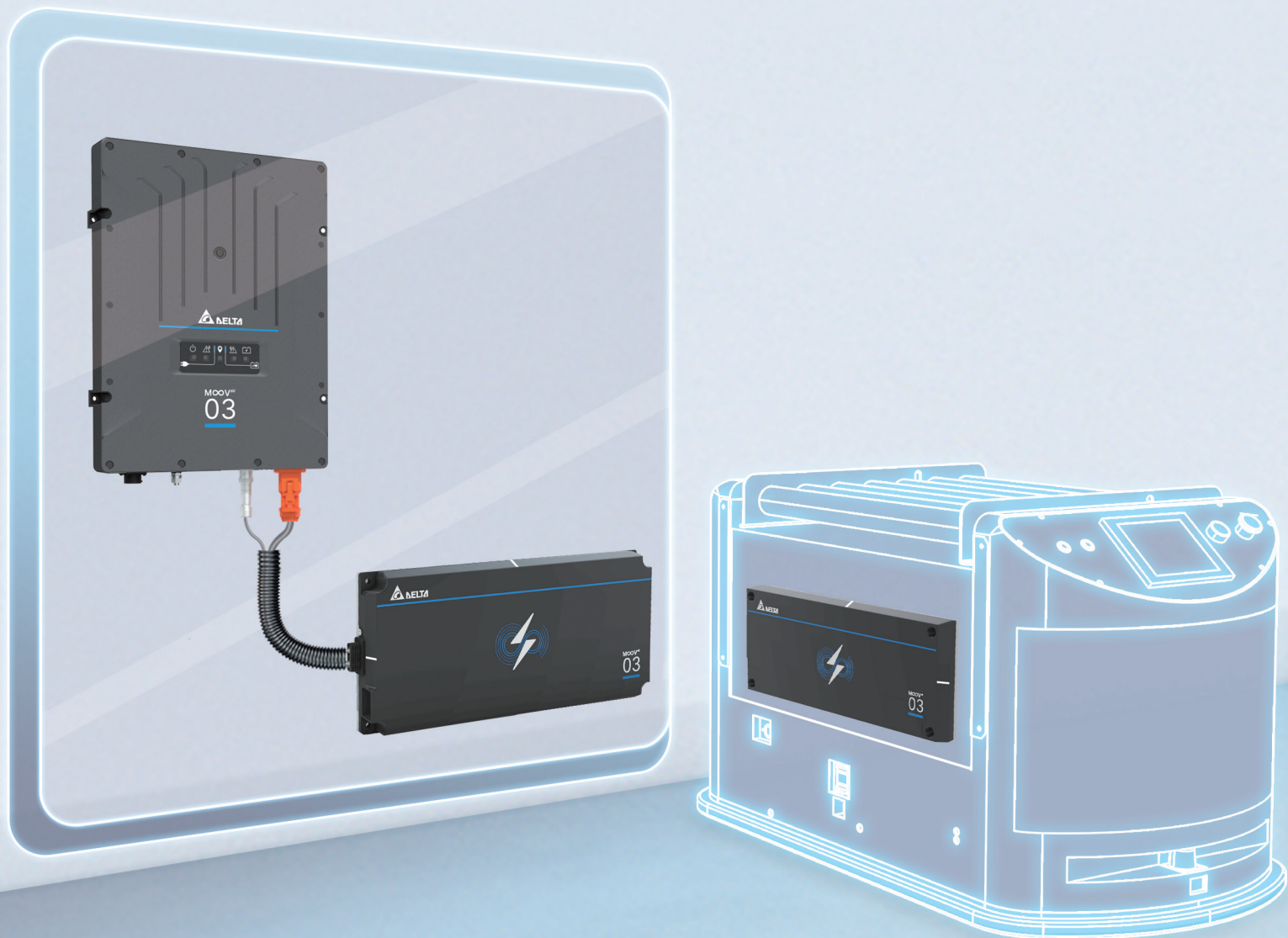




MOOV^{air}

3.3 kW Wireless Charging System

Installation and operation manual



LEGAL INFORMATION

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

Delta manuals undergo continuous revision in order to provide users 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 Therefore, before starting installation work, always consult Delta to check whether a newer version of the User Manual is available.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 in installation and commissioning of grid-connected electrical systems/products.

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Abbreviations and Acronyms

Acronym / Abbreviation Used	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

Abbreviations and Acronyms (Cont.)

Acronym / Abbreviation Used	Definition
kW	Kilowatt
lb	Pound
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 _{DC}	Volts Direct Current
V _{AC}	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
μ T	Microtesla
μ H	Microhenry
%	Percentage
N connection	Neutral line

1 Introduction

1.1 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.

1.2 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.

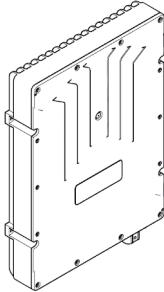
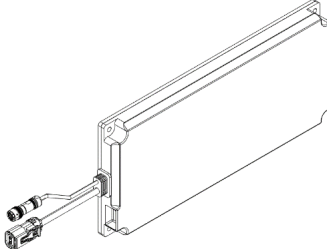
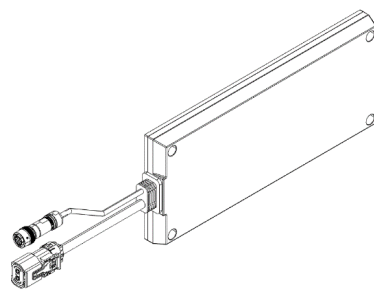
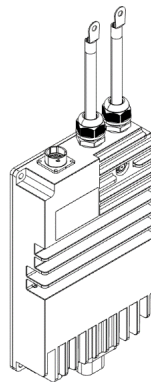
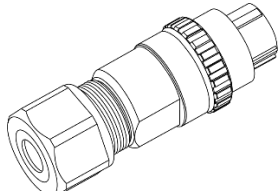
1.2.1 Access to the System

Following table contains the information about the types of users and their accessibility to the system.

S.No	Kind of Person	Users	Description
1	Ordinary person *	NA	Must not use the system.
2	Instructed person *	Operator, Driver	May use the system after being trained by skilled person.
3	Skilled person	Vehicle integrator, Facility integrator, Maintainer	May install and use the system or its parts.

* Several connectors and sockets are not accessible for ordinary person and instructed person, refer to 3.2 for the details.

1.3 Scope of Supply

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

1.4 Intended Use

CAUTION: 	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.
--	--

The intended purpose of the WCS is defined as follows:

- The system is designed only for the 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 and WSU 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 WSU. For example, plastic, wood, glass, and air etc.,
- The WSU is only intended to be covered with a plastic shield if necessary.
- The System ist intended to use only disconnected from the internet.

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 WSU covered with metal sheet.
- The WSU 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 systems is not intended to use with a direct or indirect connection to the internet.
- 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.

1.5 References

1.5.1 Delta Documentation

Item	Description	Link
1	CANopen® Protocol Spec	-

1.5.2 Open Source License & Credits

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1.6 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.

2 Safety & Regulations

2.1 Safety Symbols

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.

2.2 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
	Electromagnetic field (EMF)

Other signs are also used within the document.

	Ground (GND)
	Attention/Informative
	Refer to manual

2.3 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 P/N (料号): EOE16010870 REV (版本): P2 Input (输入): 200-240V~; 16A; 50/60Hz Output (输出): 800V~; 16A; 79-90kHz Date: YYWW S/N: ZZZZZZ Delta Energy Systems(Germany) GmbH, Tscheulinstr. 21 ,79331 Teningen, Germany		Protection class: IP65 Made in SLOVAKIA 斯洛伐克制造

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

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

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

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

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

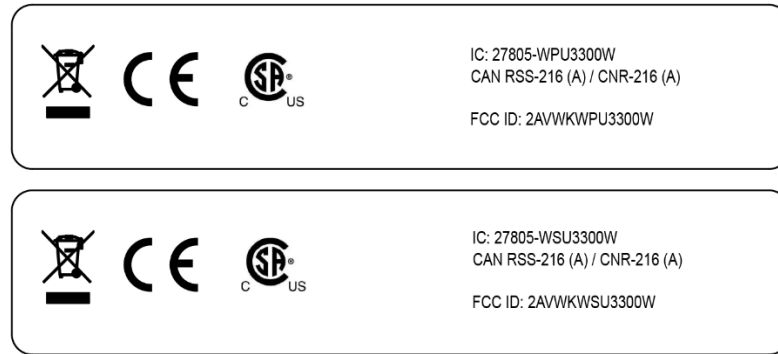


Figure. 1 Labels of Specification

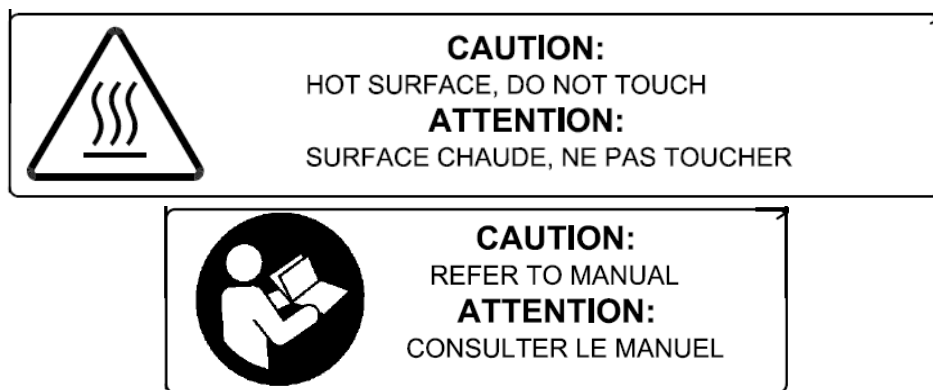


Figure. 2 Labels of Warning

2.4 Safety Instructions

2.4.1 General Safety Instructions

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

DANGER: 	Electric shock - Isolate upstream breaker connected to WPB. - Do not open the WCS subsystems during charging as it may lead to death of Personnel. - Do not open the WCS subsystems when WPB connected to mains, and WSU connected to battery.
DANGER: 	- Make sure to install WPP and WSP vertically. - 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.
DANGER: 	This equipment is not suitable for use in locations where children are likely to be present
WARNING: 	Electromagnetic Field (EMF) - The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produce a potentially harmful magnetic field during the charging process. - Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see 2.4.2 EMF Safety Instructions. - 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. - Electromagnetic field exposure to pregnant women is strictly forbidden. - Advise the end user about safety distances and affix appropriate warning labels and/or signs. - Warning signs should be clearly displayed at the charging area. - Electronic objects such as cell phones and hearing aids may get damaged.
WARNING: 	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.

	Hot surfaces • Do not touch any subsystems of the charging system while charging is in progress. • Do not touch WPP and WSP of the charging system up to 30 minutes (cooling time) after the charging process is finished. • Wear safety gloves while handling the subsystems after charging.
	Material damage • 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). • Select the installation position of the WPP and WSP accordingly. • All user types of the system must be instructed accordingly. • Make sure the application adhere to the manual.

2.4.2 EMF Safety Instructions

	Electromagnetic Field (EMF) • The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produce a potentially harmful magnetic field during the charging process. • Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see 2.4.2 EMF Safety Instructions. • 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. • Electromagnetic field exposure to pregnant women is strictly forbidden. • Advise the end user about safety distances and affix appropriate warning labels and/or signs. • Warning signs should be clearly displayed at the charging area. • Electronic objects such as cell phones and hearing aids may get damaged.
---	---

The following customers are considered for the Wireless Charging System (WCS):

1. Any customer who wants to integrate the secondary parts of the system, Wireless Secondary Pad (WSP) and Wireless Secondary Box (WSB) in an application to charge a battery e.g. forklift manufacturer, AGV manufacturer etc.
2. The customer where the application is used and who must install the primary part, Wireless Primary Box (WPB) and Wireless Primary Pad (WPP).

Vehicle Integrator

The installation of the WSP must be carried out by a skilled person. 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.

Facility Integrator

The installation of the WPP must be carried out by skilled persons. 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 (70 cm).

The distances defined in the keep-out area are referenced to the magnetic center of the WPP.

The WPP magnetic center is:

- located in the middle of the logo on the front of the housing
- referenced by side marks on the housing

Keep-out areas during charging

The keep-out area for the WPP and WSP whilst charging is depicted below:

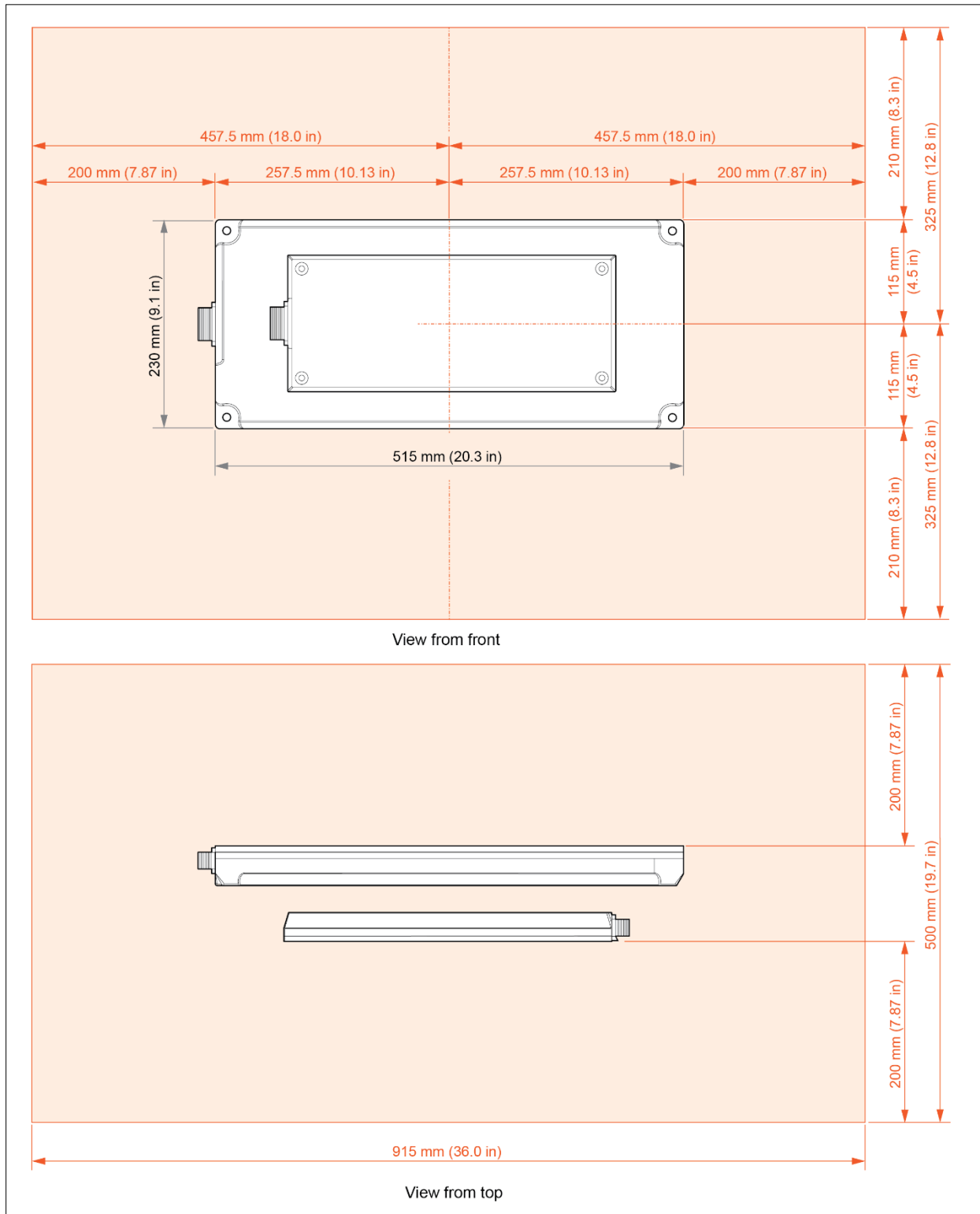


Figure. 3 Keep-out area for WPP and WSP

Communication

During communication and when not charging (no power transmission), any user must be at least 200 mm away from each edge of both pads (WSP and WPP) in all directions. The WSP and WPP will attempt to pair the communications between each other at all times when they are powered on.

Medical Implant

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.

General note

The distances provided in this document are valid for the use in free air. If metal is used in the keep-out areas, the magnetic field will be deformed. In this instance, after the WSP is installed into the vehicle, the magnetic field measurement must be performed for the application to ensure the given distances remain valid. If the distances are different to what is provided in this document, then the keep-out distances must be adjusted within the User Instructions for the application.

Note: It is likely that the measurement result allows shorter distances.

2.5 Compiiances

2.5.1 EU

2.5.1.1 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.

2.5.1.1 Radio Equipment

Radio Frequency Information:

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

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

2.5.2 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 section 2.4.2 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 charger 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 charger.

- 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.

	This device 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.
--	--

2.5.3 ISED (Canada)

2.5.3.1 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.

2.5.3.2 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.

2.5.3.3 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.

3 System Description & Operation

3.1 Overview

3.1.1 Identification of WCS Subsystems

The Delta WCS 3.3kW (Wireless Charging System) is designed to charge the batteries of electric systems wirelessly. This system 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 wireless charging system consists of four subsystems.

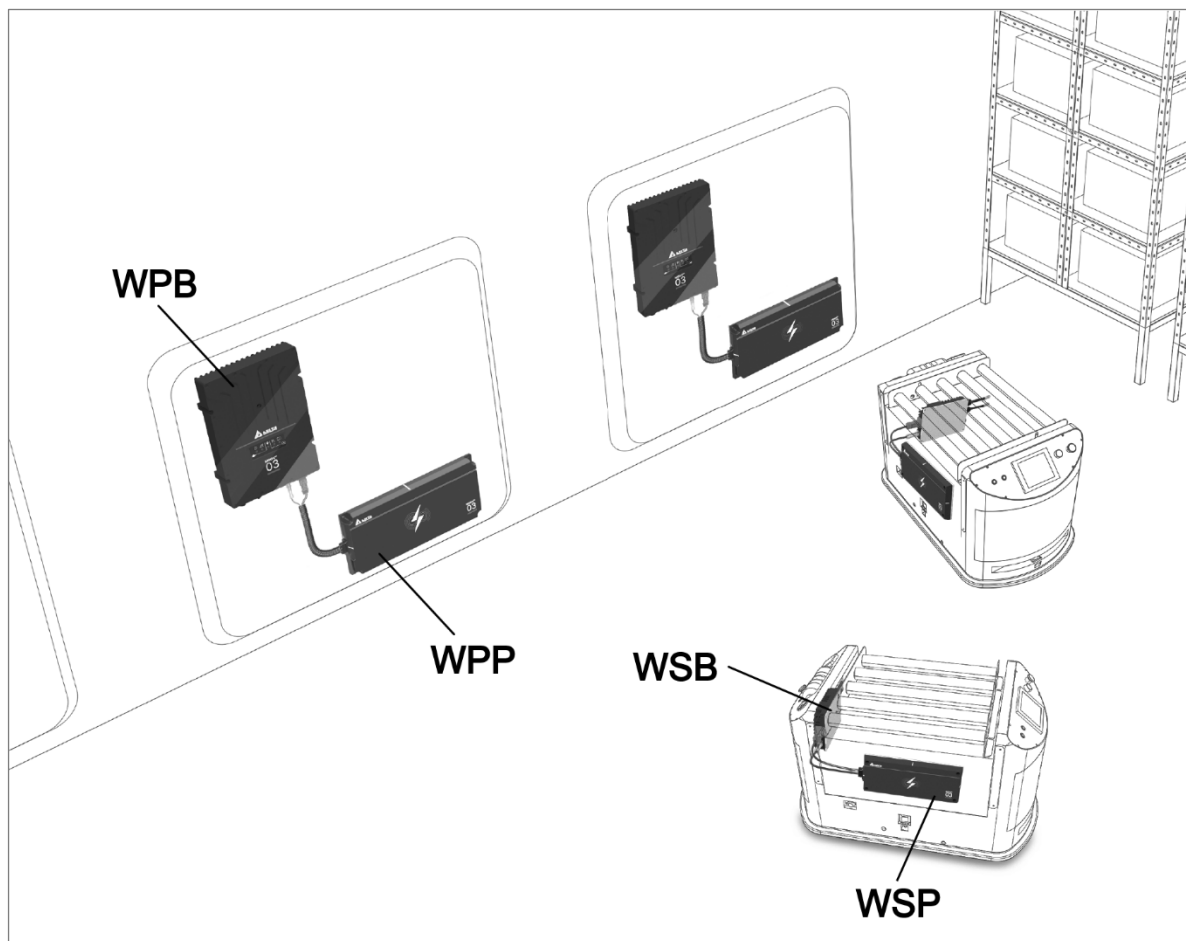


Figure. 4 WCS Subsystems (Example – Robot)

Item	Description
1	Wireless Primary Box (WPB)
2	Wireless Primary Pad (WPP)
3	Wireless Secondary Pad (WSP)
4	Wireless Secondary Box (WSB)

3.1.2 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.

ATTENTION: 	Material damage 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.
--	--

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 3.2.1.4.1 Status LED and 3.2.1.4.2 Ethernet Service Interface.

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 3.3.1.5.

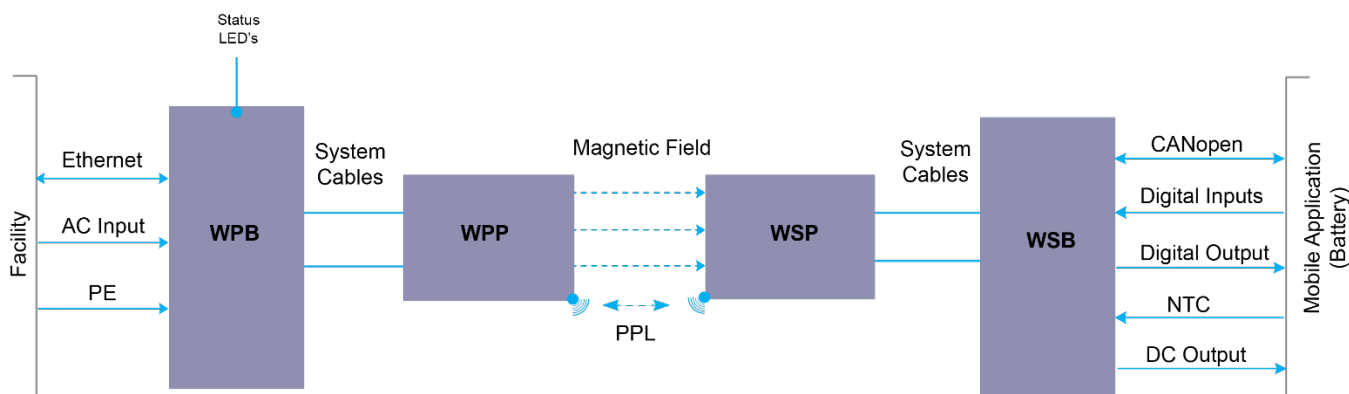


Figure. 5 Wireless Charging

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 3.5.2 WPB – Ethernet and 3.5.3 WSB – CANopen®WSB - .

3.1.3 Models, Variants & Interoperability

The 3.3kW 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.

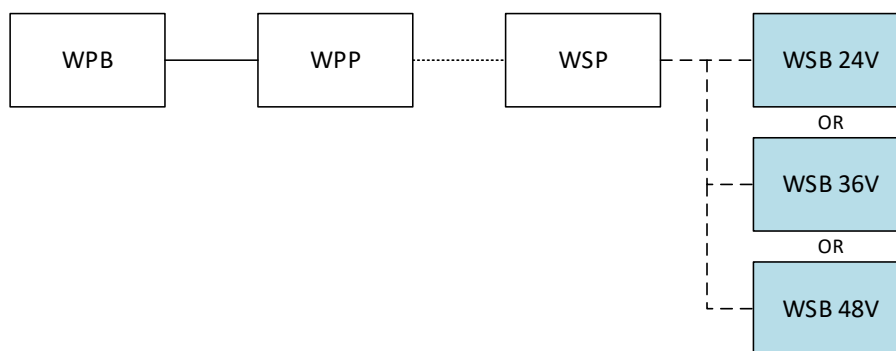


Figure. 6 Interoperability

3.2 Subsystem Description

3.2.1 WPB

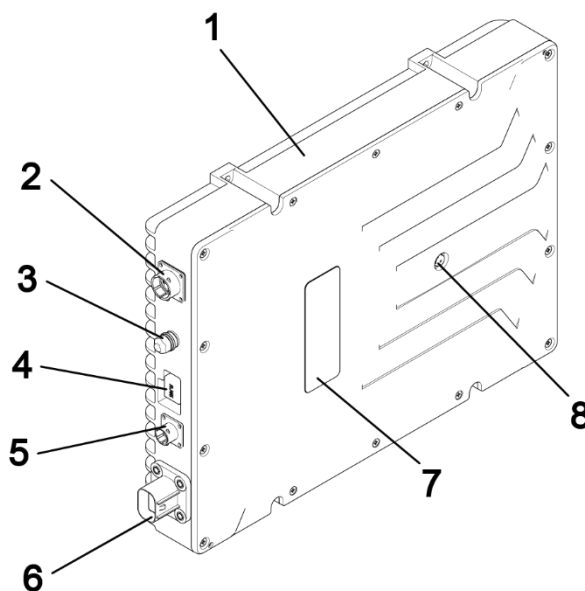
3.2.1.1 Function

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 3.3kW. 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.

Table. 1 Specifications - WPB

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 °C to +40 °C (-40 °F 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 °C to +70 °C (-49 °F to 158 °F)


Figure. 7 WPB System Components

Item	Description	Item	Description
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

3.2.1.2 AC Input

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

* 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 240Vac, and tripping characteristic B is recommended.

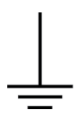
3.2.1.2.1 Earthing System

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.

3.2.1.2.2 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:

Name	Signal
1	Neutral (N)
2	Live (L)
	Protective Earth (PE)

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

A separate earth bonding stud is available. See Figure. 11.

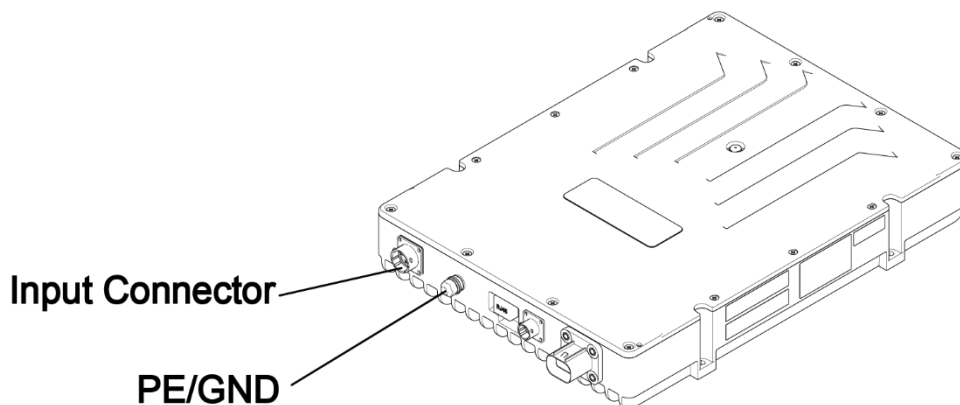


Figure. 8 AC Input Connector – WPB

3.2.1.3 Interface to WPP

Following are the connector interfaces of WPB to WPP:

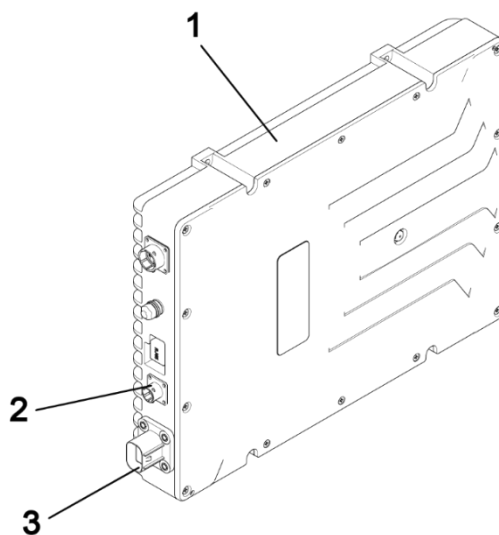


Figure. 9 WPB Interface Components

Item	Description	Item	Description
1	WPB	3	WPB Power Socket
2	WPB Signal Socket *		

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

3.2.1.4 User Interface

3.2.1.4.1 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:

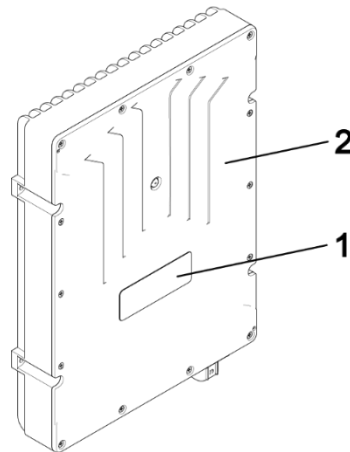


Figure. 10 WPB Status LED Panel Location

Item	Description	Item	Description
1	Status LED panel	2	Front cover

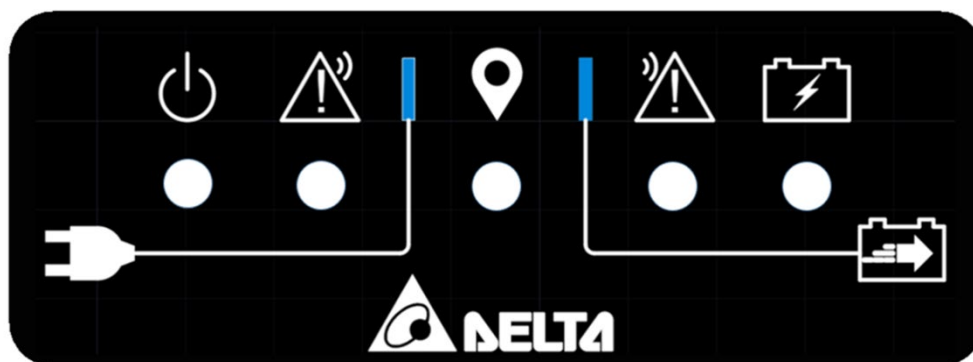


Figure. 11 Status LED Panel

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.

3.2.1.4.2 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.

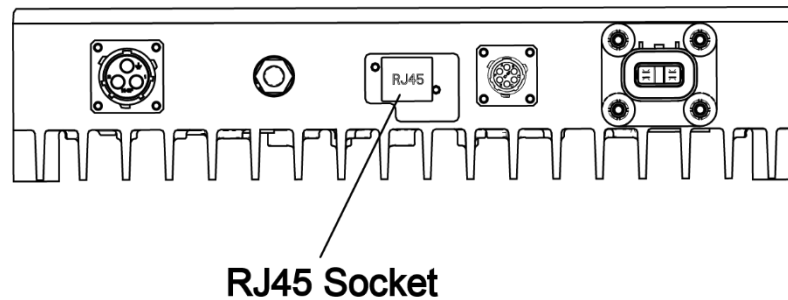


Figure. 12 Ethernet Service Interface

ATTENTION:



- Ethernet service interface must be used by qualified skilled person during the service and should be disconnected once the service is done.
- The ethernet service cable length is restricted to 3 m.

3.2.2 WPP

3.2.2.1 Function

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 3.3kW wireless power. The WPP further communicates its operating limits to the WPB. WPP also enables communication to the WSP via PPL, refer 3.5.1 WPP & WSP Interface – Pad to Pad Link (PPL). The status of the WPP can be monitored using the Status LED panel.

See Figure. 16 for main components of WPP.

Table. 2 Specifications - WPP

Description	Value
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 °C to +40 °C (-40 °F 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 WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information.
Storage temperature	-45 °C to +70 °C (-49 °F to 158 °F)

3.2.2.2 Interface to WPB

Following are the connection interfaces of WPP to WPB,

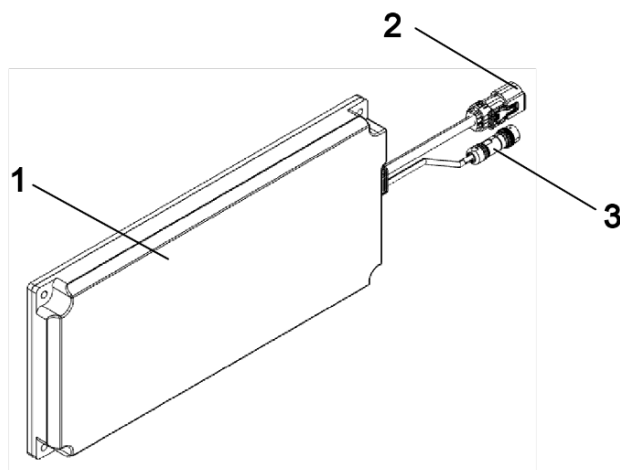


Figure. 13 WPP Interface Components

Item	Description	Item	Description
1	WPP	3	WPP Signal Connector *
2	WPP Power Connector *		

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

3.2.3 WSP

3.2.3.1 Function

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, refer 3.5.1 WPP & WSP Interface – Pad to Pad Link (PPL), and with WSB. Refer 1.1.1.1 for cable connections.

See 1.1.1.1 for main components of WSP.

Table. 3 Specifications - WSP

Description	Value
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 °C to +70 °C (-40 °F 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) Shock test 15 g (EN 60068-2-27:2009) Shock test 25 g (EN 60068-2-27:2009) 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 WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information.
Storage temperature	-45 °C to +70 °C (-49 °F to 158 °F)

3.2.3.2 Interface to WSB

Following are the connection interfaces of WSP to WSB,

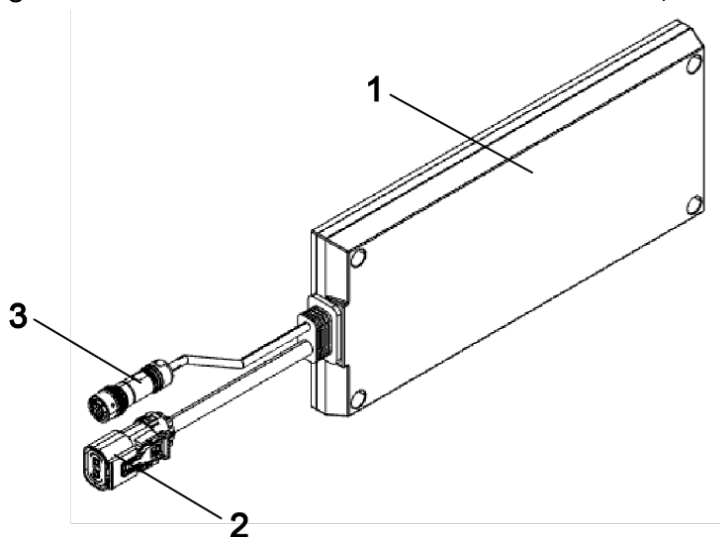


Figure. 14 WSP Interface Components

Item	Description	Item	Description
1	WSP	3	WSP Signal Connector *
2	WSP Power Connector *		

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

3.2.4 WSB

3.2.4.1 Function

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. Refer 3.2.4.2 Interface for cable connections.

See Figure. 18 for main components of WSB.

Table. 4 Specifications - WSB

Description	Value
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 °C to +70 °C (-40 °F 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) Shock test 15 g (EN 60068-2-27:2009) Shock test 25 g (EN 60068-2-27:2009) 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 WSU tested with higher impact force in accordance with IEC 62368-1, refer to standards or contact Delta for more information.
Storage temperature	-45 °C to +70 °C (-49 °F to 158 °F)

3.2.4.2 Interface to WSP

Following are the connection interfaces of WSB to WSP.

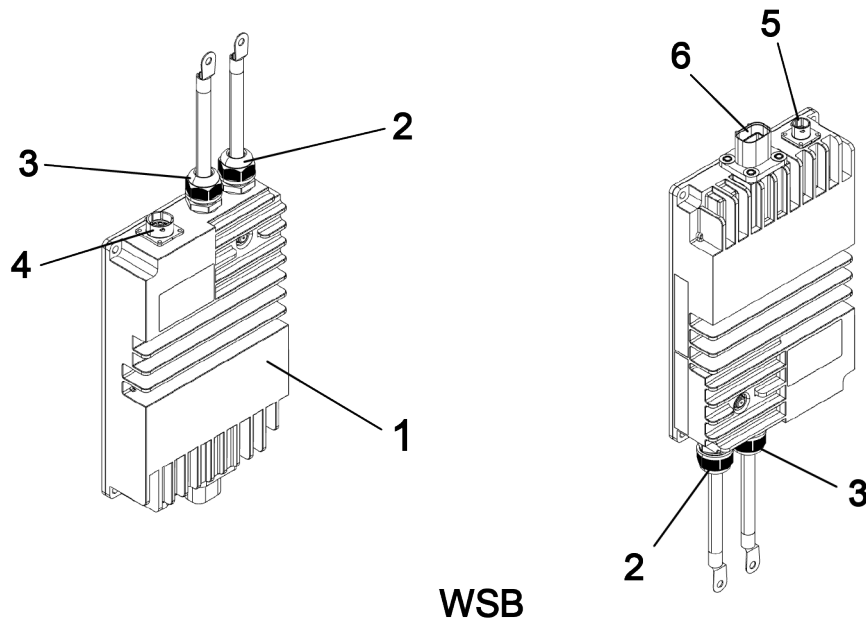


Figure. 15 WSB Interface Components

Item	Description	Item	Description
1	WSB	4	User Interface Connector *
2	DC Output +ve Cable	5	WSB Signal Connector *
3	DC Output -ve Cable	6	WSB Power Connector

* User interface connector and WSB signal connector shall not be accessible to end user in the final installation.

3.2.4.3 DC Output

Description	Value		
Nominal output voltage	25V	37.5V	50V
Output voltage range	12 to 33 V _{DC}	18 to 49.5 V _{DC}	24 to 66 V _{DC}
Maximum charge current (For more details refer 3.3.1.1 Output Operating Area).	132 A	88 A	66A

• Description	• Value
Maximum output power	3.3 kW
	See also 3.3.1 Output Power and De-rating.
Output protection	over voltage over current over temperature short circuit open circuit reverse connection
Length of RED (+) power cable	1 m (39.4 in)
Length of BLACK (-) power cable	
Ring Terminal	10 mm M10 stud

3.2.4.4 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.

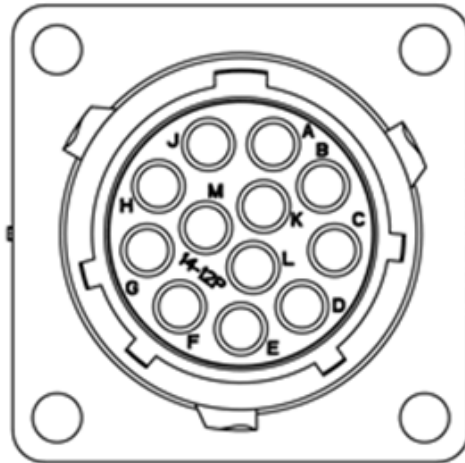


Figure. 16 WSB Signal Connector

The pinout of the WSB control interface is assigned as:

Table. 5 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

3.2.4.4.1 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.

3.2.4.4.2 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 3.4.1 External Commanded for details on CANopen® Control Mode and section 3.5.3 WSB - for details on CANopen® Communications.

3.2.4.4.3 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 (2.7V~5.5V) 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 (<0.3V) for charge enable signal to disable the charger.

3.2.4.4.4 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 (2.7V~5.5V) 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 (<0.3V) 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 disabled, WSU power loss is 3W maximum; when sleep signal enabled, WSU power loss is 0.2W maximum;

3.2.4.4.5 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 Ω minimum
5V	850 Ω minimum
12V	2k Ω minimum
24V	4k Ω 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.

3.3 System Performance

3.3.1 Output Power and De-rating

3.3.1.1 Output Operating Area – 24V

Output current and output voltage can be set within the limits as shown in Figure. 20.

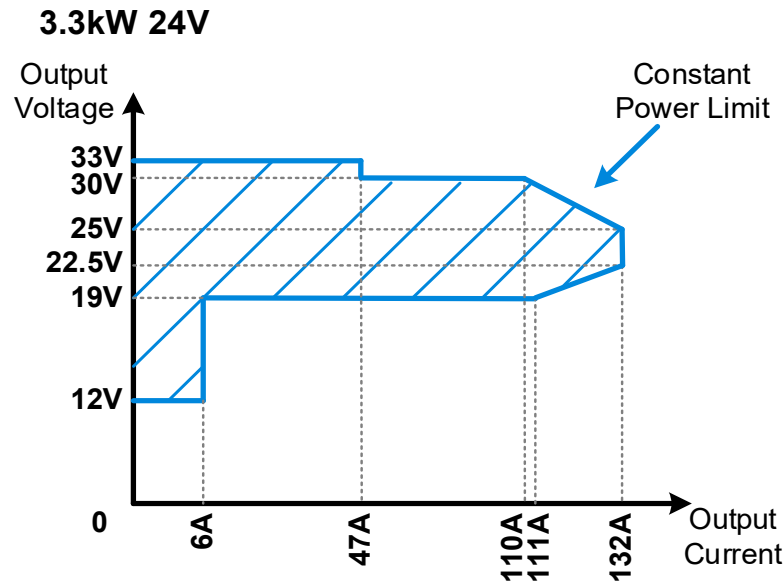


Figure. 17 Output Power and Current Limits with Variable Voltage – 24V

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

3.3.1.2 Output Operating Area – 36V

Output current and output voltage can be set within the limits as shown in Figure. 20.

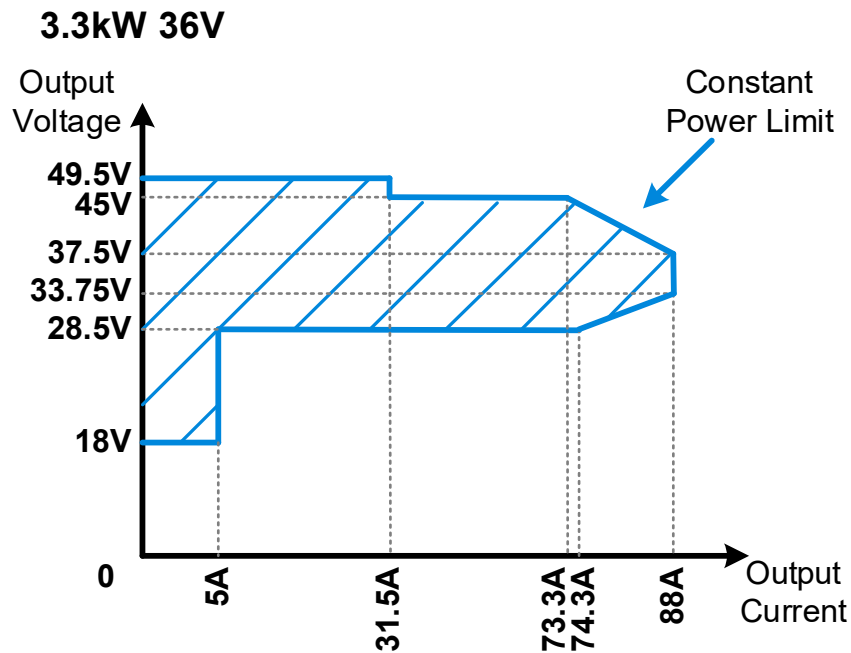


Figure. 18 Output Power and Current Limits with Variable Voltage – 36V

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

3.3.1.3 Output Operating Area – 48V

Output current and output voltage can be set within the limits as shown in Figure. 20.

3.3kW 48V

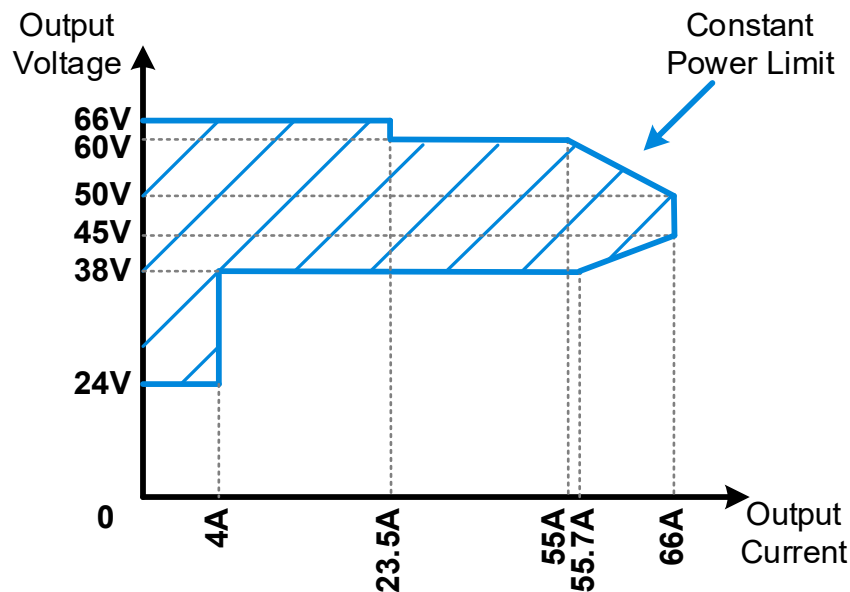


Figure. 19 Output Power and Current Limits with Variable Voltage – 48V

Using the 3.3kW 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 V to 50 V the WCS can provide a maximum output of 66 A
- above 50 V to 60 V, the constant power mode starts and user cannot achieve more than 3.3kW, as the current starts de-rating at 60 V to 66 V, maximum current limited to 23.5A.

3.3.1.4 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.

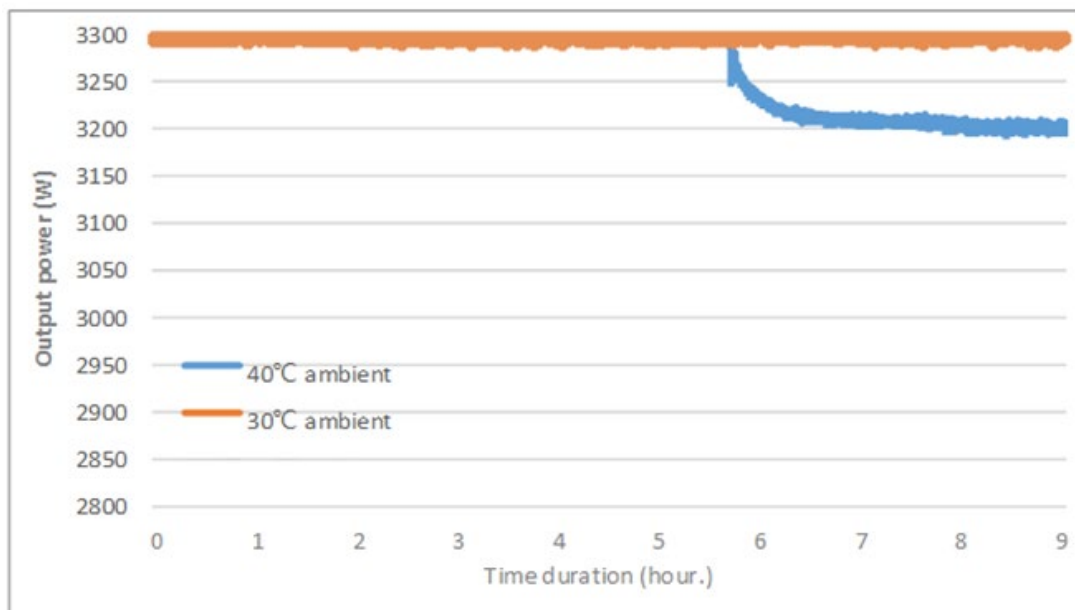


Figure. 20 Power De-rating Vs Time at Different Ambient Temperatures - WSP and WSB

At 40 °C: Full power can be given for a maximum of 330 minutes. After 330 minutes the output power will be de-rated and will eventually reduce to approximately 97% of maximum operating current.

At higher ambient temperature up to 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°C to +40°C (-40 °F to 104 °F)
WPP	-40°C to +40°C (-40 °F to 104 °F)
WSP	-40°C to +70°C (-40 °F to 158 °F), output de-rating above +40°C
WSB	-40°C to +70°C (-40 °F to 158 °F), output de-rating above +40°C

ATTENTION:



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

3.3.1.5 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.

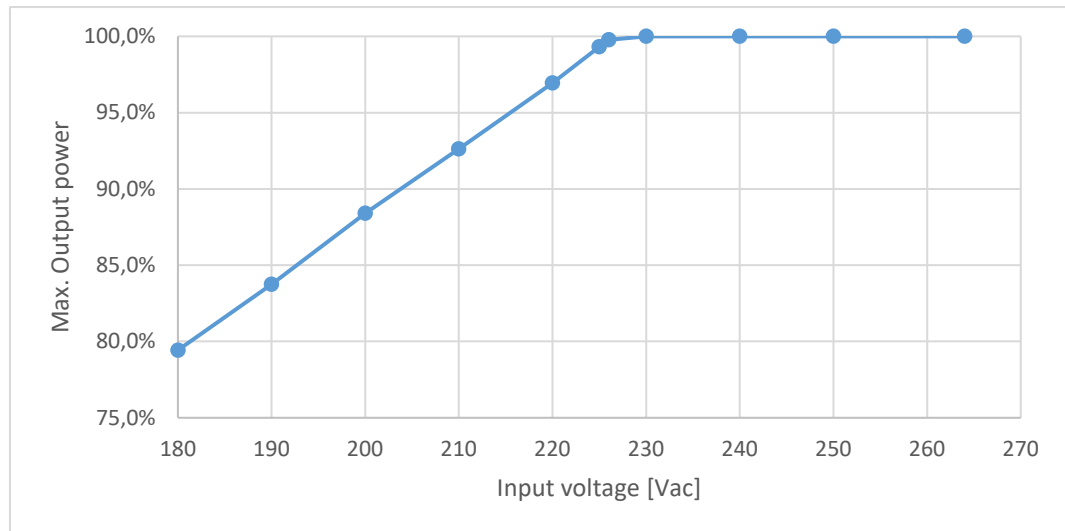


Figure. 21 Maximum Output Power Vs Input Grid Voltage

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.

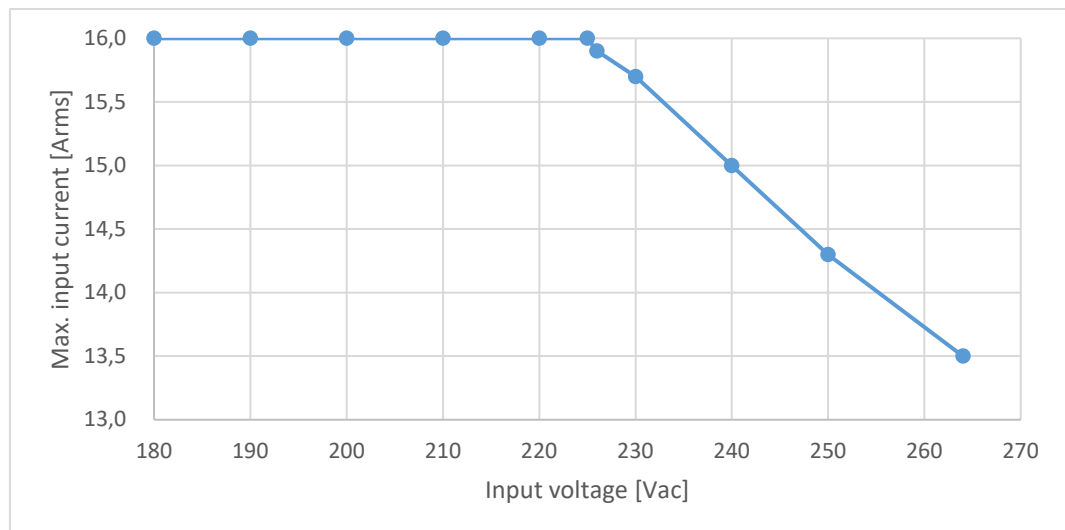


Figure. 22 Maximum Input Current Vs Input Grid Voltage

3.3.1.6 WPP & WSP Positioning

WPP is stationary whereas the WSP is movable, as it is attached to vehicle. Position of WSP is an important factor for the charging process. The better the WSP position is the more efficient and faster the results are. Improper positioning leads to lower output, longer charging time, lower charge levels and more heat.

The WSP should be positioned in front of WPP for charging with the center marks aligned as closely as possible and with a gap of 10 to 30 mm (0.4 to 1.19 in) between the faces of the pads.

In some cases, it might not be possible to position the WSP completely aligned to WPP, so a lateral offset of the WSP center mark from the WPP center position (indicated by the WPP center mark) is referred to as misalignment.

Charging is possible with a maximum misalignment from the center position as follows:

- 17mm in both x-axis and z-axis
- 25mm in the x-axis and 5mm in the z-axis
- 5mm in the x-axis and 25mm in the z-axis

Misalignment performance may be improved if one of the x-axis or z-axis is exactly in the center position (zero misalignment).

Nominal positioning is defined as 20mm gap between the faces of the pads and 0mm misalignment in both x-axis and z-axis.

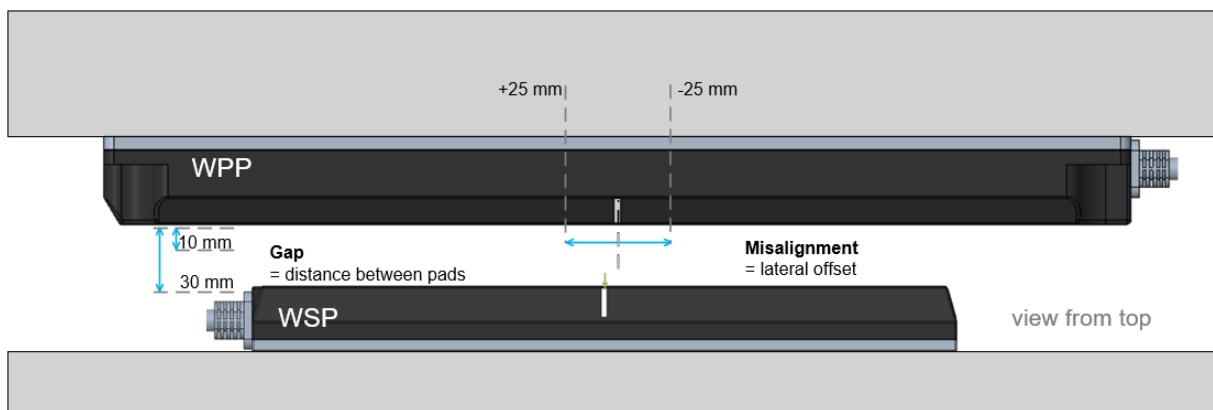


Figure. 23 Pad Position for Charging

The wireless control connection between WSP and WPP – referred to as the pad-to-pad link (PPL) is only possible when the WSP is positioned within the charging area. The position LEDs will not illuminate until a charge cycle is attempted. For effective and complete charging, the WSP must be positioned within the air gap and misalignment operational window.

Note: The WCS can report to the vehicle and/or FMS the approximate positioning information.

3.3.1.6.1 Pad Positioning at an Angle

The WSP needs to be placed exactly to the center mark of WPP, however a slight angle can be tolerated, as shown in the figures below.

Note: The air gap tolerance decreases as the positioning angle increases.

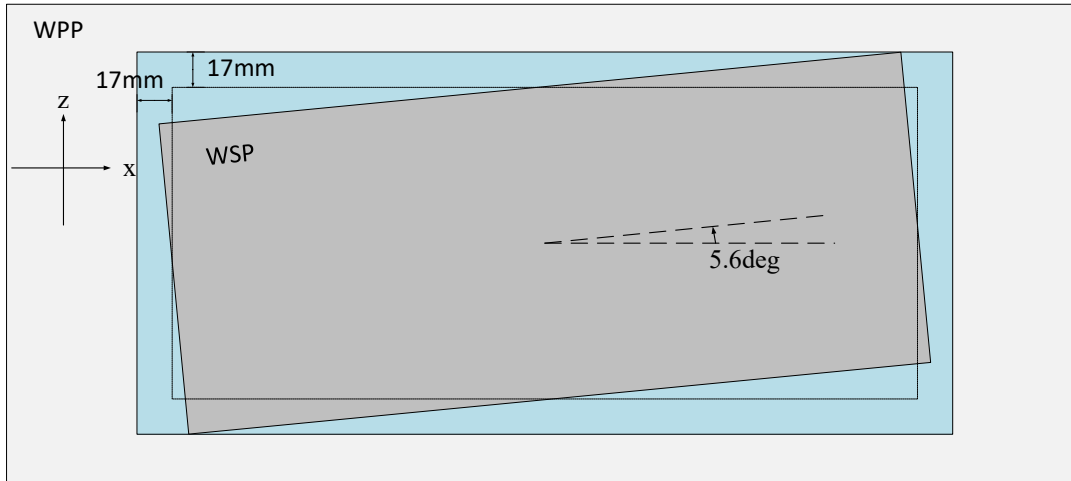


Figure. 19 Angle Tolerance - View from behind WSP

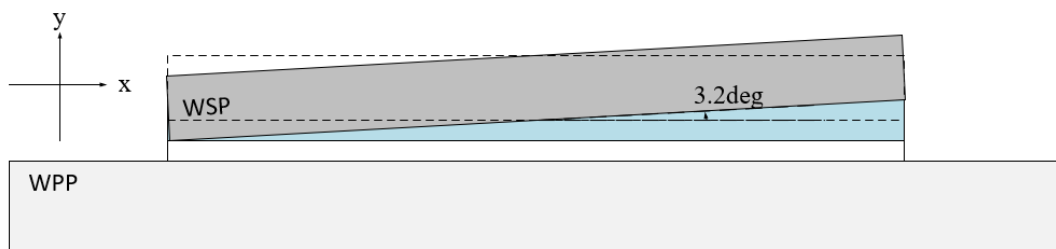


Figure. 20 Angle Tolerance - View from top of pads

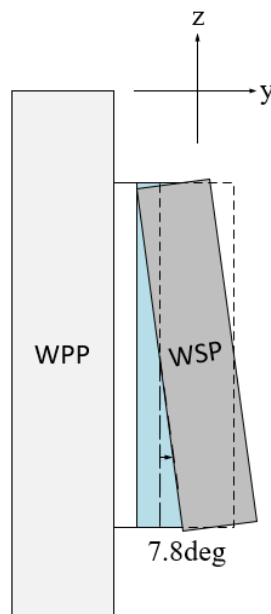


Figure. 24 Angle Tolerance - View from side of pads

3.3.1.6.2 Pad Alignment with Vertical Offset

As described above, the pads can be positioned with an offset (misalignment) of ± 25 mm (1 in) between the centering marks on the top of WSP and WPP. This is not only the case in lateral, but also in vertical direction: a vertical offset (misalignment) of up to 25 mm (1 in) between the centering marks on the side of WSP and WPP is possible.

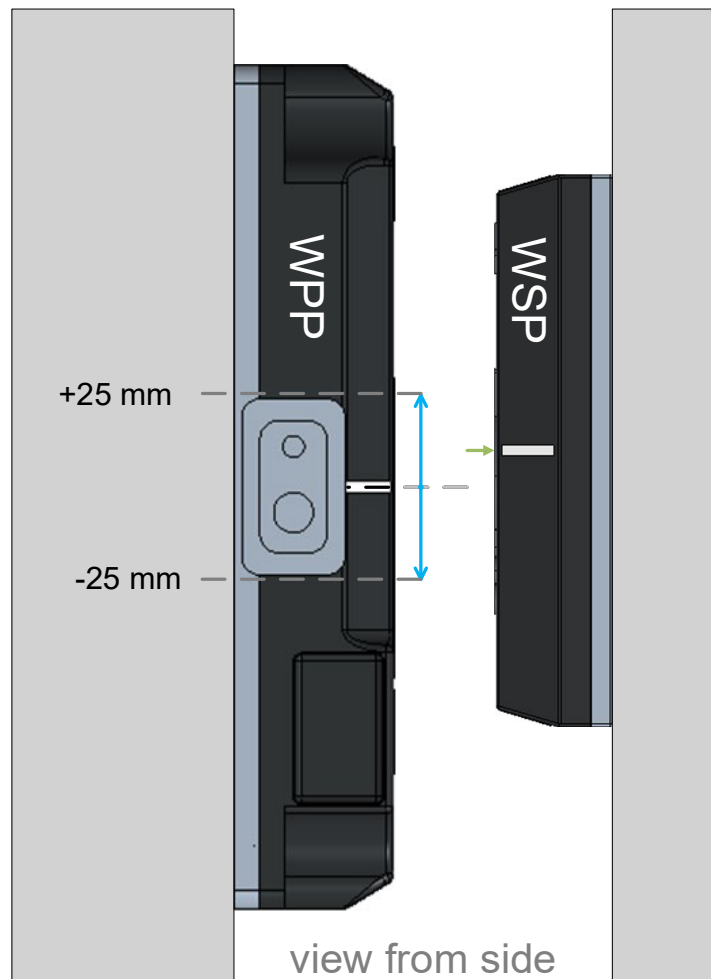


Figure. 25 Pad Alignment with Vertical Offset

3.3.1.6.3 Suboptimal Positioning

If the WPP and WSP are positioned between the optimal working area and too far away, the WSP will not be able to support the maximum output voltage. In this instance, the system will report a Suboptimal Far status through Ethernet, CANopen® and also the WPB Status LED Panel:

- Positioning LED - Green Flash

If the WPP and WSP are positioned between the optimal working area and too close, the WSP will not be able to support the maximum output current. In this instance, the system will report a Suboptimal Close status through Ethernet, CANopen® and also the WPB Status LED Panel:

- Positioning LED - Green Flash

3.3.1.7 Operating Limits

1. 25 mm (1 in) maximum misalignment is accepted between WPP and WSP otherwise charging will not start.
2. Maximum output power is 3.3kW.
3. Make sure to install the WPP and WSP at the same height within a tolerance limit of 25 mm (1 in) otherwise charging will not start.

3.3.2 Efficiency and Losses

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

Condition: Efficiency and loss based on 3.3kW/24V as below

Table. 6 Efficiency and Losses - Best Efficiency Condition

Note: Best condition, '0mm misalignment and 20mm air gap'.

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

Table. 7 Efficiency and Losses - Worst Efficiency Condition

Note: Worst condition, '30mm air gap and 17mm misalignment at both axis' or 'one axis 5mm misalignment and the other axis 25mm misalignment'.

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

Note: 36V and 48V WSB/WSP variants efficiency and losses are equal or better than 24V variant.

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

3.3.2.1 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 ↑	↑	↑	–	–

3.3.2.2 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 the WPP can run under all conditions with full power. Above 40°C, the air gap and output voltage is limited.

3.4 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	-

3.4.1 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 3.5 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.

3.4.1.1 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.

3.4.2 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).

3.4.3 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.

3.4.4 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 3.5.2.4.7 Advanced Setting Page:

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.

3.4.5 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 3.5.2.4.7 Advanced Setting Page 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.

3.5 Communications

3.5.1 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 Section 3.4 System Control Modes. Also WPP and WSP are within nominal proximity (<200 mm) 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.

3.5.2 WPB – Ethernet

3.5.2.1 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 into a web browser of another device on the network will give access to the web interface. Refer to 3.5.2.4.1 Accessing the WPB Webpage for more information on web interface.

3.5.2.2 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 WPB's on a network.

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

3.5.2.3 Identifying the Charger IP

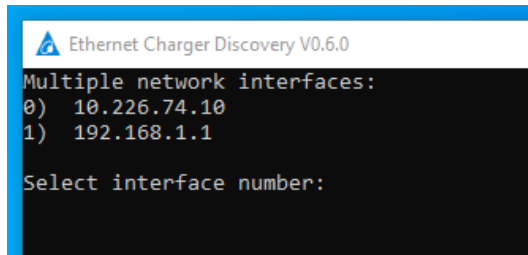
The WPB is accessed on the network by IP. For this reason, it is best to follow the instructions from the WCS installer/provider as they might have modified the defaults or designed the installation around certain IP ranges. However, if this IP information is not available, then the following method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

3.5.2.3.1 Run the Delta Charger Discovery Tool

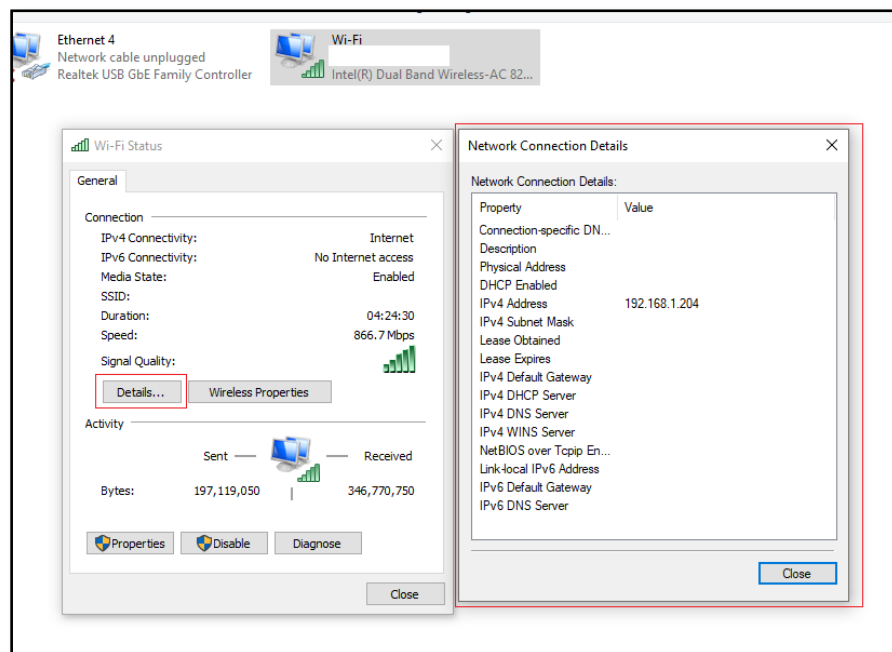
Note: Ask your sales contact for the EXE file.

To run the Delta Discovery tool on Windows:

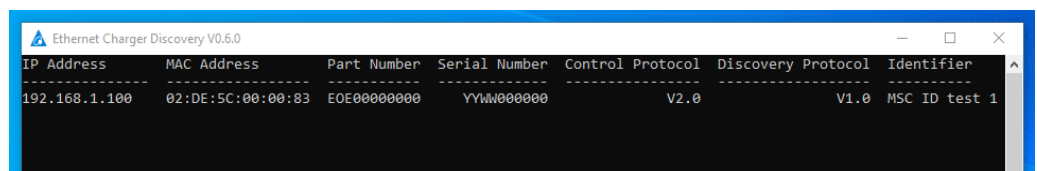
1. Double click on the executable file, (e.g. EthernetChargerDiscovery_V1.0.0.exe) and there will be a window that will open:



2. These are the available networks from the laptop and corresponds with the networking settings:



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



4. You need to type 0 or 1 and press <Enter>, in order to select which laptop network connection, the WPB is on.
5. After a moment, if the tool can discover any WPB's, 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	MSC ID test 1
Data	MSC data test 1
Email	...
Telephone	...

8. 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.

Ethernet Charger Discovery V0.6.0

IP Address	MAC Address	Part Number	Serial Number	Control Protocol	Discovery Protocol	Identifier

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

3.5.2.3.2 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.

3.5.2.4 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.

3.5.2.4.1 Accessing the WPB Webpage

Recommend use of Google Chrome or Microsoft Edge to access the charger webpage at (URL: WPB_IP/index.html).

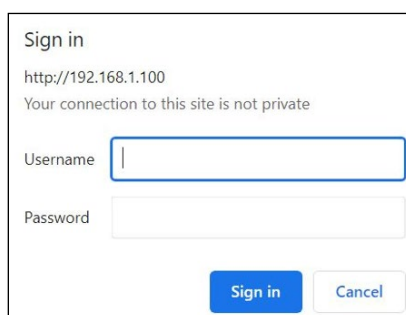
3.5.2.4.2 Usernames

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

Account	Username	Description
User	user	Basic WCS monitoring – read only view.
Admin	admin	WCS monitoring and network & user data configuration. NOTE: 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.

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

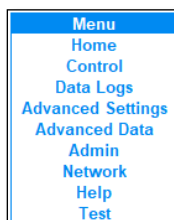
Username

Password

Figure. 26 Sign in Page

3.5.2.4.3 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.



3.5.2.4.4 Home Page

Click on **Home** from the drop-down Menu to see **Home page** (WPB_IP/index.html). It displays the WCS Status, WPU Status and WSU Status (if connected).

Home

System Status

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

WPU Status

AC voltage	0.000Vrms
AC current	0.000Arms
AC line frequency	0HZ
Power factor	0.000
AC active power	0.000W
AC apparent power	0.000VA
AC reactive power	0.000VAR
THD	0%
Faults	None
Warnings	None

WSU Status

Vehicle/Battery ID	Not Connected
Vehicle fault	N/A
Battery SoC	N/A
Charge control	Not Connected
DC V setpoint	0.000V
DC I _{max} setpoint	0.000A
DC V measured	0.000V
DC I measured	0.000A
Battery temp probe	N/A
Faults	None
Warnings	None

1. System Status

Parameter	Description
Wireless comms	Pad to Pad Link (PPL) status: • Not Connected • Connected
Position summary	Positioning between pads in textual form: • N/A • Too close • Suboptimal close • Optimal • Suboptimal far • Too far Note: 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 3.3.1.6.3.
Charge status	• Not Charging • Charging • Charge Complete • Recovery • Derating • Fault
Charge duration	Charge Cycle Elapsed Time: • minutes : seconds
De-rate status	The system is prevented from providing full DC Output power: • Active • Not Active
De-rate subsystem	All subsystems that are active will be displayed: • N/A • WPB • WPP • WSP • WSB
De-rate reason	All the reasons that are active will be displayed: • N/A • Temperature • Positioning • Input current

2. WPU Status

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

3. WSU Status

Statuses will only be displayed if the PPL connection is connected, otherwise 'Not connected' will be displayed against each parameter.

Parameter	Description
Vehicle / Battery ID	A vehicle and/or battery identification data string. If implemented within the WSB CANopen® interface: • A data string If not implemented within the WSB CANopen® interface: • N/A
Vehicle fault	A vehicle and/or battery fault. If implemented within the WSB CANopen® interface: • Not Active • Active If not implemented within the WSB CANopen® interface: • N/A
Battery SoC	The vehicle / battery State of Charge. If implemented within the WSB CANopen® interface: • n % If not implemented within the WSB CANopen® interface: • N/A
Charge control	Charge control status being received at the WSB from the external system: • Disabled; charge not being initiated • Enabled-DI; via Digital Input by vehicle • Enable-CAN; via CANopen® by vehicle • Enable-Ethernet; via Ethernet node

Parameter	Description
DC V setpoint	Voltage setpoint that the WSB is working to, which is derived from either: - Vehicle via CANopen® (ECC) - Network Node via Ethernet (ECE) - CC-CV Profile (ICP) - Multistage Profile (IMP)
DC V measured	Measured Voltage on the DC Output
DC I _{max} setpoint	Current setpoint that the WSB is working to, which is derived from either: - Vehicle via CANopen® (ECC) - Network Node via Ethernet (ECE) - CC-CV Profile (ICP) - Multistage Profile (IMP)
DC I measured	Measured Current on the DC Output
Battery temp probe	The measured temperature of the battery. If the NTC cable is fitted: - n °C If the NTC cable is not fitted: - N/A
Faults	Active Faults within the WSP or WSB
Warnings	Active Warnings within the WSP or WSB

3.5.2.4.5 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 (section 3.4.2)
- Start and Stop Internal Multistage Profile (see section 3.4.3)
- Start and Stop Internal CC-CV Profile (see section 3.4.4)
- Initiate the Li-ION Battery Recovery mode (see section 3.4.5)

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

Control

Ethernet Control

Control	☐
Voltage	0 V
Current	0 A
Cutoff current	0 A
Charge limit	0 Ah
Time limit	0 s

Enable Power

Start/Stop	☐
------------	--------------------------

Battery Recovery

Control	☐
	Recovery

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

1. The Ethernet Control section of the page is for controlling the WCS using the External Commanded Ethernet mode.
2. 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, a User logging into the webpage can view the setpoints that the FMS is providing to the WCS.

WARNING:


Do not activate this toggle (ON/OFF) if another user or FMS is controlling the WCS because the WCS will try to respond to controls from two different inputs.

Consequence: WCS error, WCS wear (e.g. if turning off and on repeatedly), Battery not charged correctly.

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.

Ethernet Control

Control OFF	Monitor only
Control ON	Enable control via Ethernet interface

Ethernet Control

Control	☐ OFF
Voltage	0 V
Current	0 A
Cutoff current	0 A
Charge limit	0 Ah
Time limit	0 s

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.

Category	Key	Description
Setpoints	Voltage	Max voltage for CV stage, formatted as a number e.g. 59.5
Setpoints	Current	Max current for CC stage, formatted as a number e.g. 62
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.
	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. (0=disabled to 1000)
	Time limit	When this time has passed within a charge, in seconds e.g. 5400, then the charger will stop the charge. (0=disabled to 86400)

- 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 the start and stop of the Internal CC-CV Profile and Internal Multistage Profile.

Enable Power

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

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

Battery Recovery

Control button	OFF	Disable the battery recovery control
	ON	Enable the battery recovery control, only when the button is ON, then could click the Recovery button to activate the battery recovery charging.
Recovery button		Click the Recovery button to activate the battery recovery as per given parameters with the Advanced Settings page. Only need to click the button one time, if failed to click the button again.

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

Charge Status

Parameter	Description
Charge mode	Setting on the WSU: - External Commanded CANopen® - External Commanded Ethernet - Internal Multistage Profile - Internal CC-CV Profile
Charge status	- Not Charging - Charging - Charge Complete - Recovery - Derating - Fault
DC V measured	Measured Voltage on the DC Output
DC I measured	Measured Current on the DC Output
Ah delivered	Ah delivered from WSU to Battery
Charge duration	Elapsed time from when the charge cycle started

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

Charge Clear

Clear

3.5.2.4.6 Data Logs Page

1. The WPU contains a series of incremental counters, capturing utilization information. The user log is displayed as below, it could be reset by the “Reset counters” button.

Data logs	
WPU User Log	
Ah delivered	1495.1AH
Wh requested from WSU	38818.1WH
Charge cycles	805
Interrupted charges	626
Uptime	67813S
Active time	51499S
Idle time	14960S
Too far / close time	1354S
Temp derating time	0S
OTP active time	0S
Recovery success count	4
Recovery fail count	1
Faults	609
Reset_counters	

2. 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 User modifying WPU settings. Click the “Download” button to download the event log, or click the “Reset” button to delete the event log.

The Events are timestamped with the date/time of the WPU.

Note: The WPU does not contain a battery-backed RTC, therefore the date/time may not be accurate, unless the time is synchronized using SNTP protocol.

WPU Event Log

Event log entries

```
{
  "Eventlog":
  {
    "Info":
    {
      "PartNumber": "EOE00000000", "SerialNumber": "YYWW000000",
      "Record 1": {
        "TimeStamp": "2025-3-21 15:49:29",
        "EventType": "Fault",
        "EventLevel": 0,
        "EventTrigger": "Ac",
        "AcVoltage": 207.5,
        "AcFreq": 60.014,
        "DeliveredPower": 0,
        "WpbTemp1": 63.4,
        "WpbTemp2": 60.4,
        "WpbTemp3": 69.3,
        "WpbTemp4": 58.9,
        "WppTemp1": 51.573,
        "WppTemp2": 0
      },
      "Record 2": {
        "TimeStamp": "2025-3-21 15:57:11",
        "EventType": "Fault",
        "EventLevel": 0,
        "EventTrigger": "Ac",
        "AcVoltage": 213.5,
        "AcFreq": 59.942,
        "D
```

Download

Reset

3. The WSU contains a series of incremental counters, capturing utilization information. The user log is displayed as below, it could be reset by the “Reset counters” button.

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

[Reset_counters](#)

4. 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 User modifying WSU settings. Click the “Download” button to download the event log, or click the “Reset” button to delete the event log.

The WPU will retain the WSU Event Log until the next WSU/Vehicle establishes PPL communications with it, which will overwrite the previous WSU Event Log stored on the WPU.

Note: The WSU does not contain a battery-backed RTC, therefore the date/time may not be accurate, unless the time is synchronized using CANopen® protocol (time taken from vehicle).

WSU Event Log

Event log entries

```
{
  "Eventlog":
  {
    "Info":
    {
      "PartNumber": "E0E0000000", "SerialNumber": "YYW000000",
    },
    "Record 1": {
      "TimeStamp": "1900-1-2 11:26:36",
      "EventType": "Fault", "EventLevel": 2,
      "EventTrigger": "OverCurr", "DeliveredCurrent": 12.54,
      "Wsu BattTemp": 0, "WsuSrTemp": 65.77, "WspTemp": 49.57,
      "Bat Volt": 25.72, "BatVoltSet": 33.02,
    },
    "Record 2": {
      "TimeStamp": "1900-1-2 11:26:47",
      "EventType": "Fault", "EventLevel": 2,
      "EventTrigger": "OverCurr", "DeliveredCurrent": 12.55,
      "Wsu BattTemp": 0, "WsuSrTemp": 65.48, "WspTemp": 54.76, "Bat"
    }
  }
}
```

[Download](#)
[Reset](#)

3.5.2.4.7 Advanced Setting Page

This page allows the access to the WCS configuration options, which is important for the operation.

1. The top section contains WPU settings.

Advanced Settings

WPU Configuration

Service

Out of service ☐ OFF

Power Limit

Maximum W

Charge Timeouts

Standby s

Charging s

Time config

Datetime

Blockout 1

Day ▼

Enable ☐ OFF

Start

End

Blockout 2

Day ▼

Enable ☐ OFF

Start

End

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	This setting allows the WPU to check it has not lost control communications. - Standby timeout - When the WPU is not charging and loses the control communication from the server then the WPU reports a warning. - Charging timeout - the WPU will stop charging and report a fault if the control is not received within the given timeframe. For both, the time is a value in seconds between 0 and 120, 0 = disabled.
Time Config	Configure the date time for WPU.
Block Out 1 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.

2. The WSU Configuration settings can also be modified and are stored on the WSU.

WSU Configuration

Charge Mode

Mode

Output Cable

Resistance Ω

Voltage Limits

Minimum V

Maximum V

Battery Capability

Maximum Voltage V

Maximum Current A

Setting	Description
Charge Mode	The Charge Mode of the WSU/Vehicle is set (typically once) when the vehicle is manufactured with the WSU installed. Control Modes consist of: • External Commanded CANopen® • External Commanded Ethernet • Internal CC-CV Profile • Internal Multistage Profile
DC Output Cable	Cable resistance can be configured for the attached DC cables so that the WSU can correctly calculate the battery voltage. The default setting is suitable for the DC cable attached to the WSB, therefore this setting will only need modified if the customer extends the DC cable connection to the battery, see section 3.2.4.2
Voltage Limits	Set a more narrow voltage window so that the WSB will confine itself to only operating within. Example uses: Preventing charge if charging at full current at lower voltages could damage the battery.
Battery Capability	Customer to enter the maximum voltage & 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.

3. Internal CC-CV Profile

For explanation of this function, see section 3.4.4.

Internal CC-CV Profile

Voltage	0	V
Current	0	A
Topping	0	V
Cutoff current	0	A
Charge limit	0	Ah
Time limit	0	s
Delayed start	0	s
Retry quantity	0	

Category	Key	Description
Setpoints	DC V setpoint	Max voltage for CV stage, formatted as a number e.g. 29.2. Range: - WSB 24V – 12V to 33V - WSB 36V – 18V to 49.5V - WSB 48V – 24V to 66V Default = 0V (disabled)
	DC I _{max} setpoint	Max current for CC stage, formatted as a number e.g. 72. Range: - WSB 24V - 0A to 132A - WSB 36V - 0A to 88A - WSB 48V - 0A to 66A 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. (configured-min-voltage to configured-max-voltage)
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: - WSB 24V - 0A to 132A - WSB 36V - 0A to 88A - WSB 48V - 0A to 66A Default = 0A (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

Category	Key	Description
	Time limit	Retry quantity 0 n this time has passed within a charge, in seconds e.g. 900, then the charger will stop the charge. 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 (0=disabled to 5)

4. Internal Multistage Profile

As the Internal Multistage Profile modes run automatically, this setting allows the WCS to attempt to clear faults. The number of times to auto retry in the event of a WCS fault e.g. 3 (0=disabled to 5).

5. Li-ION Battery Recovery

For explanation of this function, see section 3.4.5.

Battery Recovery

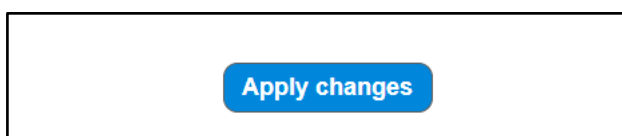
Enable	OFF	
Max current	0	A
Output voltage	0	V
Stop voltage	0	V
Time limit	0	s

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

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

6. Apply Changes

After the WSU configuration settings have been modified, need to click the “Apply Changes” button to transmit these configuration data to WSU.



3.5.2.4.8 Advanced Data Page

This page allows the user to access 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

3.5.2.4.9 Admin Page

Admin

User Accounts

Account -- Please select -- ▾

Username

Password

Apply changes

User Data

Identifier

Data

Email

Telephone

1. User Accounts

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

2. User Data

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.

WPU Identification

Flash LEDs OFF

WPB

Model Name

Part number

Hardware version

Serial number

SW - App1 version v2.0.1

SW - App2 version ...

WPP

Model Name

Part number

Hardware version

Serial number

SW - App version ...

3. WPU Identification

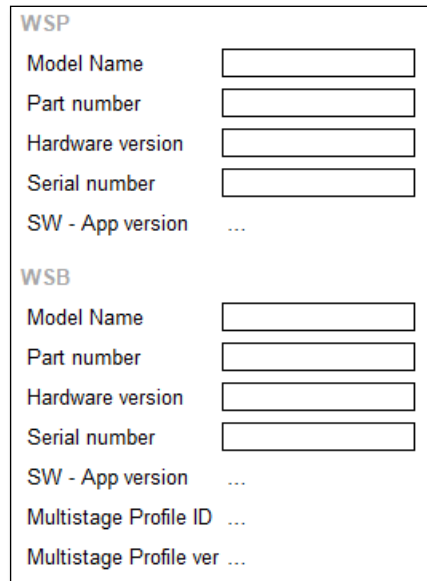
Flashes the LEDs on the WPB to visually locate the WPB (when Identify is ON the LEDs all flash).

4. WPB

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

5. WPP

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



The screenshot shows a form with two sections: WSP and WSB. Each section contains fields for Model Name, Part number, Hardware version, Serial number, and SW - App version. The WSB section also includes fields for Multistage Profile ID and Multistage Profile ver.

WSP	
Model Name	
Part number	
Hardware version	
Serial number	
SW - App version	...

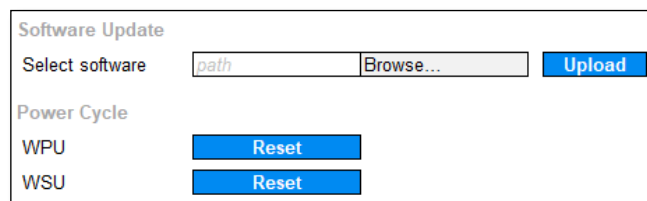
WSB	
Model Name	
Part number	
Hardware version	
Serial number	
SW - App version	...
Multistage Profile ID	...
Multistage Profile ver	...

6. WSP

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

7. WSB

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



The screenshot shows a form with two sections: Software Update and Power Cycle. The Software Update section has a text input field for 'path', a 'Browse...' button, and an 'Upload' button. The Power Cycle section has two rows: WPU and WSU, each with a 'Reset' button.

Software Update	
Select software	path Browse... Upload

Power Cycle	
WPU	Reset
WSU	Reset

8. Software Update

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

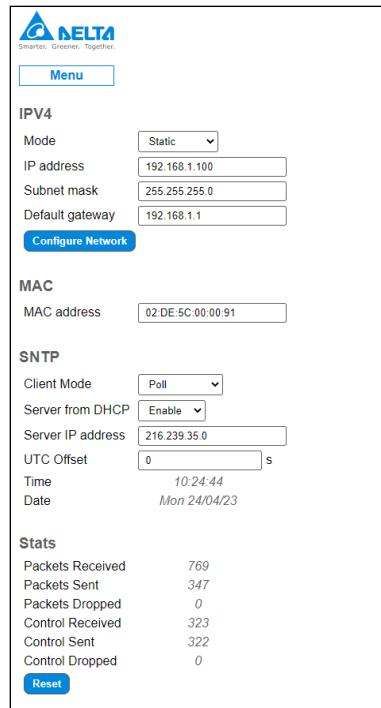
9. Power Cycle

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

3.5.2.4.10 Network Page

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

SNTP: If WPB features are used that rely on time/day (e.g. time of day charging/not charging), then setting the time or setting up the SNTP will be necessary.



The screenshot shows the Network Page interface with the following sections:

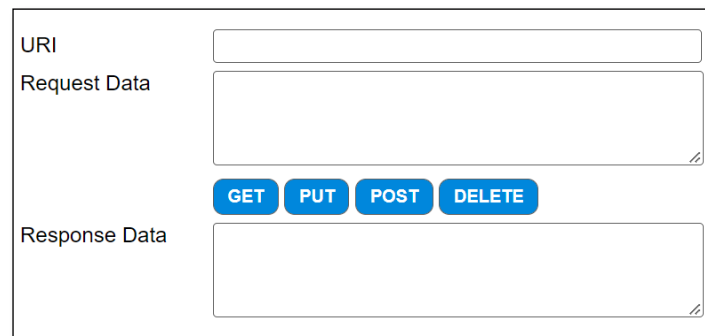
- Menu**: A button at the top.
- IPv4**:
 - Mode: Static (dropdown)
 - IP address: 192.168.1.100
 - Subnet mask: 255.255.255.0
 - Default gateway: 192.168.1.1
 - Configure Network**: A button.
- MAC**:
 - MAC address: 02:DE:5C:00:00:91
- SNTP**:
 - Client Mode: Poll (dropdown)
 - Server from DHCP: Enable (dropdown)
 - Server IP address: 216.239.35.0
 - UTC Offset: 0 s
 - Time: 10:24:44
 - Date: Mon 24/04/23
- Stats**:

Packets Received	769
Packets Sent	347
Packets Dropped	0
Control Received	323
Control Sent	322
Control Dropped	0
- Reset**: A button at the bottom.

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

3.5.2.4.11 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 top text area and the response will be shown in the bottom text area. A request can be sent using the “GET” or “POST” buttons. See Ethernet Control Protocol Specification for URL details.



The screenshot shows the Test Page interface with the following sections:

- URI**: A text input field.
- Request Data**: A large text area for entering request data.
- Buttons**: Four buttons labeled GET, PUT, POST, and DELETE.
- Response Data**: A large text area for displaying the response data.

3.5.3 WSB - CANopen®

3.5.3.1 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.

3.5.3.2 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.

3.5.3.2.1 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)

Item	Supported Bitrate
1	125 kBit/s
2	250 kBit/s
3	500 kBit/s
4	800 kBit/s
5	1000 kBit/s

3.5.3.2.2 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

3.5.3.2.3 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 200h + Node-Id	Battery status CiA-419 (Object: 0x6000)	Charge current request 1/16A CiA-419 (Object: 0x6070)		Not used				
COB-ID of Receive- PDO 1 (RPDO1)	0x220, (0x200 + Node-Id)							
Transmission Type	0xFF (details see CiA-301)							
Timeout	If timeout is reached charging is stopped (charge request = 0) Battery must send this cyclic message within the timeout limit.							
Number of mapped 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 180h + Node-ID	Charger status CiA-419 (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 200h + Node-ID of charger	Battery status CiA-419 (Object: 0x6000	Charge current request 1/16A CiA-419 (Object: 0x6070)	Not used					
Transmission type:	0xFF							
Inhibit Time (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 180h + Node-ID of charger	Charger status CiA-419 (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 3.5.3.2.3 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.

3.5.3.2.4 Charging Data Example

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

	ATTENTION: For a controlled charge, make sure to configure and use the Receive PDO only. For examples refer 3.5.3.2.3 How to Control the Charger via CANopen®.
---	---

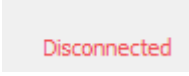
3.5.3.3 GUI

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

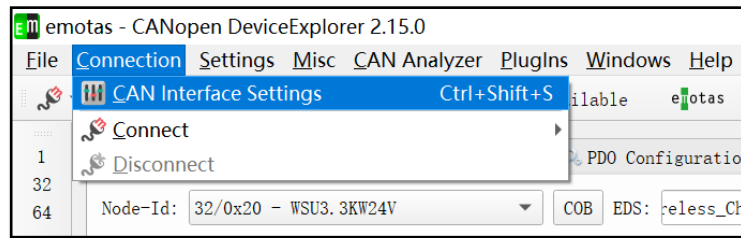
For example **Emotas CANopen® Device Explorer** to communicate with WSB.

3.5.3.4 User Configuration (Example: Emotas CANopen® Device Explorer)

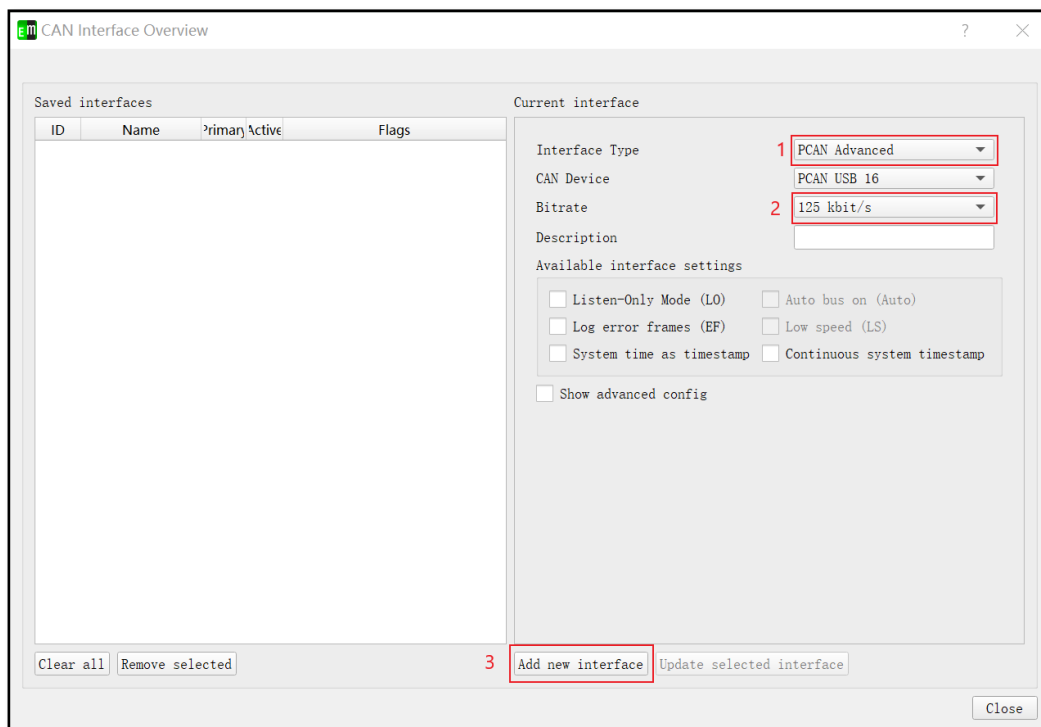
1. Power the WSB via connection to a battery with the appropriate voltage and connect the PC/Notebook to the CANopen® -Network from the WSB (Example: PCAN)
2. Make sure to install the **PEAK System Installation package** from here [PCAN-USB: PEAK-System \(www.peak-system.com/PCAN-USB.199.0.html\)](http://www.peak-system.com/PCAN-USB.199.0.html),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

	• At the bottom right corner of the CANopen® Device Explorer window user could see , this means connection is not yet done. • Emotas CANopen® Device Explorer is just for an example.
---	---

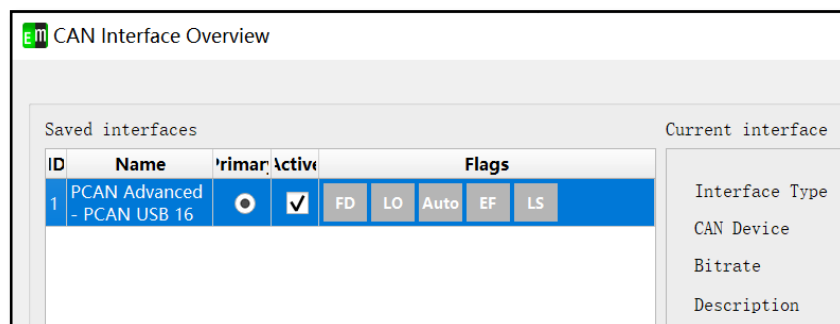
- At first, go to **Connection -> CAN Interface Settings**, a window pops up.



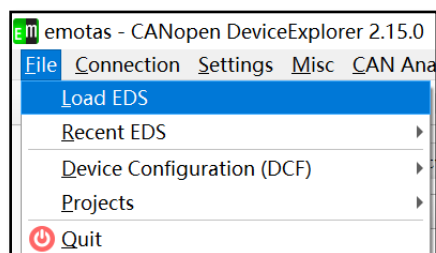
- In Current interface -> Interface Type -> select PCAN Advanced from drop down list and in Bitrate select 125kbit/s -> click on Add new interface.



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



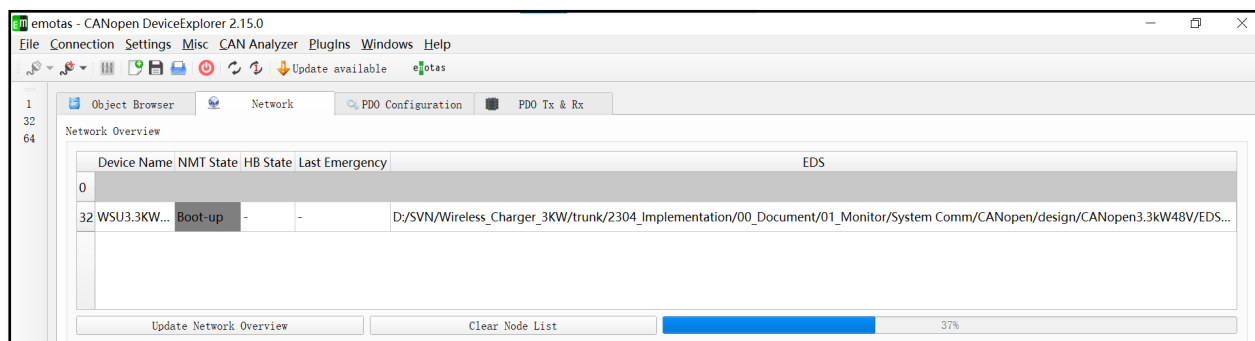
6. Import the EDS file supplied by Delta, **File -> Load EDS -> WSU.eds**.



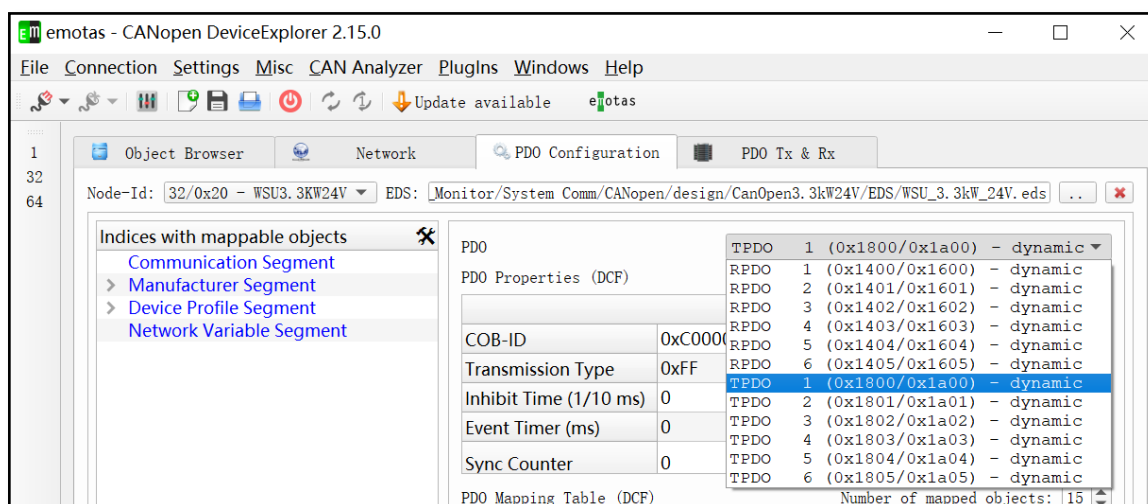
7. Once the EDS is loaded, click on **Connect** button .
8. Once the connection is done, user would see

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

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



11. 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).
12. In PDO segment select TPDO 1 (0x1800/0x1a00) - dynamic.



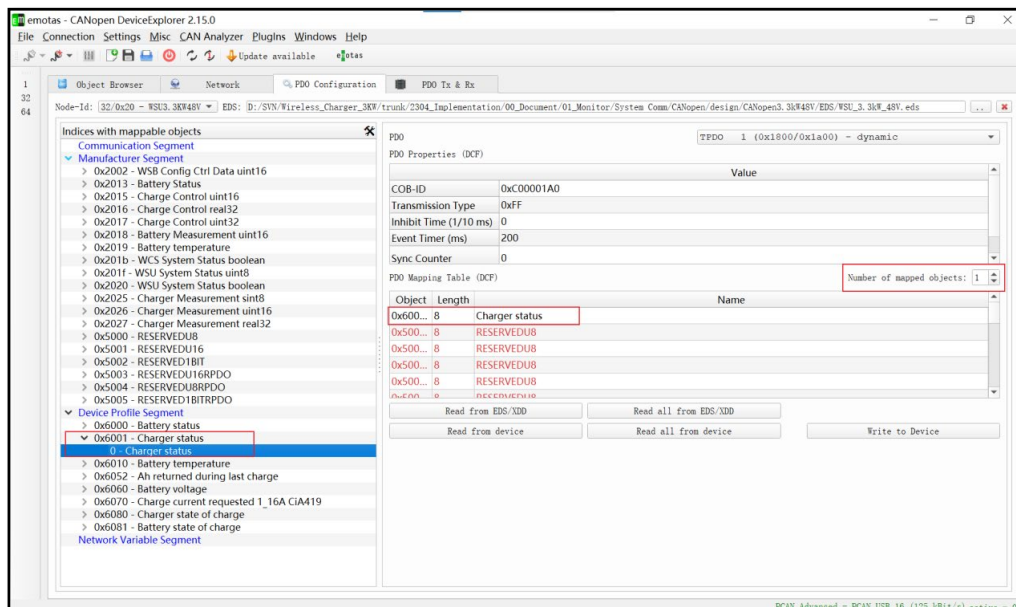
13. In PDO Properties (EDS) give values as:

Note: Item 1 to 5 in the given table is also described in CiA-301.

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

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

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

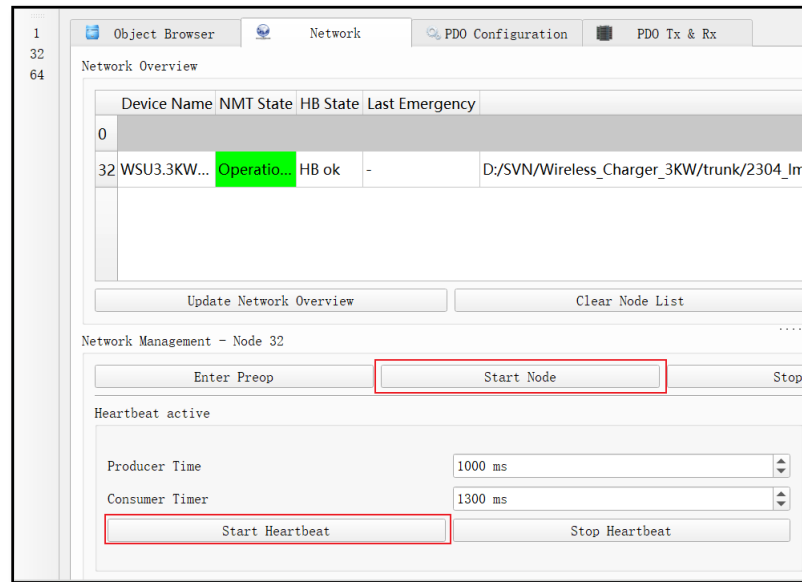


16. Repeat this process until user could see the required objects, in the **PDO Mapping Table (EDS)**.

17. Based on number of objects available in the table, give the number value in **Number of mapped objects**. Give 4 if the number of objects in the PDO Mapping Table is 4.

18. Now Click on Write to Device followed by Read from Device.

19. Select the desired Device -> Start **Heartbeat** to update NMT state automatically then click on **Start Node**.



20. User could quit the process, **File -> Quit**.
Note: For RPDO and TPDO examples refer 3.5.3.2.3 How to Control the Charger via CANopen®.

4 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.

4.1 WPB

4.1.1 Safety Instructions

DANGER: 	Electric shock Make sure that there is no power supply to WPB for the installation process, it may lead to death of Personnel.
WARNING: 	Risk of Fire - The WPB must be protected by an external fuse/circuit breaker. - 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.
CAUTION: 	- Where a mains plug is used i.e. pluggable equipment, the mains socket outlet must be easily accessible to the user of the WPB. - 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.
CAUTION: 	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.
ATTENTION: 	The WPB does not have any serviceable parts and must never be opened.

4.1.2 Special Tools & Equipment

No special tools are required while installing WPB.

4.1.3 Installation Conditions

Item	Conditions	Description
1	Location	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.
2	Position	It is recommended to install WPB vertically with connections at the bottom, to ensure maximum operating temperature. Care to be given to prevent ingress of dust and water into the unmated connectors.
3	Power supply cord	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 ² for EU. Use only copper cord and make sure to comply with wiring rules of the respective country where equipment is to be installed.
4	Connection cable to WPP	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.

4.1.4 Installation Procedure

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

1. Make sure to read and understand all the safety messages. Refer 4.1.1 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.

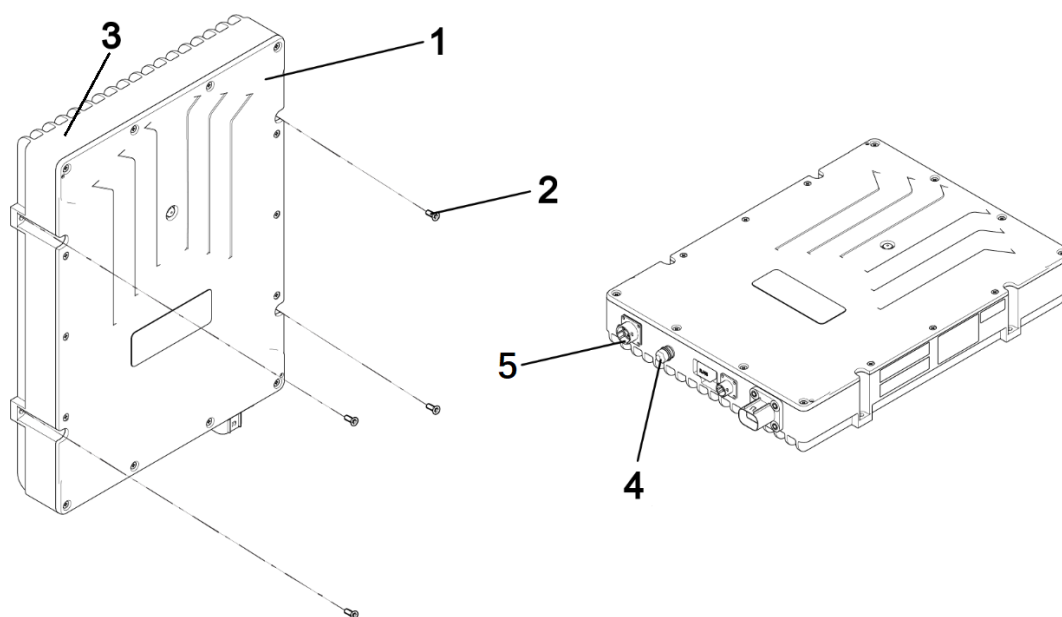


Figure. 27 WPB Installation

Item	Description	Item	Description
1	WPB	4	Ground Screw
2	Screws M6, at least 20mm in length	5	AC Input Connector

4.1.5 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.

4.1.6 Power Up & Health Checks

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

4.2 WPP

4.2.1 Safety Instructions

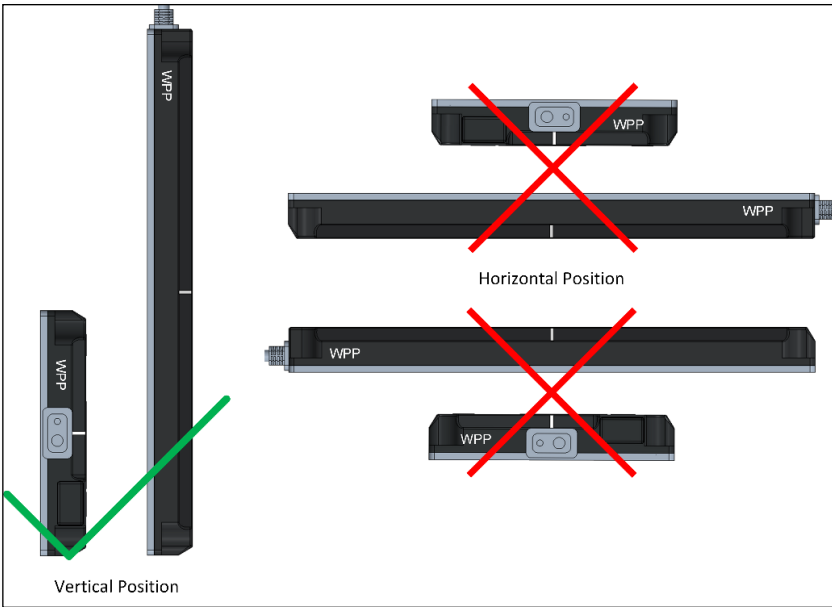
WARNING: 	Electromagnetic Field (EMF) • The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produce a potentially harmful magnetic field during the charging process. • Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see 2.4.2 EMF Safety Instructions. • 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. • Electromagnetic field exposure to pregnant Users and Children is strictly forbidden. • Advise the end user about safety distances and affix appropriate warnings. • Warning signs should be clearly displayed at the charging area. • Do not install or operate the system in the public area. • Electronic objects such as cell phones and hearing aids may get damaged.
WARNING: 	Electromagnetic Field (EMF) 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.
WARNING: 	Electric Shock 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.
CAUTION: 	Hot surfaces - Do not touch the WPP while charging is in progress. - Do not touch the WPP for at least 30 minutes (cooling time) after the charging process is finished. Make sure to wear safety gloves while handling the subsystems after charging.
ATTENTION: 	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.

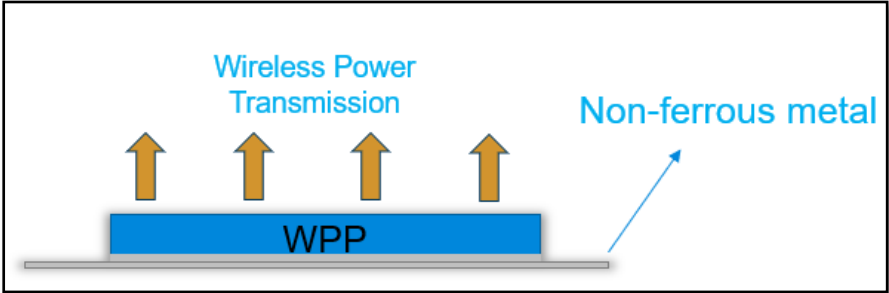
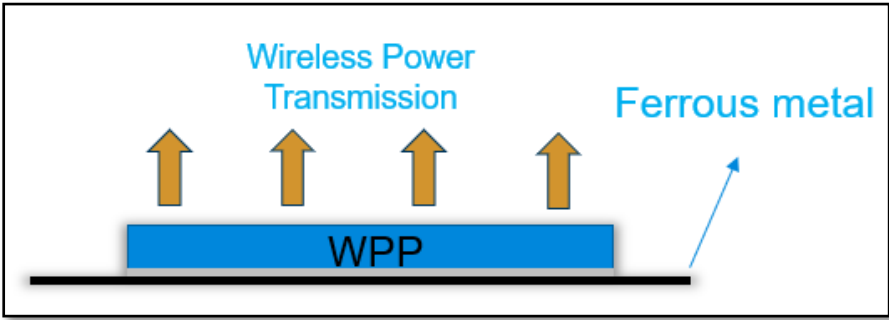
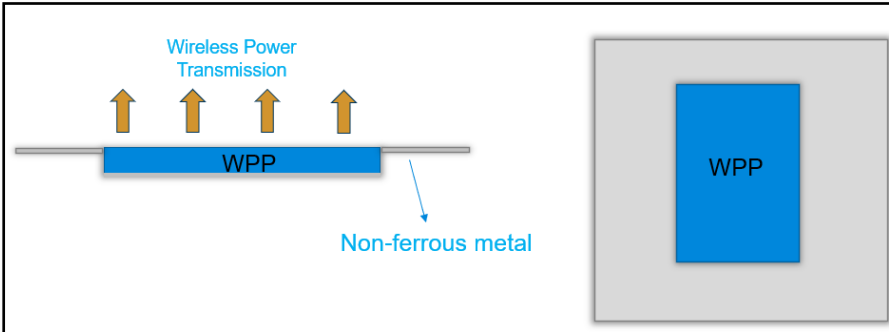
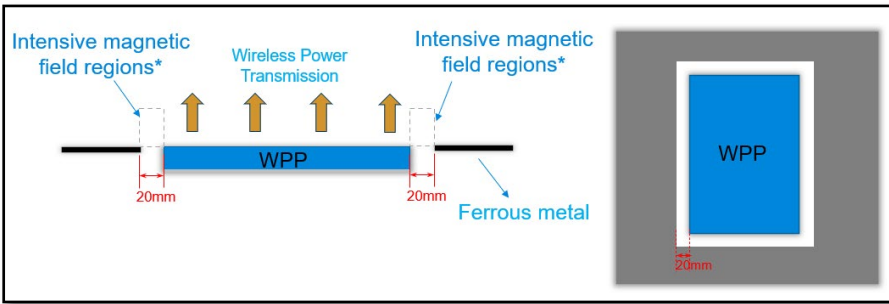
ATTENTION:	The WPP does not have any serviceable parts and must never be opened.
	
ATTENTION:	Do not lift the WPP using cable assembly. Finger lifting point is available for lifting from a flat surface. Figure. 31.
	

4.2.2 Special Tools & Equipment

No special tools are required while installing WPP.

4.2.3 Installation Conditions

Item	Conditions	Description
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.
2	Position	Make sure to install the WPP vertically on the wall: 
		Alignment of WPP with 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.
		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. WPP power & signal cables Minimum Bend Radius (MBR): 110mm. 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.
		Installation Make sure to use appropriate screws while mounting the WPP to the supporting wall/fixture with respect to the WPP weight.

3a	Mounting – On Metals	The WPP can be mounted directly on ferrous (e.g. Steel) and non-ferrous (e.g. Aluminum) metals.  
3b	Mounting: Flush with non-FE Metals	If the WPP plastic surface is flush with a non-ferrous metal plate, then no clearance from the edge of the WPP is necessary (0mm). 
3c	Mounting: Flush with FE Metals	If the WPP plastic surface is flush with a ferrous metal plate, then at least 20mm 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. * In addition to directly in front of the WPP.

4.2.4 Installation Procedure

1. Make sure to read and understand all the safety messages. Refer 4.2.1 Safety Instructions and 2.4.2 EMF Safety Instructions.
2. Install WPP (1) to the wall or to the mounting surface using 4xM8 screws (2).

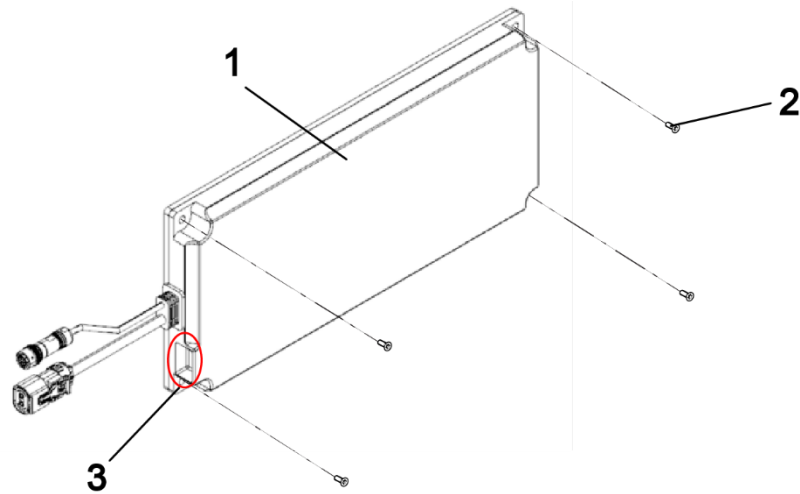


Figure. 28 Installation of WPP

Item	Description
1	WPP
2	Screws M8, at least 28mm in length
3	Lifting Point

4.2.5 Connecting WPP to WPB

WARNING: 	Electric shock Make sure to disconnect the AC supply of the WPB before connecting WPP to WPB, as it may lead to death of Personnel.
---	--

1. Make sure to read and understand all the safety messages. Refer 4.2.1 Safety Instructions.
2. Connect WPP power cable (6) to WPB power connector (3).
Note: Minimum bend radius of WPP power & signal cables MBR: 110mm.
3. Connect WPP signal cable (5) to WPB signal connector (2).

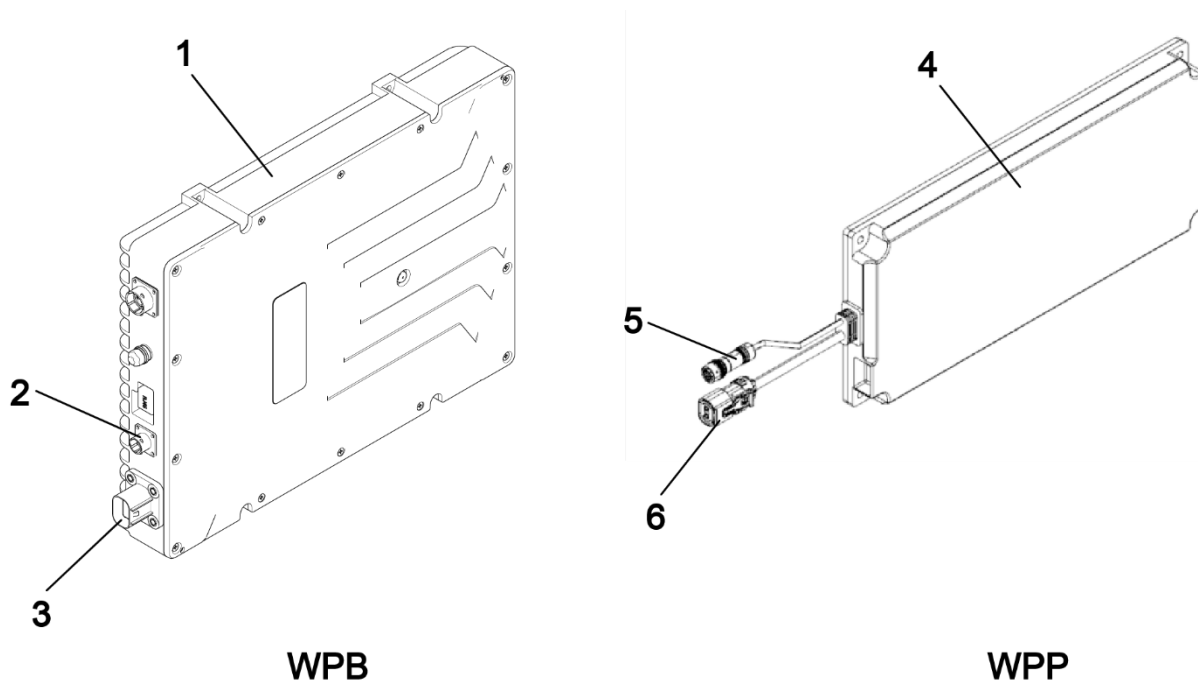


Figure. 29 Connecting WPP to WPB

Item	Description	Item	Description
1	WPB	4	WPP
2	WPB Signal Connector	5	WPP Signal Cable
3	WPB Power Connector	6	WPP Power Cable

4.2.6 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 7 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.

4.3 WSP

4.3.1 Safety Instructions

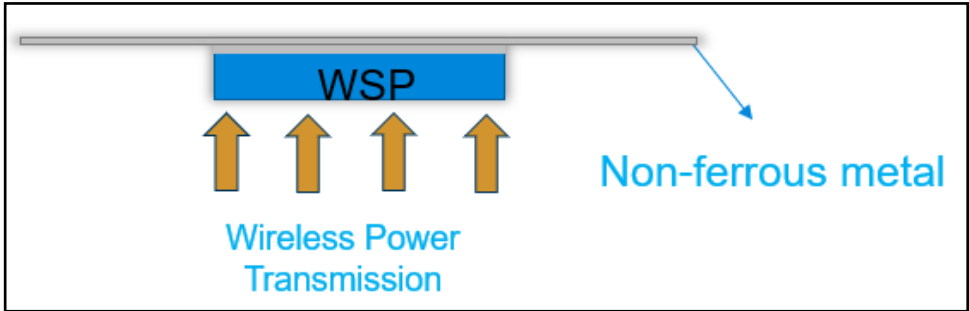
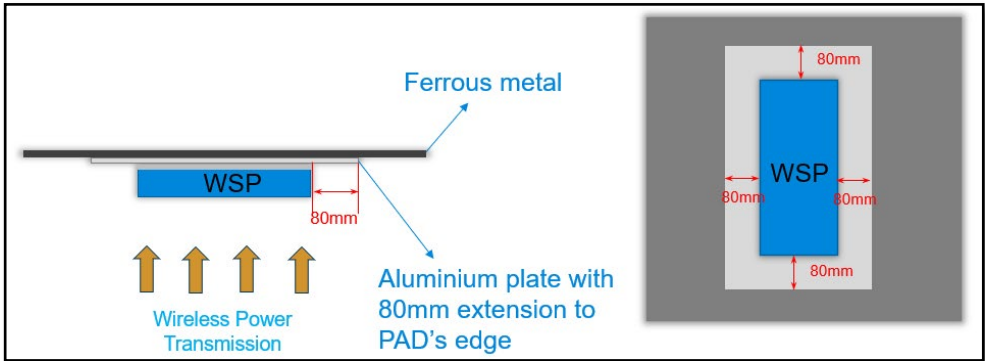
DANGER: 	Electric shock Only qualified skilled person shall install, uninstall, service and maintain the WSP.
DANGER: 	Electric Shock Disconnect all cable connections to WSP to make sure that there is no power supply to WSP for the installation process, otherwise there could be a danger of electric shock.
DANGER: 	Electric shock - Dangerous voltage levels are output by the WSP during charging. - Do not handle or disconnect the cable connections during the charging process.
ATTENTION: 	The WSP does not have any serviceable parts and must never be opened.

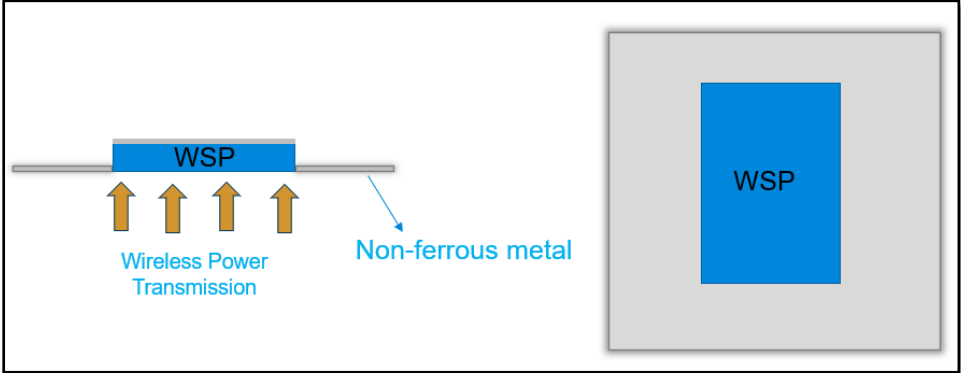
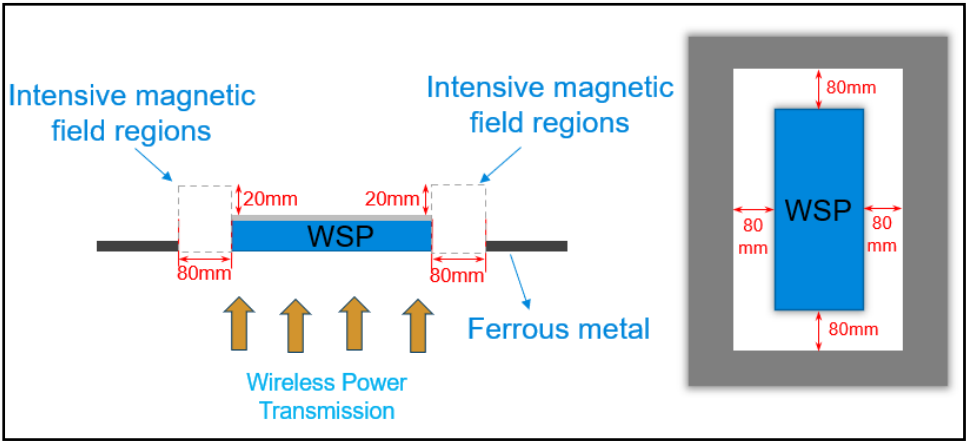
4.3.2 Special Tools & Equipment

No special tools are required while installing the WSP.

4.3.3 Installation Conditions

Item	Conditions	Description
1	Location	Make sure to install the WSP vertically on any side of the vehicle: Vertical Position Horizontal Position

Item	Conditions	Description	Item
2	Position	Alignment of WSP with WPP	Make sure to install the WSP at the same height as the WPP within the 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.
		Installation	Make sure to use appropriate screws while mounting the WSP to the vehicle with respect to the WSP weight.
3	Magnetic field	The magnetic field generated during the charging process extends behind the WSP and could interfere with vehicle electronics, and/or present a health risk to a driver, depending on their location, for further information see section 2 Safety & Regulations and Appendix B – Stray Field Distances .	
4a	Mounting – On non-FE Metals	The WSP can be mounted directly on non-ferrous (e.g. Aluminum) metals. 	
4b	Mounting: On FE Metals	If the WSP is to be mounted on ferrous metal (e.g. Steel), then a non-ferrous plate must be installed between the WSP and ferrous metal. The non-ferrous plate must overlap by at least 80mm in all directions.  Failure to adhere to this installation requirement may result in reduced performance issues and/or damage to the system.	

Item	Conditions	Description
4c	Mounting: Flush with non-FE 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 (0mm). 
4d	Mounting: Flush with FE Metals	If the WSP plastic surface is flush with a ferrous metal plate, then a clearance of at least 80mm 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.

4.3.4 Installation Procedure

4.3.4.1 Mounting the WSP on the Vehicle

1. Make sure to read and understand all the safety messages. Refer 4.3.1 Safety Instructions.
2. Make sure to disconnect all the cable connections to WSP (1). Refer 4.4.4.1 Connecting WSP to WSB.
3. Install WSP (1) to the vehicle using 4xM6 screws (2).

ATTENTION: 	- WSP could also be installed on a metal sheet which acts as a heat sink, this improves the heat dissipation during the charging process. Refer to section 4.3.3 for mounting on metals. - Mounting the WSP with a heat sink would increase the operation time at full output current before de-rating occurs (refer 3.3.1 Output Power and De-rating).
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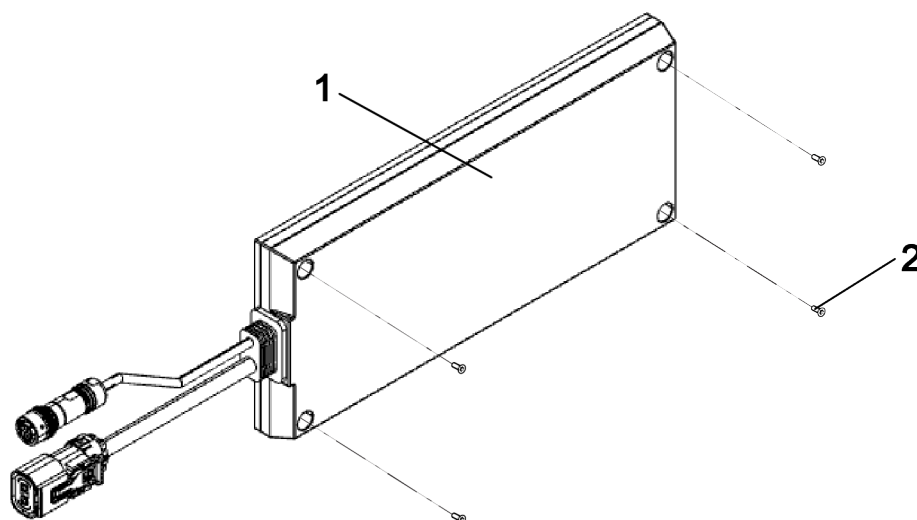


Figure. 30 Mounting WSP on the Vehicle

Item	Description
1	WSP
2	Screws M6, at least 20mm in length

4.3.5 Power Up & Health Checks

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

4.4 WSB

4.4.1 Safety Instructions

DANGER: 	Electric shock Only qualified skilled person shall install, uninstall, service and maintain the WSB.
DANGER: 	Electric shock Make sure to disconnect or switch off all the power sources before installing the WSB.
DANGER: 	Electric shock Dangerous voltage levels are input and output by the WSB during charging. Do not handle or disconnect the cable connections during the charging process.
DANGER: 	Electric shock • Make sure to disable the charge request and to disconnect the power to WSB before removing it from vehicle for service or maintenance. • Always refer to vehicle's user manual as power cables are fixed to the batteries.
ATTENTION: 	Polarization Connect the DC output cables properly with correct polarization: • RED → connect with positive (+) pole • BLACK → connect with negative (-) pole
ATTENTION: 	The WSB does not have any serviceable parts and must never be opened.

4.4.2 Special Tools & Equipment

No special tools are required while installing the WSB.

4.4.3 Installation Conditions

Item	Conditions	Description	
1	Position	Cable connection	The WSB cable connections must be protected from access to unskilled persons. The power & signal cables between WSP and WSB do not intend for dynamic use.
		Installation support	Make sure to use appropriate screws while mounting the WSB to the vehicle with respect to the WSB weight.
		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: 110mm WSB 24V & 36V DC cables MBR: 120mm WSB 48V DC cables MBR: 100mm

4.4.4 Mounting the WSB on the Vehicle

1. Make sure to read and understand all the safety messages. Refer 4.4.1 Safety Instructions.
2. Make sure to disconnect all the cable connections to WSB (1).
3. Install WSB (1) to the vehicle using 4xM6 screws (2).

ATTENTION:	• WSB 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 WSB with a heat sink would increase the operation time at full output current before de-rating occurs (refer 3.3.1 Output Power and De-rating).
	

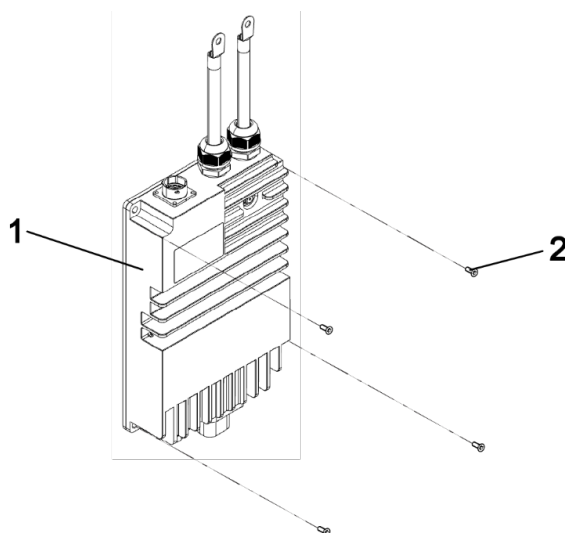


Figure. 31 Mounting WSB on Vehicle

Item	Description	Item	Description
1	WSB	2	Screws M6, at least 20mm in length

4.4.4.1 Connecting WSP to WSB

1. Make sure to read and understand all the safety messages. Refer 4.4.1 Safety Instructions.
2. Connect WSP signal cable (3) to WSB signal connector (9).
3. Connect WSP power cable (2) to WSB power connector (8).

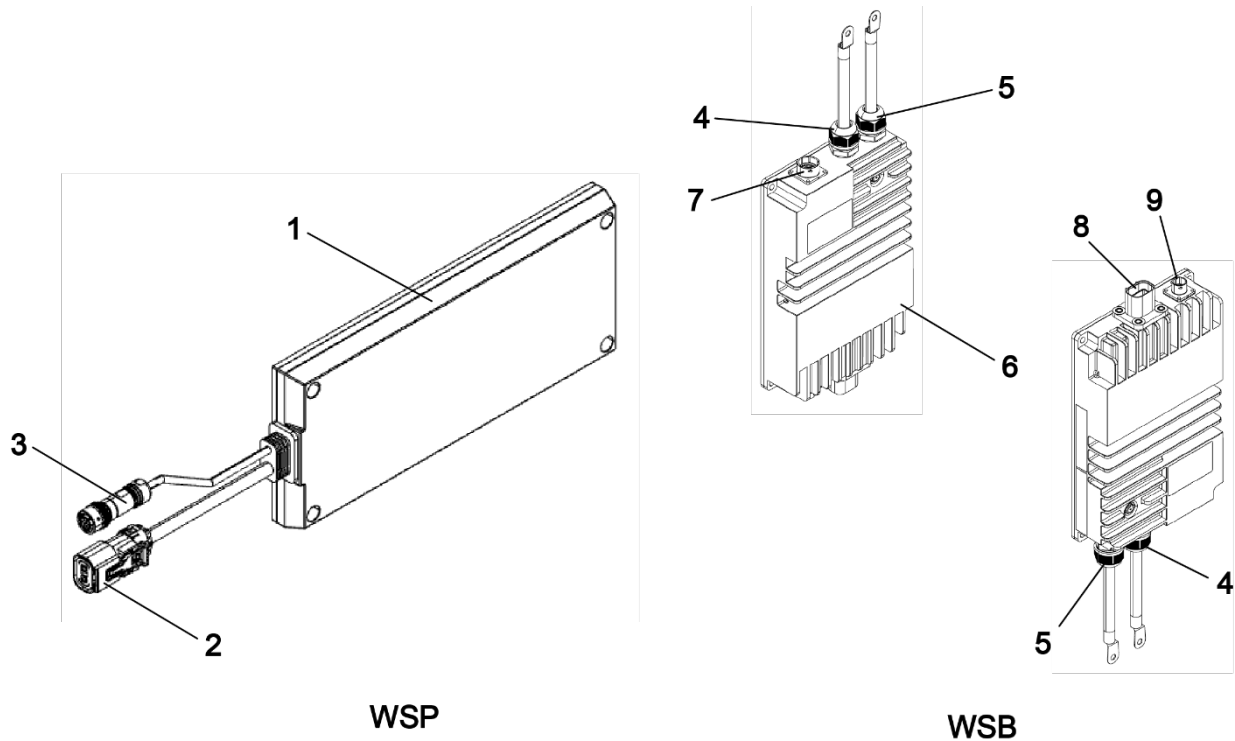


Figure. 32 Connecting WSP to WSB

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

4.4.4.2 WSB DC Power Cable Connection

1. Make sure to read and understand all the safety messages. Refer 4.4.1 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.

4.4.4.3 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. Refer to 0

User Interface and 3.4 System Control Modes.

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

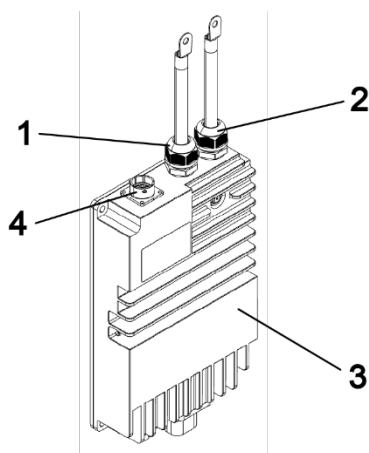


Figure. 33 WSB Cable Connections

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

4.4.4.3.1 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:

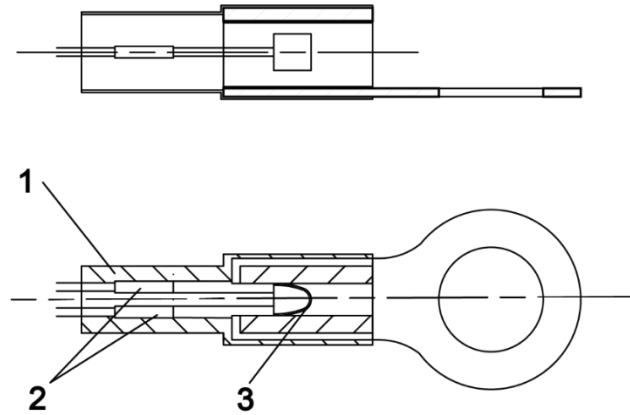


Figure. 34 NTC within Ring Terminal

Item	Description	Qty
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

4.4.5 Power Up & Health Checks

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).

ATTENTION:


The WSB will not initialize when there is no battery connected or when the battery voltage is less than:

- 24V variant: 12V
- 36V variant: 18V
- 48V variant 24V

2. If CANopen® communications are integrated, establish CANopen® communications, refer to section 3.2.4.4.2. 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.

5 System Commissioning / Start-up

5.1 Safety Instructions

	Electromagnetic Field (EMF) • The Wireless Primary Pad (WPP) and Wireless Secondary Pad (WSP) produces a potentially harmful magnetic field during the charging process. • Make sure to maintain a safe distance from WPP when charging is in progress. For more details about the safe distance see 2.4.2 EMF Safety Instructions. • 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. • Electromagnetic field exposure to pregnant Users and Children is strictly forbidden. • Advise the end user about safety distances and affix appropriate warnings. • Warning signs should be clearly displayed at the charging area. • Do not install or operate the system in the public area. • Electronic objects such as cell phones and hearing aids may get damaged.
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5.2 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).

6 Maintenance

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

6.1 Safety Instructions

During maintenance, the following warning, cautions and notes must be observed. Refer to 2.4 Safety Instructions.

6.2 Preventive Maintenance

CAUTION: 	Hot Surfaces 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.
CAUTION: 	• Make sure to check all the cables (external) for any damages and if necessary replace them. • Only qualified skilled person shall replace the cables.

	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. • Check the WPP for visible damage. If any damage is detected, discontinue use of the WPP and disconnect it from WPB, refer to section 4.2.5.	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. • 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.

6.2.1 General Cleaning

6.2.1.1 Materials

Table. 8 Cleaning Agents

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

Note:	• Use all cleaning solutions with care. • Alternative equivalents are permitted. • For plastic parts only use cleaning agents suitable for cleaning plastic.
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WARNING: 	Cleaning agents should be used with care. Make sure to follow the instructions (for example dilutions) provided in the datasheets of the cleaning agents.
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6.2.1.2 Procedure

6.2.1.2.1 Cleaning WPB & WSB

WARNING: 	Make sure to follow the health and safety instructions. Refer to 2 Safety & Regulations.
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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.

6.2.1.2.2 Cleaning WPP & WSP

WARNING: 	Make sure to follow the health and safety instructions. Refer to 2 Safety & Regulations.
CAUTION: 	Do not use heated pressure washer or a steam cleaner on WPP and 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 Table. 8, 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

6.3 Corrective Maintenance

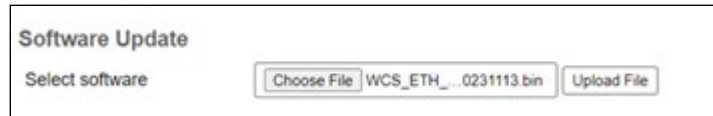
There are no replaceable parts within any of the WCS subsystems.

6.4 Firmware Update

6.4.1 WPU

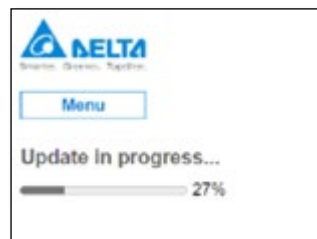
Firmware of the WPU could be updated through the Ethernet interface.

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.



6.4.2 WSU

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

6.4.2.1 Firmware

6.4.2.1.1 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:

- 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.
- 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.
- 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.
- Start the program by writing 1 to the object with index 0x1F51(sub-index 1 for WSB, sub-index 2 for WSP).
- Delay for a while, deactivate the WSU maintenance mode by writing 0x00 to the object 0x2040.
- Check the firmware version.

6.4.2.1.2 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 6.4.1 WPU.

6.4.2.2 Multistage Profile

6.4.2.2.1 Via CANopen®

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

- 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.
- 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.
- Delay for a while, deactivate the WSU maintenance mode by writing 0x00 to the object 0x2040.
- Check the charger profile ID by reading the object with index 0x2020 and sub-index 3.

6.4.2.2.2 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 6.4.1 WPU.

7 Troubleshooting

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

7.1 Identifying Subsystems to Troubleshoot

The following are different ways to identify a faulty subsystem:

- Status LED panel
- Ethernet communications interface, see section 3.5.2
- CANopen® communications interface, see section 3.5.3

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. 35 Possible Status LED Panel Scenarios

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.

7.2 Troubleshooting on WPB

Table. 9 Troubleshooting of 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 - Contact your IT network administrator
	WPB may have been misconfigured by a User e.g. wrong gateway	Contact your IT network administrator

7.3 Troubleshooting on WPP

Table. 10 Troubleshooting of 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

7.4 Troubleshooting on WSP

Table. 11 Troubleshooting of 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 3.3.1.5

7.5 Troubleshooting on WSB

Table. 12 Troubleshooting of 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 - Make sure that the polarity is not reversed
	Wrong battery	Check the voltage range of the battery, correct voltage range: - WSB 24V: 12~33V - WSB 36V: 18~49.5V - WSB 48V: 24~66V 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

7.6 Troubleshooting of Detail Faults

Table. 13 Troubleshooting of WSU Faults

Item	Fault	Definition	Clear mechanism	Troubleshooting
1	Hardware	Indicates that incompatible WSP or WPU hardware detected.	Cannot be cleared by command.	Replace with the compatible WSP or WPU module.
2	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.
3	Calibraion	Indicates that the calibration data of WSU is abnormal.	Clear by command.	Re-calibrate.
4	Sensor	Indicates that the NTC modlue is broken.	Cannot be cleared by command	Check which temperature is set to -128 or 140 and replace the new NTC module.
5	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. Check whether the WPP or WSP is moving during charging.
6	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.
7	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/warings/status of WPU and WSU.

Item	Fault	Definition	Clear mechanism	Troubleshooting
8	UnderVoltage	Indicates that the output voltage of charger is lower than 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.
9	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.	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. Check whether there is a sudden decrease of the gap and/or misalignment between WPP and WSP during charging.
10	OverTemperature	Indicates the temperature of WSU exceeds the pre-set point.	Auto clear when temperature is lower than pre-set point.	Check the temperature of WSU.
11	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.
12	Vehicle	Indicates that the vehicle side occurs fault.	Need to clear by vehicle side	
13	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.

Item	Fault	Definition	Clear mechanism	Troubleshooting
14	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.
15	ImpBattProfile	Indicates that the charger occurs charge-phase error under IMP mode	Clear by command.	Check whether the profile is matched with the battery. Check whether there is any abnormal change in the voltage and current waveform during the charging process. Record the output voltage and current, the faults/warnings/status of WPU and WSU.
16	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.
17	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.
18	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.
19	WatchdogReset	Indicates that the MCU of WSB or WSP reset due to watch dog.	Clear by command.	Record the firmware version of MCUs.

Table. 14 Troubleshooting of WPU Fault

Item	Fault	Definition	Clear mechanism	Troubleshooting
1	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.

Item	Fault	Definition	Clear mechanism	Troubleshooting
2	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.
3	Calibraion	Indicates that the calibration data of WPU is abnormal.	Clear by command.	Re-calibrate.
4	Sensor	Indicates that the NTC modlue is broken.	Cannot be cleared by command	Check which temperature would be set to -128 or 140 and replace the new NTC module.
5	Ac	Indicates that the ac voltage exceeds the limit range.	Auto clear when Ac volatge returns to normal range.	Check the voltage of AC source.
6	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/warings/status of WPU and WSU.
7	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/warings/status of WPU and WSU.
8	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/warings/status of WPU and WSU.
9	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/warings/status of WPU and WSU.
10	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/warings/status of WPU and WSU.

Item	Fault	Definition	Clear mechanism	Troubleshooting
11	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.
12	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.
13	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.
14	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.
15	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.
16	WatchdogReset	Indicates that the MCU of WPB and WPP reset due to watch dog.	Clear by command.	Record the firmware version of MCUs.

8 Accessories & Spare Parts

8.1 Parts List

Item	Part	Description	Qty
1	EOE16010870	WPB	1
2	EOE16010952	WPP	1
3	EOE16010953	WSP	1
4	EOE16011067	WSB 24V	1
5	EOE16011066	WSB 36V	1
6	EOE16010871	WSB 48V	1

8.2 Development Kit

Item	Part	Description	Qty
1	EOE99001129	- WSB Signal Cable Harness - CAN Bus 120 Ω Termination: D-Sub to D-Sub Connector - PCAN Adapter: D-Sub to USB	1

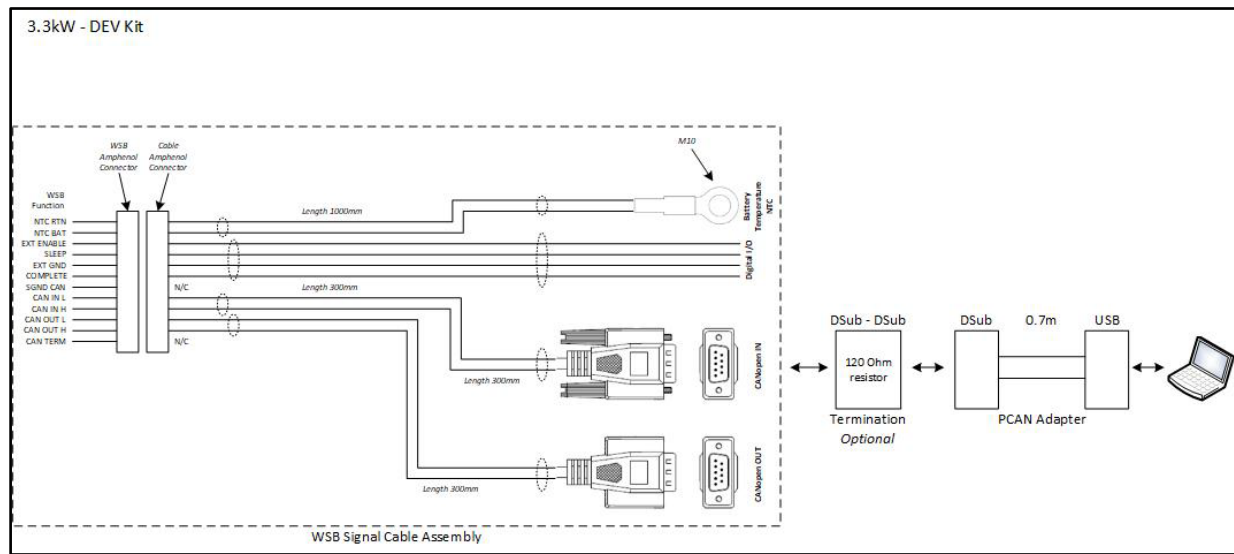


Figure. 36 Development Kit Connections

9 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.

9.1 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.

9.2 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.

9.3 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.

9.4 Product Life

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

Appendix A - Electromagnetic Field Distribution

This Appendix provides more detailed information on the WCS EMF. It does not replace section 2.4.2 EMF Safety Instructions.

Wireless charging creates a magnetic field in and around the pads and extends in all directions, of which exposure to this can pose a health risk. The measured values of the Electric Field (E), Magnetic Field (H) and Magnetic Flux Density (T) - for the wireless power transfer – used in certification for the relevant regions are listed below. Guidance reference limits from the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are also listed for information only.

All measurements are in free space, meaning that the field (E, H & B) characteristics will be different when there is metal in the area such as with a forklift truck.

For keep-out areas for safety, refer to 2.4.2 EMF Safety Instructions.

Appendix B - Product Disposal

Disposal of system and subsystems

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

Disposal of packaging materials

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



More information

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