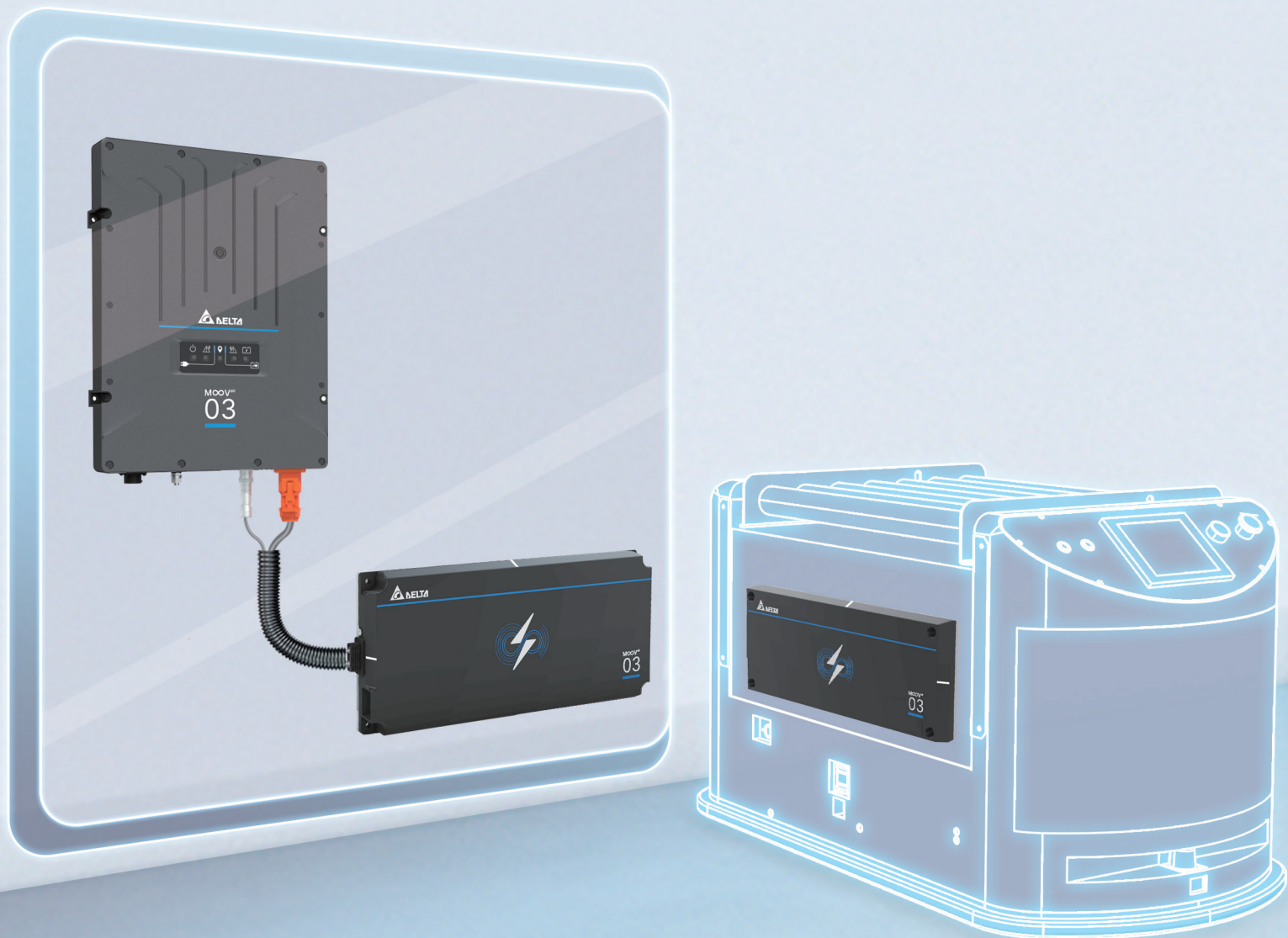




# MOOV<sup>air</sup>

## 3.3 kW Wireless Charging System

Installation and operation manual



## LEGAL INFORMATION

This manual applies to the Wireless Charging System (WCS 3.3 kW).

Delta manuals undergo continuous revision to provide user with complete information regarding the installation and operation of WCS. Therefore, before starting installation work, always consult Delta to check whether a newer version of the User Manual is available.

This manual is intended for use by electrical installers who are competent for installation and commissioning of grid-connected electrical systems/products.

The information in this manual should be treated as confidential and no part of this manual may be reproduced without prior written permission from Delta. The information in this manual may not be used for any other purpose, directly connected to the use of the WCS.

All translations of this manual that are not authorized by Delta Energy System (Germany) must be marked with the words "Translation of the original operating instructions."

© Copyright – Delta Energy Systems (Germany) – All rights reserved.

Delta Energy Systems (Germany) GmbH

Tscheulinstraße 21

79331 Teningen

Germany

## 1 Revision Record

Changes to the previous version are highlighted in **green** in this document. Changed images are **framed in green**, and the changes within these images are also highlighted in **green**.

| Revision | Date       | Description                                                                                                                                                                                                                            |
|----------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0      | 04.07.2025 | First release                                                                                                                                                                                                                          |
| 2.0      | 28.07.2025 | Information for SNTP removed because it does no longer apply to this wireless charging system.                                                                                                                                         |
| 3.0      | 24.10.2025 | Description of charging position reworked (8.4 “WPP & WSP Positioning for Charging”, p. 47)<br>Description for the installation of a technical barrier in accordance with FCC regulations added (6.5 “EMF Safety Instructions”, p. 38) |
| 4.0      | 01.04.2026 | Extensive rework of the whole document.                                                                                                                                                                                                |

## 2 Table of Contents

|          |                                                            |           |
|----------|------------------------------------------------------------|-----------|
| <b>1</b> | <b>Revision Record .....</b>                               | <b>3</b>  |
| <b>2</b> | <b>Table of Contents .....</b>                             | <b>4</b>  |
| <b>3</b> | <b>About this Document .....</b>                           | <b>8</b>  |
| 3.1      | Purpose of this Document .....                             | 8         |
| 3.2      | Target Audience .....                                      | 8         |
| 3.3      | Access to the System .....                                 | 8         |
| 3.4      | References .....                                           | 9         |
| 3.4.1    | Delta Documentation .....                                  | 9         |
| 3.4.2    | Open Source License & Credits .....                        | 9         |
| 3.5      | Exclusion of Liability .....                               | 9         |
| <b>4</b> | <b>Regulatory Compliances .....</b>                        | <b>10</b> |
| 4.1      | EU .....                                                   | 10        |
| 4.1.1    | Declaration of Conformity (DoC) .....                      | 10        |
| 4.1.2    | Radio Equipment .....                                      | 10        |
| 4.2      | FCC (USA) .....                                            | 10        |
| 4.3      | ISED (Canada) .....                                        | 11        |
| 4.3.1    | Interference statement .....                               | 11        |
| 4.3.2    | Basic RF notice .....                                      | 11        |
| 4.3.3    | Information according to RSS-102.NS.MEAS Annex C.2.3 ..... | 12        |
| <b>5</b> | <b>System Overview .....</b>                               | <b>13</b> |
| 5.1      | WCS Subsystems .....                                       | 13        |
| 5.2      | Scope of Supply .....                                      | 14        |
| 5.3      | Overview .....                                             | 15        |
| 5.3.1    | Wireless Charging .....                                    | 15        |
| 5.3.2    | Models, Variants & Interoperability .....                  | 16        |
| 5.4      | Wireless Primary Box (WPB) .....                           | 17        |
| 5.4.1    | Overview .....                                             | 17        |
| 5.4.2    | Components .....                                           | 17        |
| 5.4.3    | Status LED Panel .....                                     | 17        |
| 5.4.4    | AC Input .....                                             | 20        |
| 5.4.5    | Ethernet Service Interface .....                           | 21        |
| 5.4.6    | Connectors for WPP cables .....                            | 21        |
| 5.4.7    | Technical Specification .....                              | 22        |
| 5.5      | Wireless Primary Pad (WPP) .....                           | 23        |
| 5.5.1    | Overview .....                                             | 23        |
| 5.5.2    | Components .....                                           | 23        |
| 5.5.3    | Technical Specification .....                              | 24        |
| 5.6      | Wireless Secondary Box (WSB) .....                         | 25        |

|          |                                                      |           |
|----------|------------------------------------------------------|-----------|
| 5.6.1    | Overview .....                                       | 25        |
| 5.6.2    | Components.....                                      | 25        |
| 5.6.3    | User Interface .....                                 | 26        |
| 5.6.4    | Technical Specification .....                        | 29        |
| 5.7      | Wireless Secondary Pad (WSP).....                    | 30        |
| 5.7.1    | Overview .....                                       | 30        |
| 5.7.2    | Components.....                                      | 30        |
| 5.7.3    | Technical Specification .....                        | 31        |
| <b>6</b> | <b>Safety &amp; Regulations .....</b>                | <b>32</b> |
| 6.1      | Levels of Warning Messages .....                     | 32        |
| 6.2      | Warning & Other Signs .....                          | 32        |
| 6.3      | Labels .....                                         | 34        |
| 6.4      | General Safety Instructions .....                    | 36        |
| 6.5      | EMF Safety Instructions .....                        | 38        |
| 6.5.1    | Responsibility of the Vehicle Integrator .....       | 38        |
| 6.5.2    | Responsibility of the Facility Integrator .....      | 38        |
| <b>7</b> | <b>Intended Use .....</b>                            | <b>41</b> |
| <b>8</b> | <b>Operating Behavior .....</b>                      | <b>42</b> |
| 8.1      | Output Power and De-rating.....                      | 42        |
| 8.1.1    | Output Operating Area at 24 V Nominal Voltage .....  | 42        |
| 8.1.2    | Output Operating Area at 36 V Nominal Voltage .....  | 43        |
| 8.1.3    | Output Operating Area at 48 V Nominal Voltage .....  | 44        |
| 8.2      | Power vs. Ambient Temperature .....                  | 45        |
| 8.3      | Power Vs Input Voltage.....                          | 46        |
| 8.4      | WPP & WSP Positioning for Charging.....              | 47        |
| 8.4.1    | Optimal Alignment.....                               | 47        |
| 8.4.2    | Misalignment tolerances for the Air-gap .....        | 48        |
| 8.4.3    | Horizontal and vertical misalignment tolerances..... | 49        |
| 8.4.4    | Indication and Reporting of Charging Position.....   | 52        |
| 8.5      | Efficiency and Losses .....                          | 53        |
| 8.5.1    | Efficiency Ratings .....                             | 53        |
| 8.5.2    | Factors that Influence Losses .....                  | 54        |
| 8.5.3    | Temperature of the WPP.....                          | 54        |
| 8.6      | System Control Modes .....                           | 55        |
| 8.6.1    | External Commanded CANopen®.....                     | 55        |
| 8.6.2    | Charging with Configured System .....                | 55        |
| 8.6.3    | External Commanded Ethernet .....                    | 56        |
| 8.6.4    | Internal Multistage Profile.....                     | 56        |
| 8.6.5    | Internal CC-CV Profile.....                          | 57        |
| 8.6.6    | Li-ION Battery Recovery .....                        | 57        |
| 8.7      | Communications .....                                 | 59        |

|           |                                                                 |            |
|-----------|-----------------------------------------------------------------|------------|
| 8.7.1     | WPP & WSP Interface – Pad-to-Pad Link (PPL)                     | 59         |
| 8.7.2     | WPB – Ethernet                                                  | 59         |
| 8.7.3     | WSB – CANopen®                                                  | 90         |
| <b>9</b>  | <b>Planning</b>                                                 | <b>99</b>  |
| 9.1       | System Design                                                   | 99         |
| 9.2       | Planning the Installation                                       | 99         |
| 9.2.1     | Planning WPB Installation                                       | 99         |
| 9.2.2     | Planning WPP Installation                                       | 100        |
| 9.3       | Planning Safety Measures                                        | 101        |
| 9.3.1     | Introduction                                                    | 101        |
| 9.3.2     | Safety Keep-out Areas and Safety Markings for the Charging Zone | 102        |
| <b>10</b> | <b>Installation</b>                                             | <b>106</b> |
| 10.1      | WPB                                                             | 106        |
| 10.1.1    | Safety Instructions                                             | 106        |
| 10.1.2    | Installation Procedure                                          | 107        |
| 10.1.3    | Ethernet Connection                                             | 108        |
| 10.1.4    | Power Up & Health Checks                                        | 108        |
| 10.2      | WPP                                                             | 109        |
| 10.2.1    | Safety Instructions                                             | 109        |
| 10.2.2    | Special Tools & Equipment                                       | 110        |
| 10.2.3    | Installation Conditions                                         | 110        |
| 10.2.4    | Installation Procedure                                          | 113        |
| 10.2.5    | Connecting WPP to WPB                                           | 114        |
| 10.2.6    | Power Up & Health Checks                                        | 115        |
| 10.3      | WSP                                                             | 116        |
| 10.3.1    | Safety Instructions                                             | 116        |
| 10.3.2    | Special Tools & Equipment                                       | 116        |
| 10.3.3    | Installation Conditions                                         | 117        |
| 10.3.4    | Installation Procedure                                          | 119        |
| 10.3.5    | Power Up & Health Checks                                        | 119        |
| 10.4      | WSB                                                             | 120        |
| 10.4.1    | Safety Instructions                                             | 120        |
| 10.4.2    | Special Tools & Equipment                                       | 120        |
| 10.4.3    | Installation Conditions                                         | 120        |
| 10.4.4    | Mounting the WSB to the Vehicle                                 | 121        |
| 10.4.5    | Connecting WSP to WSB                                           | 122        |
| 10.4.6    | Power Up & Health Checks                                        | 125        |
| <b>11</b> | <b>System Commissioning / Start-up</b>                          | <b>126</b> |
| 11.1      | Safety Instructions                                             | 126        |
| 11.2      | Wireless Charging                                               | 126        |
| <b>12</b> | <b>Maintenance</b>                                              | <b>127</b> |
| 12.1      | Safety Instructions                                             | 127        |
| 12.2      | Preventive Maintenance                                          | 127        |

|           |                                              |            |
|-----------|----------------------------------------------|------------|
| 12.3      | General Cleaning .....                       | 128        |
| 12.3.1    | Materials .....                              | 128        |
| 12.3.2    | Cleaning WPB & WSB .....                     | 128        |
| 12.3.3    | Cleaning WPP & WSP .....                     | 128        |
| 12.4      | Corrective Maintenance .....                 | 129        |
| 12.5      | Firmware Update .....                        | 130        |
| 12.5.1    | WPU .....                                    | 130        |
| 12.5.2    | WSU .....                                    | 131        |
| 12.6      | WSU Multistage Profile Update .....          | 132        |
| 12.6.1    | Via CANopen® .....                           | 132        |
| 12.6.2    | Via Ethernet .....                           | 132        |
| <b>13</b> | <b>Troubleshooting .....</b>                 | <b>133</b> |
| 13.1      | Identifying Subsystems to Troubleshoot ..... | 133        |
| 13.2      | Troubleshooting on WPB .....                 | 134        |
| 13.3      | Troubleshooting on WPP .....                 | 134        |
| 13.4      | Troubleshooting on WSP .....                 | 135        |
| 13.5      | Troubleshooting on WSB .....                 | 135        |
| 13.6      | Troubleshooting of Detail Faults .....       | 136        |
| 13.6.1    | Troubleshooting of WSU Faults .....          | 136        |
| 13.6.2    | Troubleshooting of WPU Faults .....          | 139        |
| <b>14</b> | <b>Accessories &amp; Spare Parts .....</b>   | <b>141</b> |
| 14.1      | Part numbers of Subsystems .....             | 141        |
| 14.2      | Development Kit .....                        | 141        |
| <b>15</b> | <b>Warranty .....</b>                        | <b>142</b> |
| 15.1      | Warranty Conditions .....                    | 142        |
| 15.2      | Non-Warranty Conditions .....                | 142        |
| 15.3      | Return Procedure .....                       | 142        |
| 15.4      | Product Life .....                           | 142        |
| <b>16</b> | <b>Disposal .....</b>                        | <b>143</b> |
| 16.1      | Disposal of system and subsystems .....      | 143        |
| 16.2      | Disposal of packaging materials .....        | 143        |
| <b>17</b> | <b>List of Figures .....</b>                 | <b>144</b> |
| <b>18</b> | <b>Abbreviations and Acronyms .....</b>      | <b>146</b> |

## 3 About this Document

### 3.1 Purpose of this Document

This documentation describes the operation, installation, and maintenance of the Wireless Charging System 3.3kW (WCS 3.3kW) and its subsystems.

It also explains the connections and interfaces for integration with a vehicle's Battery Management System (BMS). The Wireless Secondary Pad (WSP) and Wireless Secondary Box (WSB) are installed as part of the vehicle by the vehicle integrator, whereas the Wireless Primary Box (WPB) and Wireless Primary Pad (WPP) are installed in the facility.

The document also includes the important information for the end customer, which is as follows:

- health and safety
- alignment / positioning
- the charging process
- status indicators
- system maintenance

This information should be provided to all types of users to make sure the safe and effective use of the WCS before, during and after installation.

This document contains important safety instructions and information that must be read, understood, and followed to make sure that the WCS is installed, connected and operated safely. Delta Energy Systems is not liable for any damage or harm resulting from failure to follow the safety instructions or other information contained in this document.

### 3.2 Target Audience

This documentation is intended for:

- Skilled persons for vehicle integration of the WSB and WSP.
- Skilled persons for integration of WPB/WPP at the facility.

Although this documentation is not intended for operators of the WCS, it does contain important information that must be provided to operators to ensure safe and effective use of the system after installation.

### 3.3 Access to the System

Following table contains the information about the types of users and their accessibility to the system in accordance to IEC 62368-1. In summary:

| Kind of Person    | Types of User                                             | Description                                               |
|-------------------|-----------------------------------------------------------|-----------------------------------------------------------|
| Ordinary person   | NA                                                        | Must not use the system.                                  |
| Instructed person | Operator, Driver                                          | May use the system after being trained by skilled person. |
| Skilled person    | Vehicle integrator,<br>Facility integrator,<br>Maintainer | May install and use the system or its parts.              |

## 3.4 References

### 3.4.1 Delta Documentation

| Description            | Link                |
|------------------------|---------------------|
| CANopen® Protocol Spec | Contact Delta Sales |

### 3.4.2 Open Source License & Credits

lwIP is licenced under the BSD license:

Copyright (c) 2001-2004 Swedish Institute of Computer Science.

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.

Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

The name of the author may not be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE AUTHOR ``AS IS AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE AUTHOR BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY

OF SUCH DAMAGE.

## 3.5 Exclusion of Liability

The firmware and/or hardware may be changed at any time without prior notice. For this reason it is possible that parts of these instructions, technical data and images in this documentation to differ slightly from the product in your possession. All points described in these instructions only serve the purpose of clarification and may not correspond to every situation. Legal claims cannot be made on the basis of this document.

## 4 Regulatory Compliances

### 4.1 EU

#### 4.1.1 Declaration of Conformity (DoC)

Hereby, Delta Energy Systems (Germany) GmbH declares that the radio equipment type 3.3 kW Wireless Charging System is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: [www.deltaww.com](http://www.deltaww.com).

#### 4.1.2 Radio Equipment

Radio Frequency Information:

13.56 MHz: Wireless Communication (PPL), max 200 mW

79-90 kHz: Wireless Power Transfer, max 3.3 kW

### 4.2 FCC (USA)



- During charging/operation there will be electric and magnetic fields between the pads, human bodies must not be in close proximity of the pads. Make sure to follow the installation guidance given in [6.5 EMF Safety Instructions](#). It is the responsibility of the installer to provide sufficient warnings, keep out restrictions and training to all personnel.

Active charging will generate electric and magnetic fields between the pads. The WCS has been designed to minimize stray fields and has been tested as complying with the following standards:

- 47 CFR Part 15.225 in conjunction with ANSI C63.10:2013
- 47 CFR Part 18, Subpart C
- 47 CFR FCC Part 1.1307 (clause (b)(1)(i)(B) and (b)(3)(ii)(B)), KDB 447498 D01 General RF Exposure Guidance v06 KDB 680106 D01 RF Exposure Wireless Charging App v03r01

However, it is still necessary to take precautions to work safely with the WCS.

Operators (if any) must be informed that they could be exposed to EMF, and that they must keep enough distance from the WPP at all times, including when not charging.

#### ATTENTION:



This WCS complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

This device may not cause harmful interference.

This device must accept any interference received, including interference that may cause undesired operation.

**ATTENTION:**


This equipment has been tested and found to comply with the limits for a Class A digital device, 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 a commercial 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 his own expense.

**ATTENTION:**


**As defined in FCC document “47CFR Part 15”, any changes or modifications not expressly approved by the party responsible for the compliance could void the user’s authority to operate the equipment.**

## 4.3 ISED (Canada)

### 4.3.1 Interference statement

#### Information in English

This device complies with Innovation, Science and Economic Development Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### Informations en français

Le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### 4.3.2 Basic RF notice

#### Information in English

This radio transmitter has been approved by Innovation, Science and Economic Development Canada as meeting the RF exposure requirements for an uncontrolled environment.

#### Informations en français

Cet émetteur radio a été approuvé par Innovation, Sciences et Développement économique Canada comme respectant les exigences d'exposition RF pour un environnement non contrôlé.

#### **4.3.3 Information according to RSS-102.NS.MEAS Annex C.2.3**

This Wireless Charging System is powered down within one second after the load (WSU) has been removed from the charging area.

Ce système de recharge sans fil s'éteint dans la seconde qui suit le retrait de la charge (WSU) de la zone de recharge.

## 5 System Overview

### 5.1 WCS Subsystems

The Wireless Charging System (WCS) is designed to charge the batteries of electric systems wirelessly. This WCS can be used by vehicles equipped with a battery, which are automated or manually driven, no user interaction is required to charge a battery.

The WCS consists of 4 subsystems.

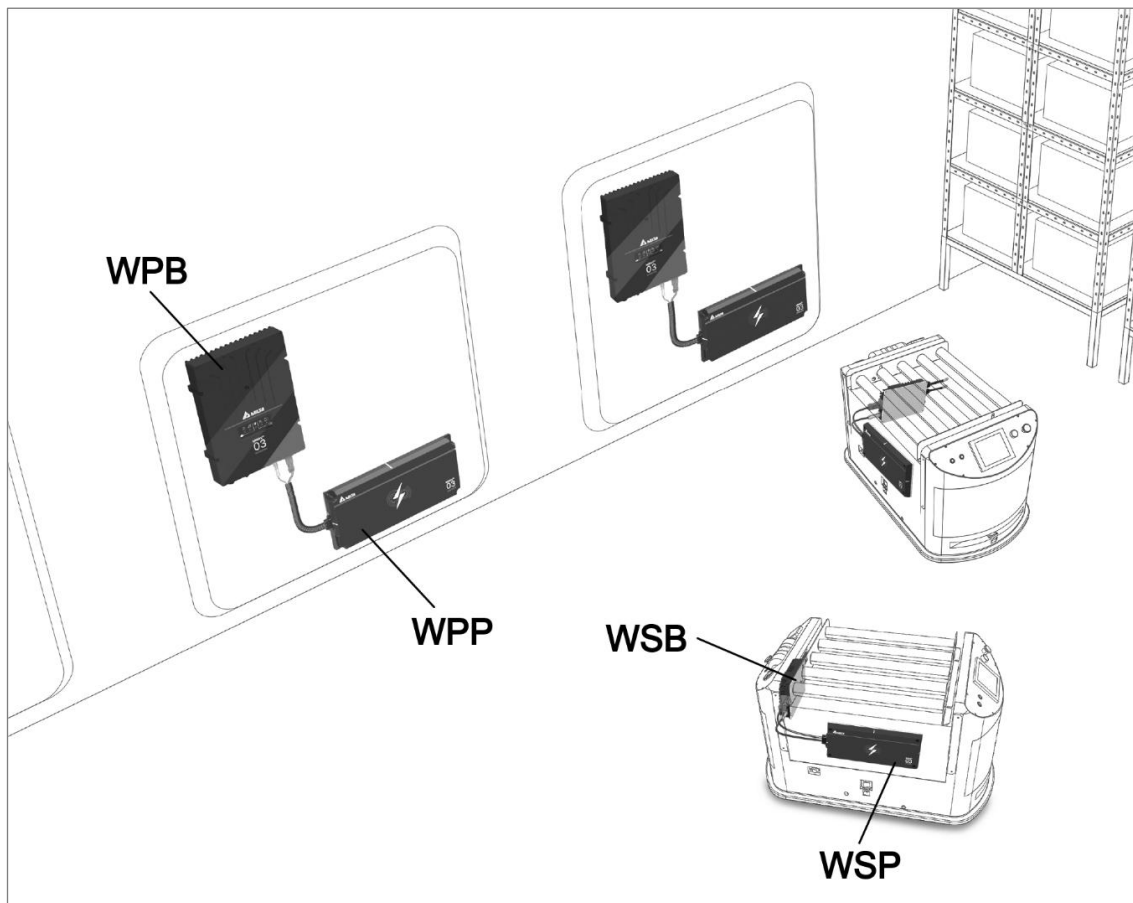
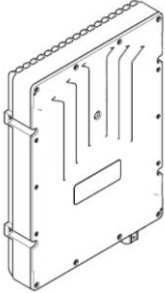
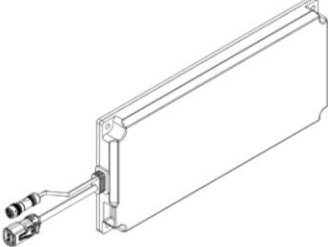
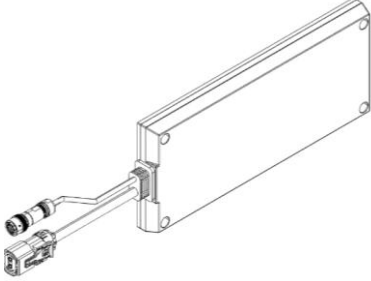
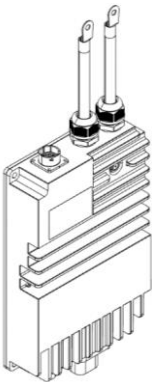
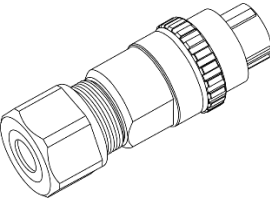


Figure. 1 Subsystems of the WCS

|   |                              |
|---|------------------------------|
| 1 | Wireless Primary Box (WPB)   |
| 2 | Wireless Primary Pad (WPP)   |
| 3 | Wireless Secondary Pad (WSP) |
| 4 | Wireless Secondary Box (WSB) |

## 5.2 Scope of Supply

| Part                                                                      |                                                                                       | Quantity |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------|
| WPB 3.3kW: Wireless Primary Box (Grid connection)                         |    | 1        |
| WPP 3.3kW: Wireless Primary Pad (generating magnetic field)               |     | 1        |
| WSP 3.3kW: Wireless Secondary Pad (Vehicle side, receives magnetic field) |    | 1        |
| WSB 3.3kW: Wireless Secondary Box (Vehicle side, charges Battery)         |  | 1        |
| AC plug (Amphenol 10-729647-Z3S) for grid connection                      |   | 1        |

## 5.3 Overview

### 5.3.1 Wireless Charging

The WCS wirelessly charges the battery of an industrial electric vehicle by means of near coupling between WPP and WSP. The magnetic field is generated by the WPP and coupled to the WSP. The WSB converts the magnetic field back to electrical current and charges the battery. The rated power of the WCS is 3.3 kW.

|                                                                                                                                                                                           |                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div style="background-color: #0056b3; color: white; padding: 5px; font-weight: bold;">ATTENTION:</div>  | <p><b>Material damage</b></p> <p>The magnetic field generated during the charging process can cause metal and other foreign objects to become hot. Therefore, it is important to keep the charging area free of foreign objects.</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The magnetic field is only emitted by the WPP when there is a WSP in the charging area. The charging status can be seen on the WPB Status LED panel, refer [5.4.3 “Status LED”, p. 17](#) and [5.4.5 “Ethernet Service Interface”, p.21](#).

The speed and efficiency of the charging process is dependent on different factors, including:

- Temperature – both the ambient temperature and the internal temperature of the subsystems.
- Pad positioning – both the distance (air gap) and the alignment of the pads, refer [8.3](#).

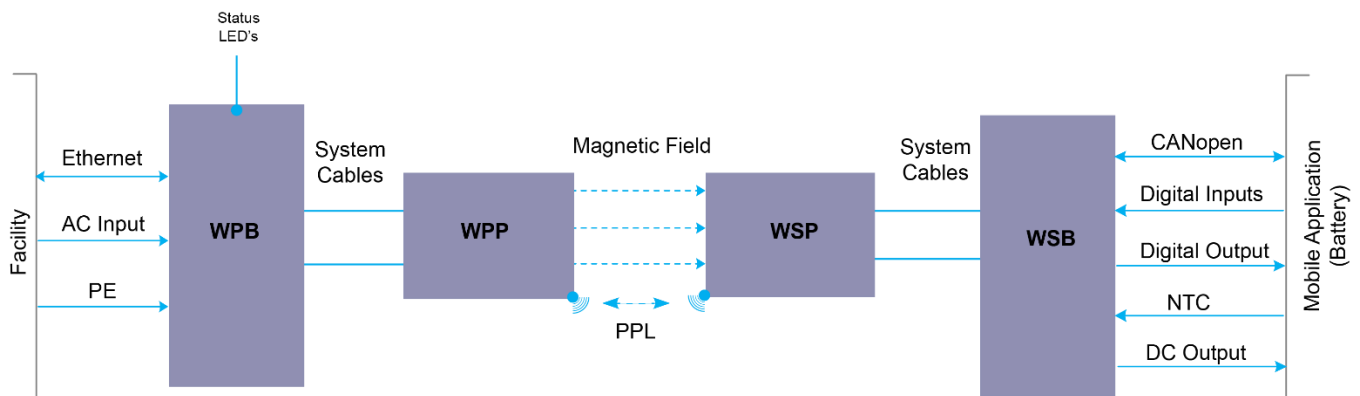


Figure. 2 Wireless Charging

There is a wired control connection between WPB – WPP, a wireless control connection between WPP – WSP referred to PPL (Pad-to-Pad Link), a wired control connection between WSP – WSB and a wired control connection between WSB and vehicle (optional). The WCS can be controlled by a variety of means, including:

- Charge setpoints from the vehicle via CANopen® (typically BMS)
- Charge setpoints from a Fleet Management System (or similar) via Ethernet
- Internal pre-programmed Multistage Profile (IMP) for Lead Acid Batteries with:
  - Start-Stop via Digital Input on WSB from vehicle
  - Start-Stop via CANopen® command from vehicle
  - Start-Stop via Ethernet command from Management System
- Internal User configurable CC-CV Profile (ICP) for Li-ION Batteries with:
  - Start-Stop via Digital Input on WSB from vehicle
  - Start-Stop via CANopen® command from vehicle
  - Start-Stop via Ethernet command from Management System

For details on the control interfaces, refer [8.7.2 “WPB – Ethernet”, p. 59](#), and [8.7.3 “WSB – CANopen®”, p. 90](#).

### 5.3.2 Models, Variants & Interoperability

The 3.3 kW WCS has different variants of WSB; each WSB is specific to a DC Output voltage range. Therefore, the WPB, WPP and WSP are common parts whilst the WSB is to be matched to the battery that is to be charged.

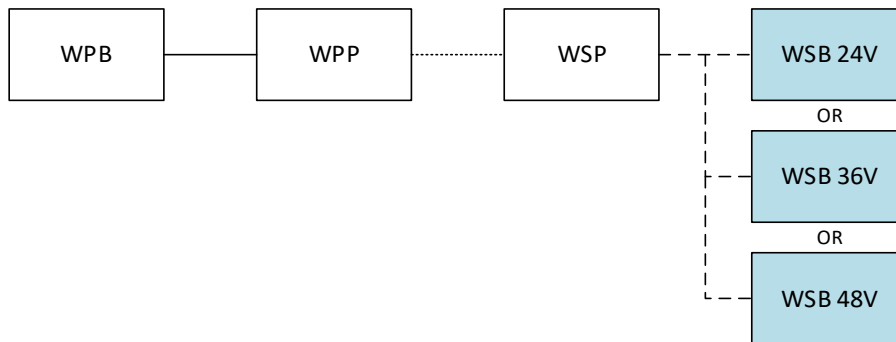


Figure. 3 Interoperability

## 5.4 Wireless Primary Box (WPB)

### 5.4.1 Overview

Wireless Primary Box (WPB) is a power electronics device which enables power transfer via the Wireless Primary Pad (WPP) to the Wireless Secondary Pad (WSP).

The WPB draws power from the grid and converts it to a medium voltage (MV) AC supply which is fed to the WPP. The maximum output power is 3.3 kW. The WPB communicates with the WPP internally, which forms part of the control loop for safe usage. It also provides User interfaces using Ethernet and Status LED's.

### 5.4.2 Components

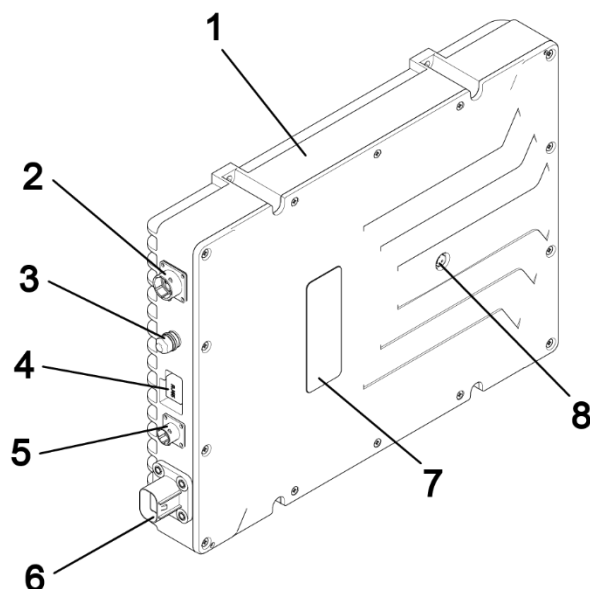


Figure. 4 Components of the Wireless Primary Box

|   |                        |   |                        |
|---|------------------------|---|------------------------|
| 1 | WPB                    | 5 | WPP Signal Connector   |
| 2 | AC Power Connector     | 6 | WPP Power Connector    |
| 3 | Protective Ground Stud | 7 | Status LED Panel       |
| 4 | Ethernet Connector     | 8 | Pressure Release Valve |

### 5.4.3 Status LED Panel

WPB is provided with a Status LED Panel which indicates the system and operating status. On the WPB, the Status LED Panel is on the front cover:

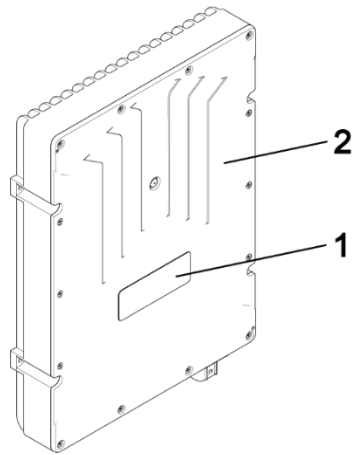


Figure. 5 WPB – Status LED Panel

- |   |                  |
|---|------------------|
| 1 | Status LED panel |
| 2 | Front cover      |



Figure. 6 Status LED Panel on the WPB

| Name                                                                                | Color  | Signal | Description                                                                                |
|-------------------------------------------------------------------------------------|--------|--------|--------------------------------------------------------------------------------------------|
| Power                                                                               |        |        |                                                                                            |
|    | Green  | ON     | AC input power supplied.                                                                   |
| WPB/WPP Fault                                                                       |        |        |                                                                                            |
|    | Red    | ON     | WPB and/or WPP Fault active or latched.                                                    |
| Positioning                                                                         |        |        |                                                                                            |
|  | Green  | ON     | WPP and WSP positioned within design tolerance                                             |
|                                                                                     | Green  | Flash  | WPP and WSP positioned suboptimal; charge can start but may not complete.                  |
|                                                                                     | Yellow | ON     | WPP and WSP positioned Too Close                                                           |
|                                                                                     | Yellow | Flash  | WPP and WSP positioned Too Far                                                             |
| WSP/WSB Fault                                                                       |        |        |                                                                                            |
|  | Red    | ON     | WSP and/or WSB Fault active or latched.                                                    |
| Charging Status                                                                     |        |        |                                                                                            |
|  | Green  | ON     | Battery fully charged. Charger is still occupied by battery/charger.                       |
|                                                                                     |        | Flash  | Battery charging                                                                           |
|                                                                                     |        | OFF    | Battery is not charging or it is already fully charged e.g. battery disconnected or fault. |

Table 1 WPB – LED indications

## 5.4.4 AC Input

### 5.4.4.1 Field Wiring Terminals

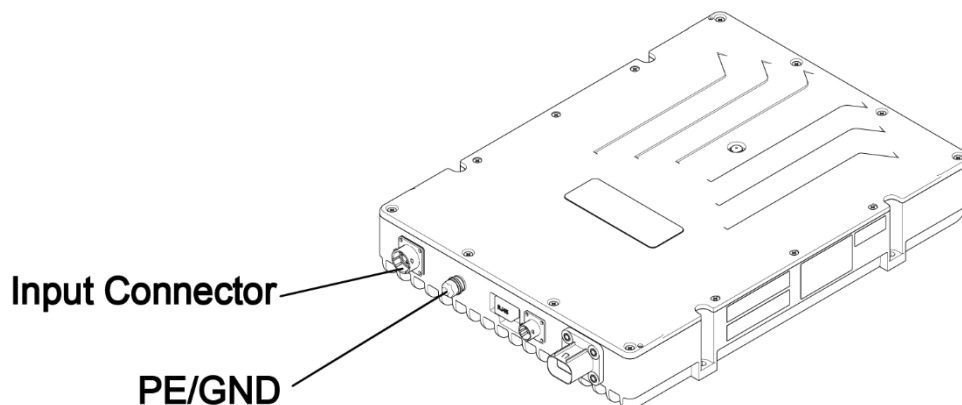


Figure. 7 Field wiring terminals on WPB

### 5.4.4.2 Earthing System

The WPB requires a 1-phase AC input connection in order to provide power to the other system components.

Earthing Systems supported are TN-C, TN-S, TN-C-S, TT with grounded star points.

### 5.4.4.3 AC Input Connector

The WPB has an AC bulkhead connector located on the bottom of the enclosure.

Amphenol 10-729648-Z3P is used, and the mating connector is Amphenol 10-729647-Z3S or similar. The pin-out is as follows:

| Connector                                                                           | Signal                |
|-------------------------------------------------------------------------------------|-----------------------|
| 1                                                                                   | Neutral (N)           |
| 2                                                                                   | Live (L)              |
|  | Protective Earth (PE) |

Table 2 WPB – AC Input connector

**NOTE:** AC input connector shall not be accessible to end user in the final installation.

A separate ground bonding stud is available, see

## 5.4.5 Ethernet Service Interface

WPB has an Ethernet service interface located on the bottom of the enclosure. The interface has a physical RJ45 socket configured with 100BASE-TX (Fast Ethernet) as per IEEE 802.3u. The Ethernet service interface can be used for system monitoring and control. For more information refer 3.5.2 WPB – Ethernet.

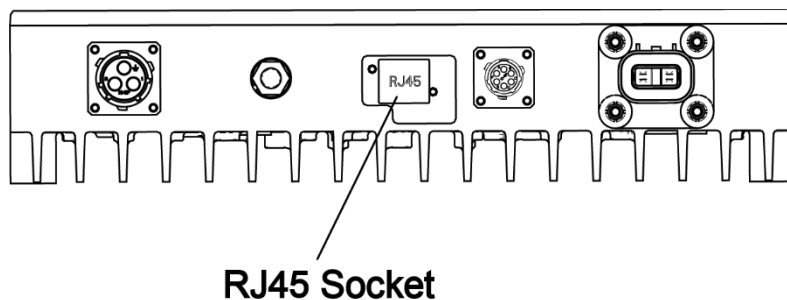


Figure. 8 Ethernet Service Interface

|                   |                                                                                                                                                                                                                                                                |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ATTENTION:</b> | <ul style="list-style-type: none"> <li>Ethernet service interface must be used by qualified skilled person during the service and should be disconnected once the service is done.</li> <li>The ethernet service cable length is restricted to 3 m.</li> </ul> |
|                   |                                                                                                                                                                                                                                                                |

## 5.4.6 Connectors for WPP cables

Following are the connector interfaces of WPB to WPP:

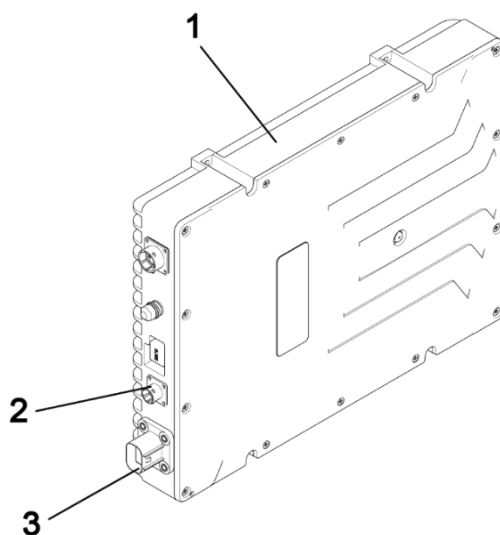


Figure. 9 WPB Interface Components

|   |                                             |
|---|---------------------------------------------|
| 1 | WPB                                         |
| 2 | WPB signal socket for signal cable from WPP |
| 3 | WPB power socket for power cable from WPP   |

**NOTE:** WPB signal socket shall not be accessible to end user in the final installation.

## 5.4.7 Technical Specification

| Description                                  | Value                                    |
|----------------------------------------------|------------------------------------------|
| Dimensions (H x W x D)                       | 420 x 310 x 68 mm (16.5 x 12.2 x 2.7 in) |
| Weight                                       | 8.3 kg (18.95 lbs) without AC cable      |
| Ingress protection classes                   | IP65                                     |
| Cooling                                      | Natural convection                       |
| Ambient temperature (operating)              | -40 to +40 °C (-40 to 104 °F)            |
| Ambient relative humidity (operating)        | 4 to 100% non-condensing                 |
| Maximum operating altitude                   | 3000 m (9842 ft) above sea level         |
| Shock and Vibration (operating)              | EN IEC 60721-3-3:2018, Class 3M11        |
| Shock and Vibration (transport and handling) | EN IEC 60721-3-2:2018, Class 2M4         |
| Storage temperature                          | -45 to +70 °C (-49 to 158 °F)            |

Table 3 Specifications WPB – Mechanical

|                                                                             | EU / UK                                                                                                                               | US / Canada                                        |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| AC Rated Input rated Voltage                                                | 230 V <sub>AC</sub> L-N<br>200 to 240 VAC, 1PH<br> | 208 V <sub>AC</sub> / 240 V <sub>AC</sub><br>L1-L2 |
| AC Input voltage range                                                      | 180 to 264 V                                                                                                                          |                                                    |
| AC Input frequency                                                          | 47 to 63 Hz                                                                                                                           |                                                    |
| Maximum AC input current                                                    | 16 A                                                                                                                                  |                                                    |
| External Fuse / Circuit Breaker *                                           | 16 A, 2-pole                                                                                                                          | 20 A, 2-pole or fuse in each line                  |
| Minimum conductor size (for mechanically protected/unprotected power cords) | 2.5 mm <sup>2</sup>                                                                                                                   | 12 AWG                                             |
| Input power                                                                 | 3.7 kVA                                                                                                                               |                                                    |
| Power factor                                                                | > 0.99                                                                                                                                |                                                    |
| Peak efficiency                                                             | > 92%                                                                                                                                 |                                                    |

Table 4 Specifications WPB – AC Input

\* **NOTE:** Externally connected to the WPB by skilled person. Only IEC and UL approved fuse or circuit breaker are allowed to use, voltage rating shall be equal or higher than 240 V<sub>AC</sub>, and tripping characteristic B is recommended.

## 5.5 Wireless Primary Pad (WPP)

### 5.5.1 Overview

The WPP is fed by the WPB with a medium voltage (MV) AC supply and transfers it to the WSP via magnetic field. The WPP supplies the WSP with up to 3.3 kW wireless power. The WPP further communicates its operating limits to the WPB. WPP also enables communication to the WSP via PPL, refer [8.7.1 WPP & WSP Interface – Pad-to-Pad Link \(PPL\)](#), p. 59. The status of the WPP can be monitored using the Status LED panel.

### 5.5.2 Components

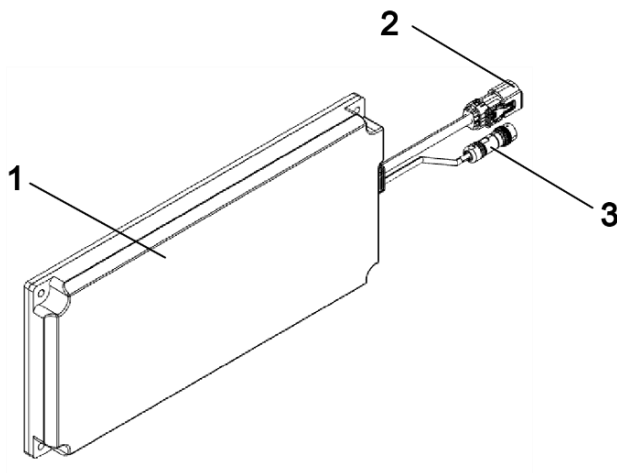


Figure. 10 Figure 1 WPP – Components

|   |                         |
|---|-------------------------|
| 1 | WPP                     |
| 2 | WPP power cable to WPB  |
| 3 | WPP signal cable to WPB |

**NOTE:** The connectors of power and signal connector must not be accessible to the end user in the final installation.

### 5.5.3 Technical Specification

|                                              |                                                                                                                                                           |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dimensions (H x W x D)                       | 230 x 515 x 44 mm (9.1 x 20.3 x 1.7 in)                                                                                                                   |
| Weight                                       | 9.5 kg (20.94 lbs) with 2 m cables                                                                                                                        |
| Cable Length                                 | 2.0 m (78.7 in)                                                                                                                                           |
| Ingress protection classes                   | IP65                                                                                                                                                      |
| Cooling                                      | Natural convection                                                                                                                                        |
| Ambient temperature (operating)              | -40 to +40 °C (-40 to 104 °F)                                                                                                                             |
| Ambient relative humidity (operating)        | 4 % to 100 % non-condensing                                                                                                                               |
| Maximum operating altitude                   | 3000 m (9842 ft) above sea level                                                                                                                          |
| Shock and Vibration (operating)              | EN IEC 60721-3-3:2018, Class 3M11                                                                                                                         |
| Shock and Vibration (transport and handling) | EN IEC 60721-3-2:2018, Class 2M4                                                                                                                          |
| Impact resistance                            | IEC 62262 Code IK07: 2 J<br>WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information. |
| Storage temperature                          | -45 to +70 °C (-49 to 158 °F)                                                                                                                             |

Table 5 Specifications WPP – Mechanical

## 5.6 Wireless Secondary Box (WSB)

### 5.6.1 Overview

The WSB receives AC voltage from the WSP which is rectified to DC voltage which is used to charge the battery. WSB can communicate with the vehicle via Digital I/O or CANopen®. The WSB is provided with over voltage protection, over current protection, reverse polarity protection, short circuit protection and over temperature protection.

### 5.6.2 Components

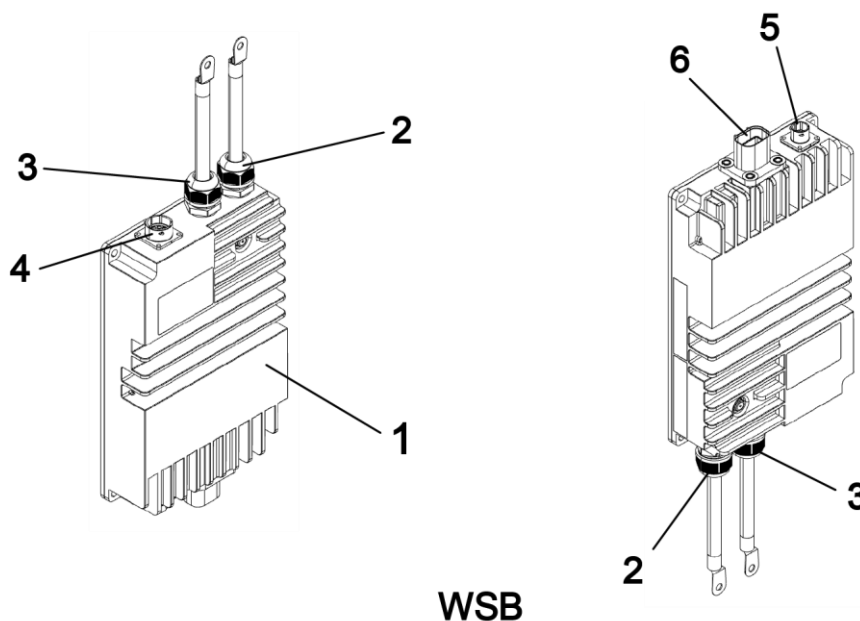


Figure. 11 WSB – Components

|   |                                                |
|---|------------------------------------------------|
| 1 | WSB                                            |
| 2 | DC output +ve cable                            |
| 3 | DC output -ve cable                            |
| 4 | User interface connector                       |
| 5 | WSB signal connector for signal cable from WSP |
| 6 | WSB power connector for power cable from WSP   |

NOTE: User interface connector and WSB signal connector must not be accessible to the end user in the final installation.

### 5.6.3 User Interface

The WSB has an external signal connector for connections to the vehicle, with Digital I/O, CANopen® communications and temperature probe interfaces.

The connector is RT001412PN03 from manufacture Amphenol and a suitable mating cable connector is RT061412SNH03 equivalent.

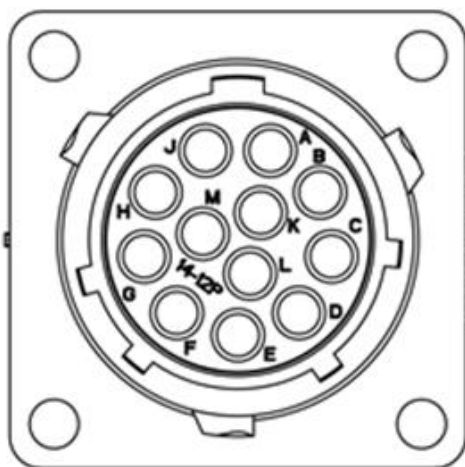


Figure. 12 WSB – signal connector

WSB Signal Connector

Table. 1 WSB Signal Connector Pinout

| Pin | Signal     | Function                                                   |
|-----|------------|------------------------------------------------------------|
| A   | SGND_CAN   | Reference of CAN                                           |
| B   | CAN_OUT_H  | BMS Vehicle CAN/ 2nd WSB                                   |
| C   | CAN_OUT_L  | BMS Vehicle CAN/ 2nd WSB                                   |
| D   | CAN_TERM   | Selection of internal terminal resistor                    |
| E   | CAN_IN_H   | BMS Vehicle CAN                                            |
| F   | CAN_IN_L   | BMS Vehicle CAN                                            |
| G   | COMPLETE   | Digital output indicates charge complete and WCS fault     |
| H   | EXT_GND    | Reference of signal COMPLETE & EXT_ENABLE & SLEEP          |
| J   | SLEEP      | Digital input for WSU sleep mode                           |
| K   | EXT_ENABLE | Digital input for enabling charger in ICP or IMP mode      |
| L   | NTC_BAT    | Battery NTC signal, shall be connected to minus of Battery |
| M   | NTC_RTN    | Reference of battery NTC signal                            |

#### 5.6.3.1 Auxiliary Input Power

The WSB derives its power from the DC Output connection, (i.e. the battery voltage) therefore in normal operation the WSB needs to be able to see a positive voltage on the DC Output to power on. This is required to be able to establish communications with the WPP for a charge cycle to commence and for the vehicle to acquire data from the WSB for system monitoring.

### 5.6.3.2 CANopen® Interface

The WSB has a CAN bus interface that can be used for monitoring the system and also for the vehicle to control the WCS.

The CAN bus communications interface is compliant to ISO 11898-1 and 11898-2. It provides both a CAN IN and a CAN OUT interface for flexibility of the wiring configuration within the vehicle. The WSB includes an optional CAN bus termination, which can be achieved using a wire loop in the customer cable assembly if desired. To add the internal terminal resistor 120 Ohm between CAN\_L and CAN\_H, CAN\_TERM (pin D) shall be connected to CAN\_IN\_L (pin F) or CAN\_OUT\_L (pin C).

See section [8.6.1 “External Commanded CANopen®”, p. 55](#) for details on CANopen® Control Mode and section [8.7.3 “WSB – CANopen®”, p. 90](#) for details on CANopen® Communications.

### 5.6.3.3 Digital Input - Charge Enable

The WSB has a charger enable digital signal input, that can be used for starting charging in IMP or ICP mode (in other modes, the signal will be neglected, thus could be left unconnected). When the mobile application needs to start charging in IMP or ICP mode, it needs to give a high voltage level (2.7 to 5.5 V) for the charge enable signal to enable the charger; when the mobile application needs to stop charging in IMP or ICP mode, it needs to give a low voltage level (<0.3 V) for charge enable signal to disable the charger.

### 5.6.3.4 Digital Input – Sleep

The WSB has a sleep mode enable signal input, that can be used for enabling WSU sleep mode to reduce the current the WSB draws from the battery when the WSB is not in use. When the mobile application wants the charger to go to sleep mode, it needs to provide a high voltage level (2.7 to 5.5 V) for the sleep enable signal to enable the WSU sleep mode; when the mobile application needs to wake up the charger from WSU sleep mode, it needs to give a low voltage level (<0.3 V) to disable the WSU sleep mode. The use of sleep mode is optional, and if not required this pin can be left unconnected.

**NOTE:** When sleep signal is disabled, WSU power loss is 3 W maximum; when sleep signal is enabled, WSU power loss is 0.2 W maximum.

### 5.6.3.5 Digital Output – Charge Complete / Fault

The WSB has a digital output pin to indicate the charge complete and fault. The pull-up resistor is required at the vehicle side if this digital output pin is used. Typical pull-up resistance is listed as below for typical pull-up voltage.

| Pull-up voltage for digital output pin | Pull-up resistance required |
|----------------------------------------|-----------------------------|
| 3.3V                                   | 600 $\Omega$ minimum        |
| 5V                                     | 850 $\Omega$ minimum        |
| 12V                                    | 2k $\Omega$ minimum         |
| 24V                                    | 4k $\Omega$ minimum         |

Due to charge complete and fault function is combined on one pin, below table shows the different status of the pin indicates different charger status:

| Voltage level at digital output pin | WCS status indication   |
|-------------------------------------|-------------------------|
| High level                          | Charge complete         |
| PWM                                 | Fault indication        |
| Low level                           | Idle or during charging |

**Note:** High level and high level of PWM voltage depends on mobile application system pull-up voltage level, low level voltage shall be lower than 0.3V.

## 5.6.4 Technical Specification

|                                              |                                                                                                                                                                |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dimensions (H x W x D)                       | 254 x 165 x 51 mm (10.0 x 6.5 x 2.0 in)                                                                                                                        |
| Weight                                       | 3.4 kg (7.5 lbs) with 1 m cables                                                                                                                               |
| Ingress protection classes                   | IP65                                                                                                                                                           |
| Cooling                                      | Natural convection                                                                                                                                             |
| Ambient temperature (operating)              | -40 ° to +70 °C (-40 to 158 °F)                                                                                                                                |
| Ambient relative humidity (operating)        | 4 to 100% non-condensing                                                                                                                                       |
| Maximum operating altitude                   | 3000 m (9842 ft) above sea level                                                                                                                               |
| Shock and Vibration (operating)              | Random vibrations (EN 60068-2-38:2008)<br>Shock test 15 g (EN 60068-2-27:2009)<br>Shock test 25 g (EN 60068-2-27:2009)<br>Shock test 30 g (EN 60068-2-27:2009) |
| Shock and Vibration (transport and handling) | EN IEC 60721-3-2:2018, Class 2M4                                                                                                                               |
| Impact resistance                            | IEC 62262 Code IK07: 2 J<br>WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information.      |
| Storage temperature                          | -45 to +70 °C (-49 to 158 °F)                                                                                                                                  |

Table 6 WSB – Specification – Mechanical

|                                 |                                                                                                         |
|---------------------------------|---------------------------------------------------------------------------------------------------------|
| Maximum output power            | 3.3 kW                                                                                                  |
| Output protection               | over voltage<br>over current<br>over temperature<br>short circuit<br>open circuit<br>reverse connection |
| Length of RED (+) power cable   | 1 m (39.4 in)                                                                                           |
| Length of BLACK (-) power cable |                                                                                                         |
| Ring Terminal                   | 10 mm M10 stud                                                                                          |
| <b>Nominal output voltage</b>   | <b>25V</b> <b>37.5V</b> <b>50V</b>                                                                      |
| Output voltage range            | 12 to 33 V <sub>DC</sub> 18 to 49.5 V <sub>DC</sub> 24 to 66 V <sub>DC</sub>                            |
| Maximum charge current).        | 132 A      88 A      66 A                                                                               |

Table 7 WSB – Specifications - Mechanical

## 5.7 Wireless Secondary Pad (WSP)

### 5.7.1 Overview

The WSP receives the wireless power transfer from the WPP. The received magnetic field is converted to AC voltage which is then supplied to the WSB. WSP communicates with WPP using PPL, and with WSB via cable.

### 5.7.2 Components

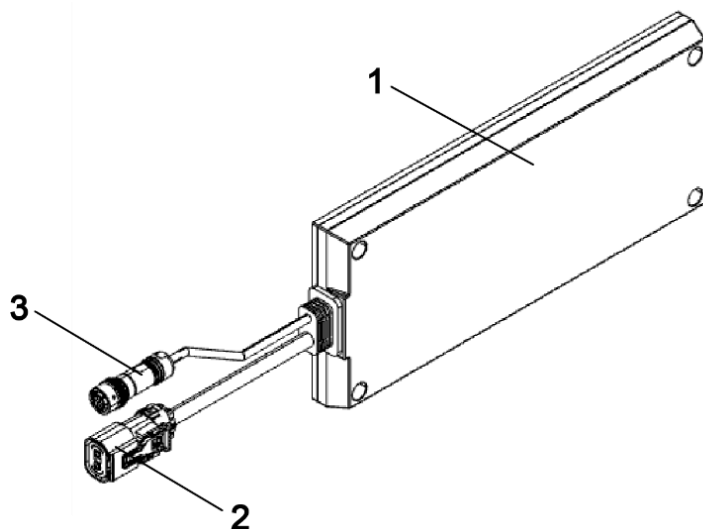


Figure. 13 WSP - Components

|   |                         |
|---|-------------------------|
| 1 | WSP                     |
| 2 | WSP power cable to WSB  |
| 3 | WSP signal cable to WSB |

**NOTE:** WSP power connector and WSP signal connector shall not be accessible to end user in the final installation.

### 5.7.3 Technical Specification

|                                              |                                                                                                                                                                |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dimensions (H x W x D)                       | 150 x 360 x 32 mm (5.9 x 14.2 x 1.3 in)                                                                                                                        |
| Weight                                       | 3.4 kg (7.5 lbs) with 1 m cables                                                                                                                               |
| Ingress protection classes                   | IP65                                                                                                                                                           |
| Cooling                                      | Natural convection                                                                                                                                             |
| Ambient temperature (operating)              | -40 to +70 °C (-40 to +158 °F)                                                                                                                                 |
| Ambient relative humidity (operating)        | 4 % to 100 % non-condensing                                                                                                                                    |
| Maximum operating altitude                   | 3000 m (9842 ft) above sea level                                                                                                                               |
| Shock and Vibration (operating)              | Random vibrations (EN 60068-2-38:2008)<br>Shock test 15 g (EN 60068-2-27:2009)<br>Shock test 25 g (EN 60068-2-27:2009)<br>Shock test 30 g (EN 60068-2-27:2009) |
| Shock and Vibration (transport and handling) | EN IEC 60721-3-2:2018, Class 2M4                                                                                                                               |
| Impact resistance                            | IEC 62262 Code IK07: 2 J<br>WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information.      |
| Storage temperature                          | -45 to +70 °C (-49 to +158 °F)                                                                                                                                 |

Table 8 WSP – Specification – Mechanical

## 6 Safety & Regulations

### 6.1 Levels of Warning Messages

The Danger, Warnings, Cautions, Attention and Note in this publication highlight the areas of concern to installation/maintenance personnel or operator. The definition of Danger, Warning, Caution, Attention and Notice as utilized throughout this publication are as follows:

#### **DANGER:**

Indicates a hazard which is an immediate threat. If not avoided, will result in serious injury or death. Strictly adhere to all Dangers.

#### **WARNING:**

Indicates a hazard which is a possible threat. If not avoided, may result in serious injury or death. Strictly adhere to all Warnings.

#### **CAUTION:**

Indicates a hazard which is a possible threat. If not avoided, may result in minor injury. Strictly adhere to all Cautions.

#### **ATTENTION:**

Indicates an operation, sequence, or function which, if not observed, may cause damage/malfunction of equipment or to surrounding objects.

#### **Note:**

Provides explanatory information/clarification not readily apparent in the text or illustrations of a procedure.

### 6.2 Warning & Other Signs

Wherever required the following labels are also marked with warning signs to indicate the type of hazard.

| Symbol                                                                              | Description            |
|-------------------------------------------------------------------------------------|------------------------|
|  | Risk of Electric shock |
|  | Hot surface            |
|  | General warning        |

| Symbol                                                                            | Description                 |
|-----------------------------------------------------------------------------------|-----------------------------|
|  | Electromagnetic field (EMF) |

Other signs are also used within the document.

|                                                                                   |                       |
|-----------------------------------------------------------------------------------|-----------------------|
|  | Ground (GND)          |
|  | Attention/Informative |
|  | Refer to manual       |

## 6.3 Labels

|                                                                                   |                               |                        |
|-----------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WPB STD 3300W 1AC FW:PFC=2.2/IPT=2.2/ETH=3.1                       |                               | Protection class: IP65 |
| P/N (料号): EOE16010870 REV (版本): P2                                                |                               | Made in SLOVAKIA       |
| Input (输入): 200-240V~; 16A; 50/60Hz                                               |                               | 斯洛伐克制造                 |
| Output (输出): 800V~; 16A; 79-90kHz Date: YYWW S/N: ZZZZZZ                          |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany     |                               |                        |

|                                                                                   |                               |                        |
|-----------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WSB STD 3300W 48V FW=3.1                                           |                               | Protection class: IP65 |
| P/N (料号): EOE16010871 REV (版本): P2                                                |                               | Made in SLOVAKIA       |
| Input (输入): 400V~; 13A; 79-90kHz                                                  |                               | 斯洛伐克制造                 |
| Output (输出): 50V=; 66A max Date: YYWW S/N: ZZZZZZ                                 |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany     |                               |                        |

|                                                                                   |                               |                        |
|-----------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WPP STD 3300W FW=2.2                                               |                               | Protection class: IP65 |
| P/N (料号): EOE16010952 REV (版本): P2                                                |                               | Made in SLOVAKIA       |
| Input (输入): 800V~; 16A; 79-90kHz                                                  |                               | 斯洛伐克制造                 |
| Date: YYWW S/N: ZZZZZZ                                                            |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany     |                               |                        |

|                                                                                   |                               |                        |
|-----------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WSP STD 3300W FW=2.2                                               |                               | Protection class: IP65 |
| P/N (料号): EOE16010953 REV (版本): P2                                                |                               | Made in SLOVAKIA       |
| Input (输入): 400V~; 13A; 79-90kHz                                                  |                               | 斯洛伐克制造                 |
| Date: YYWW S/N: ZZZZZZ                                                            |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany     |                               |                        |

|                                                                                     |                               |                        |
|-------------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WSB STD 3300W 36V FW=3.1                                             |                               | Protection class: IP65 |
| P/N (料号): EOE16011066 REV (版本): P2                                                  |                               | Made in SLOVAKIA       |
| Input (输入): 400V~; 13A; 79-90kHz                                                    |                               | 斯洛伐克制造                 |
| Output (输出): 37.5V=; 88A max Date: YYWW S/N: ZZZZZZ                                 |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany       |                               |                        |

|                                                                                     |                               |                        |
|-------------------------------------------------------------------------------------|-------------------------------|------------------------|
|  | Switching power supply (开关电源) | Engineering Sample     |
| Model (型号): CS WSB STD 3300W 24V FW=3.1                                             |                               | Protection class: IP65 |
| P/N (料号): EOE16011067 REV (版本): P2                                                  |                               | Made in SLOVAKIA       |
| Input (输入): 400V~; 13A; 79-90kHz                                                    |                               | 斯洛伐克制造                 |
| Output (输出): 25V=; 132A max Date: YYWW S/N: ZZZZZZ                                  |                               |                        |
| Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany       |                               |                        |



IC: 27805-WPU3300W  
CAN RSS-216 (A) / CNR-216 (A)  
FCC ID: 2AVWKWPU3300W



IC: 27805-WSU3300W  
CAN RSS-216 (A) / CNR-216 (A)  
FCC ID: 2AVWKWSU3300W

Figure. 14 Labels of Specification

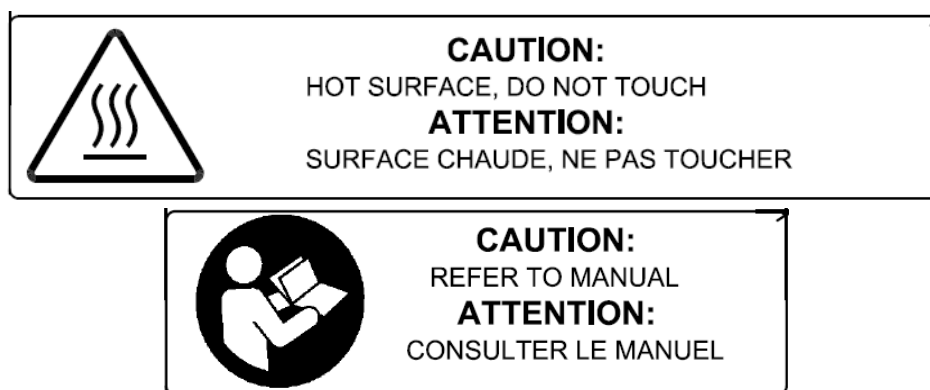


Figure. 15 Labels of Warning

## 6.4 General Safety Instructions

During handling the system/equipment, following danger, warnings, cautions and notes must be observed.

|                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>DANGER:</b></p>     | <p><b>Electric shock</b></p> <ul style="list-style-type: none"> <li>Isolate upstream breaker connected to WPB.</li> <li>Do not open the WCS subsystems during charging as it may lead to death of Personnel.</li> <li>Do not open the WCS subsystems when WPB connected to mains, and WSU connected to battery.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p><b>DANGER:</b></p>     | <ul style="list-style-type: none"> <li>Make sure to install WPP and WSP vertically.</li> <li>Make sure that both the pads are free from foreign objects to avoid overheat while charging is in progress. Clean the pads as and when needed to avoid danger.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>DANGER:</b></p>     | <p>This equipment is not suitable for use in locations where children are likely to be present</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>WARNING:</b></p>  | <p><b>Electromagnetic Field (EMF)</b></p> <ul style="list-style-type: none"> <li>The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produce a potentially harmful magnetic field during the charging process.</li> <li>Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see <b>6.5 EMF Safety Instructions</b>.</li> </ul> <p>Use of the wireless charger may affect or impair the operation of any medical devices, such as an implantable cardiac pacemaker. Check with your medical device manufacturer concerning the effects that wireless charging may have on such devices before using the wireless charger.</p> <ul style="list-style-type: none"> <li>Electromagnetic field exposure to pregnant women is strictly forbidden.</li> <li>Advise the end user about safety distances and affix appropriate warning labels and/or signs.</li> <li>Warning signs should be clearly displayed at the charging area.</li> <li>Electronic objects such as cell phones and hearing aids may get damaged.</li> </ul> |
| <p><b>WARNING:</b></p>  | <p>Make sure to observe the battery manufacturers safety instructions. If battery manufacturer instructions conflict with charger instructions then, kindly contact both of them for a right solution.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div data-bbox="410 244 587 297" data-label="Section-Header"><b>CAUTION:</b></div> <div data-bbox="430 300 566 414" data-label="Image">  </div>   | <div data-bbox="635 224 804 250" data-label="Section-Header"><b>Hot surfaces</b></div> <ul style="list-style-type: none"> <li>• Do not touch any subsystems of the charging system while charging is in progress.</li> <li>• Do not touch WPP and WSP of the charging system up to 30 minutes (cooling time) after the charging process is finished.</li> <li>• Wear safety gloves while handling the subsystems after charging.</li> </ul>                                                                                                                                                        |
| <div data-bbox="391 622 603 676" data-label="Section-Header"><b>ATTENTION:</b></div> <div data-bbox="435 678 560 799" data-label="Image">  </div> | <div data-bbox="635 504 852 530" data-label="Section-Header"><b>Material damage</b></div> <ul style="list-style-type: none"> <li>• Make sure that the metallic objects do not come in between or in contact with the pads during charging. The magnetic field causes metallic objects to become very hot, and this may lead to damage of the pads surface (WPP and WSP).</li> <li>• Select the installation position of the WPP and WSP accordingly.</li> <li>• All user types of the system must be instructed accordingly.</li> <li>• Make sure the application adhere to the manual.</li> </ul> |

## 6.5 EMF Safety Instructions

These EMF safety instructions are for the following types of users:

- **Vehicle Integrator:** Integrates the Wireless Secondary Unit (WSU, consisting of WSB and WSP) in an application to charge a battery e.g. forklift manufacturer, AGV manufacturer etc.
- **Facility Integrator:** Installs the Wireless Primary Unit (WPU, consisting of WPB and WPP) on the WCS operator's site.
- **WCS operator:** Represents the legal entity that uses the WCS for charging.

### 6.5.1 Responsibility of the Vehicle Integrator

The installation of the WSU must be carried out by skilled persons.

The vehicle integrator must:

- consider the keep-out areas to ensure that an operator is not exposed to the magnetic field.
- implement the warnings and keep-out areas into the user instructions of their application.

### 6.5.2 Responsibility of the Facility Integrator

#### 6.5.2.1 Installation of the WPU

The installation of the WPP must be carried out by skilled persons.

The facility integrator must:

- consider the keep-out areas to ensure that an operator is not exposed to the magnetic field.
- implement the warnings and keep-out areas into the user instructions of their application.

#### 6.5.2.2 Charging Process

Charging must take place in an area where the general public does not have access. A keep-out area is required to inform instructed persons how far they must stay away from the WCS during charging (see [9.3.2 “Safety Keep-out Areas and Safety Markings for the Charging Zone”](#), [p. 102](#)).

### 6.5.2.3 Training of Persons

All individuals who may come into proximity with the WCS due to their professional activities must be aware of the presence of an electromagnetic field (EMF).

It is the responsibility of the employer to provide an appropriate training for their employees.

Every employee has to be trained before they start working in the proximity of the WCS.

Every employee has to be re-trained at least once a year.

#### Trainings content

The training should cover the following topics:

##### 1) The electromagnetic field created by the WCS

Explain how the two electromagnetic fields are generated as given below.

During operation, WPP and WSP generate two types of electromagnetic fields (EMF):

##### *Communication EMF*

One electromagnetic field (EMF) is generated by the wireless communication between WPP and WSP. The communication EMF on the WPP is always present because the WPP constantly searches for a nearby WSP. The WSP generates an EMF only in the event of communication with the WPP.

During communication periods when no power is being transmitted, it is essential that individuals maintain a distance of at least 200 mm (7.87 in) from both pads (WSP and WPP), in all directions from the magnetic center.

##### *Power-transfer EMF*

The other EMF is generated during the charging process when power is transmitted from the WPP to the WSP. This EMF is significantly stronger than the EMF generated by the communication.

For the EMF generated during charging, keep-out areas are defined. See [9.3.2 “Safety Keep-out Areas and Safety Markings for the Charging Zone”, p. 102](#), and the description below.

##### 2) The purpose of the keep-out area

Explain that the keep-out area indicates the boundary where the RF exposure exceeds the limit defined by the safety standards.

##### 3) The meaning and purpose of the warning signs

Explain the warning signs installed at the boundary of the keep-out area: They warn people not to enter this area because of the electromagnetic field.

#### **4) Correct behavior to reduce the risk of RF exposure**

Explain how people should behave correctly: Do not cross the warning signs and stay outside the keep-out area during charging. This will prevent the risk of RF exposure.

## 7 Intended Use

|                                                                                                                                                 |                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div data-bbox="410 237 585 407"> <b>CAUTION:</b><br/>  </div> | <p>Any changes or modifications to the system/equipment which is not approved by the Delta, responsible for compliance could void the user's authority to operate the equipment.</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

The intended purpose of the WCS is defined as follows:

- The system is designed only for use according to the specifications and instructions described in this document by Delta.
- The system is designed for industrial use only.
- The system is designed for the environmental conditions and electrical values provided by Delta.
- The combination of WPB, WPP, WSB, and WSP is designed to transfer energy inductively via an air gap to charge an industrial battery. No other uses are permitted.
- The system is designed to charge Lithium Ion (Li-Ion) and Lead Acid batteries containing a BMS.
- The system is only intended to operate with non-magnetic and non-electrically conductive materials between the WPP and WSP. For example, plastic, wood, glass, and air etc.,
- The WSP is only intended to be covered with a plastic shield if necessary.
- The system is intended for use without an Internet connection only.

The non-intended purpose of WCS is as follows:

- Use of WPP and WSU installed horizontally.
- Use in stand-alone as power supply without battery connected.
- Use with a connection to the public grid.
- Use of WPP and WSP covered with metal sheet or carbon fiber.
- The WCS is not designed for operation under water.
- The WSB is not designed to operate in series setup.
- The WSB is not designed to charge more than one battery at the same time, especially not a series connection of batteries.
- The system is not intended for use with a direct or indirect internet connection.
- Usage going beyond the intended use as described in the document does not constitute proper use. The manufacturer is not liable for damage resulting from improper use; the operator only bears the risk. Intended use also implies that the instructions and rules prescribed by Delta are obeyed.

## 8 Operating Behavior

### 8.1 Output Power and De-rating

#### 8.1.1 Output Operating Area at 24 V Nominal Voltage

Output current and output voltage can be set within the limits as follows:

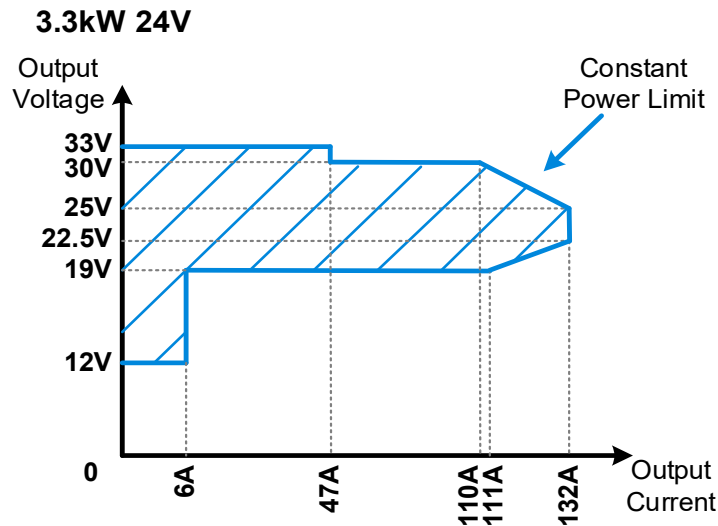


Figure. 16 Output power and current limits with variable voltage at 24 V nominal voltage

Using the 3.3kW WCS, the user can achieve the following results:

- at 12 V the WCS can provide a maximum output of 6 A (72 W)
- at 19 V the WCS can provide a maximum output of 111 A
- at 22.5 to 25 V the WCS can provide a maximum output of 132 A
- above 25 to 30V, the constant power mode starts and user cannot achieve more than 3.3 kW, as the current starts de-rating at 30 to 33 V, maximum current limited to 47 A.

## 8.1.2 Output Operating Area at 36 V Nominal Voltage

Output current and output voltage can be set within the limits as follows:

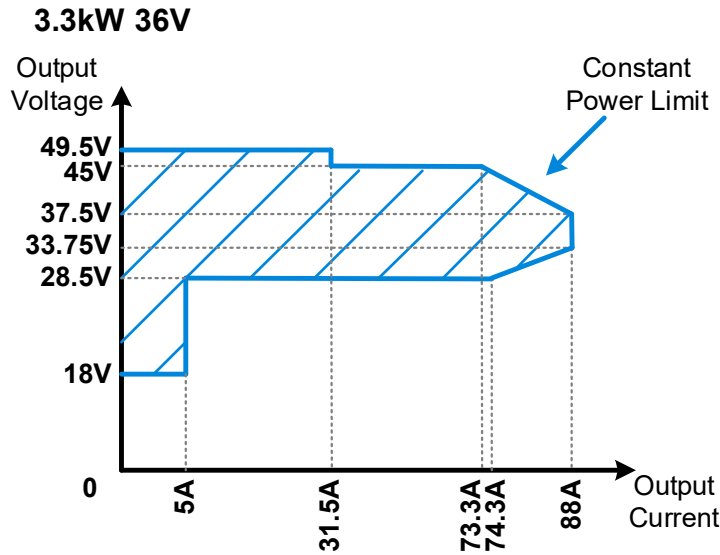


Figure. 17 Output power and current limits with variable voltage at 36 V nominal voltage

Using the 3.3kW WCS, the user can achieve the following results:

- at 18 V the WCS can provide a maximum output of 5 A (90 W)
- at 28.5 V the WCS can provide a maximum output of 74.3 A
- at 33.75 to 37.5 V the WCS can provide a maximum output of 88 A
- above 37.5 to 45 V, the constant power mode starts and user cannot achieve more than 3.3 kW, as the current starts de-rating at 45 to 49.5 V, maximum current limited to 31.5 A.

### 8.1.3 Output Operating Area at 48 V Nominal Voltage

Output current and output voltage can be set within the limits as follows.

#### 3.3kW 48V

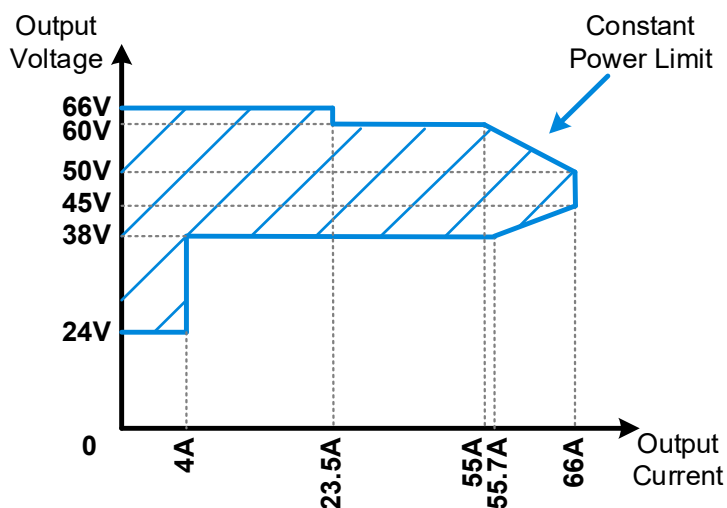


Figure. 18 Output power and current limits with variable voltage at 48 V nominal voltage

Using the 3.3 kW WCS, the user can achieve the following results:

- at 24 V the WCS can provide a maximum output of 4 A (96 W)
- at 38 V the WCS can provide a maximum output of 55.7 A
- at 45 to 50 V the WCS can provide a maximum output of 66 A
- above 50 to 60 V, the constant power mode starts and user cannot achieve more than 3.3 kW, as the current starts de-rating at 60 to 66 V, maximum current limited to 23.5 A.

## 8.2 Power vs. Ambient Temperature

The WPB and WPP can run continuously at full power in an ambient temperature of up to 40 °C. The WSP and WSB can run in cyclic intermittent operation at full power, or in continuous operation with reduced power as shown in the following graph.

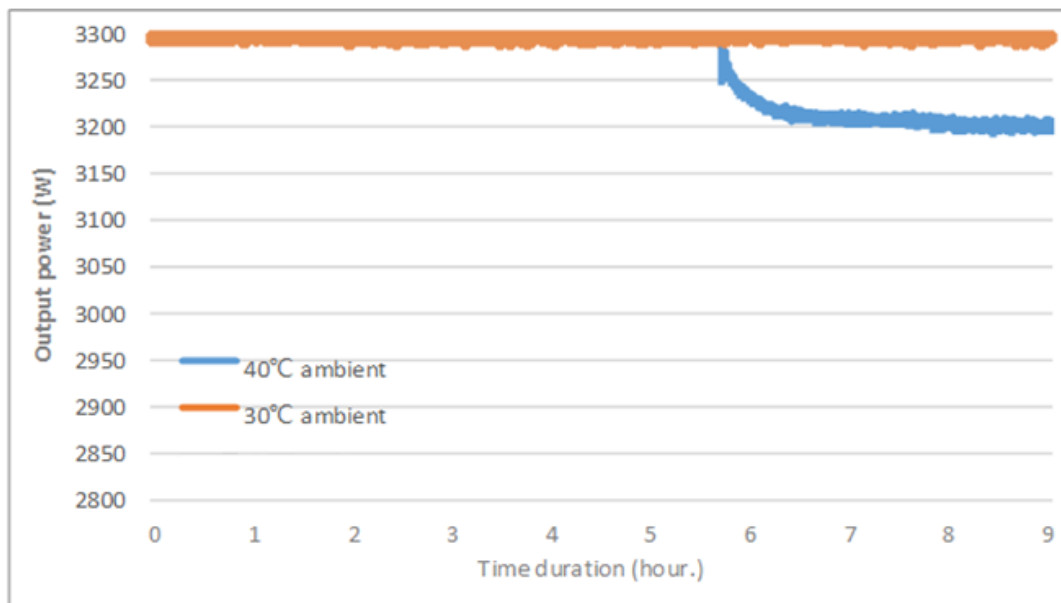


Figure. 19 Power de-rating vs. time at different ambient temperatures - WSP and WSB

At >40 °C (+104 °F): The maximum output power can be provided for up to 330 minutes. After this time, the output power will be reduced and will eventually decrease to approximately 97% of the maximum operating current.

At ambient temperatures above the maximum operating temperatures for WSP and WSB, the output power will decrease further.

The operating temperatures for the WCS subsystems are given in the following table:

| System | Ambient Temperature                                                     |
|--------|-------------------------------------------------------------------------|
| WPB    | -40 to +40° C (-40 to +104 °F)                                          |
| WPP    | -40 to +40 °C (-40 to +104 °F)                                          |
| WSP    | -40 to +70 °C (-40 to +158 °F), output de-rating above +40 °C (+104 °F) |
| WSB    | -40 to +70 °C (-40 to +158 °F), output de-rating above +40 °C (+104 °F) |

### ATTENTION:



When WSP and WSB is not in operation but exposed to direct sunlight then it may get heated up to 80 °C.

### 8.3 Power Vs Input Voltage

As WPB has an input current limitation 16 A, the whole system cannot output full power when the AC grid voltage is under a certain value.

Based on the nominal output voltage and positioning, there are the relationship between the maximum output power and input grid voltage of the system as follows.

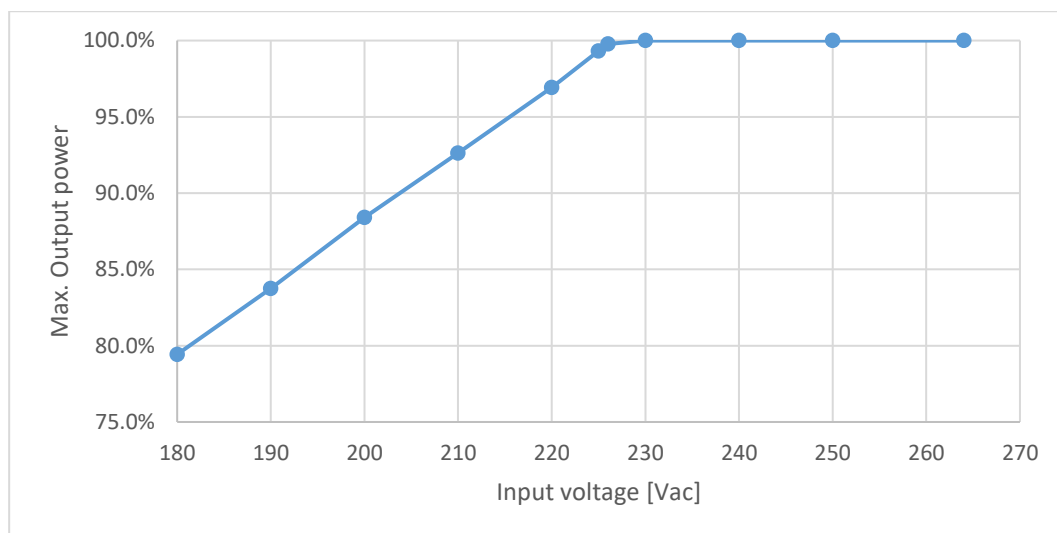


Figure. 20 Maximum output power vs. input grid voltage

At the same way, based on the nominal output voltage and positioning, there are the relationship between the maximum input current and input grid voltage as follows.

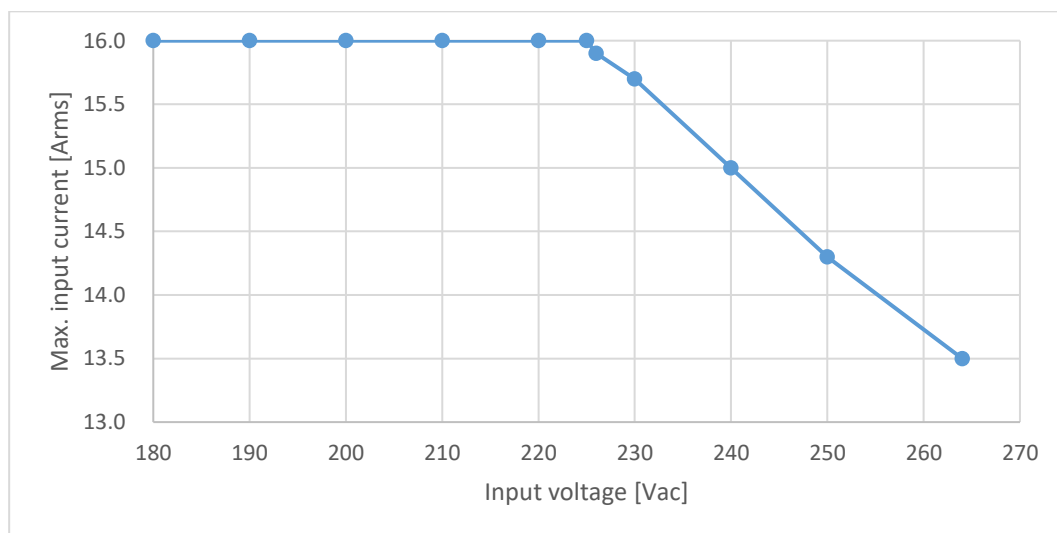


Figure. 21 Maximum input current vs. input grid voltage

## 8.4 WPP & WSP Positioning for Charging

### 8.4.1 Optimal Alignment

The optimal alignment of WPP and WSP with respect to the charging process is defined as follows:

WPP and WSP horizontally and vertically aligned at the center mark.

Nominal distance for air gap at 20 mm (0.8 in).

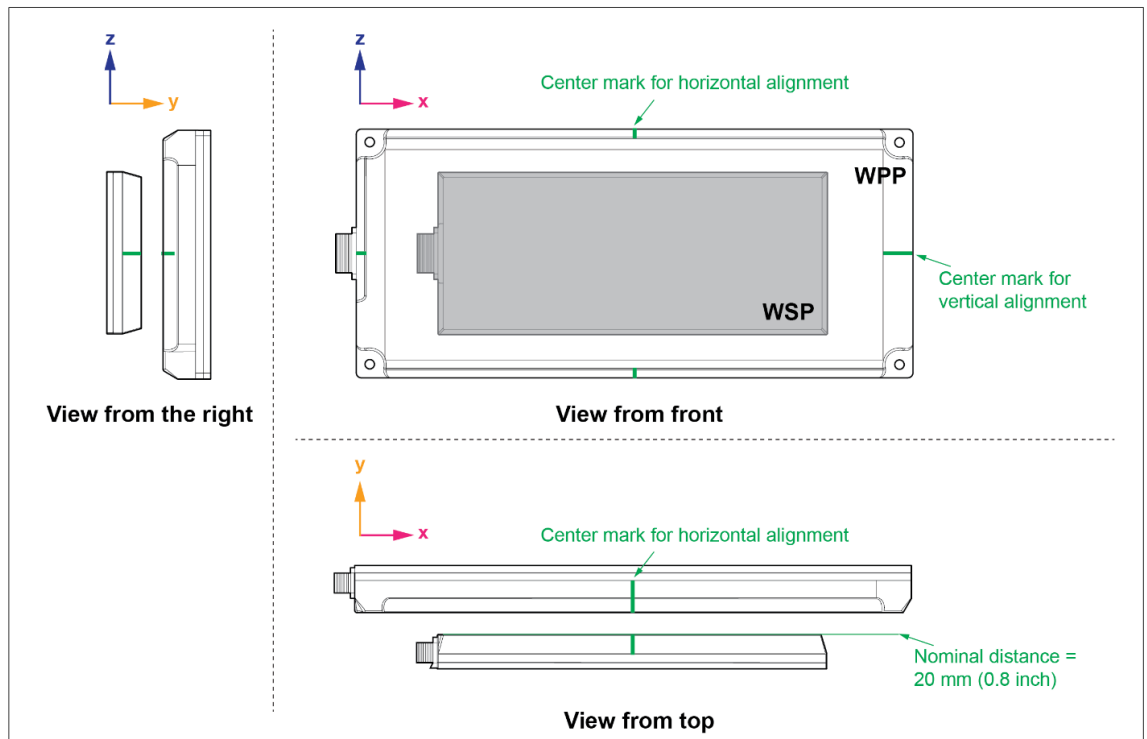


Figure. 22 Optimal alignment and nominal distance for charging

### 8.4.2 Misalignment tolerances for the Air-gap

The air gap is the distance between WPP and WSP in y-direction. The nominal distance for optimal charging is 20 mm (0.8 in). Charging is still possible within an air gap of 10 to 30 mm (0.4 to 1.2 in).

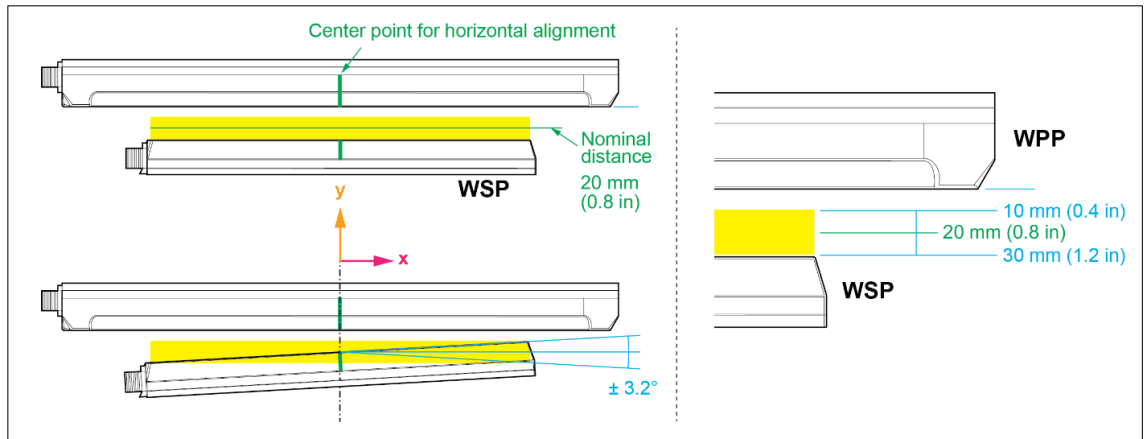


Figure. 23 Maximum misalignment for air gap

### 8.4.3 Horizontal and vertical misalignment tolerances

There are 3 misalignment areas (see figures below) defined in which charging still works.

- 17 mm (0.67 in) in both x-axis and z-axis (**Error! Reference source not found.**)
- 25 mm (0.98 in) in the x-axis and 5 mm (0.2 in) in the z-axis (**Error! Reference source not found.**)
- 5 mm (0.2 in) in the x-axis and 25 mm (0.98 in) in the z-axis (**Error! Reference source not found.**)

The WSP can be rotated within each defined area, provided that its front surface (marked green in the figures below) remains entirely within that area (marked yellow in the figures below).

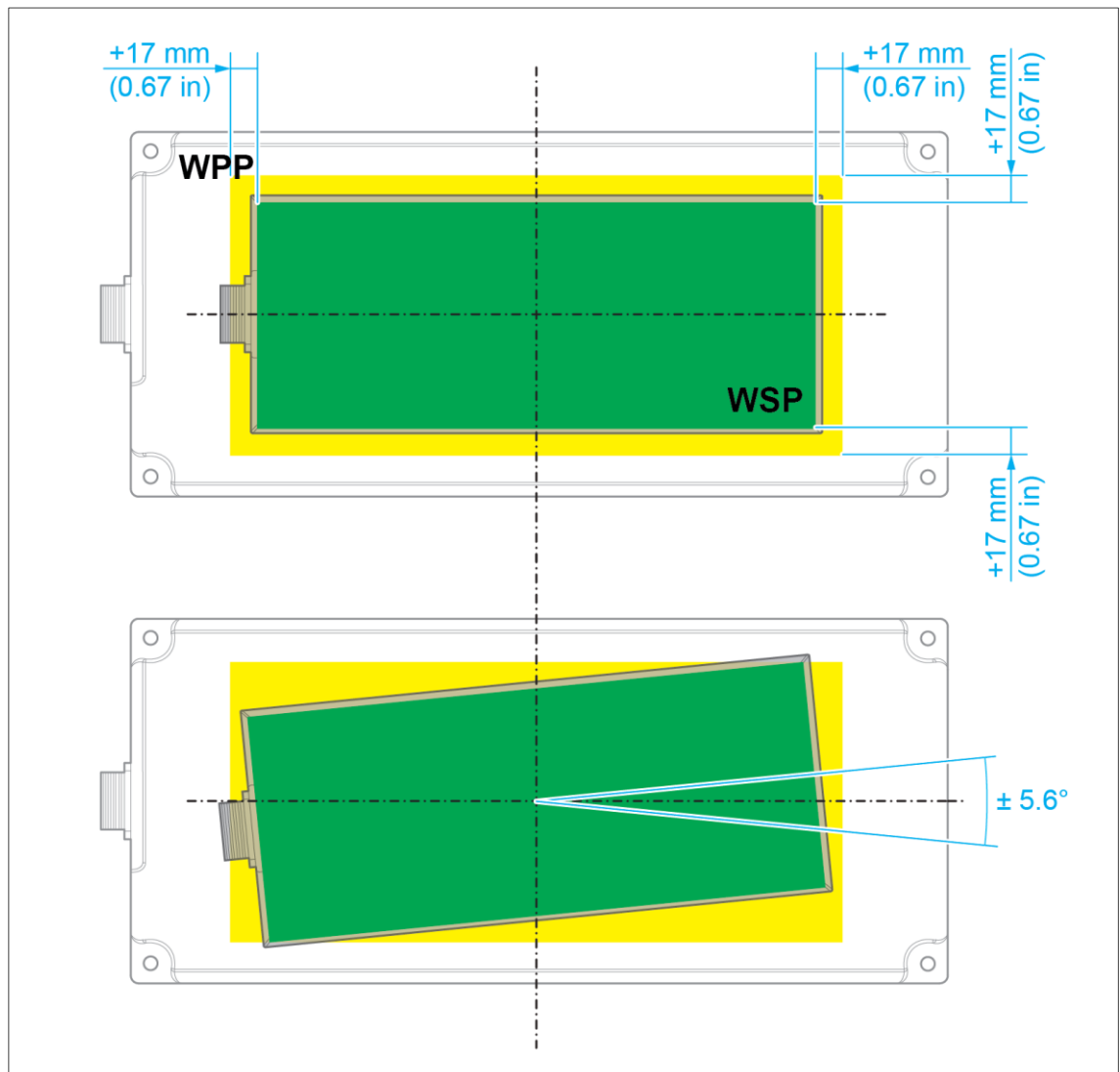


Figure. 24 Misalignment area 1 : 17 x 17 mm (0.67 x 0.67 in)

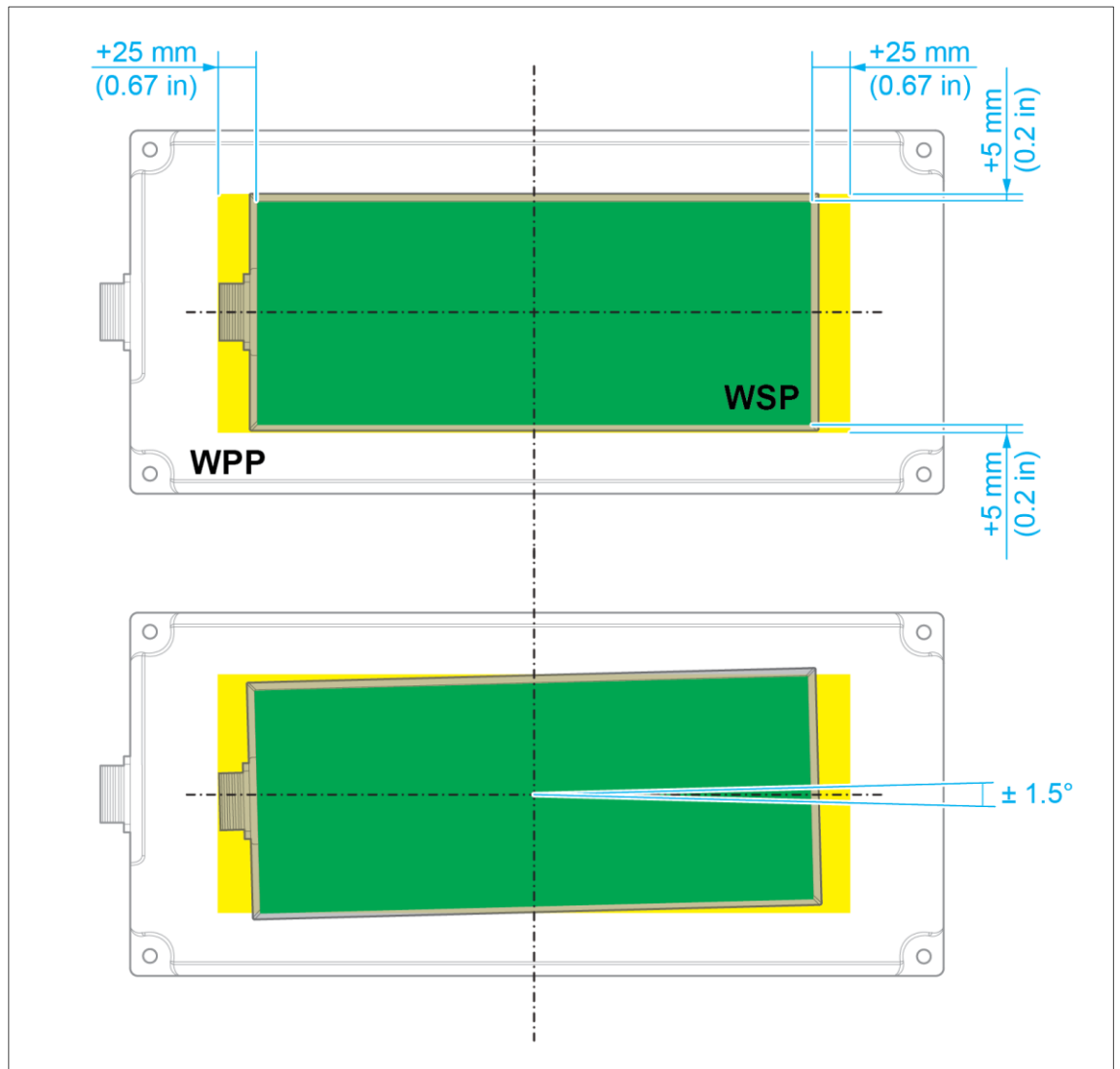


Figure. 25 Misalignment area 2: 25 x 5 mm (0.98 x 0.2 in)

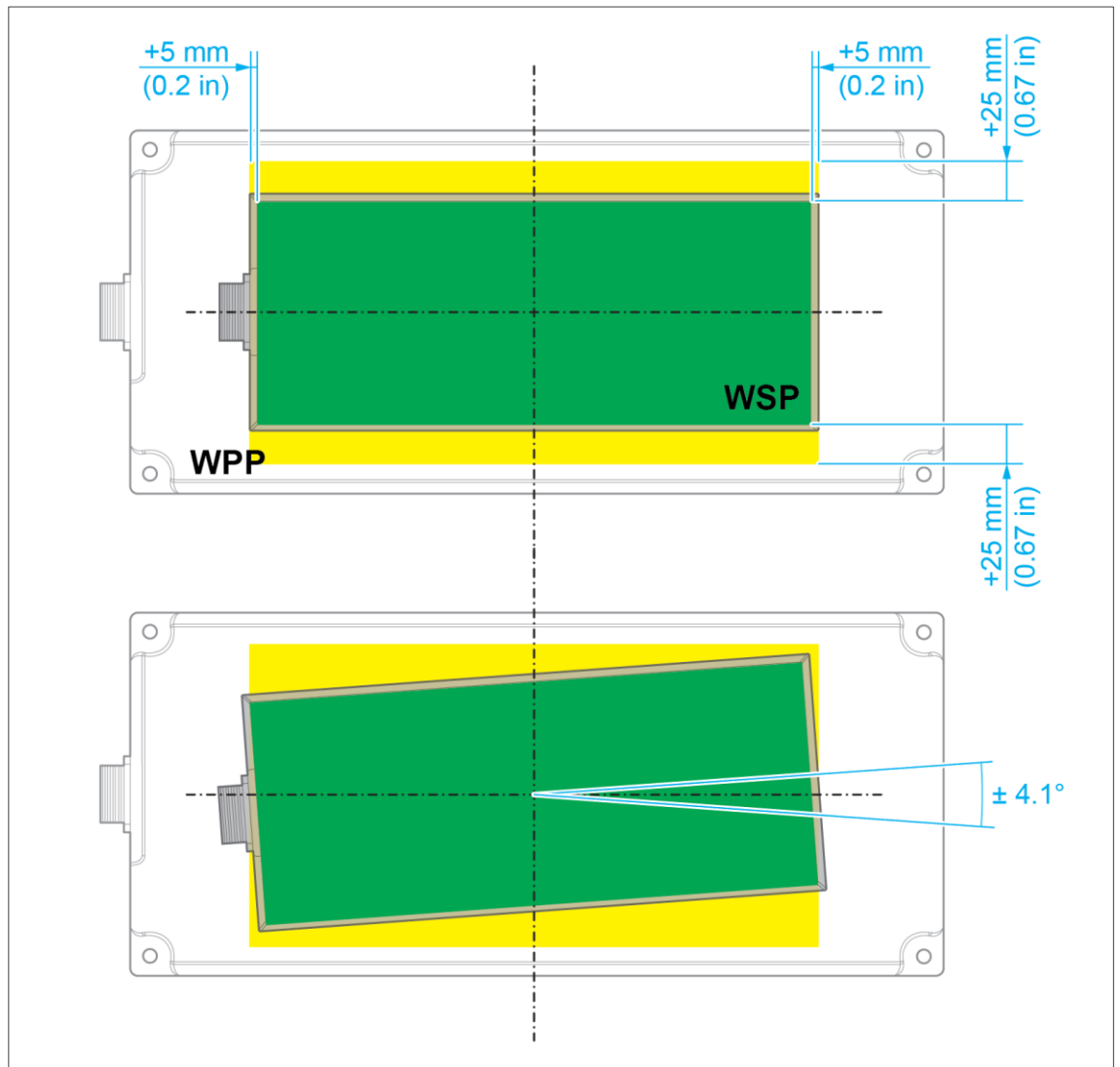


Figure. 26 Misalignment area 3: 5 x 25 mm (0.2 x 0.98 in)

The following figure shows the 3 misalignment areas combined.

**Note:** The WSP must be within the yellow area in order to charge.

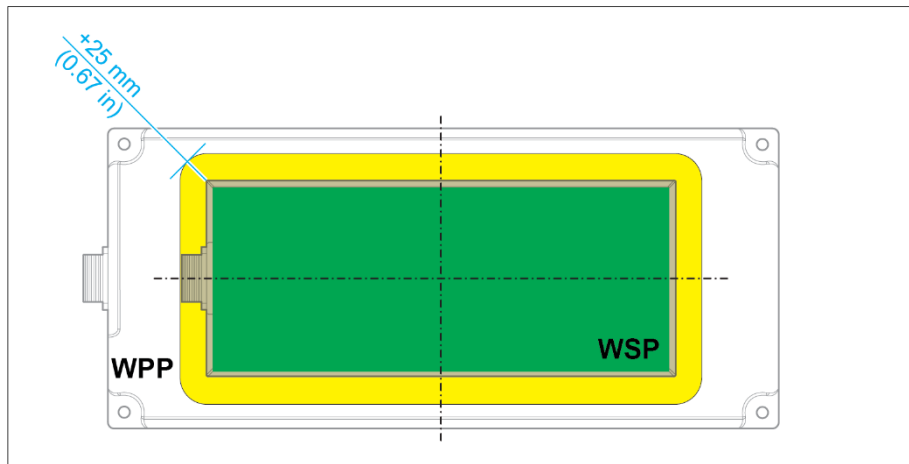


Figure. 27 Combined misalignment areas

#### 8.4.4 Indication and Reporting of Charging Position

The current position between WPP and WSP in comparison to the optimal positioning is displayed on the LED panel and reported via Ethernet and CANopen®.

## 8.5 Efficiency and Losses

### 8.5.1 Efficiency Ratings

Efficiency and losses are measured under best and worst conditions as given below:

**Testing condition:** Efficiency and loss based on 3.3 kW / 24 V.

#### Best Efficiency

Best efficiency at 20 mm air-gap and 0 mm misalignment.

| System | Losses | Efficiency |
|--------|--------|------------|
| WPB    | 148 W  | 95.85%     |
| WPP    | 35 W   | 98.97%     |
| WSP    | 21 W   | 99.38%     |
| WSB    | 72 W   | 97.86%     |
| Total  | 276 W  | 92.26%     |

Table 9 Efficiency and losses at best conditions

#### Worst Efficiency

Worst efficiency at

- 30 mm air-gap and 17 mm misalignment at both axes OR
- 5 mm misalignment at one axes and 25 mm misalignment at the other axis

| System | Loss  | Efficiency |
|--------|-------|------------|
| WPB    | 159 W | 95.61%     |
| WPP    | 83 W  | 97.60%     |
| WSP    | 26 W  | 99.23%     |
| WSB    | 73 W  | 98.82%     |
| Total  | 341 W | 90.60%     |

Table 10 Efficiency and losses at worst conditions

**Note:** Efficiency and losses of 36-V and 48-V WSB/WSP variants are equal or better than of 24-V variant.

**Note:** When there's no WSU or WSP paired with WPP and no charging is happening, the losses of WPB are approximately 7 W at nominal AC input.

## 8.5.2 Factors that Influence Losses

Following table gives information regarding the factors influencing the losses.

When the input voltage raises losses at WPB goes down. Similarly, when the output voltage raises losses at WPB and WPP raises.

| Criteria         | Losses per Subsystem |     |     |     |
|------------------|----------------------|-----|-----|-----|
|                  | WPB                  | WPP | WSP | WSB |
| Input voltage↑   | ↓                    | –   | –   | –   |
| Output voltage ↑ | ↑                    | ↑   | –   | –   |
| Output power ↑   | ↑                    | ↑   | ↑   | ↑   |
| Misalignment ↑   | ↑                    | ↑   | –   | –   |
| Airgap ↑         | ↑                    | ↑   | –   | –   |

## 8.5.3 Temperature of the WPP

As well as the ambient temperature, four other factors can influence the WPP temperature:

- Airgap, misalignment, output power and output voltage.
- Up to 40 °C (104 °F) the WPP can run under all conditions with full power. Above 40°C (104 °F), the air gap and output voltage is limited.

## 8.6 System Control Modes

The WCS can be controlled externally with routine setpoints along with start/stop control, or automatically with only start/stop control being provided externally. In all control modes, an external system must tell the WCS to start or stop the charge process given the needs of the battery and surroundings.

The WCS can be controlled by a variety of means, including:

- Charge setpoints from the vehicle via CANopen®
- Charge setpoints from a Fleet Management System (or similar) via Ethernet
- Internal pre-programmed Multistage Profile (IMP) for Lead Acid Batteries with:
  - Start-Stop via Digital Input on WSB from vehicle
  - Start-Stop via CANopen® command from vehicle
  - Start-Stop via Ethernet command from Management System
- Internal User configurable CC-CV Profile (ICP) for Li-ION Batteries with:
  - Start-Stop via Digital Input on WSB from vehicle
  - Start-Stop via CANopen® command from vehicle
  - Start-Stop via Ethernet command from Management System

The table below summarizes the System Control Modes, the type of battery associated with them:

| Battery Type (Typical)           |                       | Lead Acid                         |                                  |                             | Li-ION                                                 |                                  |                             | Lead Acid or Li-ION                     |                                              |
|----------------------------------|-----------------------|-----------------------------------|----------------------------------|-----------------------------|--------------------------------------------------------|----------------------------------|-----------------------------|-----------------------------------------|----------------------------------------------|
| System Charge Mode               |                       | Internal Multistage Profile (IMP) |                                  |                             | Internal CC-CV Profile (ICP)                           |                                  |                             | External Commanded CAN (ECC)            | External Commanded Ethernet (ECE)            |
| Responsible for Charge Setpoints |                       | Pre-defined by Delta on request   |                                  |                             | Defined by Customer or Pre-defined by Delta on request |                                  |                             | Customer Vehicle                        | Customer Network Node                        |
| Charge Control Method            |                       | Start/Stop via Digital I/O        | Start/Stop via Ethernet (cyclic) | Start/Stop via CAN (cyclic) | Start/Stop via Digital I/O                             | Start/Stop via Ethernet (cyclic) | Start/Stop via CAN (cyclic) | Start/Stop & Setpoints via CAN (cyclic) | Start/Stop & Setpoints via Ethernet (cyclic) |
| WPB - Ethernet                   | Charge Control        | -                                 | Required                         | -                           | -                                                      | Required                         | -                           | -                                       | Required                                     |
|                                  | Data Acquisition      | -                                 | Optional                         | -                           | -                                                      | Optional                         | -                           | Optional                                | Recommended                                  |
|                                  | Maintenance           | WPU & WSU                         |                                  |                             | WPU & WSU                                              |                                  |                             | WPU & WSU                               |                                              |
| WSB - Digital I/O                | Charge Enable         | Required                          | -                                | -                           | Required                                               | -                                | -                           | -                                       | -                                            |
|                                  | Charge Complete/Fault | Recommended                       | -                                | -                           | Recommended                                            | -                                | -                           | -                                       | -                                            |
|                                  | WSU Sleep             | Optional                          |                                  |                             | Optional                                               |                                  |                             | Optional                                |                                              |
| WSB - NTC                        | Batt. Temp            | Recommended                       |                                  |                             | -                                                      |                                  |                             | -                                       |                                              |
| WSB - CANopen                    | Charge Control        | -                                 | -                                | Required                    | -                                                      | -                                | Required                    | Required                                | -                                            |
|                                  | Data Acquisition      | -                                 | Optional                         | -                           | -                                                      | Optional                         | -                           | Recommended                             | Optional                                     |
|                                  | Maintenance           | WSU                               |                                  |                             | WSU                                                    |                                  |                             | WSU                                     |                                              |

### 8.6.1 External Commanded CANopen®

The charging process is initiated and controlled by the vehicle. The WSB is connected to the vehicle via the control interface (refer 8.7 Communications) based on CANopen®.

This enables the exchange of status information and control messages between the vehicle and the WSB, of which the WSB requests power from the WPU over a control loop.

### 8.6.2 Charging with Configured System

- Battery Power up.
- Charger power up.
- NMT-Master set Charger and Battery to “operational” state.
- Charging is Running.

**ATTENTION:**

The Delta product will never switch automatic after restart, from “pre-operational” to “operational” state on CANopen® -side. Only NMT-Master controls the CANopen® devices states in its CANopen® network.

### 8.6.3 External Commanded Ethernet

The charging process is initiated and controlled by the Fleet Management System (FMS) or other similar system that controls the facility AMR/AGVs. The WPB is logically connected to the FMS via the Ethernet interface, with communications protocol based on HTML/JSON.

This enables the exchange of status information and control messages between the FMS and the WSU via the WPU, of which the WSB requests power from the WPU over a control loop.

This provides the customers the ability to enable their systems for Industry 4.0 and Industrial Internet of Things (IIoT) by controlling the charge process centrally.

**Note:** It is the responsibility of the FMS to know the status/needs of the battery/BMS.

The WPB Ethernet connectivity will allow for either a physical LAN interface for connecting directly to a customer network via field cabling or connect to a RF Access Point to connect to the customer wireless network (supplied and powered by others).

### 8.6.4 Internal Multistage Profile

Delta can provide a Multistage Profile for use with traditional charging of Lead Acid batteries. The battery data sheet is required to verify against the profile. The profile is uploaded and stored to the WSB and upon a start charge request, the WCS follows the charge profile.

The charging process is initiated by one of three methods:

- Start-Stop via Digital Input on WSB from vehicle
- Start-Stop via CANopen® command from vehicle
- Start-Stop via Ethernet command from Management System

Upon profile completion, the WCS will stop charging, unless a float stage is implemented within the profile.

The WSB has a Digital Output to indicate Charging Complete or WCS Fault. Status information can be retrieved via CANopen® and/or Ethernet if connected and configured.

### 8.6.5 Internal CC-CV Profile

A basic CC-CV Profile can be operated on the WCS for use with Li-ION batteries. A User configures a set of parameters on the WSB and the WCS will follow this profile. Delta can advise on suitability of parameters if a battery data sheet is provided, otherwise it is assumed the User is competent to choose themselves.

The detail configurable parameters are as in section [8.7.2.4.7 Advanced Settings Page, p. 76](#):

The charging process is initiated by one of three methods:

- Start-Stop via Digital Input on WSB from vehicle
- Start-Stop via CANopen® command from vehicle
- Start-Stop via Ethernet command from management system

Upon profile completion, the WCS will stop charging.

The WSB has a Digital Output to indicate Charging Complete or WCS Fault. Status information can be retrieved via CANopen® and/or Ethernet if connected and configured.

### 8.6.6 Li-ION Battery Recovery

Li-ION battery recovery function is used to recover the Li-ION battery from deeply discharged state. In most Li-ION batteries' deeply-discharged state, the terminal voltage is 0, the back-to-back switches (MOSFETs) in the BMS is half-off half-on, which enables the charging but disables the discharging. In this way, the charger's output voltage is clamped by the battery, and the output current should be small. The protection state as described above also known as BMS Under Voltage Protection (UVP).

Before using the Li-ION battery recovery function, the parameters in section [8.7.2.4.7 Advanced Settings Page, p. 76](#) will need to be configured.

If the WCS is configured to allow the Li-ION battery recovery function (Enable), and the WSP is in the operation range with the WPP, the system can activate the battery recovery process through the User selecting the battery recovery button on the Ethernet webpage or send the command remotely. The battery recovery process will end when the battery voltage is larger than the configured Stop Voltage or the run time is larger than the configured Maximum Time, it will transition into standard charge mode (the charge modes described in above chapter) if the charger received the charging command from the external system.

**Note:**

- The Li-ION battery recovery function shall not be used for Lead Acid Batteries.
- The O/P voltage (recovery setpoint) and stop voltage (recovery endpoint) must be larger than the voltage which the BMS enables the back-to-back switches.
- The minimum voltage for a standard charge mode must be larger than the voltage which the BMS enables the back-to-back switches.

## 8.7 Communications

### 8.7.1 WPP & WSP Interface – Pad-to-Pad Link (PPL)

The wireless communications interface between WPP and WSP is referred as Pad to Pad Link (PPL). In the default mode the WPP is chosen to be inactive and the WSP is actively looking for WPP using the PPL. Neither the WPP nor WSP are transferring/receiving power until there is a charging request via an external interface, refer to [8.6 System Control Modes, p. 55](#). Also WPP and WSP are within nominal proximity (< 200 mm / < 7.8 in) of each other and successful communication between the two has been established. If the communication is interrupted (i.e., vehicle/WSP moves away) then the power transfer stops.

### 8.7.2 WPB – Ethernet

#### 8.7.2.1 Overview

Ethernet is a way to control, monitor, or configure the WCS.

The WPB has a webpage that can be accessed by users who are connected directly to the Ethernet port or to the same network as the WPB.

Accessing the WPB by typing its IP address (192.168.1.100) into a web browser of another device on the network will give access to the web interface. Refer to [8.7.2.4.1 Accessing the WPB Webpage, p. 62](#) for more information on web interface.

The IP address accessing the WPB must be within the local IP ranges shown in the table below.

| IP Range                     | Sub Netmask          |
|------------------------------|----------------------|
| 10.0.0.0 – 10.255.255.255    | 255.0.0.0 (or /8)    |
| 172.16.0.0 – 172.31.255.255  | 255.240.0.0 (or /12) |
| 192.168.0.0 -192.168.255.255 | 255.255.0.0 (or /16) |

#### 8.7.2.2 Ethernet Protocols

If the WCS is being controlled by an external system, WMS/AGV/etc. then software can control the WCS using the WCS protocols.

- The Control protocol allows control, configuration, and monitoring of the WCS.
- The Discovery protocol is used for discovery of WPBs on a network.

Contact your WCS dealer or sales representative for the protocol documentation.

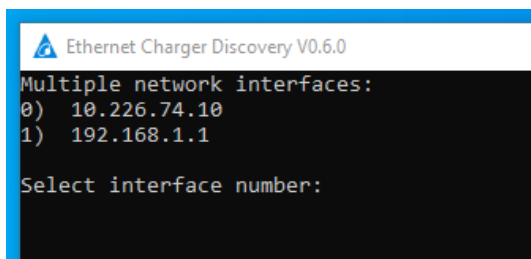
#### 8.7.2.3 Identifying the Charger IP

The WPB is accessed on the network by IP. For this reason, it is best to follow the instructions from the WCS installer/provider as they might have modified the defaults or designed the installation around certain IP ranges. However, if this IP information is not available, then the following method should be used to find the IP.

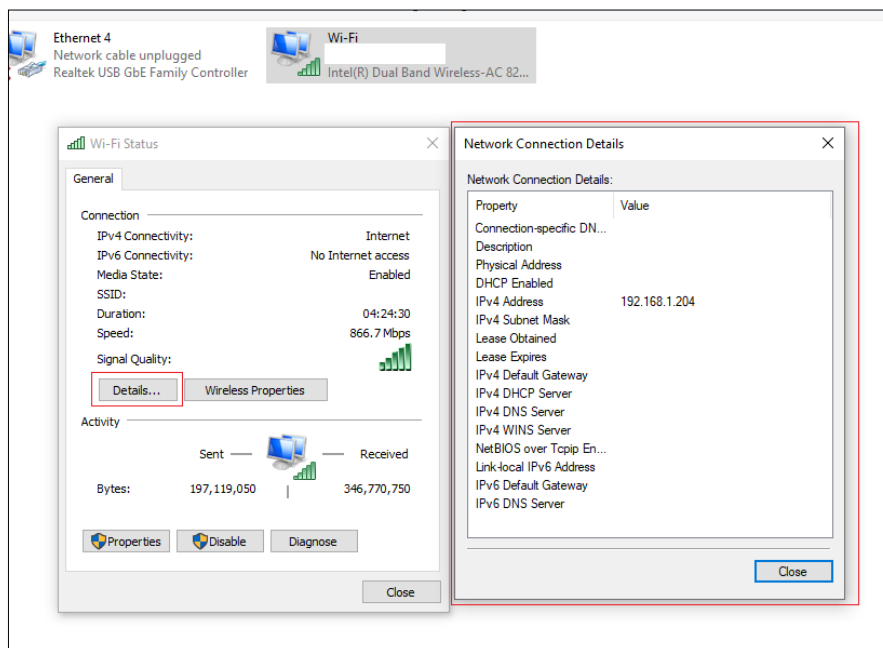
### 8.7.2.3.1 Run the Delta Charger Discovery Tool

**Note:** Ask your sales contact for the EXE file.

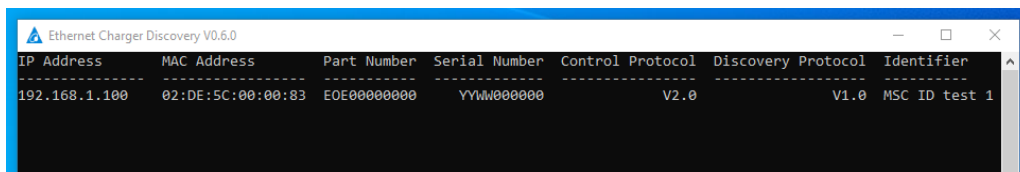
1. To run the Delta Discovery tool, double click on the executable file (e.g. EthernetChargerDiscovery\_V1.0.0.exe).



2. The number of available networks depends on the networking settings (Ethernet , Wi-Fi, etc.):



3. Usually, there will be at least 2 options as laptops have both Ethernet and Wi-Fi.



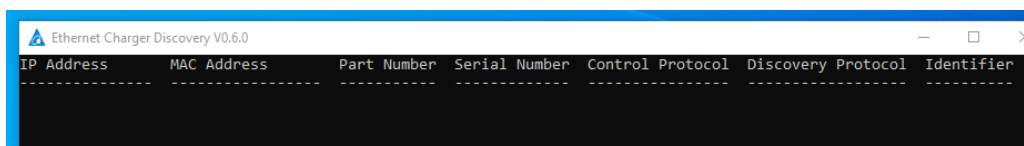
| IP Address    | MAC Address       | Part Number | Serial Number | Control Protocol | Discovery Protocol | Identifier    |
|---------------|-------------------|-------------|---------------|------------------|--------------------|---------------|
| 192.168.1.100 | 02:DE:5C:00:00:83 | EOE0000000  | YYMM000000    | V2.0             | V1.0               | MSC ID test 1 |

4. You need to type 0 or 1 and press <Enter> to select which laptop network connection, the WPB is on.
5. After a moment, if the tool can discover any WPBs, it will fill in the results, one WPB per row.
6. Here you can see the following information about the WPB:
  - IP Address – The address of the WPB, used to connect to via a browser.
  - MAC Address – This is the unique identifier of the WPB.
  - Part Number – The part number of the WPB.
  - Serial Number – The serial number of the WPB.
  - Control Protocol – The control protocol version the WPB is conforming to.
  - Discovery Protocol – The discovery protocol version the WPB is conforming to.
  - Identifier – A user-configurable identifier can be used to give the WPB a name or location label to identify it more easily than by using MAC/IP/SN.
7. This identifier example is from the **Admin** webpage:

### User Data

|            |                                                                    |
|------------|--------------------------------------------------------------------|
| Identifier | <input type="text" value="MSC ID test 1"/>                         |
| Data       | <input style="height: 40px;" type="text" value="MSC data test 1"/> |
| Email      | <input type="text" value="..."/>                                   |
| Telephone  | <input type="text" value="..."/>                                   |

If the wrong interface is chosen, the following screen will show. This is also the same screen that will show if the discovery tool cannot find a WPB.



8. Once you have the WPB IP you can then type it into a web browser and connect to the WPB.

#### 8.7.2.3.2 Get IT Help

Ask the location IT for help, since logging into a network switch or router they ought to be able to view the WPB IP.

#### 8.7.2.4 Webpage

The WPB can serve a webpage via the Ethernet. This can be accessed by a laptop on the same network as the WPB, accessing the WPB IP address in the web browser. For most of the user operations refer to the following procedure.

##### 8.7.2.4.1 Accessing the WPB Webpage

Recommend use of Google Chrome or Microsoft Edge to access the charger webpage at 192.168.1.100.

##### 8.7.2.4.2 User Roles

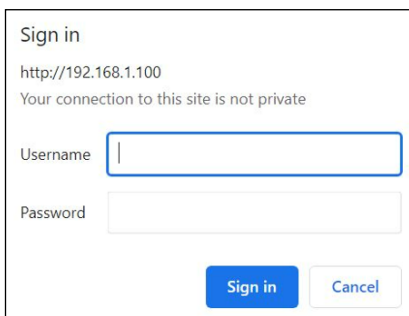
There are different User accounts with Username/Password and different levels of access.

| Account | User role | Description                                                                                                                         |
|---------|-----------|-------------------------------------------------------------------------------------------------------------------------------------|
| User    | user      | Basic WCS monitoring – read only view.                                                                                              |
| Admin   | admin     | WCS monitoring and network & user data configuration.<br><b>NOTE:</b> Admin username is designed for IT to change network settings. |
| Service | service   | WCS monitoring, network & user data configuration, WCS configuration and Ethernet control mode operations.                          |

Table 11 Webpage – User roles

Ask your WCS provider for the username/password as these can be changed from the default. Service access or Admin access may be restricted at their discretion.

When accessing the WPB, a login window will pop up requesting username and password.



Sign in

http://192.168.1.100

Your connection to this site is not private

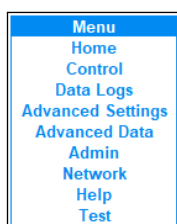
Username

Password

Figure. 28 Sign-in page

#### 8.7.2.4.3 Navigation Menu

Once the login is successful, the Navigation menu appears under the Delta logo at the top left of the page. This provides a drop-down list of links to each page on the webpage.



#### 8.7.2.4.4 Home Page

Click on **Home** from the drop-down menu to display the **Home** page(192.168.1.100).

The Home page consists of the following sections:

- **WCS Status**
- **WPU Status**
- **WSU Status** (if a WSU is connected).

Home

### System Status

|                   |                      |
|-------------------|----------------------|
| Wireless comms    | <i>Not Connected</i> |
| Position summary  | <i>N/A</i>           |
| Charge status     | <i>Fault</i>         |
| Charge duration   | <i>0:00</i>          |
| De-rate status    | <i>Not Active</i>    |
| De-rate subsystem | <i>N/A</i>           |
| De-rate reason    | <i>N/A</i>           |

### WPU Status

|                   |                                                                                  |
|-------------------|----------------------------------------------------------------------------------|
| AC voltage        | <i>0.000Vrms</i>                                                                 |
| AC current        | <i>0.000Arms</i>                                                                 |
| AC line frequency | <i>0HZ</i>                                                                       |
| Power factor      | <i>0.000</i>                                                                     |
| AC active power   | <i>0.000W</i>                                                                    |
| AC apparent power | <i>0.000VA</i>                                                                   |
| AC reactive power | <i>0.000VAR</i>                                                                  |
| THD               | <i>0%</i>                                                                        |
| Faults            | <div style="border: 1px solid black; padding: 2px; min-height: 30px;">None</div> |
| Warnings          | <div style="border: 1px solid black; padding: 2px; min-height: 30px;">None</div> |

Figure. 29 Webpage – Home page 1(2)

### WSU Status

|                              |                                                                                  |
|------------------------------|----------------------------------------------------------------------------------|
| Vehicle/Battery ID           | <i>Not Connected</i>                                                             |
| Vehicle fault                | <i>N/A</i>                                                                       |
| Battery SoC                  | <i>N/A</i>                                                                       |
| Charge control               | <i>Not Connected</i>                                                             |
| DC V setpoint                | <i>0.000V</i>                                                                    |
| DC I <sub>max</sub> setpoint | <i>0.000A</i>                                                                    |
| DC V measured                | <i>0.000V</i>                                                                    |
| DC I measured                | <i>0.000A</i>                                                                    |
| Battery temp probe           | <i>N/A</i>                                                                       |
| Faults                       | <div style="border: 1px solid black; padding: 2px; min-height: 30px;">None</div> |
| Warnings                     | <div style="border: 1px solid black; padding: 2px; min-height: 30px;">None</div> |

Figure. 30 Webpage – Home page 2(2)

## Webpage – Home page – System Status section

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wireless comms    | Pad-to-Pad Link (PPL) status:<br>Not Connected • Connected                                                                                                                                                                                                                                                                                                                                                                                                          |
| Position summary  | Positioning between pads in textual form:<br>N/A • Too close • Suboptimal close • Optimal • Suboptimal far • Too far<br><br><b>NOTE:</b> When the pads are stationery and charging is ongoing, the above position state can transition to an adjacent state over the duration of the charge process. Hence, it is recommended to position the vehicle in the optimal position prior to the charge commencing. See section <b>Error! Reference source not found.</b> |
| Charge status     | Not Charging • Charging • Charge Complete • Recovery • Derating • Fault                                                                                                                                                                                                                                                                                                                                                                                             |
| Charge duration   | Charge Cycle Elapsed Time:<br>minutes : seconds                                                                                                                                                                                                                                                                                                                                                                                                                     |
| De-rate status    | The system is prevented from providing full DC Output power:<br>Active • Not Active                                                                                                                                                                                                                                                                                                                                                                                 |
| De-rate subsystem | All subsystems that are active will be displayed:<br>N/A • WPB • WPP • WSP • WSB                                                                                                                                                                                                                                                                                                                                                                                    |
| De-rate reason    | All the reasons that are active will be displayed:<br>N/A • Temperature • Positioning • Input current                                                                                                                                                                                                                                                                                                                                                               |

Table 12 Webpage – Home page – System Status section

**Webpage – Home page – WPU Status section**

| Parameter         | Description                                                        |
|-------------------|--------------------------------------------------------------------|
| AC voltage        | AC input supply information (not to be used for metering purposes) |
| AC current        |                                                                    |
| AC line frequency |                                                                    |
| Power factor      |                                                                    |
| AC active power   |                                                                    |
| AC apparent power |                                                                    |
| AC reactive power |                                                                    |
| THD               |                                                                    |
| Faults            | Active faults within the WPB or WPP                                |
| Warnings          | Active warnings within the WPB or WPP                              |

**Table 13** Webpage – Home page – WPU Status section

## Webpage – Home page – WSU Status section

| Parameter                    | Description                                                                                                                                                                                                                                                       |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vehicle / Battery ID         | <p>A vehicle and/or battery identification data string.</p> <p>If implemented within the WSB CANopen® interface:</p> <p>A data string</p> <p>If not implemented within the WSB CANopen® interface:</p> <p>N/A</p>                                                 |
| Vehicle fault                | <p>A vehicle and/or battery fault.</p> <p>If implemented within the WSB CANopen® interface:</p> <p>Not Active • Active</p> <p>If not implemented within the WSB CANopen® interface:</p> <p>N/A</p>                                                                |
| Battery SoC                  | <p>The vehicle / battery State of Charge.</p> <p>If implemented within the WSB CANopen® interface:</p> <p>n %</p> <p>If not implemented within the WSB CANopen® interface:</p> <p>N/A</p>                                                                         |
| Charge control               | <p>Charge control status being received at the WSB from the external system:</p> <p>Disabled; charge not being initiated</p> <p>Enabled-DI; via Digital Input by vehicle</p> <p>Enable-CAN; via CANopen® by vehicle</p> <p>Enable-Ethernet; via Ethernet node</p> |
| DC V setpoint                | <p>Voltage setpoint that the WSB is working to, which is derived from either:</p> <p>Vehicle via CANopen® (ECC)</p> <p>Network Node via Ethernet (ECE)</p> <p>CC-CV Profile (ICP)</p> <p>Multistage Profile (IMP)</p>                                             |
| DC V measured                | Measured Voltage on the DC Output                                                                                                                                                                                                                                 |
| DC I <sub>max</sub> setpoint | <p>Current setpoint that the WSB is working to, which is derived from either:</p> <p>Vehicle via CANopen® (ECC)</p> <p>Network Node via Ethernet (ECE)</p> <p>CC-CV Profile (ICP)</p> <p>Multistage Profile (IMP)</p>                                             |
| DC I measured                | Measured Current on the DC Output                                                                                                                                                                                                                                 |

| Parameter          | Description                                                                                                               |
|--------------------|---------------------------------------------------------------------------------------------------------------------------|
| Battery temp probe | The measured temperature of the battery.<br>If the NTC cable is fitted:<br>n °C<br>If the NTC cable is not fitted:<br>N/A |
| Faults             | Active Faults within the WSP or WSB                                                                                       |
| Warnings           | Active Warnings within the WSP or WSB                                                                                     |

Table 14 Webpage – Home page – WPU Status

#### 8.7.2.4.5 Control Page

The **Control** page displays the charge status of the WCS for any mode of operation. It also allows the WCS to be controlled by the following methods:

- External Commanded Ethernet mode (see [8.6.3 “External Commanded Ethernet”, p. 56](#))
- Start/Stop Internal Multistage Profile (see [8.6.4 “Internal Multistage Profile”, p. 56](#))
- Start/Stop Internal CC-CV Profile (see [8.6.5 “Internal CC-CV Profile”, p. 57](#))
- Initiating the Li-ION Battery Recovery mode (see [8.6.6 “Li-ION Battery Recovery”, p. 57](#))

**Note:** The WSU configuration parameter **Charge Mode** within the **Advanced Settings** page, determines which Charge Mode is allowed.

Control

### Ethernet Control

Control ☐ OFF

Voltage  V

Current  A

Cutoff current  A

Charge limit  Ah

Time limit  s

### Enable Power

Start/Stop ☐ OFF

### Battery Recovery

Control ☐ OFF

### Charge Status

Charge mode ...

Charge status *Fault*

DC V measured 0.000V

DC I measured 0.000A

Ah delivered 0.0Ah

Charge duration 0:00

### Charge Clear

Figure. 31 Webpage – *Control* page

The **Ethernet Control** section of the page is for controlling the WCS using the **External Commanded Ethernet** mode.

The default **Control** page would be monitoring only, indicated by the **Control** toggle set to **OFF** at the top of the page. Setting the **Control** toggle to **ON** will allow the user to take control of the WCS and enable the control parameter inputs. In this case there are two options:

- User opens webpage and controls the charge process manually
- FMS (or similar) sends the Ethernet commands and controls the charge process automatically

**NOTE:** The WCS webpage can be accessed simultaneously by multiple users i.e. if an FMS is controlling the WCS, another user logging into the webpage can view the setpoints that the FMS is providing to the WCS.

|                                                                                   |                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Do not activate this toggle (<b>ON/OFF</b>) if another user or FMS is controlling the WCS because the WCS will try to respond to controls from two different inputs.</p> <p><b>Consequence:</b> WCS error, WCS wear (e.g. if turning off and on repeatedly), Battery not charged correctly.</p> |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Controlling the WCS via the webpage manually and closing the webpage will stop the message being sent and the WCS will stop charging with a communication fault.

During operation (by FMS) the control command must be sent repeatedly. If no command is received within the timeout period, the WCS will raise a communications fault and stop any charge in progress.

### Webpage – **Control** page – **Ethernet Control** section

**Control** = **OFF**      Monitoring only

**Control** = **ON**      Control via Ethernet interface enabled

Table 15      Switching **Control** mode on and off

**Ethernet Control**

|                |                                |    |
|----------------|--------------------------------|----|
| Control        | <input type="checkbox"/>       |    |
| Voltage        | <input type="text" value="0"/> | V  |
| Current        | <input type="text" value="0"/> | A  |
| Cutoff current | <input type="text" value="0"/> | A  |
| Charge limit   | <input type="text" value="0"/> | Ah |
| Time limit     | <input type="text" value="0"/> | s  |

Figure. 32 Webpage – **Control** page – **Ethernet Control** section

The WCS will increase power until it reaches the max current. When the target voltage is reached it will reduce the current to maintain that voltage. This will run continuously until there is a reason to stop, like command to Power Off, or the current delivered drops below cutoff current, or the charge limit or time limits are reached.

These parameters can be changed during the **External Commanded Ethernet** charge mode.

| Setting type              | Parameter             | Description                                                                                                                                    |
|---------------------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Setpoints                 | <b>Voltage</b>        | Max voltage for CV stage, formatted as a number e.g. 59.5                                                                                      |
| Setpoints                 | <b>Current</b>        | Max current for CC stage, formatted as a number e.g. 62                                                                                        |
| Reason to stop the charge | <b>Cutoff current</b> | When current in CV drops below this value, Amps e.g. 5.0, then the charger will end the charge.                                                |
|                           | <b>Charge limit</b>   | When this amount of charge is returned to the battery, in Amp-hours e.g. 150.0, then the charger will stop the charge.<br>(0=disabled to 1000) |
|                           | <b>Time limit</b>     | When this time has passed within a charge, in seconds e.g. 5400, then the charger will stop the charge.<br>(0 = disabled to 86400)             |

Table 16 Webpage – **Control** page – **Ethernet Control** section

### Webpage – **Control** page – **Enable Power** section

The **Enable Power** section of the **Control** page allows the start and stop of the charging process. In addition to starting and stopping the charging process for **Ethernet Control**, this toggle also allows to start and stop **Internal CC-CV Profile** and **Internal Multistage Profile**.

|                         |                                                                                                                                                                                                                                   |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Start/Stop = OFF</b> | Stop charging                                                                                                                                                                                                                     |
| <b>Start/Stop = ON</b>  | Start charging<br>ECE: as per given parameters on this page<br>ICP: as per given parameters within the Advanced Settings page: CC-CV Profile section, stored on the WSU<br>IMP: as per the Multistage Profile loaded onto the WSU |

Table 17 Webpage – **Control** page – **Enable Power** section

## Webpage - Control page – Battery Recovery section

The **Battery Recovery** section of the **Control** page allows the initiation of the Li-ION **Battery Recovery** mode.

|                        |                                                                                                                               |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>Control</b> = OFF   | Disables the <b>Battery Recovery</b> control                                                                                  |
| <b>Control</b> = ON    | Enables the <b>Battery Recovery</b> control by activating the Recovery button.                                                |
| <b>Recovery</b> button | Initiates the battery recovery as per given parameters with the <b>Advanced Settings</b> page.<br>Click the button only once. |

Table 18 Webpage – Control page – Battery Recovery section

## Webpage - Control page – Charge Status section

The **Charge Status** section of the **Control** page displays read-only information on the charge process regardless of the charge mode selected.

| Parameter              | Description                                                                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Charge mode</b>     | Sets the charge mode for the WSU:<br>External Commanded CANopen®<br>External Commanded Ethernet<br>Internal Multistage Profile<br>Internal CC-CV Profile |
| <b>Charge status</b>   | Not Charging • Charging • Charge Complete • Recovery • Derating • Fault                                                                                  |
| <b>DC V measured</b>   | Measured voltage on the DC Output                                                                                                                        |
| <b>DC I measured</b>   | Measured current on the DC Output                                                                                                                        |
| <b>Ah delivered</b>    | Ah delivered from WSU to battery                                                                                                                         |
| <b>Charge duration</b> | Elapsed time since the start of the charge cycle                                                                                                         |

## Webpage - Control page – Charge Status section

The **Charge Clear** section of the **Control** page used to clear the faults of WCS.

Charge Clear

Figure 2 Webpage – Control page – Ethernet Control section

#### 8.7.2.4.6 Data Logs Page

The Data Logs page consists of the following sections:

- WPU User Log section
- WPU Even Log section
- WSU User Log section
- WSU Event Log section

#### Webpage – Data Logs page – WPU User Log section

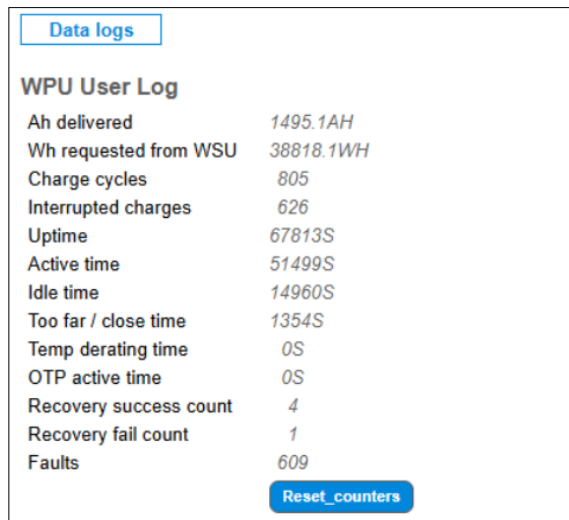


Figure. 33 Webpage – Data Logs page – WPU User Log section

The WPU contains a series of incremental counters, capturing information of its utilization. To reset the WPU user log, click the Reset counters button.

## Webpage – Data Logs page – WPU User Log section



Figure. 34 Webpage – Data Logs page – WPU Event Log section

The WPU tracks events in a log, which is displayed on the webpage and can also be downloaded to the user's PC. The event log holds 100 records and overwrites on a first in first out basis. Events range from faults to tracking users modifying WPU settings.

To download the event log, click the [Download](#) button.

To delete the event log, click the [Reset](#) button.

The events have date/time stamp.

**NOTE:** As the WPU does not contain a battery-backed RTC, the date and time may be inaccurate.

## Webpage – Data Logs page – WSU User Log section

| WSU User Log                   |           |
|--------------------------------|-----------|
| Ah delivered                   | 1488.3AH  |
| Wh requested to WPU            | 38639.0WH |
| Wh fed to battery              | 38233.3WH |
| Charge cycles                  | 793       |
| Battery deep discharges        | 3         |
| Uptime                         | 68502S    |
| Active time                    | 51622S    |
| Idle time                      | 16880S    |
| Temp derating time             | 0S        |
| Recovery success count         | 2         |
| Recovery fail count            | 2         |
| Faults                         | 241       |
| <a href="#">Reset counters</a> |           |

Figure. 35 Webpage – Data Logs page – WSU User Log section

The WSU contains a series of incremental counters, capturing utilization information.

To reset the WSU user log, click the [Reset counters](#) button.

## Webpage – Data Logs page – WSU Event Log section



Figure. 36 Webpage – Data Logs page – WSU Event Log section

The WSU tracks Events in a log, which is displayed on the webpage and can also be downloaded to the user's PC. The event log holds 100 records and overwrites on a first in first out basis. Events range from faults to tracking users modifying WSU settings.

To download the event log, click the **Download** button.

To delete the event log, click the **Reset** button.

The events have date/time stamp.

The WPU will retain the WSU event log until the next WSU/vehicle establishes PPL communications with it. This will overwrite the previous event log stored on the WPU.

**Note:** As the WSU does not contain a battery-backed RTC, the date and time may be inaccurate unless synchronised using the CANopen® protocol (time taken from the vehicle).

### 8.7.2.4.7 Advanced Settings Page

This page provides access to the WCS configuration options, which are important for operation.

The **Advanced Settings** page consists of the following sections:

- **WPU Configuration** section
- **WSU Configuration** section
- **Internal CC-CV Profile** section
- **Internal Multistage Profile** section
- **Li-ION Battery Recovery** section

#### Webpage – Advanced Settings page – WPU Configuration section

Advanced Settings

WPU Configuration

Service

Out of service

OFF

Power Limit

Maximum

3600

W

Charge Timeouts

Standby

3

s

Charging

0

s

Time config

Datetime

2025/03/21 19:23:29

Blockout 1

Day

Mon

Enable

OFF

Start

00:00

End

00:00

Blockout 2

Day

Mon

Enable

OFF

Start

00:00

End

00:00

Figure. 37 Webpage – **Advanced Settings** page – **WPU Configuration** section

| Setting                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Out of Service             | Configuring the WPU as "out of service" means the WPU will not deliver output power until "out of service" is disabled                                                                                                                                                                                                                                                                                                                            |
| Power Limit                | If application requires, this allows the output power of the WPU to be limited to less than the full performance, independent of the control modes and parameters being used. This can be set indefinitely or modified as required by a network node e.g. to save energy consumption at certain times of the day.                                                                                                                                 |
| Ethernet Charge Timeouts   | <p>This setting allows the WPU to check it has not lost control communications.</p> <p>Standby timeout - When the WPU is not charging and loses the control communication from the server then the WPU reports a warning.</p> <p>Charging timeout - the WPU will stop charging and report a fault if the control is not received within the given timeframe.</p> <p>For both, the time is a value in seconds between 0 and 120, 0 = disabled.</p> |
| Time Config                | Configure the date time for WPU.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Block Out 1<br>Block Out 2 | If there are restrictions on when a charge can occur, then block out timeslots can be set for each day. The time between Start and Stop is the time the charge cannot occur at the WPU.                                                                                                                                                                                                                                                           |

## Webpage – Advanced Settings page – WSU Configuration section

WSU Configuration

Charge Mode

Mode

...

Output Cable

Resistance

0

Ω

Voltage Limits

Minimum

0

V

Maximum

0

V

Battery Capability

Maximum Voltage

0

V

Maximum Current

0

A

Figure. 38 Webpage – Advanced Settings page – WSU Configuration section

| Setting            | Description                                                                                                                                                                                                                                                                                                            |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Charge Mode        | <p>The Charge Mode of the WSU/Vehicle is set (typically once) when the vehicle is manufactured with the WSU installed. Control Modes consist of:</p> <p>External Commanded CANopen®</p> <p>External Commanded Ethernet</p> <p>Internal CC-CV Profile</p> <p>Internal Multistage Profile</p>                            |
| DC Output Cable    | <p>The cable resistance of the DC cables connected to the WSB can be configured so that the WSU can correctly calculate the battery voltage.</p> <p>The default setting is suitable for a WSB with a standard-length DC cable.</p> <p>However, if the DC cable is extended, the cable resistance must be modified.</p> |
| Voltage Limits     | <p>Set a more narrow voltage window so that the WSB will confine itself to only operating within.</p> <p><b>Example uses:</b></p> <p>Preventing charge if charging at full current at lower voltages could damage the battery.</p>                                                                                     |
| Battery Capability | <p>Customer to enter the maximum voltage &amp; current that the external system or Profile will request throughout the charge cycle. The WPU uses this information to determine Optimal vs. Suboptimal positioning status. The default settings are the maximum capability of the WSB.</p>                             |

## Webpage – Advanced Settings page – Internal CC-CV Profile section

For explanation of this function, see [8.6.5 “Internal CC-CV Profile”, p. 57](#).

**Internal CC-CV Profile**

|                |                                |    |
|----------------|--------------------------------|----|
| Voltage        | <input type="text" value="0"/> | V  |
| Current        | <input type="text" value="0"/> | A  |
| Topping        | <input type="text" value="0"/> | V  |
| Cutoff current | <input type="text" value="0"/> | A  |
| Charge limit   | <input type="text" value="0"/> | Ah |
| Time limit     | <input type="text" value="0"/> | s  |
| Delayed start  | <input type="text" value="0"/> | s  |
| Retry quantity | <input type="text" value="0"/> |    |

Figure. 39 Webpage – Advanced Settings page – Internal CC-CV Profile section

| Setting type | Parameter | Description                                                                                                                                                                                                                |
|--------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Setpoints    | Voltage   | Max voltage for CV stage, formatted as a number e.g. 29.2.<br>Default = 0 (disabled)<br><br>Setting ranges:<br>WSB 24V: 12 to 33 V<br>WSB 36V: 18 to 49.5 V<br>WSB 48V: 24 to 66 V                                         |
|              | Current   | Max current for CC stage, formatted as a number e.g. 72.0.<br>Default = 0 (disabled)<br><br>Setting ranges:<br>WSB 24V: 0 to 132 A<br>WSB 36V: 0 to 88 A<br>WSB 48V: 0 to 66 A<br>Default = 0A (disabled)                  |
|              | Topping   | When the battery voltage is lower than the topping value and the charge command is still enable, auto start charging to avoid the battery voltage drops too low.<br><br>(configured-min-voltage to configured-max-voltage) |

| Setting type              | Parameter      | Description                                                                                                                                                                                                                                             |
|---------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reason to stop the charge | Cutoff current | When current in CV drops below this value, Amps e.g. 5.0, then the charger will end the charge. Range:<br>WSB 24V: 0 to 132 A<br>WSB 36V: 0 to 88 A<br>WSB 48V: 0 to 66 A<br>Default = 0 A (disabled)                                                   |
|                           | Charge limit   | When this amount of charge is returned to the battery, in Amp-hours e.g. 150.0, then the charger will stop the charge. Range: 0 Ah (disabled) to 1000 Ah                                                                                                |
|                           | Time limit     | <div> <b>Internal Multistage Profile</b><br/>           Retry quantity <input type="text" value="0"/> </div> When this time has passed within a charge, in seconds e.g. 900, then the charger will stop the charge.<br>Range: 0 s (disabled) to 86400 s |
|                           | Retry quantity | Number of times to auto retry in the event of a charge fault e.g. 3<br>(0 = disabled to 5)                                                                                                                                                              |

#### Webpage – Advanced Settings page – Internal Multistage Profile section

As the **Internal Multistage Profile** modes run automatically, this setting allows the WCS to attempt to clear faults. The number of times to autoretry in the event of a WCS fault e.g. 3 (0 = disabled to 5). For more information on this function, see [8.6.5 “Internal CC-CV Profile”, p. 57](#).

#### Webpage – Advanced Settings page – Li-ION Battery Recovery section

For more information on this function, see [8.6.6 “Li-ION Battery Recovery”, p. 57](#).

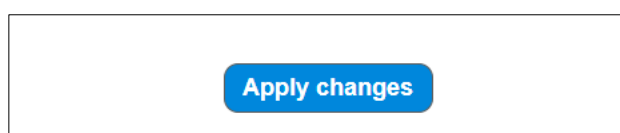
**Battery Recovery**  
 Enable ☐ OFF  
 Max current  A  
 Output voltage  V  
 Stop voltage  V  
 Time limit  s

Figure. 40 Webpage – Advanced Settings page – Li-ION Battery Recovery section

| Setting type                                                  | Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Activation                                                    | Enable         | Default disabled                                                                                                                                                                                                                                                                                                                                                                                         |
| Setpoints                                                     | Max Current    | <p>Maximum current to use to try to wake up and recover the battery. Range dependent on WSB variant:</p> <p>WSB 24V: 0.5 to 6 A</p> <p>WSB 36V: 0.5 to 5 A</p> <p>WSB 48V: 0.5 to 4 A</p> <p>Default: 0.5 A for all variants</p>                                                                                                                                                                         |
|                                                               | Output Voltage | <p>Target voltage for the recovery charge. Range and default value dependent on WSB variant:</p> <p>WSB 24V: 12 to 33 V, default: 25 V</p> <p>WSB 36V: 18 to 49.5 V, default: 37.5 V</p> <p>WSB 48V: 24 to 66 V, default: 50 V</p>                                                                                                                                                                       |
| Reason to stop the Recovery charge, allowing normal charging. | Stop Voltage   | <p>Stop the recovery charge if this voltage is reached. Range and default value dependent on WSB variant:</p> <p>WSB 24V: 12 to 33 V, default: 25 V</p> <p>WSB 36V: 18 to 49.5 V, default: 37.5 V</p> <p>WSB 48V: 24 to 66 V, default: 50 V</p> <p>Value of 0 to disable this end-condition.</p> <p><b>NOTE:</b> If this is set lower than the Output Voltage value above, it may never get reached.</p> |
|                                                               | Maximum Time   | <p>Stop the recovery charge after this time has elapsed.</p> <p>Range from 10 to 1800s, default: 60s.</p> <p><b>NOTE:</b> This is different from the 10s timeout where if Recovery cannot start it will give up.</p>                                                                                                                                                                                     |

### Webpage – Advanced Settings page – Apply Changes button

To transmit the updated configuration data to the WSU, click the **Apply Changes** button.



### 8.7.2.4.8 Advanced Data Page

This page gives access to additional internal status information for each subsystem, which may be useful when troubleshooting faults.

|                         |  |                 |
|-------------------------|--|-----------------|
| Advanced Data           |  |                 |
| WPB                     |  |                 |
| Wpb Ready Charge        |  | true            |
| Wpb Charging            |  | false           |
| Wpb High Pwr            |  | false           |
| Wpb Event0              |  | false           |
| Wpb Event1              |  | false           |
| Wpb Event2              |  | false           |
| Wpb Event3              |  | true            |
| Wpb Event4              |  | false           |
| Wpb Max Allowed Power   |  | 3598.4W         |
| Wpb Operational Mode    |  | normal          |
| Wpb Operational State   |  | ready           |
| Wpb Status Interlock    |  | false           |
| Wpb Status Occupied     |  | true            |
| Incompatible            |  | false           |
| Undetermined            |  | false           |
| Wpb Status Derating     |  | false           |
| Wpb Status Relay On     |  | true            |
| Wpb Status Pfc En       |  | true            |
| Wpb Status Buckboost En |  | true            |
| Wpb Status Buckboost Ok |  | true            |
| Wpb Status Ipt En       |  | false           |
| Wpb Temp Pfc            |  | 26.5°C / 79.7°F |
| Wpb Temp Buck           |  | 27.8°C / 82.0°F |
| Wpb Temp Boost          |  | 27.8°C / 82.0°F |
| Wpb Temp Ipt            |  | 27.5°C / 81.5°F |
| Wpb Coupling            |  | 0%              |
| Wpb Mut Ind             |  | 0uH             |
| Wpb Min Mut Ind         |  | 31uH            |
| Wpb Max Mut Ind         |  | 128uH           |

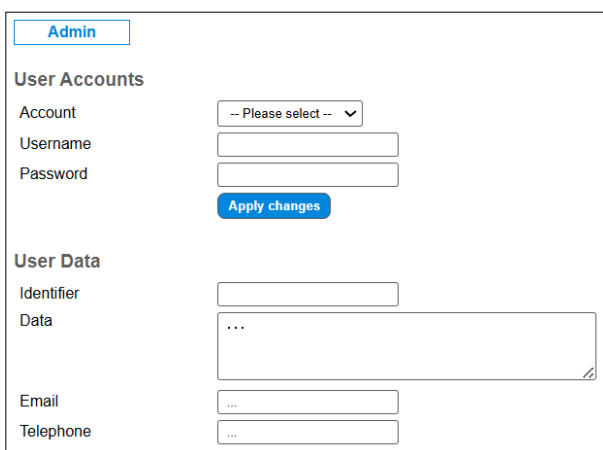
Figure. 41 Webpage – Advanced Data page

### 8.7.2.4.9 Admin Page

The **Admin** page consists of the following sections:

- **User Accounts** section
- **User Data** section
- **WPU Identification** section
- **WPB** section
- **WPP** section
- **WSB** section
- **WSP** section
- **Software Update** section
- **Power Cycle** section

#### Webpage – Admin page – User Accounts section



Admin

User Accounts

Account
-- Please select --
Username
Password
Apply changes

User Data

Identifier
Data
Email
Telephone

Figure. 42 Webpage – Admin page – User Accounts section

Allows the logged-in user to change the username and password.

## Webpage – Admin page – User Data section

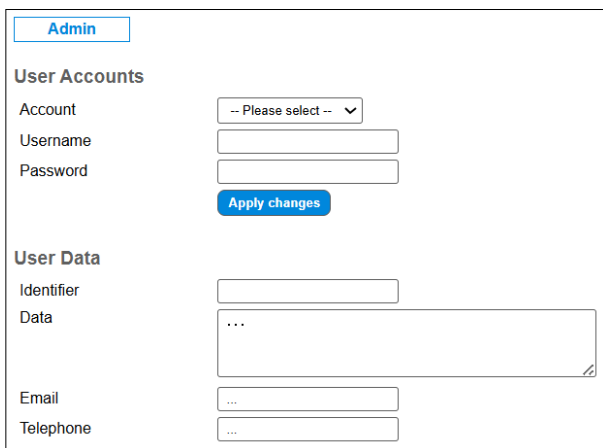


Figure. 43 Webpage – Admin page – User Data section

Allows the storage of extra information in the WPB. The identifier value is reported via the **Discovery** protocol e.g. this webpage might be used to store information about a WPB location.

The installer can provide contact email and telephone for the convenience of users.

## Webpage – Admin page – WPU Identification section

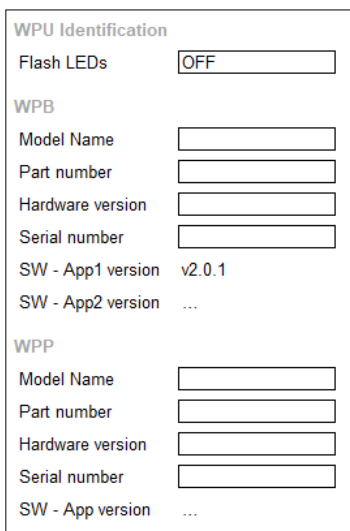


Figure. 44 Webpage – Admin page – WPU Identification section

Flashes the LEDs on the WPB to visually locate the WPB (when Identify is **ON**, the LEDs all flash).

## Webpage – Admin page – WPB section

|                           |                                  |
|---------------------------|----------------------------------|
| <b>WPU Identification</b> |                                  |
| Flash LEDs                | <input type="text" value="OFF"/> |
| <b>WPB</b>                |                                  |
| Model Name                | <input type="text"/>             |
| Part number               | <input type="text"/>             |
| Hardware version          | <input type="text"/>             |
| Serial number             | <input type="text"/>             |
| SW - App1 version         | v2.0.1                           |
| SW - App2 version         | ...                              |
| <b>WPP</b>                |                                  |
| Model Name                | <input type="text"/>             |
| Part number               | <input type="text"/>             |
| Hardware version          | <input type="text"/>             |
| Serial number             | <input type="text"/>             |
| SW - App version          | ...                              |

Figure. 45 Webpage – Admin page – WPB section

Allows the user to access the WPB hardware and software information.

## Webpage – Admin page – WPP section

|                           |                                  |
|---------------------------|----------------------------------|
| <b>WPU Identification</b> |                                  |
| Flash LEDs                | <input type="text" value="OFF"/> |
| <b>WPB</b>                |                                  |
| Model Name                | <input type="text"/>             |
| Part number               | <input type="text"/>             |
| Hardware version          | <input type="text"/>             |
| Serial number             | <input type="text"/>             |
| SW - App1 version         | v2.0.1                           |
| SW - App2 version         | ...                              |
| <b>WPP</b>                |                                  |
| Model Name                | <input type="text"/>             |
| Part number               | <input type="text"/>             |
| Hardware version          | <input type="text"/>             |
| Serial number             | <input type="text"/>             |
| SW - App version          | ...                              |

Figure. 46 Webpage – Admin page – WPP section

### Webpage – Admin page – WSP section

| WSP                    |                      |
|------------------------|----------------------|
| Model Name             | <input type="text"/> |
| Part number            | <input type="text"/> |
| Hardware version       | <input type="text"/> |
| Serial number          | <input type="text"/> |
| SW - App version       | ...                  |
| WSB                    |                      |
| Model Name             | <input type="text"/> |
| Part number            | <input type="text"/> |
| Hardware version       | <input type="text"/> |
| Serial number          | <input type="text"/> |
| SW - App version       | ...                  |
| Multistage Profile ID  | ...                  |
| Multistage Profile ver | ...                  |

Figure. 47 Webpage – Admin page – WSP section

Allows the user to access the connected WSP hardware and software information.

### Webpage – Admin page – WSB section

| WSP                    |                      |
|------------------------|----------------------|
| Model Name             | <input type="text"/> |
| Part number            | <input type="text"/> |
| Hardware version       | <input type="text"/> |
| Serial number          | <input type="text"/> |
| SW - App version       | ...                  |
| WSB                    |                      |
| Model Name             | <input type="text"/> |
| Part number            | <input type="text"/> |
| Hardware version       | <input type="text"/> |
| Serial number          | <input type="text"/> |
| SW - App version       | ...                  |
| Multistage Profile ID  | ...                  |
| Multistage Profile ver | ...                  |

Figure. 48 Webpage – Admin page – WSB section

Allows the user to access the connected WSB hardware and software information, including identification of the **Internal Multistage** profile that is loaded.

### Webpage – Admin page – Software Update section

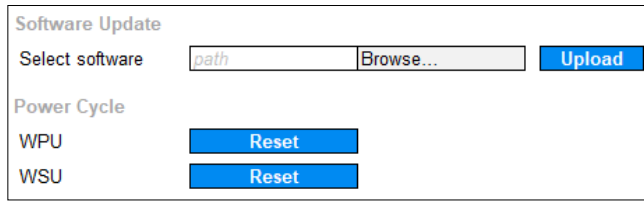


Figure. 49 Webpage – Admin page – Software Update section

Allows the user to update the firmware on all subsystems of the WCS by choosing the file provided by the dealers or sales representative.

### Webpage – Admin page – Power Cycle section

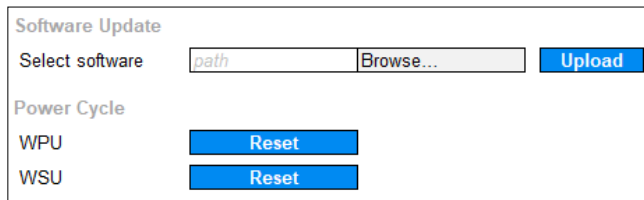


Figure. 50 Webpage – Admin page – Power Cycle section

Offers a convenient method to power cycle the WPU or WSU.

#### 8.7.2.4.10 Network Page

This page allows the user to adjust the WPB network settings e.g. changing of WPB IP mode from DHCP to Static.

Network

IPV4

Mode

Static

IP address

192.168.1.100

Subnet mask

255.255.255.0

Default gateway

192.168.1.1

Configure Network

MAC

MAC address

00:18:23:6D:03:00

Stats

Packets Received

454

Packets Sent

179

Packets Dropped

0

Control Received

137

Control Sent

136

Control Dropped

5

Reset

Figure. 51 Webpage – Network page

Changing IP settings may require power cycling AC. Turn off the WPB AC supply until the charger lights go OFF.

### 8.7.2.4.11 Test Page

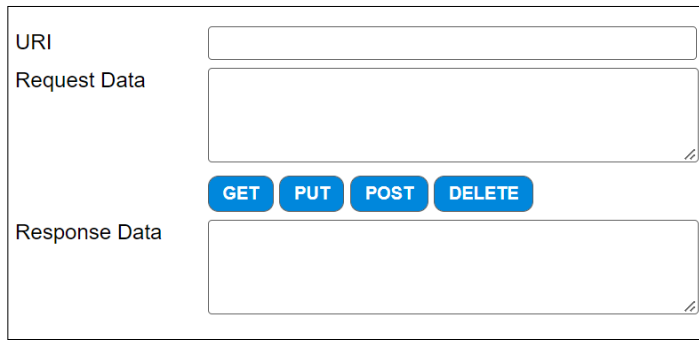


Figure. 52 Test page

This page is for software engineers. It allows testing of individual commands in the Delta WCS Ethernet Control Protocol. The command URL can be selected from the drop-down list or entered manually. Data for a **POST** request can be entered in the **Request Data** text field and the response will be shown in the **Response Data** text field. A request can be sent using the **GET** or **POST** buttons. See Ethernet Control Protocol Specification for URL details.

## 8.7.3 WSB – CANopen®

### 8.7.3.1 Overview

The following information gives a brief description of the requirements for the battery which is going to be installed on the vehicle. The vehicle communicates with the WSB, using CAN bus to convey the current & voltage limits along with the other status information to control the battery charging process.

See CiA-419 and CiA-301 for more information.

### 8.7.3.2 Protocol

This section explains the CANopen® interface in order to control and monitor the chargers on the vehicles. The protocol complies with CANopen® standards CiA301.

#### 8.7.3.2.1 Bitrate

Bitrate explains the number of bits processed in a given unit of time, below tables shows the supported bit rates. The product out-of-the-box will have a default bit-rate of 125kbps.

Sample Point could be 80% or 87.5% (Recommended by CiA-301)

| Supported Bitrates |
|--------------------|
| 125 kBit/s         |
| 250 kBit/s         |
| 500 kBit/s         |
| 800 kBit/s         |
| 1000 kBit/s        |

#### 8.7.3.2.2 How to initialize CANopen®

The product out-the-box will have a default bitrate of 125kbit/s and has no configured node ID. These can be updated using the Layer Settings Services (LSS) defined in CiA 305.

The product needs to be configured with the following parameters:

- Valid and free Node-ID in the CANopen® network
- Valid bitrate according to the other devices in the CANopen® network

### 8.7.3.2.3 How to Control the Charger via CANopen®

The product would need the following minimum controls:

Charger RPDO1 Mapping:

| COB-ID                                | Process data in binary code                                                                                                       |                                                                         |        |          |        |        |        |        |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------|----------|--------|--------|--------|--------|
|                                       | Byte 0                                                                                                                            | Byte 1                                                                  | Byte 2 | Byte 3   | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
| RPDO1<br>200h<br>+<br>Node-Id         | Battery status<br>CiA-419<br>(Object:<br>0x6000)                                                                                  | Charge<br>current<br>request<br>1/16A<br>CiA-419<br>(Object:<br>0x6070) |        | Not used |        |        |        |        |
| COB-ID of<br>Receive-PDO<br>1 (RPDO1) | 0x220, (0x200 + Node-Id)                                                                                                          |                                                                         |        |          |        |        |        |        |
| Transmission<br>Type                  | 0xFF (details see CiA-301)                                                                                                        |                                                                         |        |          |        |        |        |        |
| Timeout                               | If timeout is reached charging is stopped (charge request = 0)<br>Battery must send this cyclic message within the timeout limit. |                                                                         |        |          |        |        |        |        |
| Number of<br>mapped<br>objects        | 2                                                                                                                                 |                                                                         |        |          |        |        |        |        |

Charger TPDO1 Mapping:

| COB-ID                  | Process data in binary code                  |          |        |        |        |        |        |        |
|-------------------------|----------------------------------------------|----------|--------|--------|--------|--------|--------|--------|
|                         | Byte 0                                       | Byte 1   | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
| TPDO1<br>180h + Node-ID | Charger status<br>CiA-419<br>(Object: 0x6001 | Not used |        |        |        |        |        |        |
| Transmission type:      | 0xFF                                         |          |        |        |        |        |        |        |
| Inhibit Time (1/10ms):  | 0                                            |          |        |        |        |        |        |        |
| Event Timer:            | 200 ms                                       |          |        |        |        |        |        |        |
| Sync counter:           | 0                                            |          |        |        |        |        |        |        |

Corresponding Battery TPDO1 Mapping:

| COB-ID                                   | Process data in binary code                   |                                                             |        |          |        |        |        |        |
|------------------------------------------|-----------------------------------------------|-------------------------------------------------------------|--------|----------|--------|--------|--------|--------|
|                                          | Byte 0                                        | Byte 1                                                      | Byte 2 | Byte 3   | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
| TPDO1<br>200h<br>+<br>Node-ID of charger | Battery status<br>CiA-419<br>(Object: 0x6000) | Charge current request 1/16A<br>CiA-419<br>(Object: 0x6070) |        | Not used |        |        |        |        |
| Transmission type:                       | 0xFF                                          |                                                             |        |          |        |        |        |        |
| Inhibit Time<br>(1/10ms):                | 0                                             |                                                             |        |          |        |        |        |        |
| Event Timer:                             | 200 ms                                        |                                                             |        |          |        |        |        |        |
| Sync counter:                            | 0                                             |                                                             |        |          |        |        |        |        |

Corresponding Battery RPDO1 Mapping:

| COB-ID                                   | Process data in binary code                   |          |        |        |        |        |        |        |
|------------------------------------------|-----------------------------------------------|----------|--------|--------|--------|--------|--------|--------|
|                                          | Byte 0                                        | Byte 1   | Byte 2 | Byte 3 | Byte 4 | Byte 5 | Byte 6 | Byte 7 |
| RPDO1<br>180h<br>+<br>Node-ID of charger | Charger status<br>CiA-419<br>(Object: 0x6001) | Not used |        |        |        |        |        |        |

**ATTENTION:**


This is the minimum configuration for a charge process. Please add additional objects for your specific project. The charge process occurs only, when the NMT-Master commanded the charger and battery to enter NMT operational state.

**Byte 0:** Battery status (here must be set to “1” for a valid charge request, is “0” then no charge request).

**Recommendation:** setup RPDOs on the charger to receive TPDOs sent cyclically by the battery, with the Max current and Max voltage and battery ready being broadcast.

The charger can receive these values in a number of formats (see Objects in EDS file) can be used according to the common voltage/current data scaling available and broadcast by CANopen® batteries).

The charger will not operate unless the NMT master has commanded the charger to enter NMT state Operational.

The normal sequence of operation is:

- Un-configured System:
  - Setup Node-ID and bitrate, Layer Settings Services (LSS) defined in CiA 305.
  - Configuration of TPDO and RPDO (charger and battery), refer 8.7.3.2.3 How to Control the Charger via .
  - Save configuration (object: 0x1010, details see CiA-301).
  - NMT-Master commanded charger and battery to enter NMT operational state.
  - Check the charger and battery is operating.
- Configured System:
  - NMT-Master commanded charger and battery to enter NMT operational state
  - Check the charger and battery is operating

**NOTE:** A CANopen® virtual node can be setup and used to send set points to the WSB for assessment purposes if a battery / BMS is not available.

#### 8.7.3.2.4 Charging Data Example

**Precondition:** Delta-product with Node-Id: 0x20

|                                                                                                                                                                                                                                                                            |                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div style="background-color: #0056b3; color: white; padding: 5px; text-align: center; font-weight: bold;">ATTENTION:</div> <div style="text-align: center; margin-top: 10px;">  </div> | <p>For a controlled charge, make sure to configure and use the Receive PDO only. For examples refer <a href="#">8.7.3.2.3 “How to Control the Charger via CANopen®”, p. 91</a>.</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### 8.7.3.3 GUI

The charger is designed to operate with commercially available BUS analyzer tools that supports CANopen®.

For example **Emotas CANopen® Device Explorer** to communicate with WSB.

### 8.7.3.4 User Configuration (Example: Emotas CANopen® Device Explorer)

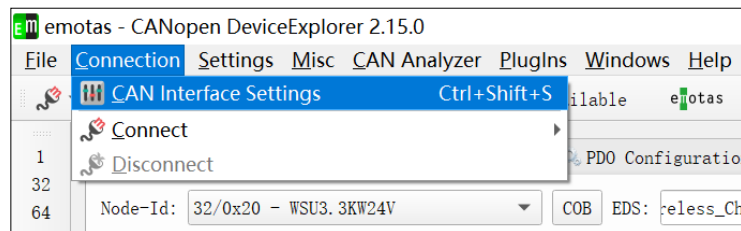
1. Power the WSB via connection to a battery with the appropriate voltage and connect the PC/Notebook to the CANopen® -Network from the WSB (Example: PCAN)
2. Make sure to install the **PEAK System Installation package** from here [PCAN-USB: PEAK-System \(www.peak-system.com/PCAN-USB.199.0.html\)](http://www.peak-system.com/PCAN-USB.199.0.html), if it is not already installed.  
From Windows **Start**, open **Emotas CANopen® Device Explorer**.

**ATTENTION:**

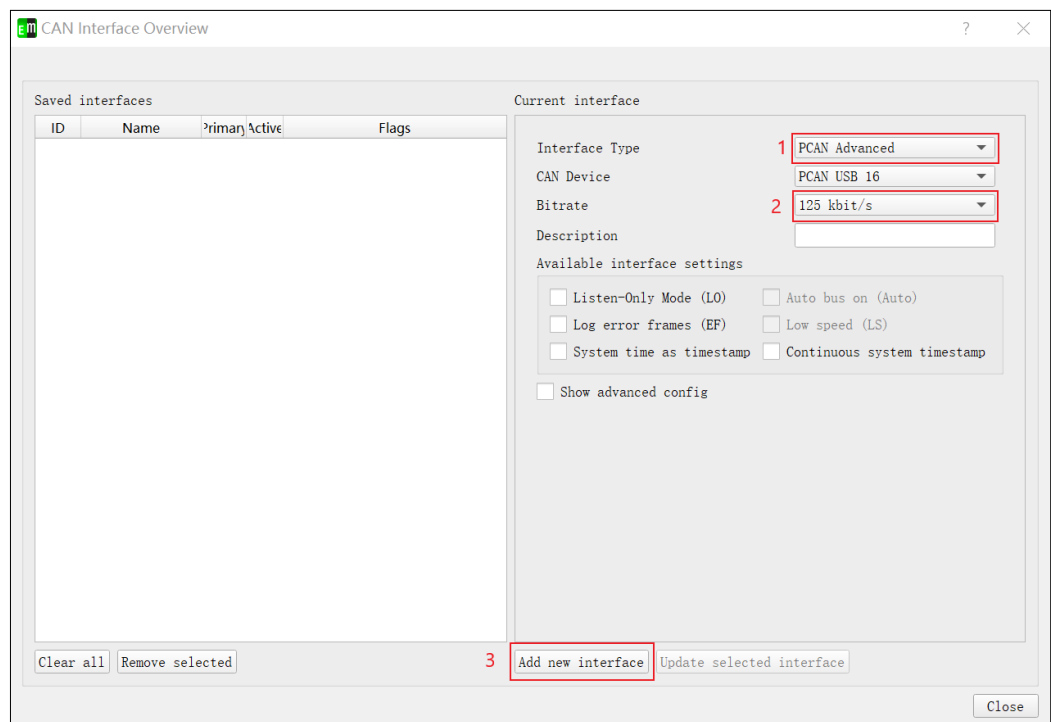
At the bottom right corner of the **CANopen® Device Explorer** window user could see Disconnected, this means connection is not yet done.

Emotas CANopen® Device Explorer is just for an example.

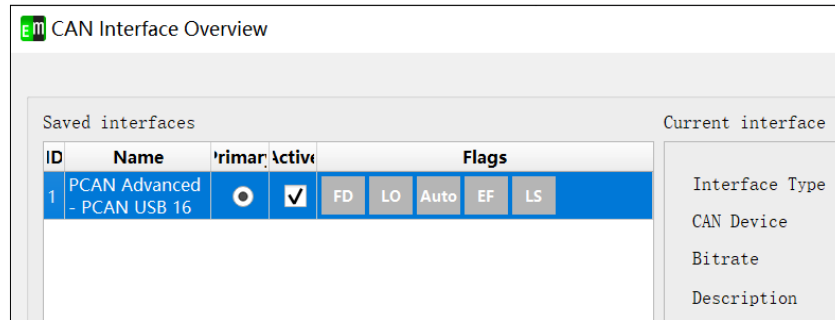
3. At first, go to **Connection -> CAN Interface Settings**, a window pops up.



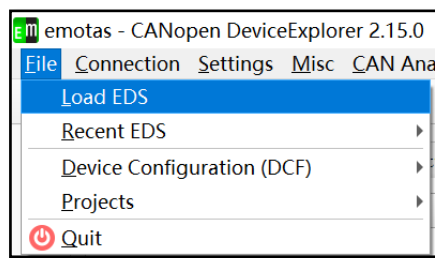
4. In **Current interface -> Interface Type -> select PCAN Advanced** from drop down list and in **Bitrate** select **125 kbit/s** -> click on **Add new interface** button.



Now, select the newly added PCAN by clicking on the **Primary** column of the newly added PCAN -> next **Close** the window.



5. Import the EDS file supplied by Delta: **File** → **Load EDS** → **WSU.eds**.

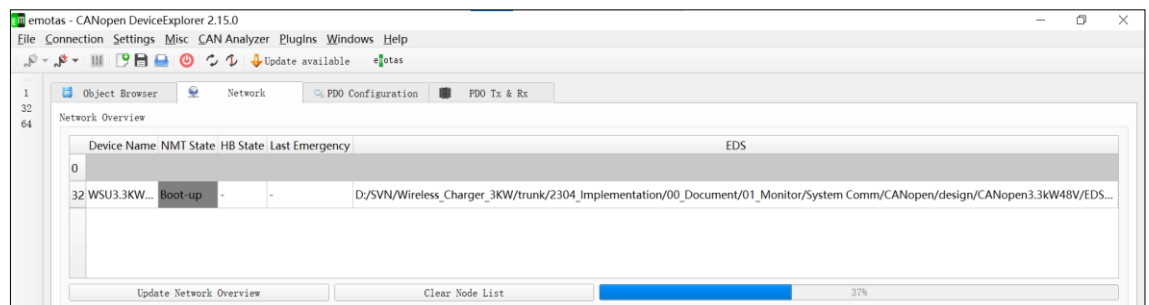


6. Once the EDS is loaded, click on **Connect** button

Once the connection is done, user would see

PCAN Advanced - PCAN USB 16 (125 kBit/s) - 0 %

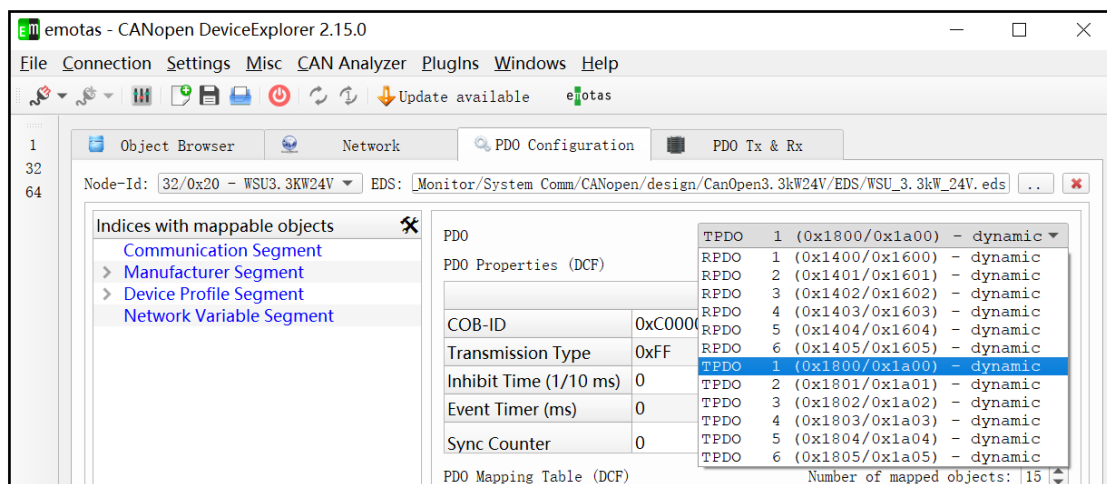
7. Now go to **Network** tab -> click on the **Update Network Overview** button, let it complete by 100%.
8. Once the desired Device name is displayed, user could stop the process by clicking on **Stop** button.



9. Now go to **PDO configuration** tab.

**Note:** RPDO (Receive-PDO, cyclic messages from battery to charger) and TPDO (Transmit-PDO, cyclic messages from charger to battery).

10. In **PDO** section, select **TPDO 1 (0x1800/0x1a00) - dynamic**.



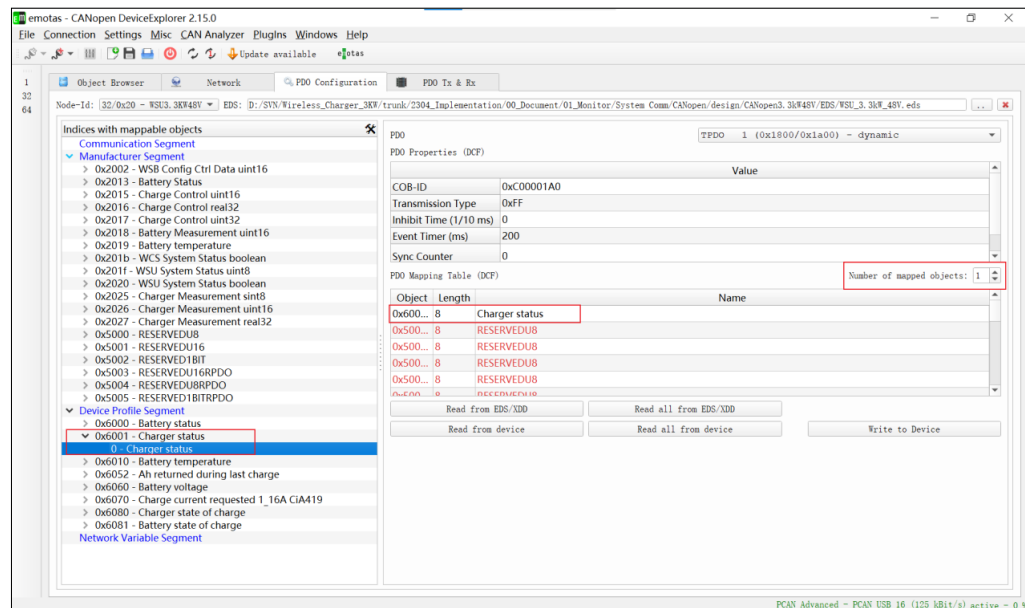
11. In **PDO Properties (EDS)** give values as:

**Note:** The parameters given in the table below are also described in CiA-301.

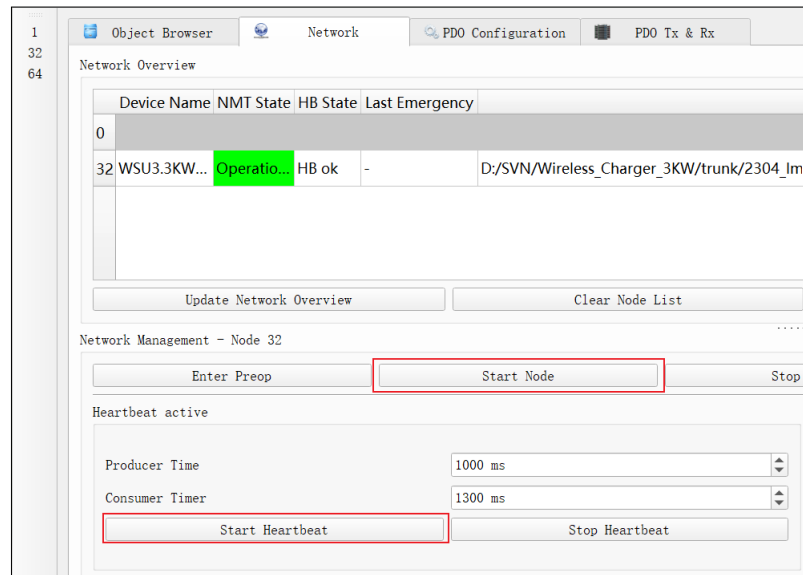
| Description            | Values                                                                                                                                |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| COB-ID                 | 0x1A0<br><b>Note:</b> The battery must have a RPDO with this COB-ID. Otherwise the battery would not receive the data in the message. |
| Transmission Type      | 0xFF                                                                                                                                  |
| Inhibit Time (1/10 ms) | 0                                                                                                                                     |
| Event Timer (ms)       | User defined (Example 200 ms)                                                                                                         |
| Sync Counter           | 0x0                                                                                                                                   |

12. In **PDO Mapping Table (EDS)** table double click on each **Name** to delete the default objects.

13. Now on the left side, open the **Manufacturer Segment / Device Profile Segment** tree. Drag and drop the required objects.



14. Repeat this process until user could see the required objects, in the **PDO Mapping Table (EDS)**.
15. Based on number of objects available in the table, give the number value in **Number of mapped objects**. Enter 4, if the number of objects in **PDO Mapping Table** is also 4.
16. Now click on the **Write to Device** button and then on the **Read from Device** button.
17. Select the desired device. Click on the **Start Heartbeat** button to update NMT state automatically, then click on the **Start Node** button.



18. User could quit the process, **File** → **Quit**.

Note: For RPDO and TPDO examples refer 8.7.3.2.3 How to Control the Charger via CANopen®.

## 9 Planning

### 9.1 System Design

The optimal alignment of the Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) during the charging process is the key factor in system design.

Since the WSP is mounted on the vehicle, the vehicle design often limits the mounting options for the WSP.

The mounting orientation of the WSP on the vehicle then determines the mounting orientation of the WPP.

Keep in mind, that the WPP and WSP can only be aligned in one configuration.

The mounting location of the Wireless Primary Box (WPB) can be chosen relatively freely. However, the cable length of the WPP must be considered.

The following sections describe the various mounting options.

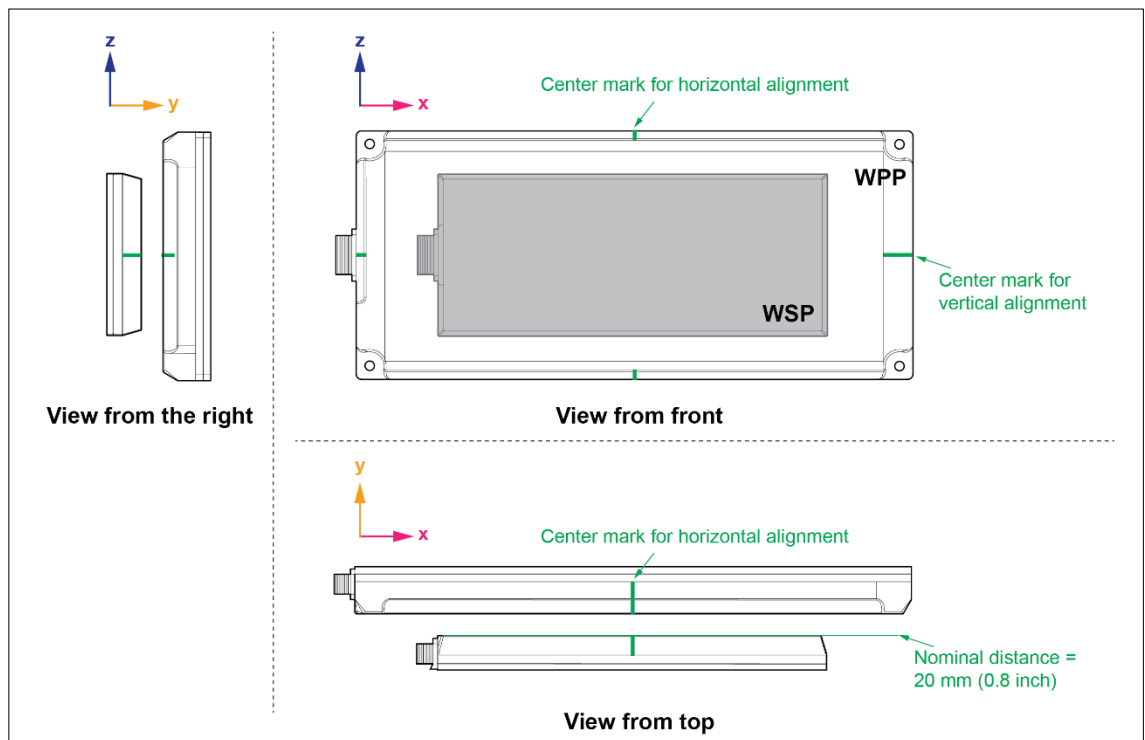


Figure. 53 Optimal mounting orientation of WPP and WSP

## 9.2 Planning the Installation

### 9.2.1 Planning WPB Installation

#### 9.2.1.1 General Recommendations

The WPB is designed to withstand harsh climatic conditions, however a solar shield is recommended to protect it from direct sunlight, as overheating of WPB may result in de-rating of the output power even shutdown of the system.

To ensure maximum operating temperature, it is recommended that WPB is installed vertically with the connections at the bottom. Take care to prevent dust and water from entering the unmated connectors.

The power supply cord must have a minimum conductor size of 12 AWG for US.

The power supply cord must have a minimum conductor size of 2.5 mm<sup>2</sup> for EU.

Use only copper cord and make sure to comply with wiring rules of the respective country where equipment is to be installed.

The power cable between WPP and WPB has a length of 2 m (6.6 ft). The installation positions must be chosen accordingly. If the WPP is positioned closer to the WPB, the slack cable can be coiled up. Shortening of the cable after production is not possible and must not be attempted.

#### **9.2.1.2 Material and tools needed for mounting the WPB**

4 screws for mounting the WPB.

No special tools are required while installing WPB.

### **9.2.2 Planning WPP Installation**

#### **9.2.2.1 General Recommendations**

The WPP is designed to withstand harsh climatic conditions, however a solar shield is recommended to protect it from direct sunlight, as overheating of WPP may result in de-rating of the output power and shutdown of the system.

#### **9.2.2.2 Material and tools needed for mounting the WPB**

4 screws for mounting the WPB.

No special tools are required while installing WPB.

## 9.3 Planning Safety Measures

### 9.3.1 Introduction

#### 9.3.1.1 Introduction



- Always consider the national and local safety regulations regarding the installation and use of wireless charging systems in industrial environments.

#### 9.3.1.2 The Presence of Electromagnetic Fields (EMF)

During operation, WPP and WSP generate two types of electromagnetic fields (EMF):

##### *Communication EMF*

One electromagnetic field (EMF) is generated by the wireless communication between the WPP and WSP. The communication EMF on the WPP is always present because the WPP constantly searches for a nearby WSU. The WSP generates an EMF only in the event of communication with the WPP.

During communication periods when no power is being transmitted, it is essential that individuals maintain a distance of at least 200 mm (7.87 in) from both pads (WSP and WPP), in all directions from the magnetic center.

##### *Power-transfer EMF*

The other EMF is generated during the charging process when power is transmitted from the WPP to the WSP. This EMF is significantly stronger than the EMF generated by the communication.

For the EMF generated during charging, keep-out areas are defined. See [9.3.2 “Safety Keep-out Areas and Safety Markings for the Charging Zone”](#), p. 102.

#### 9.3.1.3 Medical Implants

Use of the WCS may affect or impair the operation of any medical devices, such as an implantable cardiac pacemaker. Check with your medical device manufacturer concerning the effects that wireless charging may have on such devices before using the WCS.

In general, ISO14117 specifies immunity levels for implantable cardiac pacemaker at  $15 \mu T_{rms}$ .

### 9.3.1.4 Keep-out Areas

Please note that the safety distances specified in [9.3.2 “Safety Keep-out Areas and Safety Markings for the Charging Zone”, p. 102](#), are applicable for the operation of the WCS in free air. If metal is used in the keep-out areas, the magnetic field will be deformed. After installing the WSU on the vehicle, a magnetic field measurement must be performed for this WSU to ensure the given distances remain valid. If the distances deviate from those specified in this document, the keep-out distances must be adjusted as outlined in the User Instructions for the application.

## 9.3.2 Safety Keep-out Areas and Safety Markings for the Charging Zone

The facility integrator must consider the national and regional safety regulations regarding wireless charging in an industrial environment.

### 9.3.2.1 USA/FCC: Safety requirements for the facility integrator

The following safety measures have to be organized by the facility integrator.

- (A) Install a blue warning sign “NOTICE” at the boundary of the keep-out area based on the installation variant of the WPP as defined in [9.3.2.2 “Keep-out Areas”, p. 103](#).

This sign warns of a general danger.

**NOTICE**

- (B) Install a RF energy advisory symbol at the boundary of the keep-out area based on the installation variant of the WPP as defined in [9.3.2.2 “Keep-out Areas”, p. 103](#).

This sign warns of non-ionizing radiation created during charging.



- (C) Provide a training, see [6.5.2.3 “Training of Persons”](#))

### 9.3.2.2 Keep-out Areas

Below figures show the minimum safety distances for each allowed installation variant.

The safety distances mark the area which must not be entered because of the electromagnetic field during charging.

No persons are allowed in the red zone during charging.

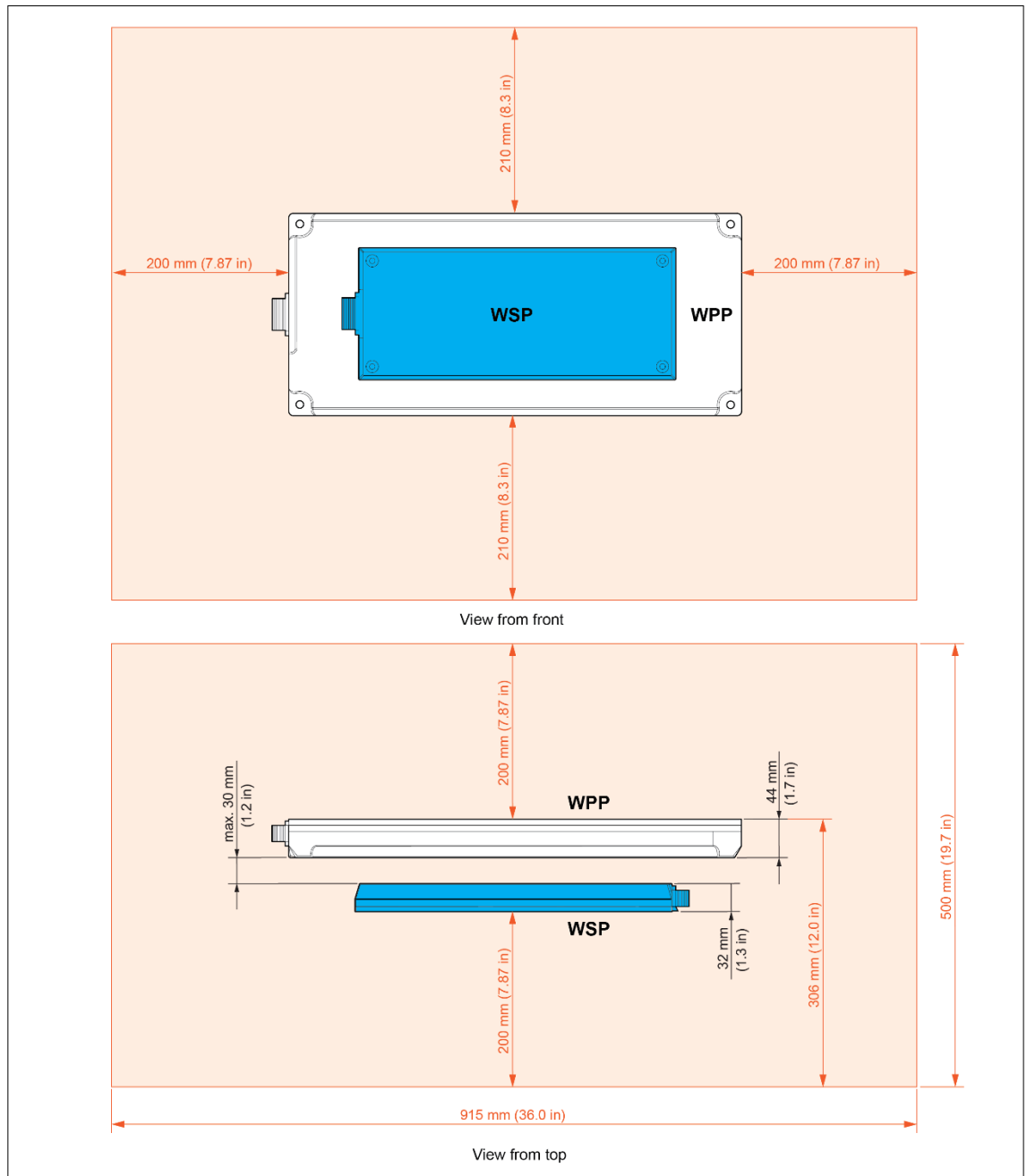


Figure. 54 Keep-out area

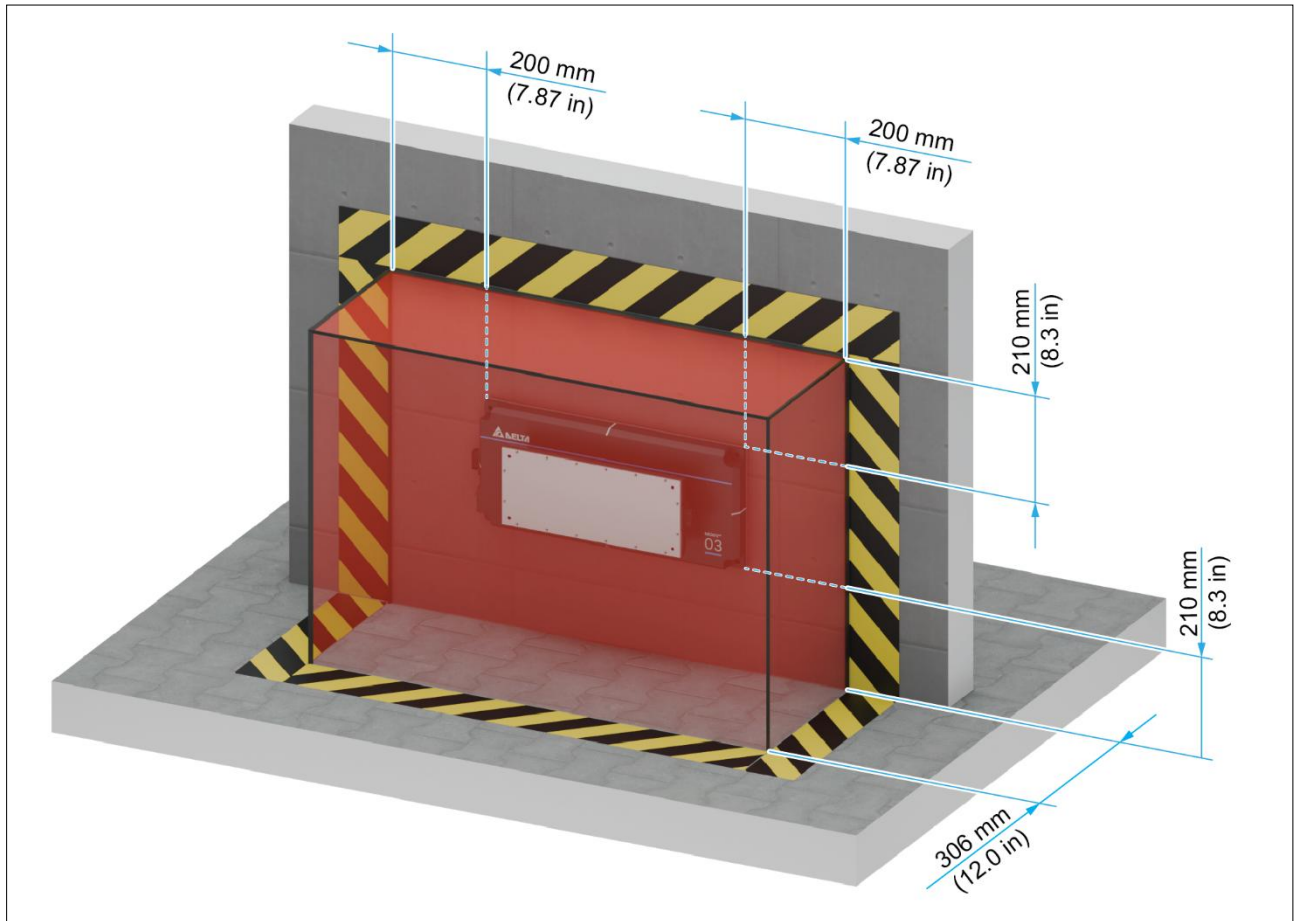


Figure. 55 Keep-out area, WPP mounted to a wall

The black-and-yellow tape marks the keep-out area, shown in red, around the WPP.

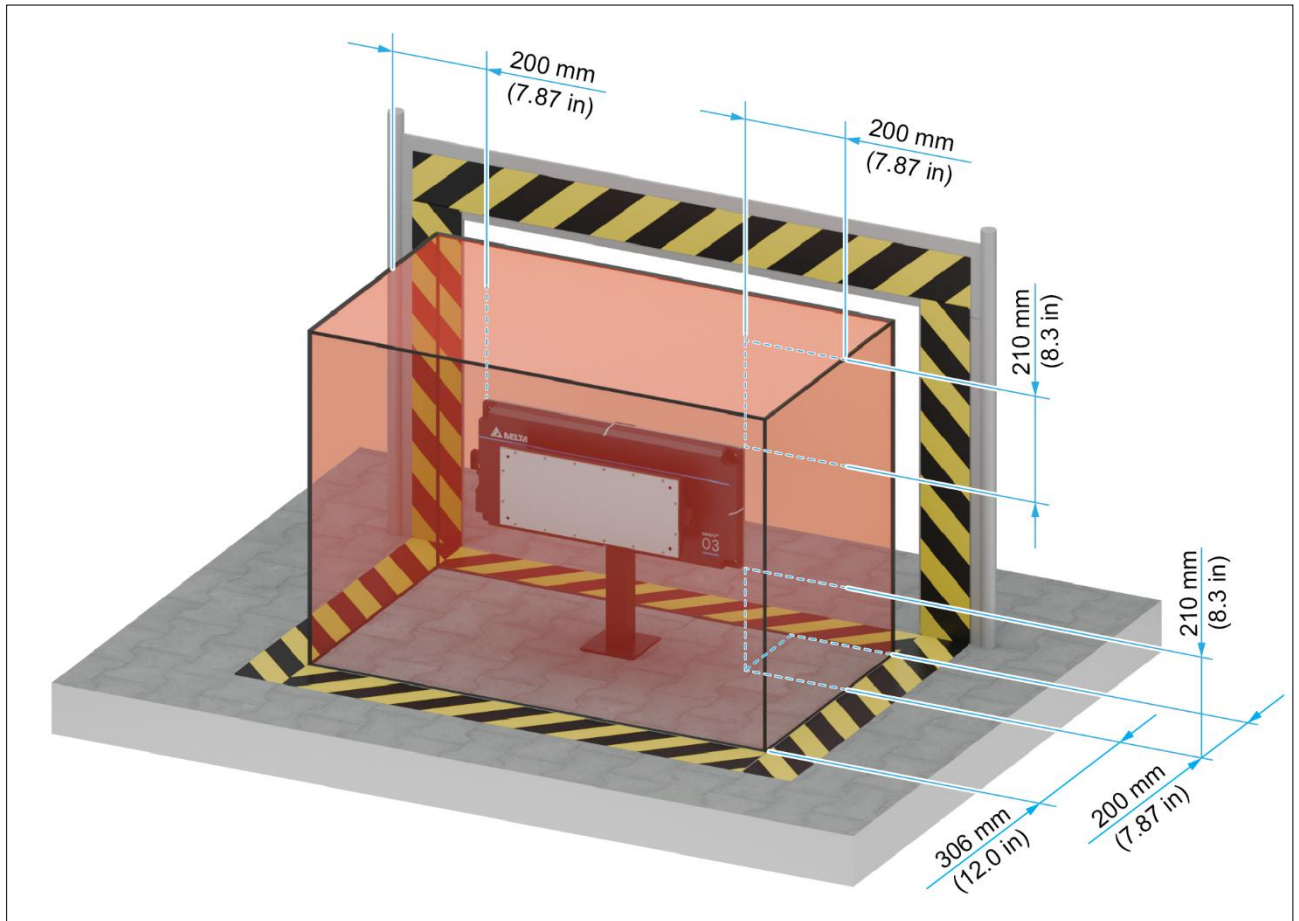


Figure. 56 Keep-out area, WPP mounted to a post

The black-and-yellow tape marks the keep-out area, shown in red, around the WPP.

## 10 Installation

The User type installing the WPB and WPP within the end facility is different from a User type installing the WSP and WSB on a vehicle, which would typically happen in a manufacturing plant. As such, the instructions below cater for this.

### 10.1 WPB

#### 10.1.1 Safety Instructions

|                                                                                                              |                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>DANGER:</b></p>       | <p><b>Electric shock</b></p> <ul style="list-style-type: none"> <li>▶ Make sure that there is no power supply to WPB for the installation process, it may lead to death of Personnel.</li> </ul>                                                                                                                              |
| <p><b>WARNING:</b></p>      | <p><b>Risk of Fire</b></p> <ul style="list-style-type: none"> <li>▶ The WPB must be protected by an external fuse/circuit breaker.</li> <li>▶ In North America, use only on circuits provided with branch circuit protection in accordance with the National Electrical Code, NFPA 70 or Canadian Electrical Code.</li> </ul> |
| <p><b>CAUTION:</b></p>     | <ul style="list-style-type: none"> <li>▶ Where a mains plug is used i.e. pluggable equipment, the mains socket outlet must be easily accessible to the user of the WPB.</li> <li>▶ If a switch is used to isolate the WPB from a 220 V-240 V supply, the switch must be rated for at least 240 V.</li> </ul>                  |
| <p><b>CAUTION:</b></p>    | <ul style="list-style-type: none"> <li>▶ Do not connect the WPB to any public grid, always connect to industrial grid. On public grid, the system will work as intended, but it might cause malfunction of other devices.</li> </ul>                                                                                          |
| <p><b>ATTENTION:</b></p>  | <p>The WPB does not have any serviceable parts and must never be opened.</p>                                                                                                                                                                                                                                                  |

## 10.1.2 Installation Procedure

|                                                                                                          |                                                                                                            |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <p><b>WARNING:</b></p>  | <p>Only Qualified skilled persons or service technicians should install WPB.</p>                           |
| <p><b>CAUTION:</b></p>  | <p>WPB shall be fixed to a wall, floor or other structure with 4 screws with nominal diameter of 6 mm.</p> |

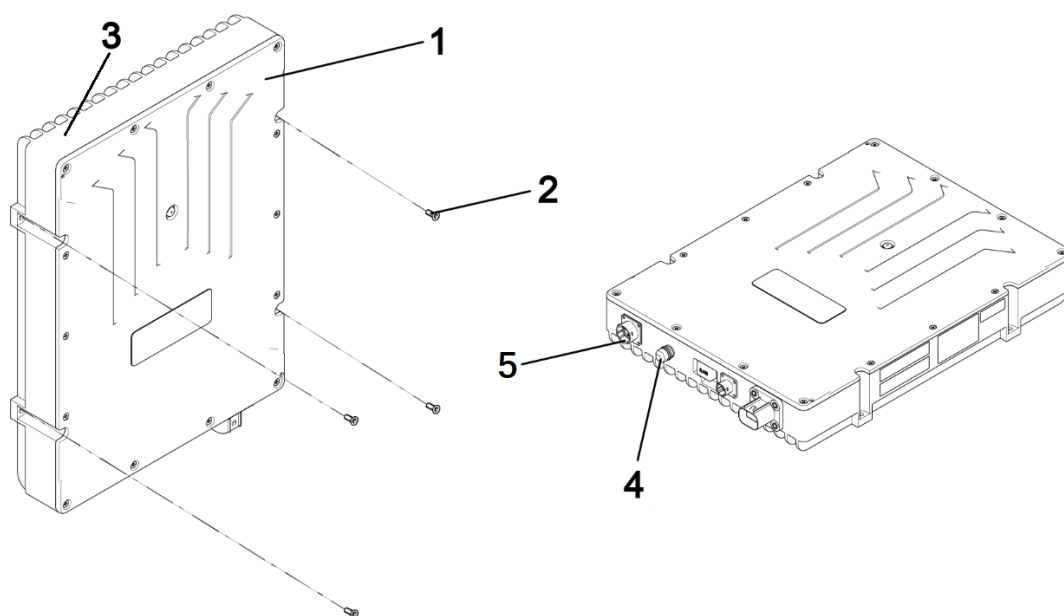


Figure. 57 WPB installation

|   |                                    |
|---|------------------------------------|
| 1 | WPB                                |
| 2 | Screws M6, at least 20mm in length |
| 4 | Ground screw                       |
| 5 | AC Input Connector                 |

1. Make sure to read and understand all the safety messages. Refer 10.1.1 Safety Instructions.
2. Make sure to disconnect all the cable connections to WPB (1).
3. Install WPB (1) to the wall or to the mounting surface using 4xM6 screws (2).
4. The top part of WPB enclosure (3) shall be protected in final installation. It is recommended to install a mesh or similar across enclosure to prevent direct contact with the enclosure.
5. Optional: Connect ground screw (4) to the GND to ensure proper earthing.
6. Connect AC input cable from the grid to WPB AC Input connector (5).
7. Optional: Connect Ethernet cables to RJ45 connector.

### 10.1.3 Ethernet Connection

The RJ45 connector for the Ethernet service interface is provided on the bottom of the WPB. The interface is compatible with shielded CAT5 cable or greater, with a maximum cable length of 100m. A dust cover is attached close to the RJ45 port, which is intended to realize IP rating when RJ45 port is not used. An Amphenol boot rubber is required for IP rating if Ethernet cable is connecting to RJ45 connector, see Accessories section.

### 10.1.4 Power Up & Health Checks

It is best practice to install and connect the WPB and WPP prior to powering up and performing health checks.

## 10.2 WPP

### 10.2.1 Safety Instructions

|                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>WARNING:</b></p>      | <p><b>Electromagnetic Field (EMF)</b></p> <ul style="list-style-type: none"> <li>▶ The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produce a potentially harmful magnetic field during the charging process.</li> <li>▶ Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see <b>6.5 EMF Safety Instructions</b>.</li> </ul> <p>Use of the wireless charger may affect or impair the operation of any medical devices, such as an implantable cardiac pacemaker. Check with your medical device manufacturer concerning the effects that wireless charging may have on such devices before using the wireless charger.</p> <ul style="list-style-type: none"> <li>▶ Electromagnetic field exposure to pregnant Users and Children is strictly forbidden.</li> <li>▶ Advise the end user about safety distances and affix appropriate warnings.</li> <li>▶ Warning signs should be clearly displayed at the charging area.</li> <li>▶ Do not install or operate the system in the public area.</li> <li>▶ Electronic objects such as cell phones and hearing aids may get damaged.</li> </ul> |
| <p><b>WARNING:</b></p>    | <p><b>Electromagnetic Field (EMF)</b></p> <ul style="list-style-type: none"> <li>▶ Make sure that there is no WSP in charging range when the installation of the WPP is carried out, particularly when connecting the WPP cable to the WPB. Charging could begin unexpectedly, which enables the magnetic field.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <p><b>WARNING:</b></p>    | <p><b>Electric Shock</b></p> <ul style="list-style-type: none"> <li>▶ Disconnect all cable connections to WPP to make sure that there is no power supply to WPP for the installation process, otherwise there could be a danger of electric shock.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p><b>CAUTION:</b></p>    | <p><b>Hot surfaces</b></p> <ul style="list-style-type: none"> <li>▶ Do not touch the WPP while charging is in progress.</li> <li>▶ Do not touch the WPP for at least 30 minutes (cooling time) after the charging process is finished.</li> <li>▶ Make sure to wear safety gloves while handling the subsystems after charging.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><b>ATTENTION:</b></p>  | <p>If the WPP needs to be replaced in the field, best practice is to isolate the AC Input supply to the WPB before replacing the WPP.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|                                                                                                            |                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ATTENTION:</b></p>  | <p>The WPP does not have any serviceable parts and must never be opened.</p>                                                                                   |
| <p><b>ATTENTION:</b></p>  | <p>Do not lift the WPP using cable assembly. Finger lifting point is available for lifting from a flat surface. <b>Error! Reference source not found..</b></p> |

## 10.2.2 Special Tools & Equipment

No special tools are required while installing WPP.

## 10.2.3 Installation Conditions

### 10.2.3.1 Location

The WPP is designed to withstand harsh climatic conditions, however a solar shield is recommended to protect it from direct sunlight, as overheating of WPP may result in de-rating of the output power and shutdown of the system.

### 10.2.3.2 Mounting Orientation

Make sure to install the WPP vertically on the wall:

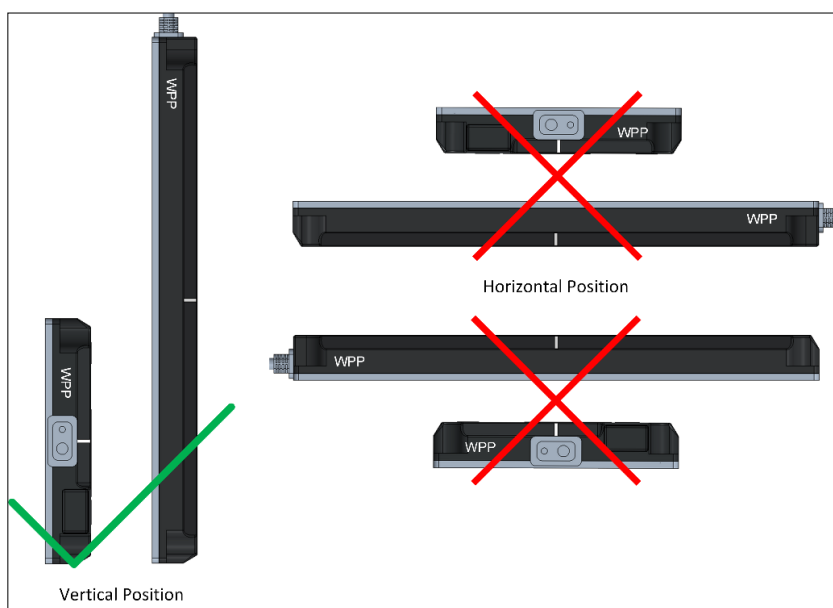


Figure. 58 Mounting orientations

### 10.2.3.3 Alignment of WPP and WSP

Make sure to install the WPP at the same height as the WSP within a misalignment tolerance limit otherwise wireless power transfer is not possible. Also consider applicable vehicle tire wear that may change the height of the WSP over time.

### 10.2.3.4 Cable Connection

The length of the power & signal cables between WPB and WPP is 2 m. The power & signal cables of WPP do not intend for dynamic use. Choose the installation positions of WPB and WPP accordingly and keep within minimum bend radius.

Minimum bend radius (MBR) of WPP power and signal cables: 110 mm (4.3 in).

The WPP can pair with the WSP at 0 and 180 degrees rotation. If the WPP is positioned closer to the WPB, the slack cable can be coiled up. Shortening of the cable after production is not possible and must not be attempted.

### 10.2.3.5 Mounting Material

Make sure to use appropriate screws while mounting the WPP to the supporting wall/fixture with respect to the WPP weight.

### 10.2.3.6 Mounting On Metals

The WPP can be mounted directly on ferrous (e.g. steel) and non-ferrous (e.g. aluminum) metals.

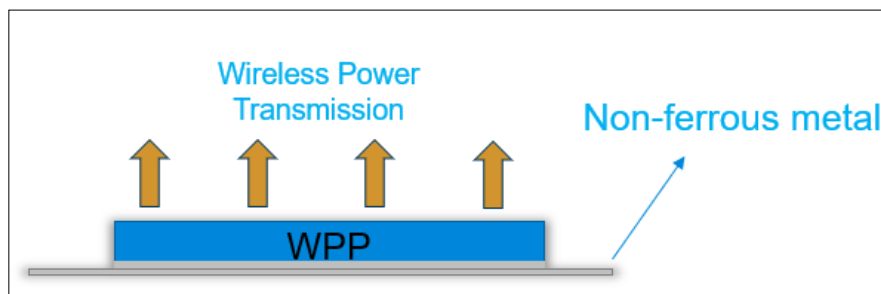


Figure. 59 WPP – Mounting on non-ferrous metal

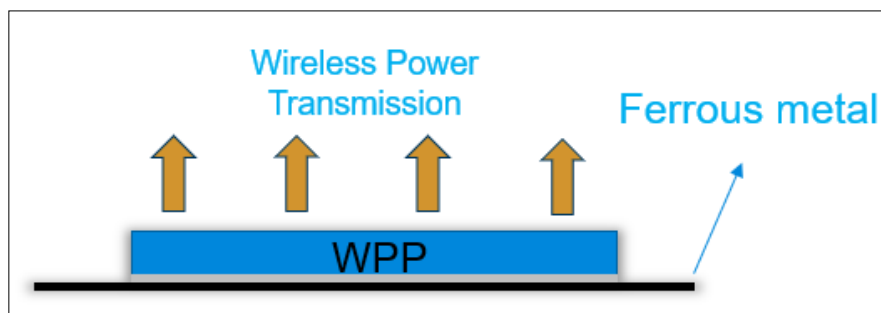


Figure. 60 WPP – Mounting on ferrous metal

If the WPP plastic surface is flush with a non-ferrous metal plate, then no clearance from the edge of the WPP is necessary (0 mm / 0 in).

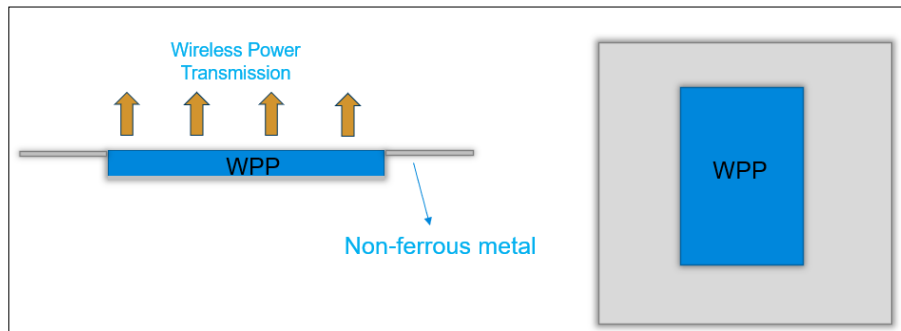


Figure. 61 WPP – Mounting flush with non-ferrous metals

If the WPP plastic surface is flush with a ferrous metal plate, then at least 20 mm (0.79 in) clearance from the edge of the WPP is necessary.

Failure to adhere to this installation requirement may result in reduced performance issues and/or damage to the system.

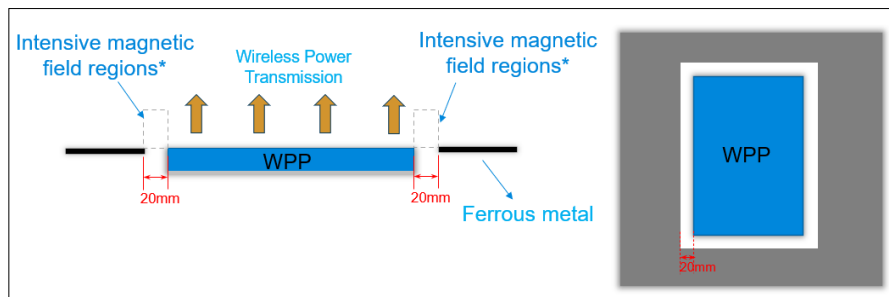


Figure. 62 WPP – Mounting flush with ferrous metals

\* In addition to directly in front of the WPP.

## 10.2.4 Installation Procedure

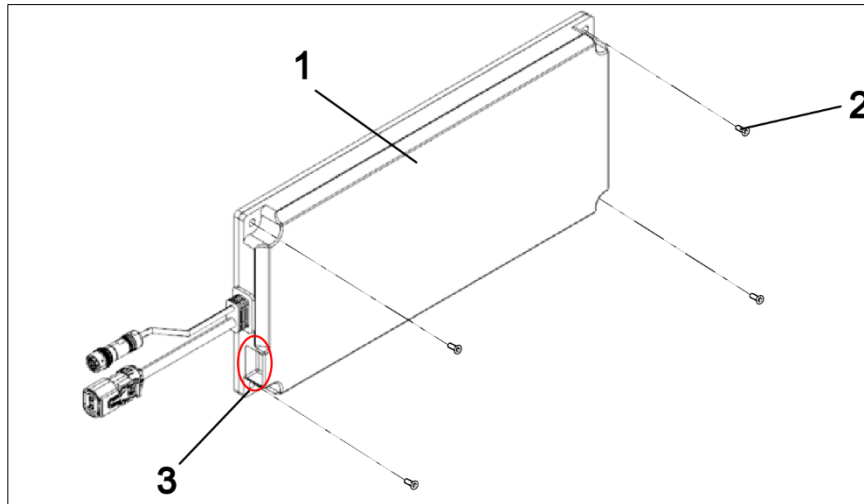


Figure. 63 WPP – Installation

|   |                                    |
|---|------------------------------------|
| 1 | WPP                                |
| 2 | Screws M8, at least 28mm in length |
| 3 | Lifting Point                      |

1. Make sure to read and understand all the safety messages. Refer 10.2.1 Safety Instructions and 6.5 EMF Safety Instructions.
2. Install WPP (1) to the wall or to the mounting surface using 4x M8 screws (2).

## 10.2.5 Connecting WPP to WPB

|                                                                                   |                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>WARNING:</b></p> <p><b>Electric shock</b></p> <p>► Make sure to disconnect the AC supply of the WPB before connecting WPP to WPB, as it may lead to death of Personnel.</p> |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

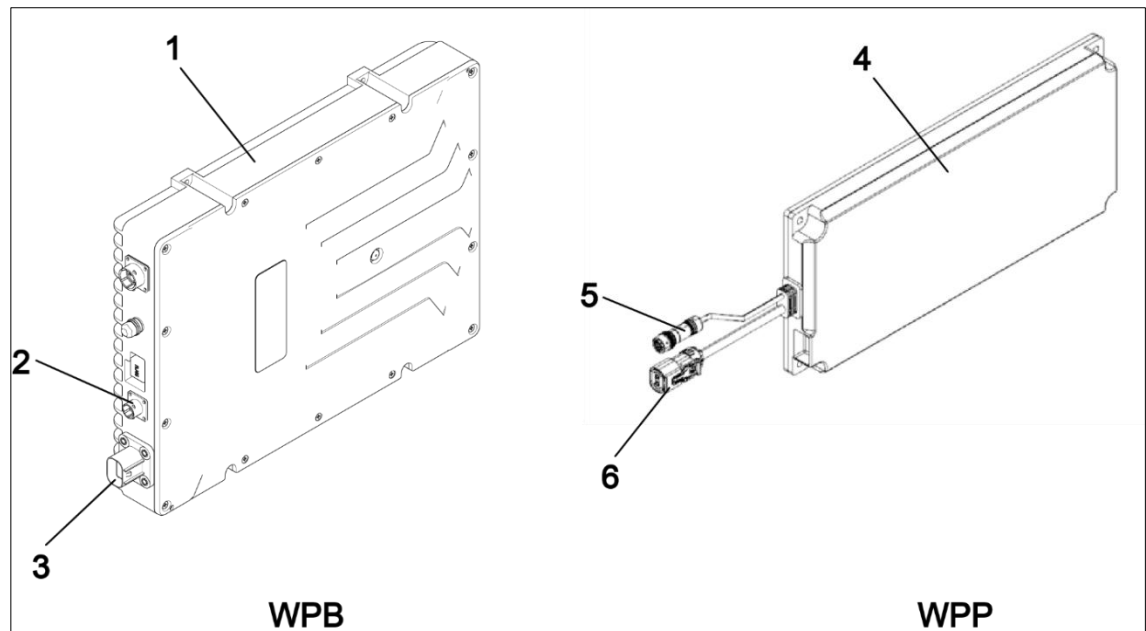


Figure. 64 Connecting WPP to WPB

|   |                      |
|---|----------------------|
| 1 | WPB                  |
| 2 | WPB Signal Connector |
| 3 | WPB Power Connector  |
| 4 | WPP                  |
| 5 | WPP Signal Cable     |
| 6 | WPP Power Cable      |

1. Make sure to read and understand all the safety messages.
2. Connect WPP power cable (6) to WPB power connector (3).  
**Note:** Minimum bend radius of WPP power and signal cables: 110 mm (4.3 in).
3. Connect WPP signal cable (5) to WPB signal connector (2).

## **10.2.6 Power Up & Health Checks**

- 1.** Verify that the previous WPB and WPP installation instructions have been carried out successfully.
- 2.** Enable the AC supply to the WPB.
- 3.** Observe that the Power LED is illuminated green on the WPB Status LED Panel.
- 4.** Observe that there is no other LED illuminated on the WPB Status LED Panel including the WPU Fault LED.
- 5.** If the WPU Fault LED is illuminated, refer to section 13 Troubleshooting.
- 6.** The WPB Ethernet service interface can now be accessed, see section 3.5.2. Log onto the Ethernet webpage.
- 7.** Verify that the WPB and WPP SW versions can be read and are the latest revisions.
- 8.** Verify that the WPB and WPP are not reporting any Warnings/Faults.
- 9.** Check and/or modify the User Configurable parameters as required.
- 10.** Log out of the Ethernet webpage.

## 10.3 WSP

### 10.3.1 Safety Instructions

|                                                                                                             |                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>DANGER:</b></p>      | <p><b>Electric shock</b></p> <p>Only qualified skilled person shall install, uninstall, service and maintain the WSP.</p>                                                                                                                                     |
| <p><b>DANGER:</b></p>      | <p><b>Electric Shock</b></p> <ul style="list-style-type: none"> <li>▶ Disconnect all cable connections to WSP to make sure that there is no power supply to WSP for the installation process, otherwise there could be a danger of electric shock.</li> </ul> |
| <p><b>DANGER:</b></p>      | <p><b>Electric shock</b></p> <p>Dangerous voltage levels are output by the WSP during charging.</p> <ul style="list-style-type: none"> <li>▶ Do not handle or disconnect the cable connections during the charging process.</li> </ul>                        |
| <p><b>ATTENTION:</b></p>  | <p>The WSP does not have any serviceable parts and must never be opened.</p>                                                                                                                                                                                  |

### 10.3.2 Special Tools & Equipment

No special tools are required while installing the WSP.

### 10.3.3 Installation Conditions

#### 10.3.3.1 Mounting Orientation

Make sure to install the WSP vertically on any side of the vehicle

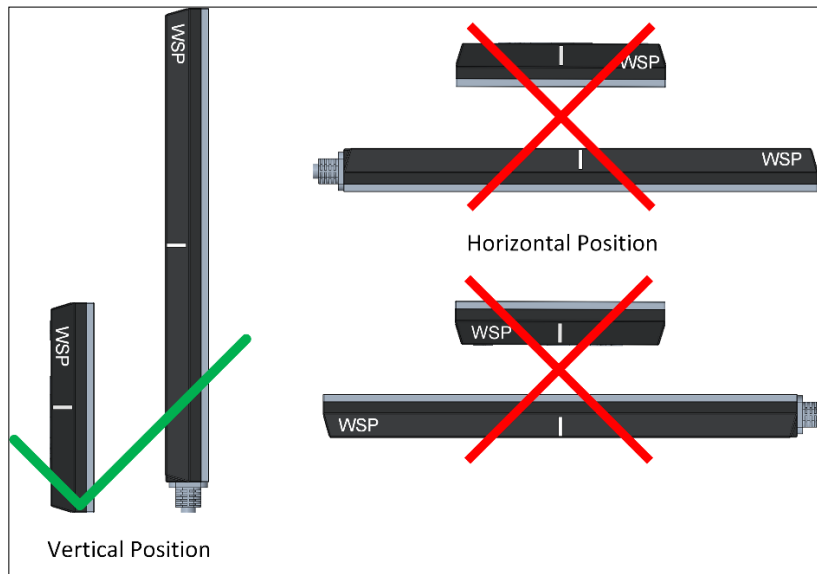


Figure. 65 WSP – Mounting Orientation

#### 10.3.3.2 Mounting on Metals

If the WSP plastic surface is flush with a non-ferrous metal plate, then no clearance from the edge of the WPP is necessary (0 mm / 0 in).

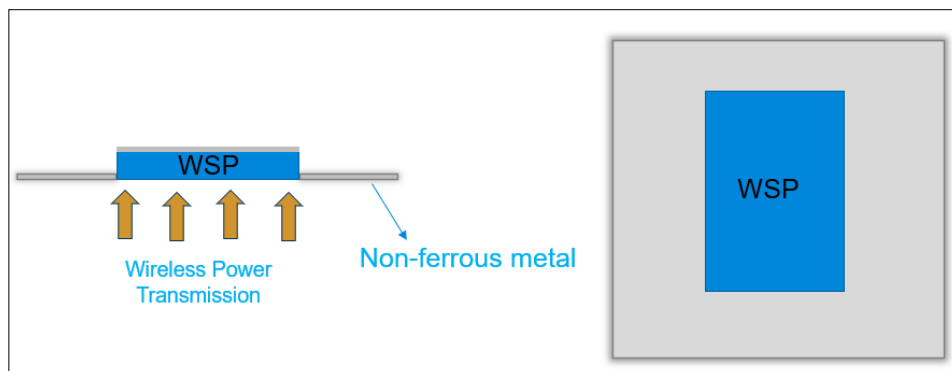


Figure. 66 WSP – Mounting flush with non-ferrous metal

If the WSP plastic surface is flush with a ferrous metal plate, then a clearance of at least 80 mm (3.2 in) from the edge of the WSP is necessary.

Failure to adhere to this installation requirement may result in reduced performance issues and/or damage to the system.

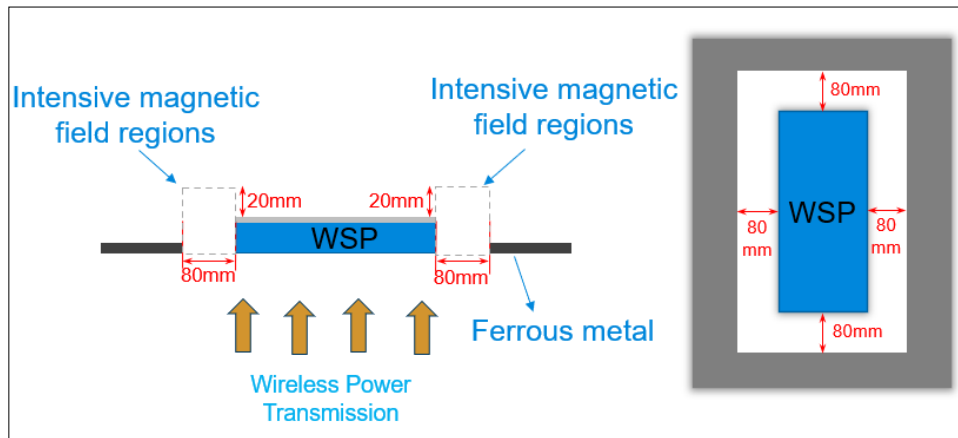


Figure. 67 WSP – Mounting flush with ferrous metals

## 10.3.4 Installation Procedure

### 10.3.4.1 Mounting the WSP on the Vehicle

|                                                                                                            |                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ATTENTION:</b></p>  | <p>WSP could also be installed on a metal sheet which acts as a heat sink, this improves the heat dissipation during the charging process. Mounting the WSP with a heat sink would increase the operation time at full output current before de-rating occurs (refer <a href="#">8.1 Output Power and De-rating</a>).</p> |
|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

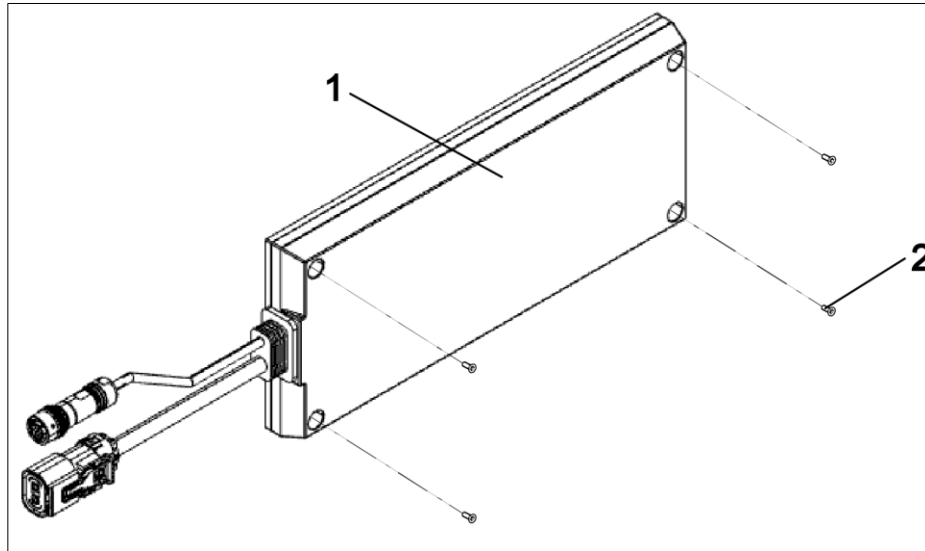


Figure. 68 WSP – Mounting to the vehicle

- |   |                                    |
|---|------------------------------------|
| 1 | WSP                                |
| 2 | Screws M6, at least 20mm in length |

1. Make sure to read and understand all the safety messages..
2. Make sure to disconnect all the cable connections to WSP (1). Refer [10.4.5 Connecting WSP to WSB](#).
3. Install WSP (1) to the vehicle using 4x M6 screws (2).

## 10.3.5 Power Up & Health Checks

The WPB needs to be installed prior to powering up and performing health checks.

## **10.4 WSB**

### **10.4.1 Safety Instructions**

### **10.4.2 Special Tools & Equipment**

No special tools are required while installing the WSB.

### **10.4.3 Installation Conditions**

#### **10.4.3.1 Cable Connection**

The WSB cable connections must be protected from access to unskilled people.

The power & signal cables between WSP and WSB are not intended for dynamic use.

#### **10.4.3.2 Installation Support**

Make sure to use appropriate screws while mounting the WSB to the vehicle with respect to the WSB weight.

#### **10.4.3.3 Cable Management**

Make sure that WSB installation position is adequate for WSP cables and vehicle/battery cables for routing and keeping within minimum bend radius.

WSP power & signal cables MBR: 110 mm (4.3 in)

WSB 24V & 36V DC cables MBR: 120 mm (4.7 in)

WSB 48V DC cables MBR: 100 mm (3.9 in)

## 10.4.4 Mounting the WSB to the Vehicle

|                                                                                                            |                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ATTENTION:</b></p>  | <p>WSB could also be installed on a metal sheet which acts as a heat sink, this improves the heat dissipation during the charging process.</p> <p>Mounting the WSB with a heat sink would increase the operation time at full output current before de-rating occurs (refer <a href="#">8.1 Output Power and De-rating</a>).</p> |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

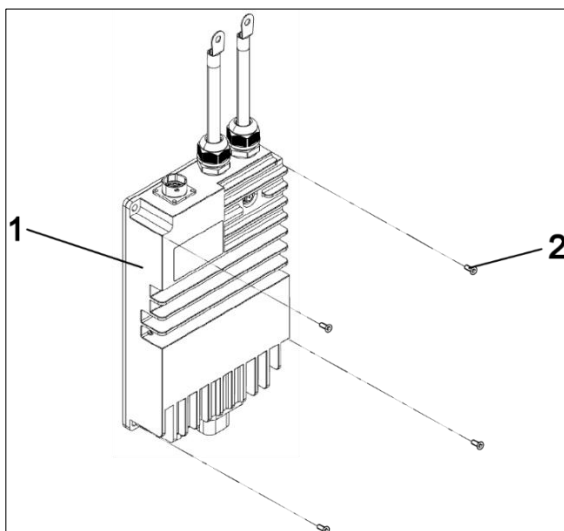


Figure. 69 WSB – Mounting to the vehicle

- |   |                                    |
|---|------------------------------------|
| 1 | WSB                                |
| 2 | Screws M6, at least 20mm in length |

1. Make sure to read and understand all the safety messages.
2. Make sure to disconnect all the cable connections to WSB (1).
3. Install WSB (1) to the vehicle using 4xM6 screws (2).

## 10.4.5 Connecting WSP to WSB

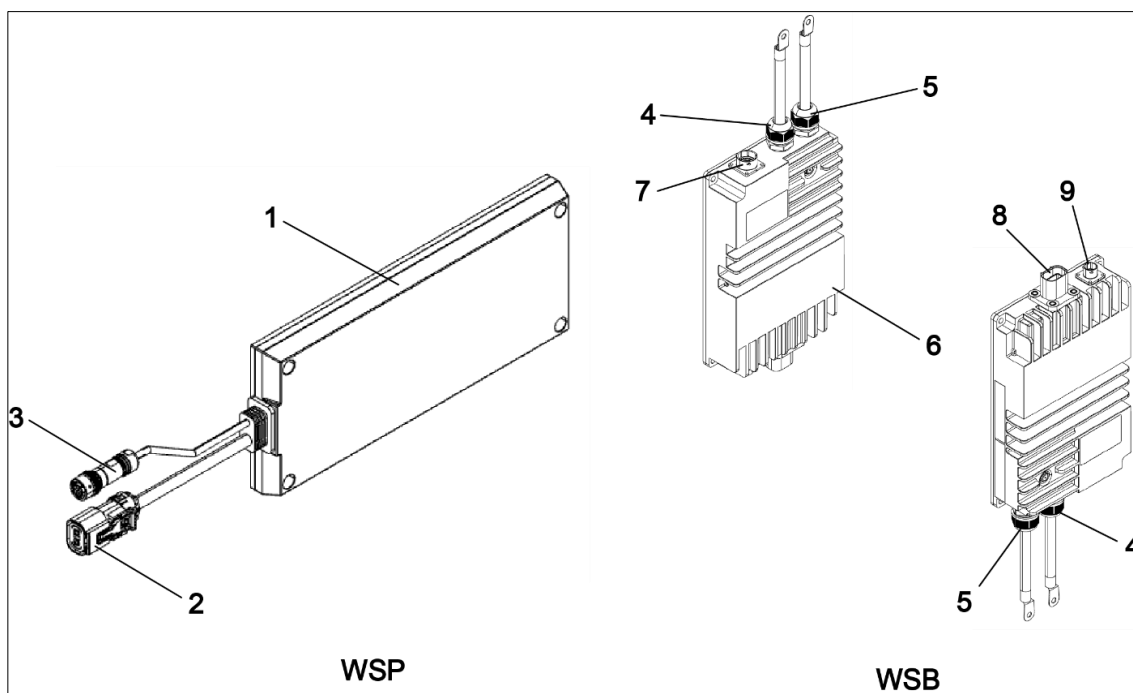


Figure. 70 WSP – Connecting to WSB

|   |                              |
|---|------------------------------|
| 1 | WSP                          |
| 2 | WSP Power Cable              |
| 3 | WSP Signal Cable             |
| 4 | WSB DC Output -ve Cable      |
| 5 | WSB DC Output +ve Cable      |
| 6 | WSB                          |
| 7 | WSB User Interface Connector |
| 8 | WSB Power Connector          |
| 9 | WSB Signal Connector         |

1. Make sure to read and understand all the safety messages.
2. Connect WSP signal cable (3) to WSB signal connector (9).
3. Connect WSP power cable (2) to WSB power connector (8).

### 10.4.5.1 WSB DC Power Cable Connection

1. Make sure to read and understand all the safety messages. Refer 10.4.1 Safety Instructions.
2. Connect the DC output cables RED (1) to the positive pole (+) of the battery and BLACK (2) to the negative pole (-) of the battery.

### 10.4.5.2 WSB User Interface Cable Connection

The desired system control mode with the method to start & stop charging and the data acquisition option will determine if the User Interface Cable is required or not.

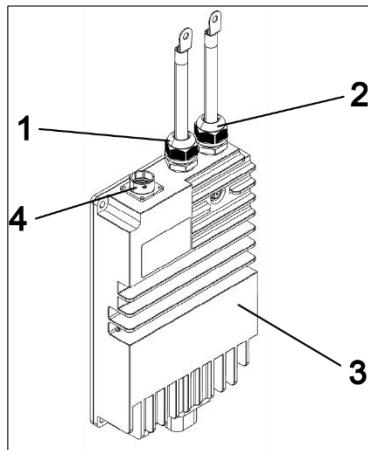


Figure. 71 WSB – Cable connections

|   |                          |
|---|--------------------------|
| 1 | DC Output -ve Cable      |
| 2 | DC Output +ve Cable      |
| 3 | WSB                      |
| 4 | User Interface Connector |

1. If required connect the (customer provided) User Interface Cable to the WSB.

### 10.4.5.3 NTC Cable Design

If lead acid battery temperature compensation is required for Internal Multiphase Profile (IMP) charge mode, then a temperature probe can be installed within a ring terminal within the customer User Interface Cable assembly. An example ring terminal with embedded NTC design is provided below:

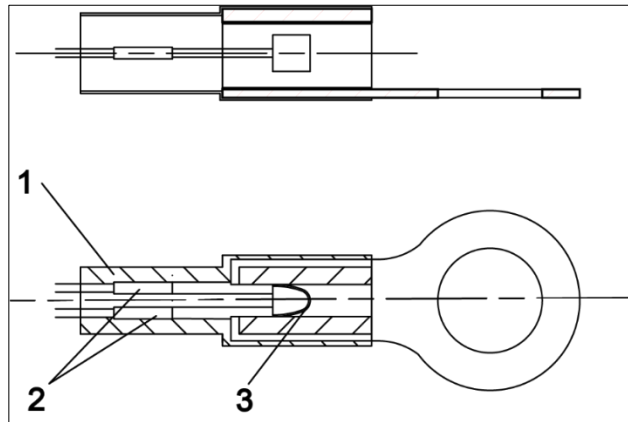


Figure. 72 WSB – NTC with ring terminal

| Item | Description                                                                  | Quantity |
|------|------------------------------------------------------------------------------|----------|
| 1    | H/S Tube, 10 x 0.35mm                                                        | 1        |
| 2    | H/S Tube, 2 x 0.2mm                                                          | 2        |
| 3    | NTC, 10 kOhm. Vendor P/N: Thinking Electronic TTC3A103F34D1EH2 or equivalent | 1        |

## 10.4.6 Power Up & Health Checks

|                                                                                                            |                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ATTENTION:</b></p>  | <p>The WSB will not initialize when there is no battery connected or when the battery voltage is less than:</p> <ul style="list-style-type: none"> <li>▶ 24 V variant: 12 V</li> <li>▶ 36 V variant: 18 V</li> <li>▶ 48 V variant: 24 V</li> </ul> |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1. Check the voltage on the battery terminals is within voltage tolerance of the WSB interface (WSB Auxiliary power is derived from DC output interface).
2. If CANopen® communications are integrated, establish CANopen® communications, refer to section [5.6.3.2](#). If CANopen® is not integrated, skip the following steps and instead perform within section 5 after step 1.
3. Verify that the WSB and WSP software versions can be read and are the latest revisions.
4. Verify that all information that is desired is being received by the vehicle.
5. Verify that the WSB/WSP is not reporting any Warnings/Faults.
6. Check and/or modify the User Configurable parameters as required.

## 11 System Commissioning / Start-up

### 11.1 Safety Instructions

|                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>Electromagnetic Field (EMF)</b></p> <ul style="list-style-type: none"> <li>▶ The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produces a potentially harmful magnetic field during the charging process.</li> <li>▶ Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see <b>6.5 EMF Safety Instructions</b>.</li> </ul> <p>Use of the wireless charger may affect or impair the operation of any medical devices, such as an implantable cardiac pacemaker. Check with your medical device manufacturer concerning the effects that wireless charging may have on such devices before using the wireless charger.</p> <ul style="list-style-type: none"> <li>▶ Electromagnetic field exposure to pregnant Users and Children is strictly forbidden.</li> <li>▶ Advise the end user about safety distances and affix appropriate warnings.</li> <li>▶ Warning signs should be clearly displayed at the charging area.</li> <li>▶ Do not install or operate the system in the public area.</li> <li>▶ Electronic objects such as cell phones and hearing aids may get damaged.</li> </ul> |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 11.2 Wireless Charging

Once the subsystems have been installed, powered up and health checked successfully, the wireless charging process can then be performed on a battery that requires charging.

1. Position the vehicle so that the WSP is within range of the WPP (see 3.3.1.5 WPP & WSP Positioning for correct positioning).
2. Depending on the system charge mode selected, initiate the external system to start a charge cycle.
3. Verify that the following WPB Status LEDs are illuminated only:
  - AC Power: Green
  - Positioning: Green
  - Charging: Green Flash
4. Logon to the Ethernet webpage and check the health status and make sure that there are no Warnings/Faults, including de-rating.
5. If applicable, verify that all data that has been configured to be sent from the vehicle to the WPB (via WSP & WPP) is being received e.g. Battery SoC.
6. If applicable, verify that all data that has been configured to be sent from the WCS to the vehicle is being received e.g. positioning information.
7. Monitor the Battery SoC from the vehicle and ensure that the charge time is as expected (calculation).

## 12 Maintenance

This section contains detailed step-by-step instructions necessary to carry out all types of maintenance tasks on the system.

### 12.1 Safety Instructions

During maintenance, the following warning, cautions and notes must be observed.

### 12.2 Preventive Maintenance

|                                                                                                           |                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>CAUTION:</b></p>   | <p><b>Hot Surfaces</b></p> <ul style="list-style-type: none"> <li>▶ Make sure that both the pads (WPP and WSP) are free from foreign object to avoid overheating while charging is in progress. Clean the pads as and when needed to avoid danger of overheating.</li> </ul> |
| <p><b>CAUTION:</b></p>  | <ul style="list-style-type: none"> <li>▶ Make sure to check all the cables (external) for any damages and if necessary replace them.</li> <li>▶ Only qualified skilled person shall replace the cables.</li> </ul>                                                           |

|     | Daily Check                                                                                                                                                                                                                                            | Yearly Inspection                                                                                      |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| WPB | Make sure that the Status LED panel indicates correct function and status: Power LED on, Fault LEDs off, other indicators working as intended.                                                                                                         | Periodic inspection according to the NFPA 70B, EN 50110 or regional/country equivalent is recommended. |
| WPP | Check for metallic foreign objects on the WPP, if present clear away with a soft brush or similar.<br><br>Check the WPP for visible damage. If any damage is detected, discontinue use of the WPP and disconnect it from WPB, refer to section 10.2.5. | Periodic inspection according to NFPA 70B, EN 50110 or regional/country equivalent is recommended.     |
| WSP | Check for metallic foreign objects on the WSP, if present clear away with a soft brush or similar.<br><br>Check the WSP on every vehicle for visible damage. If any damage is detected, discontinue the use of WSP.                                    | Periodic inspection according to NFPA 70B, EN 50110 or regional/country equivalent is recommended.     |
| WSB | Check the WSB on every vehicle for visible damage. If any damage is detected, discontinue the use of WSB.                                                                                                                                              | Periodic inspection according to NFPA 70B, EN 50110 or regional/country equivalent is recommended.     |

## 12.3 General Cleaning

### 12.3.1 Materials

|                                                                                                                                                                                                                          |                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div data-bbox="416 353 603 405" data-label="Text"> <b>WARNING:</b> </div> <div data-bbox="443 414 576 528" data-label="Image">  </div> | <p>Cleaning agents should be used with care. Make sure to follow the instructions (for example dilutions) provided in the datasheets of the cleaning agents.</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Material                                        |
|-------------------------------------------------|
| Electrical Contact Cleaner                      |
| Kärcher VehiclePro Truck Cleaner, acidic RM 804 |
| Kärcher Autoshampoo 3-IN-1 RM 610               |

Table 19 Recommended cleaning agents

#### Note:

- Use all cleaning solutions with care.
- Alternative equivalents are permitted.
- For plastic parts only use cleaning agents suitable for cleaning plastic.

### 12.3.2 Cleaning WPB & WSB

1. Put clean PVC or polythene gloves on your hands to protect your hands from cleaning agents.
2. Wipe off any dirt with a clean dry cloth or soft brush. Use a microfiber or a soft lint-free cloth only. Do not use abrasive cloths, towels, paper towels or similar items.
3. Dirt, oil and grease may require a solvent to be removed. If this is required use an alcohol solution consisting of 70% isopropyl alcohol and 30% water. Keep liquids away from the WPB. Moisten (not wet) a microfiber or soft lint-free cloth with the cleaning agent and wipe clean.
4. Dry all of the equipment before use.

### 12.3.3 Cleaning WPP & WSP

1. Put clean PVC or polythene gloves on your hands to protect your hands from cleaning agents.
2. Wipe off any dirt with a clean dry cloth or soft brush. Use a microfiber or a soft lint-free cloth only. Do not use abrasive cloths, towels, paper towels or similar items.
3. Dirt, oil and grease may require a solvent to be removed. If this is required use an alcohol solution consisting of 70% isopropyl alcohol and 30% water. Keep liquids away

from the WPB. Moisten (not wet) a microfiber or soft lint-free cloth with the cleaning agent and wipe clean.

4. For cleaning by cold water pressure washer, either clean without cleaning agent or use a cleaning agent as referred in **Error! Reference source not found.**, items 2 & 3 with a dosage of up to 3%. Pressure washer suitability as follows:
  - Flow rate: 12 l/m min
  - Impact force: 1.2 N

## 12.4 Corrective Maintenance

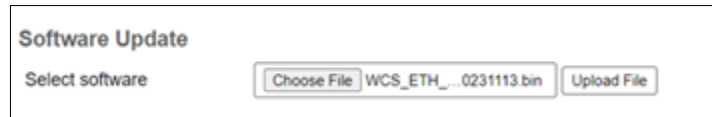
There are no replaceable parts within any of the WCS subsystems.

## 12.5 Firmware Update

### 12.5.1 WPU

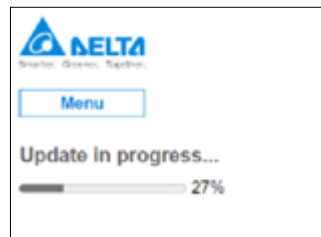
Firmware of the WPU could be updated through the Ethernet interface.

1. Login to the webpage and switch to “Admin” page, chose a firmware which needs to update.



2. Click the **Upload File** button, the updating will start, and the progress is displayed on the webpage.

**Note:** Attachment file names have a limit of 59 characters.



3. When the update process is finished, it will automatically switch back to the “Admin” page, and the latest firmware version can be checked on that page.



## 12.5.2 WSU

The firmware and the multi-stage profile on the WSU could be updated via the Ethernet or CANopen® interface.

### 12.5.2.1 Via CANopen®

The WSB and WSP firmware could be updated from the CANopen® interface with similar process, but the sub-index 1 is for WSB and sub-index 2 is for WSP, detail process is as below:

1. Write 0x85EAC1CE to the object 0x2040 to activate the WSU maintenance mode. Read the object 0x2040 to check the result, value 2 means WSU maintenance mode activated.
2. Stop the program by writing 0 to the object with index 0x1F51 (sub-index 1 for WSB, sub-index 2 for WSP). The state could be checked by reading this object, value 0 means the program is stopped, value 1 means the program is running.
3. Download the WSB/WSP firmware through the object with index 0x1F50 (sub-index 1 for WSB, sub-index 2 for WSP). The type of this object is domain, the whole file could be downloaded with protocol SDO download segment.
4. Start the program by writing 1 to the object with index 0x1F51(sub-index 1 for WSB, sub-index 2 for WSP).
5. Delay for a while, deactivate the WSU maintenance mode by writing 0x00 to the object 0x2040.
6. Check the firmware version.

### 12.5.2.2 Via Ethernet

When updating the WSU firmware through Ethernet interface, it is same as updating the WPU firmware, but need to pair the WSU with the WPU, then import the WSU firmware on the “Admin” page and click **Download File** button.

For information refer to section [12.5.1 WPU](#).

## 12.6 WSU Multistage Profile Update

### 12.6.1 Via CANopen®

The multistage profile could be updated from the CANopen® interface, detail process is as below:

1. Write 0x85EAC1CE to the object 0x2040 to activate the WSU maintenance mode.  
Read the object 0x2040 to check the result, value 2 means WSU maintenance mode activated.
2. Download the multistage profile through the object with index 0x2200. The type of this object is domain, the whole file could be downloaded with protocol SDO download segment.
3. Delay for a while, deactivate the WSU maintenance mode by writing 0x00 to the object 0x2040.
4. Check the charger profile ID by reading the object with index 0x2020 and sub-index 3.

### 12.6.2 Via Ethernet

When updating the multistage profile through Ethernet interface, it is same as updating the WPU firmware, but need to pair the WSU with the WPU, then import the multistage profile on the “Admin” page and click **Download File** button. For information refer to section [12.5.1 WPU](#).

## 13 Troubleshooting

This section provides information for identification and correction of malfunctions and faults of the WCS.

### 13.1 Identifying Subsystems to Troubleshoot

The following are different ways to identify a faulty subsystem:

- Status LED panel
- Ethernet communications interface, see section [8.7.2](#).
- CANopen® communications interface, see section [8.7.3](#).

| 3.3kW WCS Status LEDs                   |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
|-----------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Category                                | WPU                                                                                 |                                                                                     | POS                                                                                 | WSU                                                                                 |                                                                                     |
| Symbol                                  |  |  |  |  |  |
| Description                             | AC IN                                                                               | Fault                                                                               |                                                                                     | Fault                                                                               | Charge                                                                              |
| AC Not OK                               |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| AC OK                                   |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| AC OK, Position OK, Charging            |                                                                                     |                                                                                     |                                                                                     |                                                                                     | Flash                                                                               |
| AC OK, Position Suboptimal, Charging    |                                                                                     |                                                                                     | Flash                                                                               |                                                                                     | Flash                                                                               |
| AC OK, Position too far, not charging   |                                                                                     |                                                                                     | Flash                                                                               |                                                                                     |                                                                                     |
| AC OK, Position too close, not charging |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| AC OK, Charge Complete                  |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WPU Fault                               |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WSU Fault                               |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WPU & WSU Fault                         |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WPU Warning                             |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WSU Warning                             |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| WPU & WSU Warning                       |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |

Figure 3 LED indications for faults on status LED panel

**Note:** Further diagnostics for troubleshooting can be acquired from the Ethernet webpage and/or CANopen® interface e.g. PPL Connection Status, detailed Positioning Status etc.

## 13.2 Troubleshooting on WPB

| Symptom                            | Probable Cause                                               | Corrective Action                                                                                                                                            |
|------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No power to WPB                    | WPB is not connected properly to grid                        | Check the connection between WPB and grid                                                                                                                    |
|                                    | WPB Internal defect                                          | Confirm with Delta and request for replacement if it is within the Warranty period                                                                           |
| Cannot connect to Ethernet webpage | No power to WPB                                              | As above                                                                                                                                                     |
|                                    | Ethernet cable not properly connected                        | Check connections on WPB and other end of cable                                                                                                              |
|                                    | User PC network settings                                     | Check User PC network settings                                                                                                                               |
|                                    | Network switch Firewall rules and settings                   | To bypass any network problems, it is recommended to connect the WPB to the User PC directly with an Ethernet cable<br>Contact your IT network administrator |
|                                    | WPB may have been misconfigured by a User e.g. wrong gateway | Contact your IT network administrator                                                                                                                        |

Table 20 Troubleshooting on WPP

## 13.3 Troubleshooting on WPP

| Symptom         | Probable Cause                       | Corrective Action                                                                  |
|-----------------|--------------------------------------|------------------------------------------------------------------------------------|
| No power to WPP | WPP is not connected properly to WPB | Check the connection between WPB and WPP (power connector and signal connector)    |
|                 | WPP Internal defect                  | Confirm with Delta and request for replacement if it is within the Warranty period |

Table 21 Troubleshooting on WPP

## 13.4 Troubleshooting on WSP

| Symptom         | Probable Cause                                                | Corrective Action                                                                                 |
|-----------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| No power to WSP | WSP is not connected properly to WSB                          | Check the connection between WSB and WSP (power connectors and signal connector)                  |
|                 | WSP internal defect                                           | Confirm with Delta and request for replacement if it is within the Warranty period                |
|                 | Pad to pad positioning (air gap and/or misalignment) is wrong | Check the position of both the pads and correct it as referenced in section <a href="#">8.3</a> . |

Table 22 Troubleshooting on WSP

## 13.5 Troubleshooting on WSB

| Symptom               | Probable Cause                                                | Corrective Action                                                                                                                                                                   |
|-----------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No power to WSB       | WSB is not installed properly and is not connected to battery | Check the installation of WSB and make sure all connections to battery are correct                                                                                                  |
|                       | WSB internal defect                                           | Confirm with Delta and request for replacement if it is within the Warranty period                                                                                                  |
| Charging not starting | Battery connection to WSB is incorrect                        | Make sure to securely connect both the red and black cables to the battery terminals<br>Make sure that the polarity is not reversed                                                 |
|                       | Wrong battery                                                 | Check the voltage range of the battery, correct voltage range:<br>WSB 24V: 12 to 33 V<br>WSB 36V: 18 to 49.5 V<br>WSB 48V: 24 to 66 V<br>Below or above this range is not accepted. |
|                       | Battery is Full                                               | Charging does not happen when battery is full, User should know this information via BMS or vehicle SoC gauge                                                                       |
|                       | Charge Mode and/or charge settings not correct                | Check the Charge Mode and WCS settings on the Ethernet webpage                                                                                                                      |

Table 23 Troubleshooting on WSB

## 13.6 Troubleshooting of Detail Faults

### 13.6.1 Troubleshooting of WSU Faults

| Fault        | Definition                                                                          | Clear mechanism                                               | Troubleshooting                                                                                                                                                                                     |
|--------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hardware     | Indicates that incompatible WSP or WPU hardware detected.                           | Cannot be cleared by command.                                 | Replace with the compatible WSP or WPU module.                                                                                                                                                      |
| Firmware     | Indicates that WSU is not compatible with other MCUs in firmware.                   | Cannot be cleared by command.                                 | Check the firmware version of MCUs and update the compatible firmware.                                                                                                                              |
| Calibration  | Indicates that the calibration data of WSU is abnormal.                             | Clear by command.                                             | Re-calibrate.                                                                                                                                                                                       |
| Sensor       | Indicates that the NTC module is broken.                                            | Cannot be cleared by command                                  | Check which temperature is set to -128 or 140 and replace the new NTC module.                                                                                                                       |
| LossMonitor  | Indicates that the loss of charger is abnormal.                                     | Auto clear, if occurred 5 times then latch WSU for 5 minutes. | Check whether there exists metal objects between WPP and WSP.<br>Check whether the WPP or WSP is moving during charging.                                                                            |
| ShortCircuit | Indicates that the output side of charger occurs short circuit fault when charging. | Clear by command.                                             | Check the cable connection between the charger output and battery.                                                                                                                                  |
| OverVoltage  | Indicates that the output voltage of charger exceeds the pre-set protection.        | Clear by command.                                             | Check the cable connection of output side, battery voltage and the setting of the max voltage is not appropriate. Record the output voltage and current, the faults/warnings/status of WPU and WSU. |
| UnderVoltage | Indicates that the output voltage of charger is lower the pre-set point.            | Auto clear when the voltage is over than the pre-set point.   | Check whether the battery is over-discharged or the setting of the min voltage is not appropriate.                                                                                                  |

| Fault              | Definition                                                                                   | Clear mechanism                                              | Troubleshooting                                                                                                                                                                                                                                                                                                       |
|--------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OverCurrent        | Indicates that the output current of charger exceeds the pre-set point.                      | Auto clear when the current is lower than the pre-set point. | <p>Check whether there is a sudden voltage drop in the battery. This phenomenon may be caused by the BMS bypassing the higher voltage battery cells when the battery is almost fully charged.</p> <p>Check whether there is a sudden decrease of the gap and/or misalignment between WPP and WSP during charging.</p> |
| OverTemperature    | Indicates the temperature of WSU exceeds the pre-set point.                                  | Auto clear when temperature is lower than pre-reset point.   | Check the temperature of WSU.                                                                                                                                                                                                                                                                                         |
| PowerStage         | Indicates the output voltage or current of charger is over the reference value.              | Clear by command.                                            | Check whether the charging current command is still high when the battery is almost fully charged. If so, it is necessary to reduce the charging current command when the battery is almost fully charged.                                                                                                            |
| Vehicle            | Indicates that the vehicle side occurs fault.                                                | Need to clear by vehicle side                                |                                                                                                                                                                                                                                                                                                                       |
| IcpSetpoints       | Indicates that the set-point of voltage and current exceeds the charger limit under ICP mode | Auto clear when the set-point is correct.                    | Check the set-point configuration of ICP and modify to the value within the scope.                                                                                                                                                                                                                                    |
| ImplInvalidProfile | Indicates that the parameters of profile is invalid under IMP mode.                          | Auto clear when the re-imported profile is valid.            | Update the valid profile.                                                                                                                                                                                                                                                                                             |

| Fault              | Definition                                                                        | Clear mechanism                                                       | Troubleshooting                                                                                                                                                                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ImpBattProfile     | Indicates that the charger occurs charge-phase error under IMP mode               | Clear by command.                                                     | <p>Check whether the profile is matched with the battery.</p> <p>Check whether there is any abnormal change in the voltage and current waveform during the charging process.</p> <p>Record the output voltage and current, the faults/warnings/status of WPU and WSU.</p> |
| ImpBattTemperature | Indicates that the the battery temperature exceeds the limit range under IMP mode | Clear by command.                                                     | Check the temperature of battery and the configuration of the profile.                                                                                                                                                                                                    |
| CommCan            | Indicates that the communication of canopen occurs fault under ECC                | Clear by command or switch out Operational Mode of NMT state machine. | Check the heartbeat or RPDO message.                                                                                                                                                                                                                                      |
| CommInternal       | Indicates that the the communication of can between WSB and WSP occurs failure    | Auto clear when the communication is rebuilt.                         | Check the connection of the communication wire between WSB and WSP.                                                                                                                                                                                                       |
| WatchdogReset      | Indicates that the MCU of WSB or WSP reset due to watch dog.                      | Clear by command.                                                     | Record the firmware version of MCUs.                                                                                                                                                                                                                                      |

Table 24 Troubleshooting of WSU Faults

## 13.6.2 Troubleshooting of WPU Faults

| Fault       | Definition                                                                            | Clear mechanism                                                                    | Troubleshooting                                                                                                                                                        |
|-------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hardware    | Indicates that incompatible WPP or WSU hardware detected..                            | Cannot be cleared by command until re-compatible.                                  | Replace with the compatible WPP and WSB module.                                                                                                                        |
| Firmware    | Indicates that WPU is not compatible with other MCUs in firmware.                     | Cannot be cleared by command until re-compatible.                                  | Check the firmware version of MCUs and update the compatible firmware.                                                                                                 |
| Calibration | Indicates that the calibration data of WPU is abnormal.                               | Clear by command.                                                                  | Re-calibrate.                                                                                                                                                          |
| Sensor      | Indicates that the NTC module is broken.                                              | Cannot be cleared by command                                                       | Check which temperature would be set to -128 or 140 and replace the new NTC module.                                                                                    |
| Ac          | Indicates that the ac voltage exceeds the limit range.                                | Auto clear when Ac voltage returns to normal range.                                | Check the voltage of AC source.                                                                                                                                        |
| Pfc         | Indicates the input power or the inductance current of PFC is over the pre-set point. | Auto clear when input power or inductance current is lower than the pre-set point. | Check the output voltage of AC source, the gap and misalignment between WPP and WSP. Record the output voltage and current, the faults/warnings/status of WPU and WSU. |
| BulkOv      | Indicates the output voltage of PFC is over the pre-set point.                        | Auto clear when bulk voltage is lower than the pre-reset point.                    | Record the output voltage and current, the faults/warnings/status of WPU and WSU.                                                                                      |
| BuckBoostOc | Indicates the output current of Buckboost is over the pre-set point.                  | Clear by command or automatically (5s).                                            | Record the output voltage and current, the faults/warnings/status of WPU and WSU.                                                                                      |
| BuckBoostOv | Indicates the output voltage of Buckboost is over the pre-set point.                  | Clear by command or automatically (5s).                                            | Record the output voltage and current, the faults/warnings/status of WPU and WSU.                                                                                      |

| Fault         | Definition                                                                    | Clear mechanism                                       | Troubleshooting                                                                                                                       |
|---------------|-------------------------------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| IptOc         | Indicates the output current RMS of IPT is over the pre-set point.            | Clear by command or automatically (5s).               | Check the gap and misalignment between WPP and WSP. Record the output voltage and current, the faults/warnings/status of WPU and WSU. |
| PhaseDet      | Indicates the detected phase of IPT exceeds the limit.                        | Clear by command or automatically (5s).               | Check the output terminal connection of WPB. Record the output voltage and current, the faults/warnings/status of WPU and WSU.        |
| Position      | Indicate the position between WSP and WPP is too close or too far.            | Clear by command or automatically (5s) .              | Check the gap and misalignment between WPP and WSP.                                                                                   |
| OverTemp      | Indicates the temperature of WPU exceeds the pre-set point.                   | Clear when temperature is lower than pre-reset point. | Check the temperature of WPU.                                                                                                         |
| CommEth       | Indicates that the the reception of Control Command is timeout under ECE mode | Clear by command.                                     | Check the transmission of Control Command in webpage.                                                                                 |
| CommInternal  | Indicates that the the communication in WPU occurs failure.                   | Auto clear when the communication is rebuilt.         | Check the connection of the communication wire between WPB and WPP.                                                                   |
| WatchdogReset | Indicates that the MCU of WPB and WPP reset due to watch dog.                 | Clear by command.                                     | Record the firmware version of MCUs.                                                                                                  |

## 14 Accessories & Spare Parts

## 14.1 Part numbers of Subsystems

| Part number | Name of subsystem |
|-------------|-------------------|
| EOE16010870 | WPB               |
| EOE16010952 | WPP               |
| EOE16010953 | WSP               |
| EOE16011067 | WSB 24V           |
| EOE16011066 | WSB 36V           |
| EOE16010871 | WSB 48V           |

Table 25 Part numbers of subsystems

## 14.2 Development Kit

| Part number | Description                                                                                                                                             |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| EOE99001129 | Development kit.<br>Consists of:<br>WSB Signal Cable Harness<br>AN Bus 120 $\Omega$ Termination: D-Sub to D-Sub Connector<br>PCAN Adapter: D-Sub to USB |

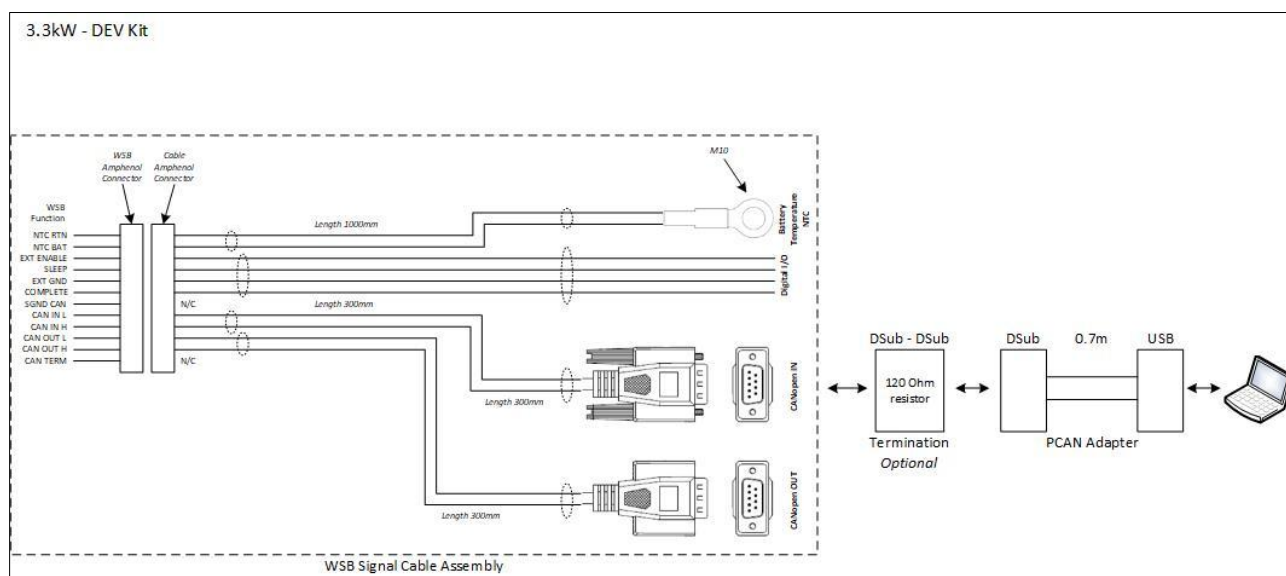


Figure. 73 sDevelopment Kit connectios

## 15 Warranty

The following section provides the information regarding warranty and non-warranty conditions. Make sure to go through these conditions before approaching Delta for warranty service.

### 15.1 Warranty Conditions

The limited warranty is applicable for physical goods/products purchased from Delta and covers the following conditions.

- The limited warranty applies only to material and production defects under normal use and maintenance during the warranty period.
- Delta repairs or exchanges the defective parts under normal use and maintenance during the warranty period.
- The warranty period for the physical goods/products purchased from Delta is valid for 24 months from the date of manufacturing.

### 15.2 Non-Warranty Conditions

The limited warranty does not cover the following conditions:

- Any defects which is not resulting from material and production.
- Failed to obey the safety instructions and guidance given in this document.
- Scratches and wear due to improper handling or installation of the physical goods/products.
- Any indication that the enclosure for WPB, WPP, WSP or WSB has been opened.
- Cables or connectors have been removed or changed.
- The firmware being loaded is of an older version than the one indicated on the product label.
- Accidental damage or damage caused by other devices.

Kindly contact Delta to determine the problem and to provide a most appropriate solution.

### 15.3 Return Procedure

In case of repair or return under limited warranty period, kindly contact your Delta sales representative who would assign a RMA number and provide packing and shipping details.

### 15.4 Product Life

Each subsystem product life is 10 years or 44,000 hours, whichever comes first.

## **16 Disposal**

### **16.1 Disposal of system and subsystems**

The WCS and its subsystems constitute industrial electronic equipment. Disposal must be in accordance with applicable local regulations.

### **16.2 Disposal of packaging materials**

Packaging materials must be disposed of in accordance with applicable local regulations.

## 17 List of Figures

|                           |                                                                                       |    |
|---------------------------|---------------------------------------------------------------------------------------|----|
| Figure. 1                 | Subsystems of the WCS.....                                                            | 13 |
| Figure. 2                 | Wireless Charging .....                                                               | 15 |
| Figure. 3                 | Interoperability .....                                                                | 16 |
| Figure. 4                 | Components of the Wireless Primary Box.....                                           | 17 |
| Figure. 5                 | WPB – Status LED Panel .....                                                          | 18 |
| Figure. 6                 | Status LED Panel on the WPB .....                                                     | 19 |
| Figure. 7                 | Field wiring terminals on WPB.....                                                    | 20 |
| Figure. 8                 | Ethernet Service Interface .....                                                      | 21 |
| Figure. 9                 | WPB Interface Components .....                                                        | 21 |
| Figure. 10                | Figure 1 WPP – Components.....                                                        | 23 |
| Figure. 11                | WSB – Components .....                                                                | 25 |
| Figure. 12                | WSB – signal connector .....                                                          | 26 |
| WSB Signal Connector..... |                                                                                       | 26 |
| Figure. 13                | WSP - Components .....                                                                | 30 |
| Figure. 14                | Labels of Specification.....                                                          | 35 |
| Figure. 15                | Labels of Warning.....                                                                | 35 |
| Figure. 16                | Output power and current limits with variable voltage at 24 V nominal voltage.....    | 42 |
| Figure. 17                | Output power and current limits with variable voltage at 36 V nominal voltage.....    | 43 |
| Figure. 18                | Output power and current limits with variable voltage at 48 V nominal voltage.....    | 44 |
| Figure. 19                | Power de-rating vs. time at different ambient temperatures - WSP and WSB.....         | 45 |
| Figure. 20                | Maximum output power vs. input grid voltage .....                                     | 46 |
| Figure. 21                | Maximum input current vs. input grid voltage .....                                    | 46 |
| Figure. 22                | Optimal alignment and nominal distance for charging .....                             | 47 |
| Figure. 23                | Maximum misalignment for air gap.....                                                 | 48 |
| Figure. 24                | Misalignment area 1 : 17 x 17 mm (0.67 x 0.67 in) .....                               | 49 |
| Figure. 25                | Misalignment area 2: 25 x 5 mm (0.98 x 0.2 in) .....                                  | 50 |
| Figure. 26                | Misalignment area 3: 5 x 25 mm (0.2 x 0.98 in) .....                                  | 51 |
| Figure. 27                | Combined misalignment areas .....                                                     | 52 |
| Figure. 28                | Sign-in page.....                                                                     | 63 |
| Figure. 29                | Webpage – Home page 1(2) .....                                                        | 64 |
| Figure. 30                | Webpage – Home page 2(2) .....                                                        | 64 |
| Figure. 31                | Webpage – <b>Control</b> page .....                                                   | 69 |
| Figure. 32                | Webpage – <b>Control</b> page – <b>Ethernet Control</b> section .....                 | 70 |
| Figure. 33                | Webpage – <b>Data Logs</b> page – <b>WPU User Log</b> section .....                   | 73 |
| Figure. 34                | Webpage – <b>Data Logs</b> page – <b>WPU Event Log</b> section .....                  | 74 |
| Figure. 35                | Webpage – <b>Data Logs</b> page – <b>WSU User Log</b> section .....                   | 74 |
| Figure. 36                | Webpage – <b>Data Logs</b> page – <b>WSU Event Log</b> section .....                  | 75 |
| Figure. 37                | Webpage – <b>Advanced Settings</b> page – <b>WPU Configuration</b> section .....      | 76 |
| Figure. 38                | Webpage – <b>Advanced Settings</b> page – <b>WSU Configuration</b> section .....      | 78 |
| Figure. 39                | Webpage – <b>Advanced Settings</b> page – <b>Internal CC-CV Profile</b> section ..... | 79 |
| Figure. 40                | Webpage – <b>Advanced Settings</b> page – <b>Li-ION Battery Recovery</b> section..... | 80 |
| Figure. 41                | Webpage – <b>Advanced Data</b> page .....                                             | 82 |
| Figure. 42                | Webpage – <b>Admin</b> page – <b>User Accounts</b> section .....                      | 83 |
| Figure. 43                | Webpage – <b>Admin</b> page – <b>User Data</b> section .....                          | 84 |
| Figure. 44                | Webpage – <b>Admin</b> page – <b>WPU Identification</b> section .....                 | 84 |
| Figure. 45                | Webpage – <b>Admin</b> page – <b>WPB</b> section .....                                | 85 |
| Figure. 46                | Webpage – <b>Admin</b> page – <b>WPP</b> section .....                                | 85 |

|            |                                                      |     |
|------------|------------------------------------------------------|-----|
| Figure. 47 | Webpage – Admin page – WSP section .....             | 86  |
| Figure. 48 | Webpage – Admin page – WSB section .....             | 86  |
| Figure. 49 | Webpage – Admin page – Software Update section ..... | 87  |
| Figure. 50 | Webpage – Admin page – Power Cycle section .....     | 87  |
| Figure. 51 | Webpage – Network page .....                         | 88  |
| Figure. 52 | Test page .....                                      | 89  |
| Figure. 53 | Optimal mounting orientation of WPP and WSP .....    | 99  |
| Figure. 54 | Keep-out area .....                                  | 103 |
| Figure. 55 | Keep-out area, WPP mounted to a wall .....           | 104 |
| Figure. 56 | Keep-out area, WPP mounted to a post .....           | 105 |
| Figure. 57 | WPB installation .....                               | 107 |
| Figure. 58 | Mounting orientations .....                          | 110 |
| Figure. 59 | WPP – Mounting on non-ferrous metal .....            | 111 |
| Figure. 60 | WPP – Mounting on ferrous metal .....                | 111 |
| Figure. 61 | WPP – Mounting flush with non-ferrous metals .....   | 112 |
| Figure. 62 | WPP – Mounting flush with ferrous metals .....       | 112 |
| Figure. 63 | WPP – Installation .....                             | 113 |
| Figure. 64 | Connecting WPP to WPB .....                          | 114 |
| Figure. 65 | WSP – Mounting Orientation .....                     | 117 |
| Figure. 66 | WSP – Mounting flush with non-ferrous metal .....    | 117 |
| Figure. 67 | WSP – Mounting flush with ferrous metals .....       | 118 |
| Figure. 68 | WSP – Mounting to the vehicle .....                  | 119 |
| Figure. 69 | WSB – Mounting to the vehicle .....                  | 121 |
| Figure. 70 | WSP – Connecting to WSB .....                        | 122 |
| Figure. 71 | WSB – Cable connections .....                        | 123 |
| Figure. 72 | WSB – NTC with ring terminal .....                   | 124 |
| Figure. 73 | sDevelopment Kit connectios .....                    | 141 |

## 18 Abbreviations and Acronyms

| Acronym / Abbreviation | Definition                                                                                                                    |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| A                      | Ampere                                                                                                                        |
| AC                     | Alternating Current                                                                                                           |
| AMR                    | Automated Mobile Robot                                                                                                        |
| AGV                    | Automated Guided Vehicle                                                                                                      |
| AWG                    | American Wire Gauge                                                                                                           |
| approx.                | Approximately                                                                                                                 |
| BMS                    | Battery Management System                                                                                                     |
| CAN                    | Controller Area Network                                                                                                       |
| Cont.                  | Continued                                                                                                                     |
| °C                     | Centigrade                                                                                                                    |
| dB(A)                  | The unit of measurement of the sound pressure level according to the internationally standardized frequency weighting curve A |
| DC                     | Direct Current                                                                                                                |
| DIN                    | Deutsche Industrie Norm                                                                                                       |
| e.g.                   | Example                                                                                                                       |
| EMF                    | Electromagnetic Field                                                                                                         |
| EN                     | European Norm / European standard                                                                                             |
| EU                     | European                                                                                                                      |
| FE                     | Chemical Element: Iron (Ferrous)                                                                                              |
| FMS                    | Fleet Management System                                                                                                       |
| ft                     | Feet                                                                                                                          |
| GND                    | Ground                                                                                                                        |
| Hz                     | Hertz                                                                                                                         |
| H x W x D              | Height x Width x Depth                                                                                                        |
| i.e.                   | That is, for example                                                                                                          |
| ICP                    | Internal User configurable CC-CV Profile                                                                                      |
| in                     | Inch                                                                                                                          |
| IMP                    | Internal pre-programmed Multistage Profile                                                                                    |
| I/O                    | Input or Output                                                                                                               |
| kBit/s                 | Kilobit per second                                                                                                            |
| kg                     | Kilogram                                                                                                                      |
| KOhm                   | Kilo Ohm (Unit of Electrical Resistance)                                                                                      |
| kV                     | Kilo Volt                                                                                                                     |
| KVA                    | Kilo Volt Amps                                                                                                                |
| kW                     | Kilowatt                                                                                                                      |
| lb                     | Pound                                                                                                                         |

| Acronym / Abbreviation | Definition                                          |
|------------------------|-----------------------------------------------------|
| LED                    | Light Emitting Diode                                |
| m                      | Meter                                               |
| ms                     | Milli Second                                        |
| mA                     | Milliampere                                         |
| Max.                   | Maximum                                             |
| MBR                    | Minimum Bend Radius                                 |
| mm                     | Millimeter                                          |
| NC                     | Not Connected                                       |
| NFPA                   | National Fire Protection Association                |
| Ohm                    | Unit of Electrical Resistance                       |
| OTP                    | Over Temperature Protection                         |
| PE                     | Protective Earth                                    |
| PPL                    | Pad to Pad Link (communication between WPP and WSP) |
| RMA                    | Return Material Authorization                       |
| RTC                    | Real Time Clock                                     |
| V                      | Volts                                               |
| V <sub>DC</sub>        | Volts Direct Current                                |
| V <sub>AC</sub>        | Volts Alternating Current                           |
| WCS                    | Wireless Charging System                            |
| WPB                    | Wireless Primary Box                                |
| WPP                    | Wireless Primary Pad                                |
| WPU                    | Wireless Primary Unit                               |
| WSB                    | Wireless Secondary Box                              |
| WSP                    | Wireless Secondary Pad                              |
| WSU                    | Wireless Secondary Unit                             |
| WMS                    | Warehouse Management System                         |
| WPT                    | Wireless Power Transmission                         |
| μT                     | Micro Tesla                                         |
| μH                     | Micro Henry                                         |
| %                      | Percentage                                          |
| N connection           | Neutral line                                        |



## **USA**

Delta Electronics (Americas) Ltd.  
Raileigh Office  
5101 Davis Dr, Durham, NC 27709, U.S.A.  
USA  
+1-919-767-3800  
IEV.sales@deltaww.com  
**www.delta-americas.com**

## **Europe / Global**

Delta Energy Systems (Germany) GmbH  
Tscheulinstraße 21  
79331 Teningen  
Germany  
+49-7641-455-0  
E-mail: IEV.sales@deltaww.com  
**www.deltaww.com**