240 VAC
Power factor	>0.99 @ 120 VAC	>0.98 @ 230 VAC

Regulatory	
Efficiency	90% at full load, 120 VAC, 48 VDC   92% at full load, 240 VAC, 48 VDC California Energy Commission (CEC) standards pending
Safety	Pending: UL1564, CSA 107.2, EN 60335-2-29, AZ/NZS60335 (RSM)
Emissions	FCC Part 15 / ICES 003 Class A, EN55011
Immunity	EN 61000-3-2, EN 61000-3-3, EN 61000-6-2, EN 61000-6-4

Environmental	
Operating temperature	-40°C to +65°C (-40°F to 149°F) <span style="float: right;">Derated output at &gt;40°C (104°F)</span>
Storage temperature	-40°C to +85°C (-40°F to 185°F)
Ingress protection	Charger rated IP66 (Complete protection against contact, dust, and powerful water jets) with sealed Delta-Q AC cord AC input connector rated to IP20 (protect against dust and water -- keep clean and dry) with a non-Delta-Q AC cord
Chemical	MIL 810-G, Method 504.1: Withstands exposure to chemicals typically found in application (battery acid, salt, cleaners, fertilizers, etc.)
Salt	Withstands 720 hours (30 days) salt spray test per GMW 3172 with 5% (w/w) salt solution (pH 6.5-7.2) at 35°C (95°F) without degradation of performance
Shock / vibration	Infrequent shock: 100g, 11ms half-sine pulse, 3 cycles in each of 3 axes Repetitive shock (bump): 25g, 11ms, 2400 cycles Vibration: Random vibration of 4.55g from 10-1000Hz for 8 hours in each of 3 axes, using the sprung mass profile of GMW 3172
Humidity	0 to 95% non-condensing
Altitude	< 15,000 feet derated above 20°C



## Usability Features

- + Optional CAN bus communication for machine integration or lithium BMS
- + Multi-color LED indicator for AC source, battery status, charging, error, fault
- + Numeric display for charge profile, alarm/fault codes
- + Field programmable with up to 25 charge profiles
- + Auto-recharge for low voltage in maintenance mode
- + OEM customizable, field replaceable cable design

# IC900 Charger Specifications

Mechanical	
Dimensions	Charger: 33.5 x 17.9 x 10.2 cm (13.2 x 7.0 x 4.0")
	Shipping carton: 38.7 x 23.0 x 20.0 cm (15.2 x 9.1 x 7.9")
Weight	Charger: 4.4 kg (9.6 lbs)
	Shipping carton: 5.0 kg (11.0 lbs)
AC input connector	IEC320/C14 Receptacle with Delta-Q AC cord retention tabs
DC output connector	M6 threaded fasteners for ring terminals, field replaceable in the event of cross-threading or other damage Allowable cable diameter depends on cable clamp orientation: 6.5mm (2 x 6AWG) 1c cable or 10mm (12AWG) 4c cord
Signal Connector	IC900 BASE
	6.3 mm (1/4") blade terminals: C1 - Battery Temp Sense '-' C2 - Battery Temp Sense '+' C3 - Interlock Signal L1 - Remote LED '+' L2 - Remote LED '-'
Signal Connector	IC900 COMM
	6.3 mm (1/4") blade terminals - C1, C2, C3, L1, L2 TE AmpSeal automotive connector (IP6K9K rated) - mates with TE Connectivity AmpSeal Plug (p/n: 776273): Signals for CANbus (isolated); Remote status indicators; Battery temp sense; Solid State Interlock
Service port	Sealed (IP66) USB 2.0 Host Port (Type A) with dust cover
Mounting holes	6.4mm (1/4") dia. slots in each corner allow for safe installation on a shelf or on a wall or bulkhead
Cooling	Active cooling (Variable speed, Field serviceable, Field replaceable, Fan)

Operation						
Status indicators	AC present, charging status (low state-of-charge, high state-of-charge, complete), alarm, fault, USB activity					
Numeric display	Displays selected charging profile, alarm and / or fault codes					
Long-term storage mode	Automatic restart to maintain battery state-of-charge and prevent sulphation or freezing					
Power source	Charge control circuitry powered from AC input. Backup power provided by battery if AC not present.					
	24 VDC BASE	36 VDC BASE	48 VDC BASE	24 VDC COMM	36 VDC COMM	48 VDC COMM
Standby AC power consumption	< 2.2 W	< 2.2 W	< 2.4 W	< 2.3 W	< 2.4 W	< 2.6 W
Quiescent DC current (connected to battery only)	< 27 mA (0.65 W)	< 18 mA (0.65 W)	< 15 mA (0.72 W)	< 62 mA (1.5 W)	< 42 mA (1.5 W)	< 33 mA (1.6 W)
<i>Note: for up to 18 days, after which current draw is &lt; 9 mA</i>						

Communications / Signals	IC900 BASE	IC900 COMM
Battery temperature input	Isolated temperature sensor signals (mates with Delta-Q isolated battery temperature sensors)	
Interlock signal	Normally-Closed (NC) Signal - Batt+ Voltage on C3 when AC not present	
Solid State Interlock Relay	Not available	NC Relay Contact - 80 VDC max, 10 ADC max (polarized)
Remote Status LED	Tri-color RED/YELLOW/GREEN	
CANbus	Not available	Isolated CAN-H, CAN-L, CAN-GND CANopen CiA 418: Battery and CiA 419: Charger

USB Host Port	
Required equipment	Standard USB flash drive with FAT formatting
Charge Tracking Data Points	VAC, IAC, VDC, IDC, temperature (battery & charger) Ahr returned, charge duration, end of charge voltage, fault / error codes logged
Software Update	Allows updating of software using USB flash drive, replacing software and / or charge profiles

# IC900 Charger Specifications

## Special Features

Charging profile selection	Up to 25 charging profiles stored on the charger. Button and LED numeric display allows default charging profile to be selected
Datalogging	Flash memory for logging charge cycle parameters (V, I, T, Ah returned, charge duration), events and diagnostic information
Service	No custom service tools needed. USB Flash Drive used to update charger software, load charging profiles, select default charging profile, and download charge tracking and diagnostic information. Software can be upgraded and logged charge cycle information can be downloaded using CANbus (for OEM handhelds).
External communications	PC-based configuration software for field programmability, analyzing charging performance and troubleshooting issues

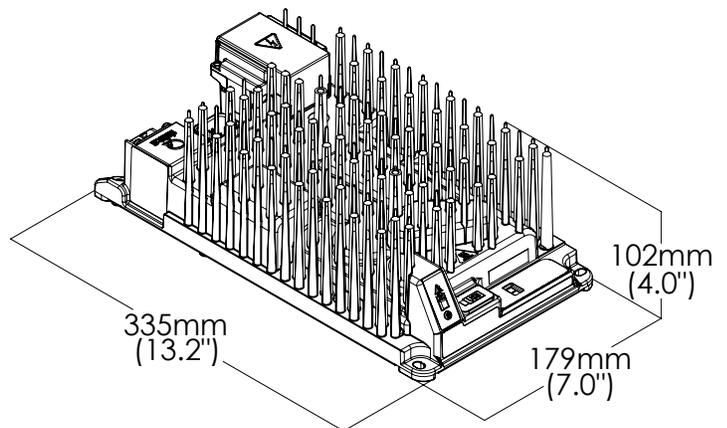
## Options

OEM-specific AC, DC & signal cords	Customized cords to suit OEM requirement, factory-installed for OEM convenience
AC cord	Delta-Q's sealed, IEC-compliant AC power cords provide a sealed, retained AC connection when mated with an IC Series Charger. Cords available for North America, Europe, Great Britain, China, Japan, and Australia. The sealed connection prevents damage from fluids, dirt or acid corrosion, as well as maintaining a firm connection between the power cord and inlet. The charger can also be connected to an off-the-shelf, country-specific AC cord which has a standard IEC320 C13 plug.
Isolated battery temperature sensor	Mounts on battery post or can be attached to side of a battery to provide battery temperature information to charging profiles which will do battery temperature voltage compensation.
Tri-color remote status indicator	Mimics behavior of charger's status display - Flashing Green = Charging, Solid Green = Charging complete, Flashing Yellow = Error Condition, Solid Red = Charger Fault
IC series handle & rubber feet kit	Easily insert into charger's mounting holes to protect mounting surface and prevent charger from sliding.



IC1200 COMM (Rear View). View of battery temperature sense and interlock blade terminals within DC output block.

## Dimensions



Additional certifications can be pursued based on market demand.



IC

1200



Available models:

24 V / 50 A

36 V / 33 A

48 V / 25 A

# Delta-Q IC 1200

## 1200W Industrial Battery Charger

Capable of charging lead acid (wet, AGM, gel) and lithium battery types, the IC1200 Charger is available in on- and off-board configurations. CAN bus communication ensures seamless machine integration and cables are completely customizable. Suitable applications include: boom lifts, lift trucks, floor care, utility vehicles, and power sports.



Rugged, sealed aluminum die cast enclosure protects against vibration, shock, dirt and fluids. Automotive reliability and tested to a 8-year service life.



Two-way communication through USB host port to solve battery issues with charge cycle data and improve machine performance with new charge profiles or software improvements.



Lab optimized charging profiles for all popular industrial battery brands and types to extend battery life and minimize charge times.



Wide AC input voltage range capable of operating on any single-phase grid worldwide. 93% efficient and meets energy efficiency standards, including CEC.

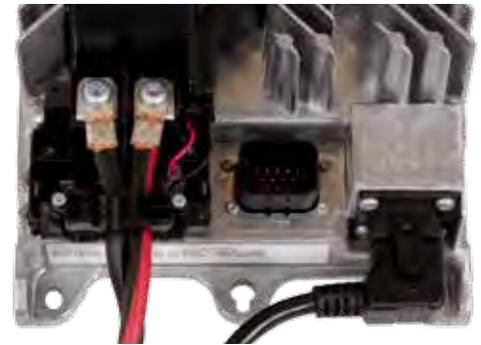
# IC1200 Charger Specifications

DC Output	24 VDC	36 VDC	48 VDC
Maximum DC output voltage	36 V	54 V	72 V
Maximum DC output current	50.0 A	33.3 A	25.0 A
Maximum DC output power	1200 W		
Deep discharge recovery (minimum voltage)	1.2 V	1.8 V	2.4 V
Maximum interlock signal current	10 A	10 A	10 A
Maximum solid state relay current rating (COMM models)	10 A	10 A	10 A
Battery type	Lead acid (wet / AGM / gel), lithium		
Reverse polarity	Electronic protection with auto-reset		
Short circuit	Electronic current limit		

AC Input		
AC input voltage range	85-270 VAC	
Nominal AC input voltage	100-240 VAC	
Nominal AC input frequency	50 / 60 Hz	
Maximum AC input current	14.5 A	
Nominal AC input current	13.4 A @ 100 VAC	11.1 A @ 120 VAC
	5.7 A @ 230 VAC	5.5 A @ 240 VAC
Nominal AC power factor	>0.99 @ 120 VAC	>0.98 @ 230 VAC

Regulatory	
Efficiency	93% peak efficiency, California Energy Commission compliant
Safety	Pending: UL1564, CSA 107.2, EN 60335-2-29, AZ/NZS60335 (RSM)
Emissions	FCC Part 15 / ICES 003 Class A, EN55011
Immunity	EN 61000-3-2, EN 61000-3-3, EN 61000-6-2, EN 61000-6-4

Environmental	
Operating temperature	-40°C to +65°C (-40°F to 149°F) <span style="float: right;">Derated output at &gt;40°C (104°F)</span>
Storage temperature	-40°C to +85°C (-40°F to 185°F)
Ingress protection	Charger rated IP66 (Complete protection against contact, dust, and powerful water jets) with sealed Delta-Q AC cord AC input connector rated to IP20 (protect against dust and water -- keep clean and dry) with a non-Delta-Q AC cord
Chemical	MIL 810-G, Method 504.1: Withstands exposure to chemicals typically found in application (battery acid, salt, cleaners, fertilizers, etc.)
Salt	Withstands 720 hours (30 days) salt spray test per GMW 3172 with 5% (w/w) salt solution (pH 6.5-7.2) at 35°C (95°F) without degradation of performance
Shock / vibration	Infrequent shock: 100g, 11ms half-sine pulse, 3 cycles in each of 3 axes Repetitive shock (bump): 25g, 11ms, 2400 cycles Vibration: Random vibration of 4.55g from 10-1000Hz for 8 hours in each of 3 axes, using the sprung mass profile of GMW 3172
Humidity	0 to 95% non-condensing
Altitude	< 15,000 feet derated above 20°C
Acoustic noise	<50 dB at 3m (only during operating periods while charging)



## Usability Features

- + Optional CAN bus communication for machine integration/BMS tie-in
- + Multi-color LED indicator for AC source, battery status, charging, error, fault
- + Numeric display for charge profile, alarm/fault codes
- + Field programmable with up to 25 charge profiles
- + Auto-recharge for low voltage in maintenance mode
- + OEM customizable, field replaceable cable design
- + Integrated carrying handle

# IC1200 Charger Specifications

Mechanical	
Dimensions	Charger: 33.5 x 17.9 x 10.5 cm (13.2 x 7.0 x 4.1")
	Shipping carton: 38.7 x 23.0 x 20.0 cm (15.2 x 9.1 x 7.9")
Weight	Charger: 4.1 kg (9.0 lbs)
	Shipping carton: 4.7 kg (10.2 lbs)
AC input connector	IEC320/C14 Receptacle with Delta-Q AC cord retention tabs
DC output connector	M6 threaded fasteners for ring terminals, field replaceable in the event of cross-threading or other damage Allowable cable diameter depends on cable clamp orientation: 6.5mm (2 x 6AWG) 1c cable or 10mm (12AWG) 4c cord
Signal Connector	IC1200 BASE
	6.3 mm (1/4") blade terminals: C1 - Battery Temp Sense '-' C2 - Battery Temp Sense '+' C3 - Interlock Signal L1 - Remote LED '+' L2 - Remote LED '-' F1 - Fan '-' F2 - Fan '+'
Signal Connector	IC1200 COMM
	6.3 mm (1/4") blade terminals - C1, C2, C3, L1, L2 TE AmpSeal automotive connector (IP6K9K rated) - mates with TE Connectivity AmpSeal Plug (p/n: 776273): Signals for CANbus (isolated); Remote status indicators; Battery temp sense; Solid State Interlock
Service port	Sealed (IP66) USB 2.0 Host Port (Type A) with dust cover
Mounting holes	6.4mm (1/4") dia. slots in each corner allow for safe installation on a shelf or on a wall or bulkhead
Cooling	Active cooling (Variable speed, Field serviceable, Field replaceable, Fan)

Operation																					
Status indicators	AC present, charging status (low state-of-charge, high state-of-charge, complete), alarm, fault, USB activity																				
Numeric display	Displays selected charging profile, alarm and / or fault codes																				
Long-term storage mode	Automatic restart to maintain battery state-of-charge and prevent sulphation or freezing																				
Power source	Charge control circuitry powered from AC input. Backup power provided by battery if AC not present.																				
	<table border="1"> <thead> <tr> <th>24 VDC BASE</th> <th>36 VDC BASE</th> <th>48 VDC BASE</th> <th>24 VDC COMM</th> <th>36 VDC COMM</th> <th>48 VDC COMM</th> </tr> </thead> <tbody> <tr> <td>Standby AC power consumption</td> <td>&lt; 2.2 W</td> <td>&lt; 2.2 W</td> <td>&lt; 2.4 W</td> <td>&lt; 2.3 W</td> <td>&lt; 2.4 W</td> <td>&lt; 2.6 W</td> </tr> <tr> <td>Quiescent DC current (connected to battery only)</td> <td>&lt; 27 mA (0.65 W)</td> <td>&lt; 18 mA (0.65 W)</td> <td>&lt; 15 mA (0.72 W)</td> <td>&lt; 62 mA (1.5 W)</td> <td>&lt; 42 mA (1.5 W)</td> <td>&lt; 33 mA (1.6 W)</td> </tr> </tbody> </table>	24 VDC BASE	36 VDC BASE	48 VDC BASE	24 VDC COMM	36 VDC COMM	48 VDC COMM	Standby AC power consumption	< 2.2 W	< 2.2 W	< 2.4 W	< 2.3 W	< 2.4 W	< 2.6 W	Quiescent DC current (connected to battery only)	< 27 mA (0.65 W)	< 18 mA (0.65 W)	< 15 mA (0.72 W)	< 62 mA (1.5 W)	< 42 mA (1.5 W)	< 33 mA (1.6 W)
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<i>Note: for up to 18 days, after which current draw is &lt; 9 mA</i>																					

Communications / Signals	IC1200 BASE	IC1200 COMM
Battery temperature input	Isolated temperature sensor signals (mates with Delta-Q isolated battery temperature sensors)	
Interlock signal	Normally-Closed (NC) Signal - Batt+ Voltage on C3 when AC not present	
Solid State Interlock Relay	Not available	NC Relay Contact - 80 VDC max, 10 ADC max (polarized)
Remote Status LED	Tri-color RED/YELLOW/GREEN	
CANbus	Not available	Isolated CAN-H, CAN-L, CAN-GND CANopen CiA 418: Battery and CiA 419: Charger

USB Host Port	
Required equipment	Standard USB flash drive with FAT formatting
Charge Tracking Data Points	VAC, IAC, VDC, IDC, temperature (battery & charger) Ahr returned, charge duration, end of charge voltage, fault / error codes logged
Software Update	Allows updating of software using USB flash drive, replacing software and / or charge profiles

# IC1200 Charger Specifications

## Special Features

Charging profile selection	Up to 25 charging profiles stored on the charger. Button and LED numeric display allows default charging profile to be selected
Datalogging	Flash memory for logging charge cycle parameters (V, I, T, Ah returned, charge duration), events and diagnostic information
Service	No custom service tools needed. USB Flash Drive used to update charger software, load charging profiles, select default charging profile, and download charge tracking and diagnostic information. Software can be upgraded and logged charge cycle information can be downloaded using CANbus (for OEM handhelds).
External communications	PC-based configuration software for field programmability, analyzing charging performance and troubleshooting issues

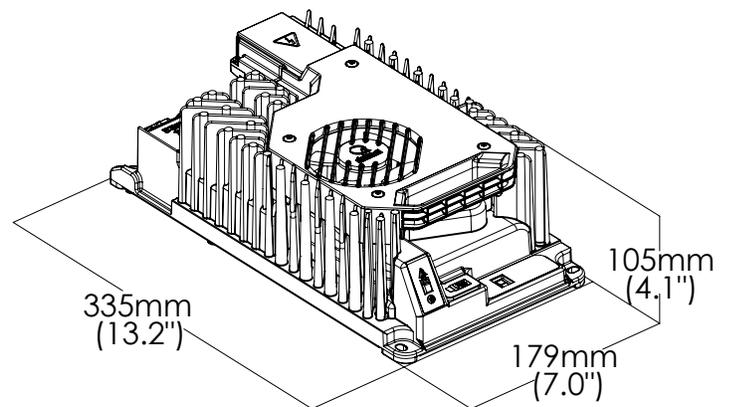
## Options

OEM-specific AC, DC & signal cords	Customized cords to suit OEM requirement, factory-installed for OEM convenience
AC cord	Delta-Q's sealed, IEC-compliant AC power cords provide a sealed, retained AC connection when mated with an IC Series Charger. Cords available for North America, Europe, Great Britain, China, Japan, and Australia. The sealed connection prevents damage from fluids, dirt or acid corrosion, as well as maintaining a firm connection between the power cord and inlet. The charger can also be connected to an off-the-shelf, country-specific AC cord which has a standard IEC320 C13 plug.
Isolated battery temperature sensor	Mounts on battery post or can be attached to side of a battery to provide battery temperature information to charging profiles which will do battery temperature voltage compensation.
Tri-color remote status indicator	Mimics behavior of charger's status display - Flashing Green = Charging, Solid Green = Charging complete, Flashing Yellow = Error Condition, Solid Red = Charger Fault
IC series handle & rubber feet kit	Easily insert into charger's mounting holes to protect mounting surface and prevent charger from sliding.



IC1200 COMM (Rear View). View of battery temperature sense and interlock blade terminals within DC output block.

## Dimensions



Additional certifications can be pursued based on market demand.

## 12.0 Replacement Parts List

Part	Part No.	Description
USB port dust cover	400-0299	Covers USB host port from dust / liquid ingress
DC block cover	400-0300	Covers DC terminal fixtures from dust / liquid ingress
DC cable clamp	400-0354	Fastens DC cabling in place at the point of exit out of the DC block.
Torx T30 / M6 bolts	410-0365	Bolts for DC positive / negative terminals
M6 square nut	400-0305	Nuts for DC positive and negative terminals

Contact Delta-Q for the current list of all available accessories and cables.

# 13.0 Glossary

Term	Definition
AC	Alternating current
CAN	Controller area network, a standard automotive serial network protocol
DSP	Digital signal processor
DC	Direct current
ELV	Extra low voltage
HV	High voltage
HW	Hardware
ID	Identification
kW	Kilowatt
LED	Light emitting diode
LIN	Local interconnect network, a low-cost automotive serial network protocol
LV	Low voltage
MB	Megabyte, a measure of digital storage space
MCU	Microcontroller - also abbreviated uC or $\mu$ C
PC	Personal computer, typically referring to Windows-based systems
PFC	Power factor correction
SW	Software
TBD	To be determined
USB	Universal Serial Bus, a connection technology for attaching peripheral devices to a computer to provide fast data exchange.
VAC	Volts of alternating current



IC650

IC900

IC1200