ROBUST SERIES BATTERY CHARGERS
TECHNICAL MANUAL

MICROPOWER GROUP™
POWERFUL SOLUTIONS PARTNER

Introduction

For hardware specifications, see separate documents "Specification".
For installation and operation instructions, see "Installation and user manual".
This document presents the remaining features of Robust series chargers, configuration, CAN remote control, connections, and options.

This document applies to typical hardware versions. Special HW versions for specific applications are not documented in this manual. This document applies to standard software type 11613002 revision 5-13, if not otherwise stated. Special SW types for specific applications are not documented in this manual.

Information is subject to change without notice.

1. Modes

The charger has several operation modes, for example, charger, fixed power supply, and several remote-controlled power supply modes.

Charger mode is a standalone device, which controls the battery charging process according to selected internal algorithm and other charging parameters. Note that charging lithium battery requires BMS (Battery Management System) for safety reasons.

Fixed power supply (SDO power supply) mode is a standalone power supply with configurable nonvolatile voltage and current settings. In this mode, the charger outputs power immediately after startup. Configuration items UdcLimit and IdcLimit are used. This mode uses a fast HW control loop, which is stable for almost all loads.

Protocol power supply (PDO power supply) mode is a remote controlled power supply that provides setting and measurement messages. It is necessary to keep sending messages. If required CAN messages are not received, power output is switched off after some seconds. Note the involved SW control loop behavior. Constant voltage type load, for example, battery, is needed for output to be stable. SW loop has a slow response to load changes. Thus, this mode might be better described as CAN controlled battery charger.

Power supply mode is a remote controlled power supply that provides close compatibility to PAP3200/CAN product family. This mode uses a fast HW control loop, which is stable for almost all loads. This feature is available in software revision 7 and later.

1.1 Common features for all modes

Robust series chargers feature dynamic power limit. This means maximum voltage and maximum current can be set at the same time. One of them can be output at one time. Depending on load, output operates on voltage, cur,rent or power limit. Limits are either maximums of the power version or smaller values set by a charging algorithm, remote control message,s or configured limits.

The STOP button switches output off both in charger and power supply modes. Pressing STOP again restores output.

Remote input can be configured to start/stop functionality. Power output is on if remote input is active (closed contact).

2. Configurable items

Some settings can be configured using the front panel and CAN commands. Almost all settings can be configured usan ing optional radio module. All settings can be set at the factory.

Configuring method	Documented in:
Front panel	chapter "Editing charging configuration"
CAN bus	chapter "CAN remote control"
Radio	Access Service Tool documentation
Factory setting	ask from your supplier. Convenient if your order large quantities.

Operation mode can be configured via all four methods. Operation modes are described in chapter "Modes". Other items are listed below.

2.1 Charging parameters

This group of settings includes algorithm, battery capacity, cell count, cable resistance and base load. These items are applied only in charger mode. These settings can be set also using CAN bus. See chapter "CAN remote control".

Algorithm number

Configurable via	Front panel: yes	CAN: yes	Radio: yes	Factory setting: yes

Default value: 1
Algorithm number is unique identifier of algorithms within Access and Robust series of chargers. See chapter "Algorithms" for available algorithms and numbers.

Battery capacity

Configurable via	Front panel: yes	CAN: yes	Radio: yes	Factory setting: yes

Default value: 50, unit: Ah, range: 50 ... 2000[1]
A list of predefined values between 50 and 800 is available using the front panel. See chapter "Editing charging configuration". While these are often sufficient, battery capacity can be set freely using other methods. Accurate capacity setting ensures optimal charging process.
[1] Since SW revision 11, range is 1 ... 9999 Ah. When setting low battery capacity, note the charger output accuracy.

Number of cells

Configurable via	Front panel: no	CAN: yes	Radio: yes	Factory setting: yes

Default value: according to nominal voltage of the charger: for example, 12 cells for nominally 24 V charger, 24 for nominally 48 V charger, unit: -, range: 6 ... 50[1]
Number of cells can be configured to a lower value than the nominal. For example, 12 V battery can be charged using nominally 24 V charger. Naturally meaningful maximum depends on the power version.

[1] For SW revision 11 and later: range is 1 ... 999 cells. When setting low number of cells, note the charger output accuracy and fixed battery detection low limit of 6 V (15 V for power version 48 V 60 A).

Base load

Configurable via	Front panel: no	CAN: yes	Radio: yes	Factory setting: yes

Default value: 0, unit: mA , range: 0 ... 65535
Eventual current consumption of a load parallel to battery during charging can be compensated with this parameter. Current should be constant so eventual Ah counters in the algorithm operate reliably.

Cable resistance

Configurable via	Front panel: no	CAN: yes	Radio: yes	Factory setting: yes

Default value: 0, unit: mOhm, range: 0 ... 99
Voltage drop in cabling between charger and battery can be compensated with this parameter. Depending on algorithm, this can improve charging process efficiency. Be careful not to overcompensate as this can result in unstable operation and too high cell voltages.

2.2 Parallel control

Configurable via	Front panel: yes	CAN: no	Radio: yes	Factory setting: yes

Default value: off, range: off/on
This setting enables group of chargers, connected in parallel, to deliver large current. When value "on" is selected, this charger (master) controls other Robust series chargers (slaves) over CAN bus. Other chargers in the group are configured to mode: charger or protocol power supply, parallel control: off. CAN Node-IDs for slaves are automatically set. Software revision 6 or later is required for this feature.

This kind of parallel operation is available in charger and protocol power supply modes. Up to five chargers (1 master + 5 slaves) can be connected. Eventual optional connections should be made to the master charger (with parallel setting “on”). In charger mode, master charger controls other chargers. In protocol power supply mode, group (master) appears as one charger to CAN system controller.

2.3 Series operation

Series operation for large output voltage is not supported by Robust software. Connecting Robust chargers in series is not recommended.

2.4 IdcLimit

Configurable via	Front panel: no	CAN: yes	Radio: yes	Factory setting: yes

Default value: max. current of the power version, unit: A, range: 0...max. current of the power version. Parameter IdcLimit defines maximum DC current output. In case of other DC current limits, for example that calculated by charging algorithm or CAN messages in protocol power supply mode, lowest limit defines maximum current output. IdcLimit is not applied in power

supply mode. IdcLimit is also the current setting in fixed power supply mode. See chapter "CAN remote control" - "fixed power supply mode" for CAN messages.

2.5 UdcLimit

Configurable via	Front panel: no	CAN: yes	Radio: yes	Factory setting: yes

Default value: nominal voltage of the power version, unit: mV, range: 0...max. voltage of the power version. UdcLimit is the voltage setting in fixed power supply mode. See chapter "CAN remote control" -" fixed power supply mode" for CAN messages.

2.6 Remote input

Configurable via	Front panel: yes	CAN: yes*	Radio: yes	Factory setting: yes

Default value: no function, range: no function, start/stop, stop.
When value "start/stop" is configured, active remote input (closed contact) is required for power output.

Value "stop" is not documented yet.
This setting is valid in all modes.
Using front panel, values "no function" and "start/stop" can be selected.
Physical connection is documented in chapter "Connections".
* Since software revision 11. See chapter “CAN remote control” for CAN messages.

2.7 Remote output

Configurable via	Front panel: no	CAN: yes*	Radio: yes	Factory setting: yes

Default value: "no function" in SW revision 6 and earlier, "mains" in SW revision 7 and later, range: no function, alarm, phase, BBC, water, air pump, mains.
When value "alarm" is configured, remote output relay is activated during all alarms.
When value "mains" is configured, remote output relay is activated whenever charger is mains powered. For other configuration possibilities, see Access documentation.
Remote output can be connected also to button F1 or F2. Button connection overrides other functions using the remote output.
This setting is valid in all modes.
Physical connection is documented in chapter "Connections".
* Since software revision 11. See chapter “CAN remote control” for CAN messages.

2.8 Buttons F1 and F2

Configurable via	Front panel: no	CAN: no	Radio: yes	Factory setting: yes

Default value: no function, range: no function, equalize, remote out.
When value "equalize" is configured, the button will trigger equalize charging. This function tells the charging curve to run an equalize charge. How the actual equalize charge is performed is defined in the charging curve, normally when the battery is fully charged. The button can be pressed at any time even if no battery is connected. When value "remote out" is configured, the button will toggle the remote output relay. Button connection overrides other functions using the remote output.

3. Editing charging configuration

This chapter presents editing charging configuration using the front panel. Also, CAN-bus and optional radio module can be used, see separate chapters.

1. Disconnect battery.
2. Connect mains power.
3. Wait until blue LED lits. Within 20s, press STOP, and keep pressing for 10s. LEDs should flash shortly. Release STOP. Special configuration mode has been entered.
4. Press STOP to scroll down the list. List of items are in table below.
5. To set item on/off, press F1.

6. After you have selected algorithm and battery capacity (and eventual other selections), disconnect mains power. Configuration is automatically stored to non-volatile memory.

Following table applies to software revision 2 and later. Bold text in coloured areas indicates LED "on".

						**Item**
1	**red**	**yellow**	**green**	**blue**	**s.green**	algorithm 1 LK10-06 freely ventilated lead-acid (default)
2	**red**	**yellow**		**blue**	**s.green**	algorithm 41 LK10-18 freely ventilated lead-acid, ionic mix
3	**red**		**green**	**blue**	**s.green**	algorithm 3 LK20-09 sealed gel/AGM lead-acid
4	**red**			**blue**	**s.green**	algorithm 16 LK10-05 freely ventilated lead-acid
5				**blue**	**s.green**	algorithm 17 PP100 freely ventilated lead-acid
6			**green**	**blue**	**s.green**	algorithm 18 PP101 sealed gel/AGM lead-acid
7		**yellow**		**blue**	**s.green**	algorithm 19 PP102 sealed gel/AGM lead-acid "Sonnenschein"
8		**yellow**	**green**	**blue**	**s.green**	algorithm 20 LK23-03 "Evolution"
9	**red**	**yellow**	**green**		**s.green**	capacity 50 Ah (default)
10	**red**	**yellow**			**s.green**	capacity 75 Ah
11	**red**		**green**		**s.green**	capacity 100 Ah
12	**red**				**s.green**	capacity 125 Ah
13					**s.green**	capacity 150 Ah
14			**green**		**s.green**	capacity 200 Ah
15		**yellow**			**s.green**	capacity 250 Ah
16		**yellow**	**green**		**s.green**	capacity 300 Ah
17	**red**	**yellow**	**green**	**blue**		capacity 350 Ah
18	**red**	**yellow**		**blue**		capacity 400 Ah
19	**red**		**green**	**blue**		capacity 450 Ah
20	**red**			**blue**		capacity 500 Ah
21				**blue**		capacity 550 Ah
22			**green**	**blue**		capacity 600 Ah
23		**yellow**		**blue**		capacity 700 Ah
24		**yellow**	**green**	**blue**		capacity 800 Ah
25	**red**	**yellow**	**green**			Charging mode
26	**red**	**yellow**				Remote input, off●-no function, on●-start/stop
27	**red**		**green**			CAN function
28	**red**					Parallel control
29						Battery monitoring unit control
30			**green**			Charging mode
31		**yellow**				CAN Status

Notes/description for some configurable items

Capacity
Select capacity that is nearest to the capacity of your battery, for example 200 Ah for battery with nominal capacity of 175 ... 225 Ah.

Charging mode and CAN function
Mode is set using combinations of list items:

Mode	Set item
Charger (default)	25, Charging mode: off 27, CAN function: off 30, Charging mode: off
Fixed power supply	25, Charging mode: on 27, CAN function: on 30, Charging mode: off
Protocol power supply	25, Charging mode: off 27, CAN function: on 30, Charging mode: off
Power supply	25, Charging mode: off 27, CAN function: on 30, Charging mode: on

Remote input
Default value is "no function". When value "Start/Stop" is selected, active remote input (closed contact) is required for power output.

Battery monitoring unit control
Default setting is off. When optional radio module and battery monitoring unit are installed, charging process can be controlled by the battery monitoring unit. For more information, see Access documentation.

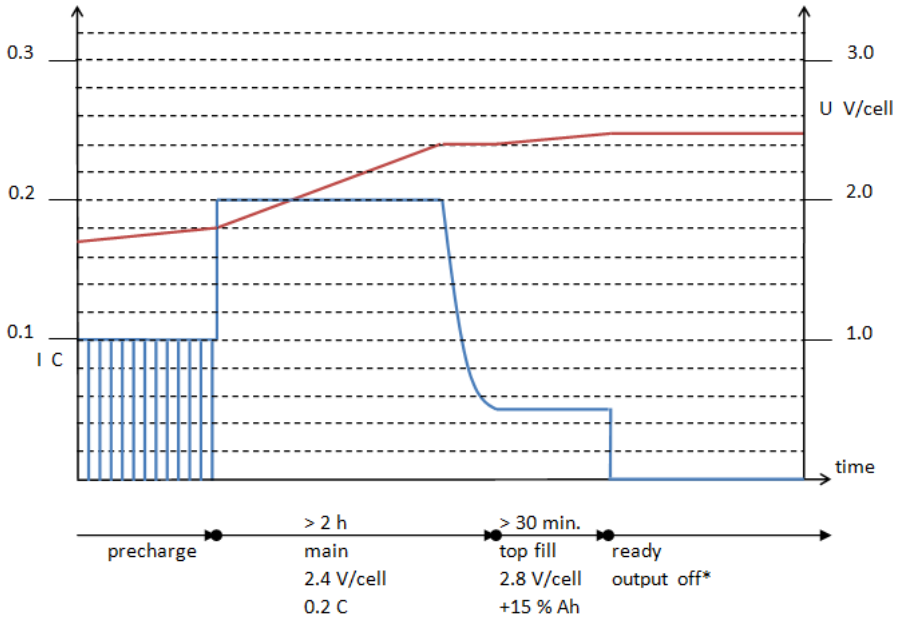
4. Algorithms

Verify compatibility of the algorithm with the battery manufacturer. Note that charging lithium battery requires BMS (Battery Management System) for safety reasons.

Notes for all algorithms:
- "Sealed" is a generic term for GEL and AGM types of lead-acid batteries, which are not freely ventilating to surrounding air.
- Current is indicated in terms of C, which is current compared to nominal capacity. For example, 0.2 C for 100 Ah battery is 20 A.
- There is an Ah counter and limit in almost all algorithms. If charger and battery are connected continuously (often called 'floating'), and there is enough base load, eventually charger will display alarm and switch DC power off. Floating applications are better served using fixed power supply mode with suitable voltage and current values.

4.1 LK10-06 freely ventilated lead-acid

Algorithm number: 1



Charging phase "top fill" charges +15 % compared to charged Ah of main phase.
Battery temperature compensation:
- voltage -3 mV / °C per cell, neutral at 30 °C
- current derated to zero in the range [-30 ... -35] and [+45 ... +60] °C

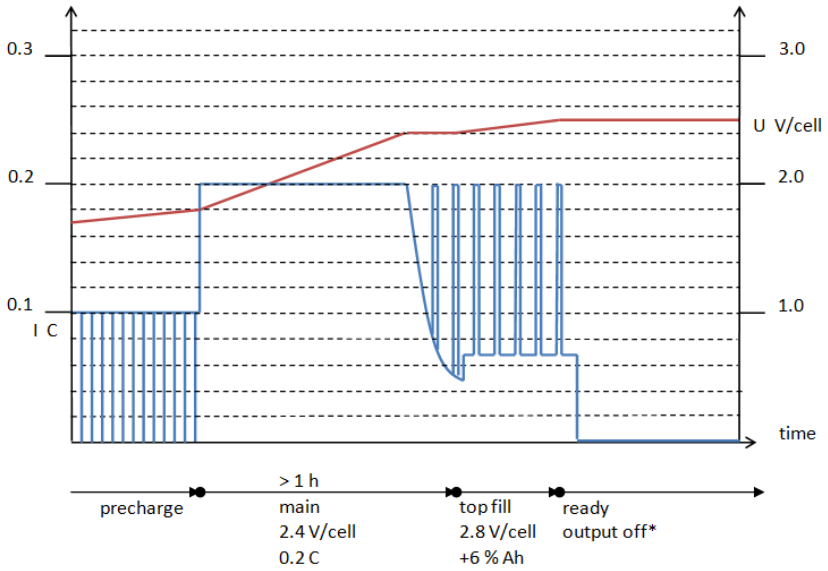
* In maintenance phase, battery voltage is periodically checked. If it is below 2.17 V/cell, 2-minute 0.05 C current pulse is used.

4.2 LK10-18 freely ventilated lead-acid, using ionic mixing

Algorithm number: 41

Ionic mixing current pulses are used to reduce charging time without using air pump.

41. LK10-18 freely ventilated lead-acid, using ionic mixing



Charging phase "top fill" charges +6 % compared to charged Ah of main phase.
Battery temperature compensation:
- voltage -3 mV / °C per cell, neutral at 30 °C
- current derated to zero in the range [-30 ... -35] and [+45 ... +60] °C

* In maintenance phase, battery voltage is periodically checked. If it is below 2.17 V/cell, 2-minute 0.05 C current pulse is used.

NOTE

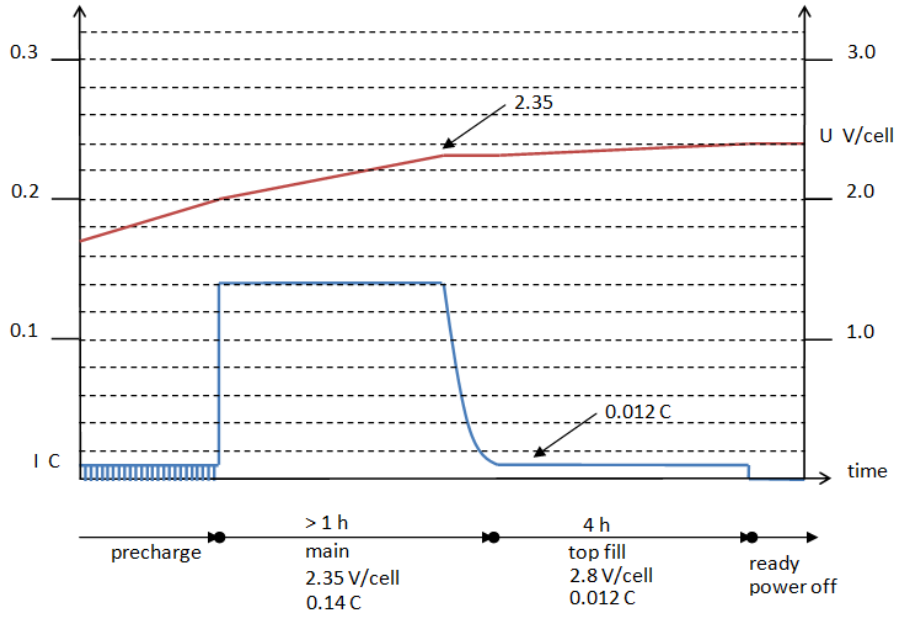
Algorithm LK10-04 (number 2) is replaced by algorithm LK10-18 (number 41) since SW revision 9. Algorithms are similar but top fill current pulses are longer and base current was changed from 0.05 C to 0.07 C.

NOTE

In SW revision 11 automatic equalization was added. It starts 16 hours from charge start, uses 0.05 C current and runs for 3 hours.

4.3 LK20-09 sealed gel/AGM lead-acid

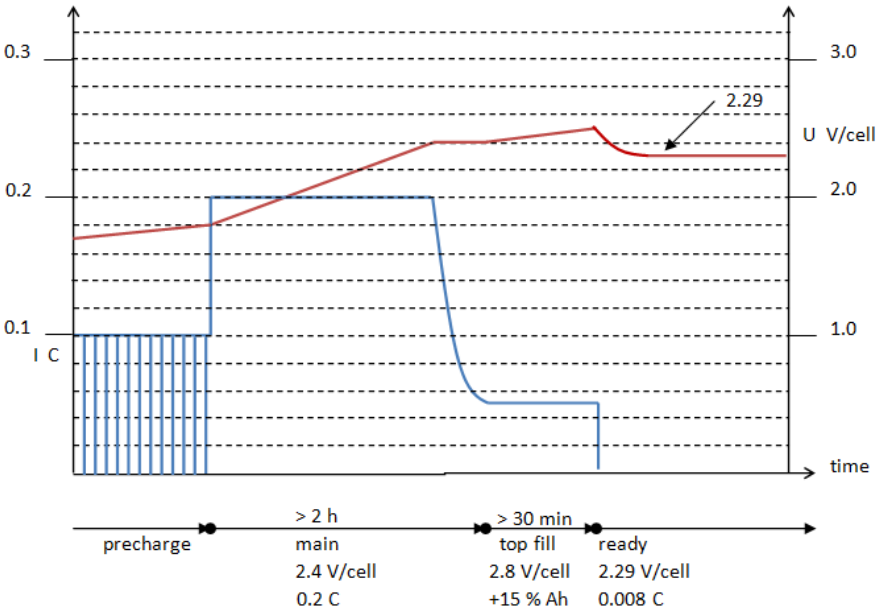
Algorithm number: 3



Battery temperature compensation: none.
This algorithm has equalization built in. If battery is left connected to charger for 16 hours, a 30 h equalization phase runs with current 0.006 C and voltage 2.8 V/cell. This could be useful to perform equalizing over a weekend.

4.4 LK10-05 freely ventilated lead-acid, with constant voltage maintenance charging

Algorithm number: 16

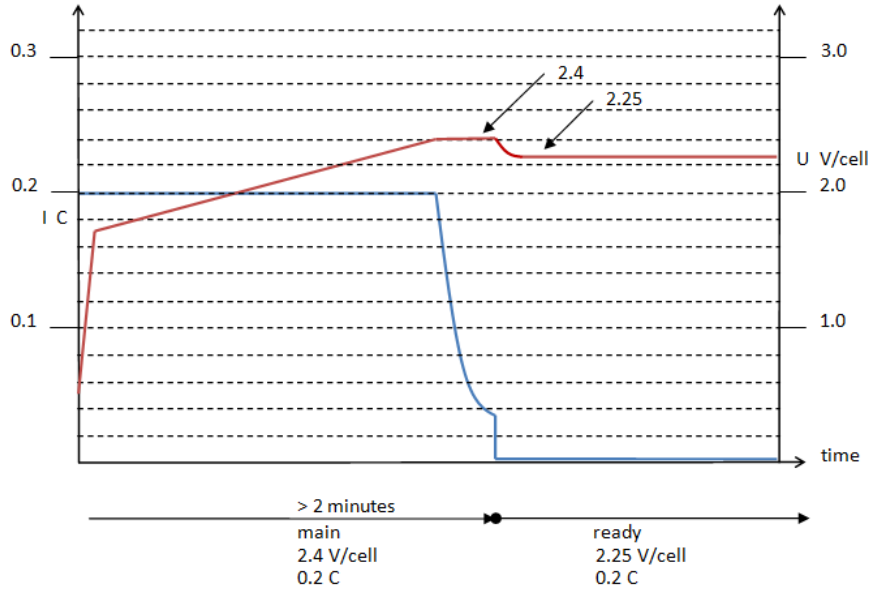


Charging phase "top fill" charges +15 % compared to charged Ah of main phase.

Battery temperature compensation:
- voltage -3 mV / °C per cell, neutral at 30 °C
- current derated to zero in the range [-30 ... -35] and [+45 ... +60] °C

4.5 PP100 freely ventilated lead-acid, with constant voltage maintenance charging

Algorithm number: 17

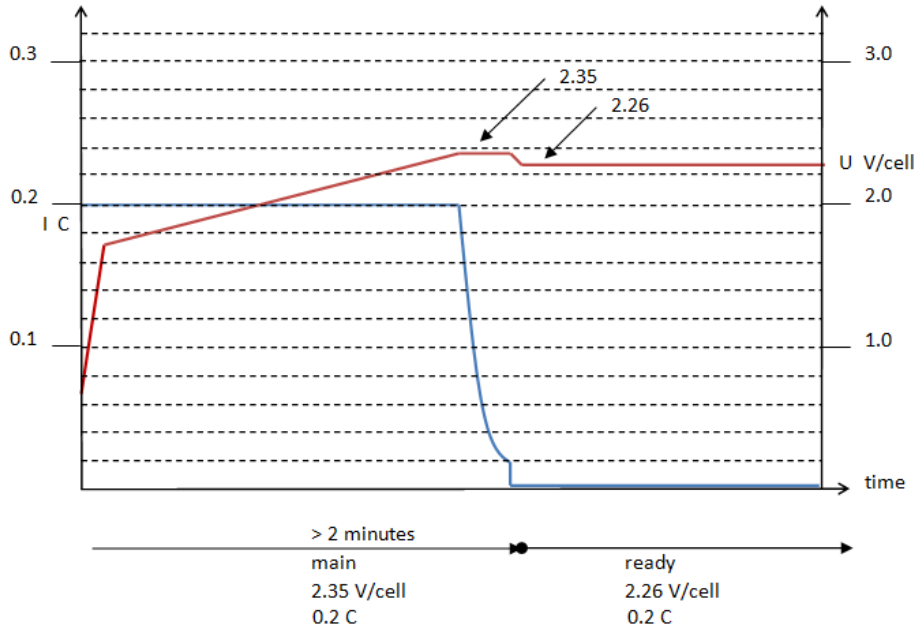


Battery temperature compensation:
- voltage -4 mV / °C per cell, neutral at 25 °C
- current derated to zero in the range [-30 ... -35] and [+40 ... +50] °C

NOTE
This algorithm uses low battery detection voltage: 0.5 V/cell. Be careful not to inadvertently use battery with smaller number of cells, for example 24 V charger for a 12 V battery.

4.6 PP101 sealed gel/AGM lead-acid, with constant voltage maintenance charging

Algorithm number: 18

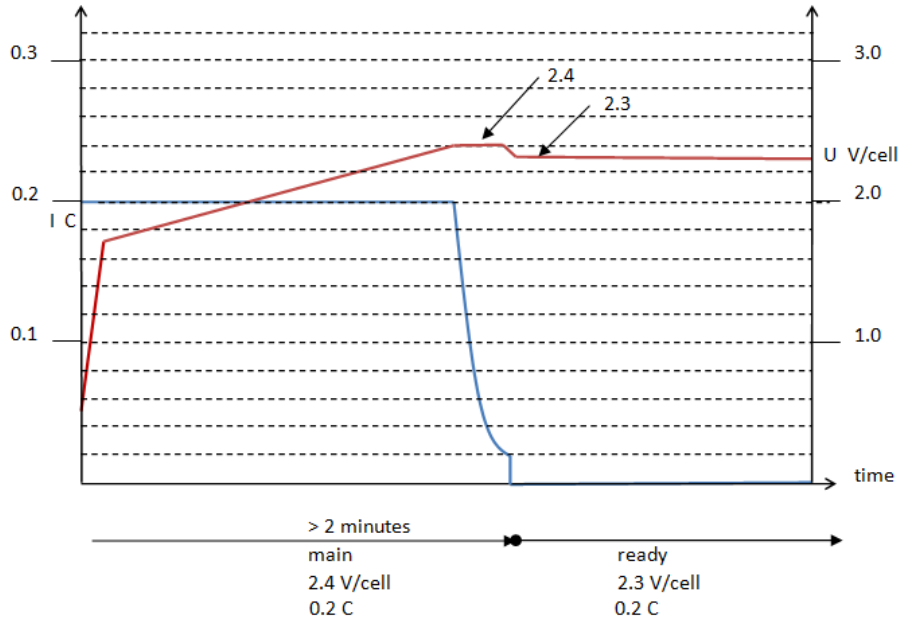


Battery temperature compensation:
- voltage -4 mV / °C per cell, neutral at 25 °C
- current derated to zero in the range [-30 ... -35] and [+40 ... +50] °C

NOTE
This algorithm uses low battery detection voltage: 0.5 V/cell. Be careful not to inadvertently use battery with smaller number of cells, for example 24 V charger for a 12 V battery.

4.7 PP102 sealed gel/AGM lead-acid "Sonnenschein"

Algorithm number: 19



Battery temperature compensation:
- voltage -4 mV / °C per cell, neutral at 25 °C
- current derated to zero in the range [-30 ... -35] and [+40 ... +50] °C

NOTE
This algorithm uses low battery detection voltage: 0.5 V/cell. Be careful not to inadvertently use battery with smaller number of cells, for example 24 V charger for a 12 V battery.

4.8 LK23-03 "Evolution"

Algorithm number:20

For detailed information contact Enersys (ref: CDC-Evo 05).
This algorithm is available in software revision 9 and later.

5. CAN remote control

For physical connection to CAN port, see chapter "Connections".

Robust series CAN communication is not CiA certified nor CANopen complete, but communication is based on CANopen and complies with selected parts of standard CiA 301. In the following presentation, basic knowledge about CAN and CANopen is assumed.

Frame: Standard CAN frame with 11-bit identifier
Bit rate: 20 ... 1000 kbit/s
Node-ID: 1 ... 127

Configurable items are accessed using CANopen SDO protocol. See "Node-ID" for examples of how CAN messages are built.
Nonvolatile settings are nonvolatile without separate save command, automatically written to flash. Therefore, for long lifetime, avoid sending excessive amounts of these messages.
Most nonvolatile settings are active immediately, but some require restart.

5.1 Node-ID

This CANopen object is used to configure node-ID.

Index	Sub-index	Format	Unit	Range	Default value	Item
2057h	01	uint8		1..127	1Dh*	CAN Node-ID

* Default node-ID is 1 in software revision 6 and earlier.

Changed CAN node-ID is nonvolatile, active immediately after response. This setting is applied in power supply modes. In charger mode, node-ID is automatically assigned, so configured node-ID is ignored.

Message to access node-ID is built according to CANopen SDO protocol:
CAN-ID: 600h + node-ID, DLC: 8, data[0]: according to CANopen, data[1-2]: OD index, data[3]: OD subindex, data[4]: node-ID. Unused bytes are ignored.

Example messages:

CAN-ID	DLC	Data [0...7] (hex)	Comment
601h	8	40 57 20 01 00 00 00 00	Read CAN node-ID
581h	8	4F 57 20 01 01 00 00 00	Response from charger: node-ID is 1

CAN-ID	DLC	Data [0...7] (hex)	Comment
601h	8	2F 57 20 01 02 00 00 00	Write CAN node-ID 2
581h	8	60 57 20 01 01 00 00 00	Response from charger

NOTE
The first data byte in SDO write operation is 2Fh for 1-byte object, 2Bh for 2-byte object and 23h for 4-byte object. For 4-byte object, also 22h can be used. Unused data in response might be filled with random data. CANopen uses little endian byte order.

5.2 Bit rate

This CANopen object is used to configure bit rate.

Index	Sub-index	Format	Unit	Range	Default value	Item
5FFFh	02	uint16	kbit/s	20...1000*	125	CAN bit rate

* Values 20, 50, 125, 250, 500, 800 and 1000 are supported.

Changed bit rate is nonvolatile, active after restart. This feature is available in software revision 7 and later.

5.3 Setting mode via CAN

Mode is defined by two CANopen objects:

Index	Sub-index	Format	Unit	Range	Default value	Item
2058h	01	uint8		0...3	0	ChargingMode
2056h	01	uint8		0...4	1	CAN function

For a mode, set these two objects to:

Mode	ChargingMode	CAN function
Charger	0	1
Charger with CAN status	0	4
Fixed power supply	2	3
Protocol power supply	0	3
Power supply	3	3

Other combinations of values are reserved.
These settings are nonvolatile. Some mode changes are active immediately, some require restart.
This feature is available in software revision 7 and later.
Charger with CAN status is available in software revision 11 and later.

5.4 Software version

Charger software version can be read using SDO objects:

Index	Sub-index	Format	Unit	Range	Default value	Item
2202h	01	uint32				SW type; 11613002 for standard SW. Does not change for the lifetime of the SW.
2202h	02	uint32				SW revision. Incremented for new revisions.

This feature is available in software revision 7 and later.

5.5 Bootloader version

Charger bootloader version can be read using SDO objects:

Index	Sub-index	Format	Unit	Range	Default value	Item
2203h	01	uint32				Bootloader type; 11617029 as standard.
2203h	02	uint32				SW revision. Incremented for new revisions.

This feature is available in software revision 11 and later.

5.6 Power version

Charger power unit version can be read using SDO object:

Index	Sub-index	Format	Unit	Range	Default value	Item
2059h	01	uint32				Power version

At time of writing, defined values are:
0: 1100 W 24 V nominal 40 A maximum
1: 2300 W 24 Vnom. 80 A
2: 1100 W 36 Vnom. 22 A
3: 1100 W 48 Vnom. 20 A
4: 2300 W 36 Vnom. 53 A
5: 2300 W 48 Vnom. 40 A
6: 3000 W 24 Vnom. 105 A
7: 3000 W 48 Vnom. 60 A
200: 3000 W 280 Vnom. 520 Vmax. 10 A
201: 650 W (model 888) 24 Vnom. 28 A
202: 3000 W 96 Vnom. 30 A
203: 650 W (model 888) 48 Vnom. 14 A
205: 888 W (model 888) 24 Vnom. 35 A
206: 1100 W (model 888) 24 Vnom. 40 A
207: 888 W (model 888) 48 Vnom. 17 A
208: 1100 W (model 888) 48 Vnom. 20 A

This feature is available in software revision 9 and later.

NOTE
Maximum output voltage is 1.5 * nominal, except as stated above.
For hardware specifications, see separate documents.

5.7 Remote output

This CANopen SDO object is used to configure Remote Output.

Index	Sub-index	Format	Unit	Range	Default value	Item
2061h	01	uint8			6	Remote output function

The range of values is:
0: no function
1: alarm
2: charging phase
3: BBC (Best Battery Choice)
4: N/A
5: N/A
6: mains

This feature is available in software revision 11 and later.

5.8 Charger mode

At startup, charger sends boot-up message
CAN-ID: 700h + node-ID, DLC: 1, data: 0
Charger sends heartbeat message once per second
CAN-ID: 700h + node-ID, DLC: 1, data: 05h
Charger sends SYNC message once per second
CAN-ID: 080h, DLC: 0

Charger enters operational state automatically. Charger sends some other CAN messages related to automatic group functionality.

5.9 Charging parameters

These CANopen SDO objects are used to configure charging parameters.

Index	Sub-index	Format	Unit	Range	Default value	Item
2000h	01	uint16			1	Algorithm number
2000h	02	uint16	Ah	50...2000	50	Battery capacity
2000h	03	uint16		6...50	12*	Number of cells
2000h	04	uint16	mA	0...65535	0	Base load
2000h	05	uint16	mOhm	0...99	0	Cable resistance

* Default number of cells is set according to nominal voltage of the charger. For more details, see chapter "Charging parameters" - number of cells.

These settings are nonvolatile.

5.10 Measurements or monitoring

In software revision 7 and later, measurements are available via power supply mode messages, which work also in charger mode. See chapter "power supply mode".

In software revision 11 and later, charging can be monitored via CAN Status messages. For details of CAN messages, see document 3914008 – chapter “CAN Status”. Note, parallel operation with CAN Status enabled is not supported. CAN Status messages can be enabled:
- using front panel, see chapter “Editing charging configuration”.
- using CAN message, see chapter “Setting mode via CAN”.

5.11 Fixed power supply mode

In this mode, charger outputs power immediately after startup. For defining power output, two CANopen SDO objects are used:

Index	Sub-index	Format	Unit	Range	Default value	Item
2001h	01	uint32	mV	0...max*	nom**	UdcLimit
2001h	02	uint32	A	0...max*	max*	IdcLimit

* Maximum output of the power version
** Nominal voltage of the power version

NOTE
Values are nonvolatile, automatically written to flash. Therefore, for long lifetime, avoid sending excessive amounts of these messages. Configuration item IdcLimit applies also in other operation modes. See "Configurable items" - "IdcLimit".

Example messages:

CAN-ID	DLC	Data (hex)	Comment
601h	8	23 01 20 01 C0 5D 00 00	U set 24000 mV

CAN-ID	DLC	Data (hex)	Comment
601h	8	23 01 20 02 0A 00 00 00	I set 10 A

5.12 Protocol power supply mode

This power supply mode uses CANopen PDO protocol.

After startup, charger is in pre-operational state.
Charger sends boot-up message
CAN-ID: 700h + node-ID, DLC: 1, data: 0.
Charger sends heartbeat message once per second
CAN-ID: 700h + node-ID, DLC: 1, data: 7Fh.
It is recommended to wait couple of seconds after bootup messages before attempting to communicate.

Set charger to operational state by sending *start remote node* message.
CAN-ID: 000, DLC: 2, data[0]: 1, data[1]: node-ID

For example:

CAN-ID	DLC	Data (hex)	Comment
000h	2	01 01	start device with node-ID 01

Then, charger sends heartbeat message once per second.
CAN-ID: 700h + node-ID, DLC: 1, data: 05h.

NOTE
Charger sends some extra messages during startup and change of operational state. Without SYNC message, charger returns to pre-operational mode after 2...3 seconds. This applies to SW revision 9. Earlier SW revisions stay in operational mode for unlimited time.

5.12.1 Power output

For power output, three CANopen PDO messages are needed from CAN controller to charger.

1) Voltage and current setting
CAN-ID: 200h + node-ID, DLC: 8, data[0-3]: voltage in Volts, data[4-7]: current in Amperes.
Numeric format: IEEE-754 single precision floating point, 32 bit.

NOTE
The little endian byte order of CANopen.

Example message:

CAN-ID	DLC	Data (hex)	Comment
201h	8	00 00 10 42 00 00 20 42	Uset 36.0 V, Iset 40.0 A

2) Power setting
CAN-ID: 300h + node-ID, DLC: 8, data[0-3]: power in Watts, data[4-7]: not used, set to 0. Numeric format: IEEE-754 single precision floating point, 32 bit.

Example message:

CAN-ID	DLC	Data (hex)	Comment
301h	8	00 80 89 44 00 00 00 00	Pset 1100 W

3) SYNC

CAN-ID	DLC	Data (hex)	Comment
080h	0	-	Also message with counter byte is valid.

Period of one second is recommended. If these messages are not received for some seconds,

power output is switched off.

NOTE
Configuration item IdcLimit applies in protocol power supply mode.

5.12.2 Measurements

In operational state, sending sync produces two PDO messages of measurement data as response.

1) Voltage and current
CAN-ID: 180h + node-ID, DLC: 8, data[0-3]: voltage in Volts, data[4-7] current in Amperes.
Numeric format: IEEE-754 single precision floating point, 32 bit.

For example:

CAN-ID	DLC	Data (hex)	Comment
181h	8	B1 88 C3 41 82 01 F0 41	Umeas 24.441733 V, Imeas 30.000736 A

2) Power
CAN-ID: 280h + node-ID, DLC: 8, data[0-3]: power in Watts, data[4-7]: (reserved).
Numeric format: IEEE-754 single precision floating point, 32 bit.

For example:

CAN-ID	DLC	Data (hex)	Comment
281h	8	F4 4A 37 44 12 00 00 00	Pmeas 733.17114 W

5.13 Power supply mode

Power supply mode provides close CAN remote control compatibility to PAP3200/CAN product family. This mode is available in software revision 7 and later.

5.13.1 Power output

These CANopen SDO objects are used to set power output:

Index	Sub-index	Format	Unit	Range	Default value	Item
2401h	01	uint32	mV	0...max*	-**	Uset
2401h	02	uint32	mA	0...max*	-**	Iset

* Maximum output of the power version.
** Default Uset and Default Iset are used as startup values, see below.

These settings are volatile.
There is no separate on/off setting. Setting Iset to zero switches output off.

After startup, voltage and current settings are zero by default. These settings can also be set to non-zero values. Without remote control, charger then outputs power same way as a power supply with fixed U and I values.

Index	Sub-index	Format	Unit	Range	Default value	Item
2401h	06	uint32	mV	0...max*	0	Default Uset

2401h	07	uint32	mA	0...max*	0	Default Iset

* Maximum output of the power version.
These settings are nonvolatile.

5.13.2 Measurements

Index	Sub-index	Format	Unit	Range	Default value	Item
2402h	01	uint32	mV	0...max	-	Uact, measured output voltage
2402h	02	uint32	mA	0...max	-	Iact, measured output current
2402h	06	int32	0.1 °C	-50...+150 °C	-	Internal temperature

These messages work also in other modes.

5.13.3 CAN safety timer

If a new Uset/Iset message from CAN controller is not found within a time interval (it is assumed that CAN control is lost), active Uset and Iset values are replaced by Default Uset and Default Iset values. Setting CAN safety timer to zero means this feature is not active.

Index	Sub-index	Format	Unit	Range	Default value	Item
2401h	0Bh	uint8	s	0...255	0 (off)	CAN safety timer time interval

This setting is nonvolatile.

5.13.4 Power supply mode example

After startup, charger sends heartbeat once/second. The data is 7Fh, which hints that device is in pre-operational state. Despite this, there is no need to send *start node* message to output power. Minimum messages to output power in power supply mode are Uset and Iset.

Here is a CAN bus log from startup to power output:

#	Time s		ID	DLC	Data	Notes
1	2.208	Tx	071D	1	00	bootup message
2	2.210	Tx	009D	8	00 00 00 00 00 00 00 00	
3	3.207	Tx	071D	1	7F	heartbeat
4	4.207	Tx	071D	1	7F	
5	4.984	Rx	061D	8	22 01 24 01 10 27 00 00	Uset 10 000 mV
6	4.987	Tx	059D	8	60 01 24 01 00 00 00 00	response
7	5.207	Tx	071D	1	7F	
8	6.206	Tx	071D	1	7F	
9	6.596	Rx	061D	8	22 01 24 02 88 13 00 00	Iset 5000 mA
10	6.599	Tx	059D	8	60 01 24 02 00 00 00 00	response
11	7.206	Tx	071D	1	7F	
12	8.205	Tx	071D	1	7F	
13	9.205	Tx	071D	1	7F	

5.13.5 Robust series and PAP3200/CAN – power supply mode differences

SDO download message

First byte "nes" bits (see CiA 301 7.2.4.3.3) need careful setting in Robust series. PAP3200 accepts any alternative for first byte, even a non-correct one. For Robust, they must indicate correct data length, except also 22h as first byte is accepted for four bytes data length.

LED indication

PAP3200/CAN has yellow constantly on. Robust sets big yellow on when power output is on.

High internal temperature

PAP3200/CAN shows red color in its sole LED, Robust shows steady red and blinking yellow. The temperature limits for showing alarm and switching output off, vary somewhat between power versions. Operating charger within environmental specification ensures internal temperature low enough.

Periodic CAN messages

PAP3200/CAN does not send heartbeat. This might be changed in future SW revisions. Robust sends heartbeat CAN-ID:700h + node-ID, DLC: 1, data:7Fh, once per second by default.

Event related CAN messages

Robust sends some extra messages, for example at startup CAN-ID 800h + node-ID, DLC: 8, data 00 00 00 00 00 00 00 00.

Bootup CAN messages

PAP3200/CAN sends two bootup messages, Robust only one.

For example:

	CAN-ID	DLC	Data	CAN-ID	DLC	Data
PAP3200	71Dh	1	01	71Dh	1	00
Robust	71Dh	1	00			

The first bootup message from PAP3200/CAN uses fixed node-ID of 1Dh and fixed bit rate 125 kbit/s. The second bootup message uses configured node-ID and bitrate. PAP3200/CAN bootup messages might be changed in future SW revisions.

It is recommended to wait couple of seconds after bootup messages before attempting to communicate.

CAN safety timer

PAP3200/CAN safety timer can be kept inactive with any message with correct node-ID. Robust requires Uset or Iset message.

CAN node-ID

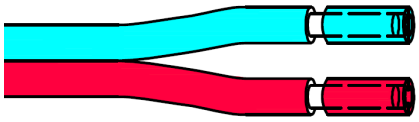
PAP3200/CAN node-ID is accessed using OD index 5FFFh. Robust node-ID can be accessed same way in SW revision 7 and later. OD index 2057h works in all Robust SW revisions.

Changed node-ID is active after restart in PAP3200/CAN, immediately (after response) in Robust.

6. Connections

Mains cable of Robust chargers is typically terminated to European style schuko plug. Various lengths are available.

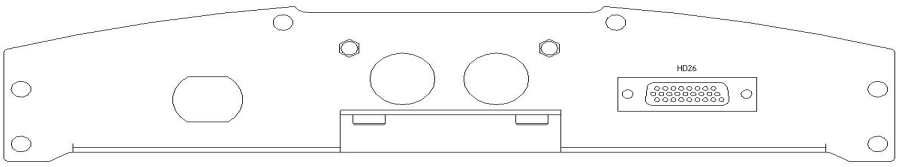
DC cables of Robust chargers typically:
- have cross sectional conductor area 6, 10, 16 or 25 mm^2 depending on output current
- not terminated



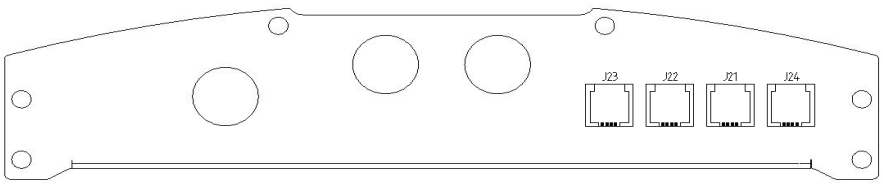
Various lengths are available.

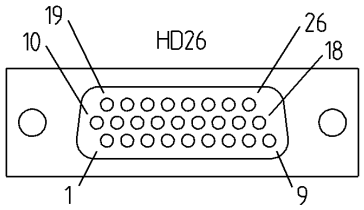
Ask your supplier for alternatives. Note that system IP class can change based on selected cabling. High voltage models are intended for fixed installation and are supplied without cables by default.

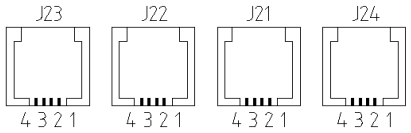
Robust chargers provide optional features over a 26-pin high-density D-sub socket located in the bottom panel.



Early Robust 1100 chargers provide optional features over 4 pcs of RJ11 sockets located in the bottom panel. There are some limitations on connecting these. Not all can be connected at the same time while maintaining IP class. For details, ask your supplier or the manufacturer.

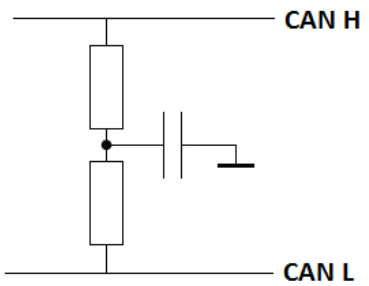






RJ pin	RJ wire color	HD26 pin	Description
J23-1	black	4	LED green anode, 10mA current source
J23-2	red	22	LED common cathode, connected to battery minus [H]
J23-3	green	14	LED red anode, 10mA current source
J23-4	yellow	5	LED yellow anode, 10mA current source
J22-1	black	2	Sense plus (+) [H]
J22-2	red	12	Battery temperature compensation (-). Sensor consists of two Philips/NXP KTY83-120 sensors connected in series.
J22-3	green	3	Battery temperature compensation (+)
J22-4	yellow	20	Sense minus (-) [H]
J21-1	black	19	Remote input (+) *
J21-2	red	1	CAN-bus Hi *
J21-3	green	10	CAN-bus Lo *
J21-4	yellow	11	Remote input (-) *
J24-1	black	26	Remote output relay, Common 60 V 0.25 A
J24-2	red	18	Remote output relay, Normally Open
J24-3	green	9	Remote output relay, Normally Closed
J24-4	yellow		Not connected
		7	Isolated output ground * (same ground as in pin 11)
		8	Detect [H]
		17	14 V output [H] (optional feature)
		25	Isolated output +5 V 50 mA *

* CAN bus signals, remote input and isolated 5 V output operate from supply, which is galvanically isolated from charger DC power output. This output is overload protected.
CAN bus is using internally weak split termination (2 * 1 kOhm, 100 nF) to isolated output ground.



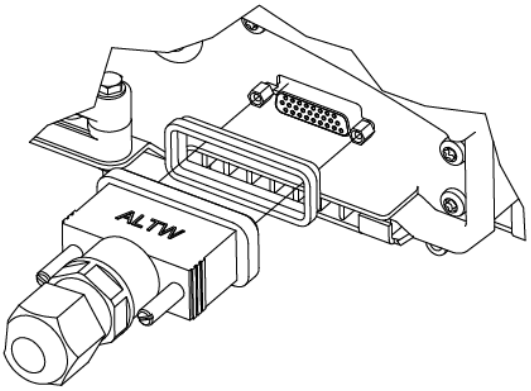
Since October 2018, 120 Ohm termination resistor is also mounted by default. Optionally, it can be left unmounted.

[H] Notes for high-voltage (96 V nominal and above) versions:
Different from low voltage versions, DC power output is isolated from all other connections.
Pin 22 is isolated from battery minus and provides ground for 14 V output and Detect-signal.
Voltage sense feature is not available.

Detect is an alternative Remote input.
It outputs about 14 V when not loaded, 8 ... 10 mA when activated by shorting to battery minus.
This feature has been added to Robust chargers during year 2018.

14 V (non-regulated) output is optional feature, must be specified when ordering. 400 mA surge can be output for one second, this is overload protected. 10 mA can be output continuously. This output is not galvanically isolated from battery minus (except in high-voltage versions). This feature has been made available to Robust chargers in year 2019. This output withstands 60 V voltage in chargers manufactured 2020 May or later, 30 V earlier.

Before inserting D-sub connector, make sure hex nuts in the charger are properly tightened.
Recommended torque for D-sub screws is 0.5 Nm.



For available cables to utilize these optional features, see chapter "Options and accessories".

7. Options and accessories

Options and accessories in addition to those listed here might be available. Ask your supplier.

7.1 Radio module

Robust series chargers can be equipped at the factory with optional internal radio module. Radio module enables short range communication with other chargers and battery monitoring units. Also, communication to PC-computer via USB radio dongle is possible. The radio functionality of Robust series and Access series is compatible.

Microsoft Windows™ software "Access Service Tool" is convenient tool for:
- configuring chargers and the system
- reading logs and statistical data from charger
- monitoring charger operation in real time

For more information on using the radio functionality, see Access documentation.
Windows is a trademark of Microsoft Corp.

7.2 Battery temperature sensor and voltage sense

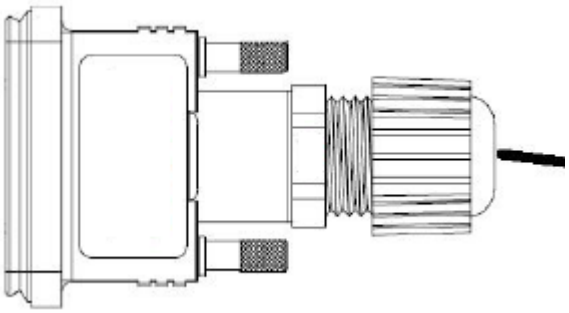
In charger mode, battery temperature compensation is automatically used, if sensor is connected and selected algorithm has temperature compensation defined.

In charger mode, DC cable voltage loss compensation can be done programmatically using charging parameter "cable resistance". Compensation can also be done by hardware using sense wires. This method works in all modes.

Length 2.5 m to first joint, total 3.2 m, IP67 at charger end, IPxx at fuse holder, other joints molded. The black rectangular piece is temperature sensor and is attached externally to the battery pack. Black and red ring terminals are connected to - and + poles. Positive wire also has a fuse (3 A, type ATO). Also, 5 m version is available.

7.3 CAN cable

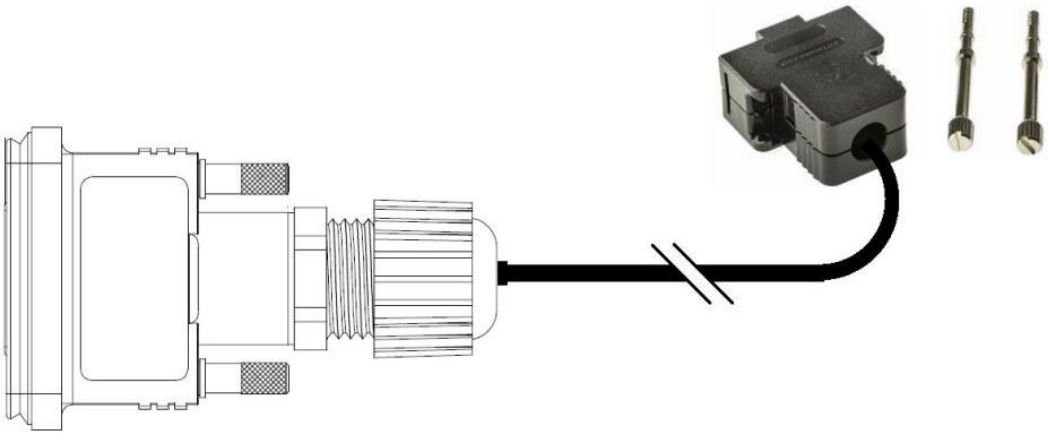
CAN cable for Robust chargers is as standard 3 m in length, IP67, not terminated. Not terminated both in terms of second connector and line impedance.



HD26M pin	Wire color	Signal
10	white	CAN_L
1	brown	CAN_H

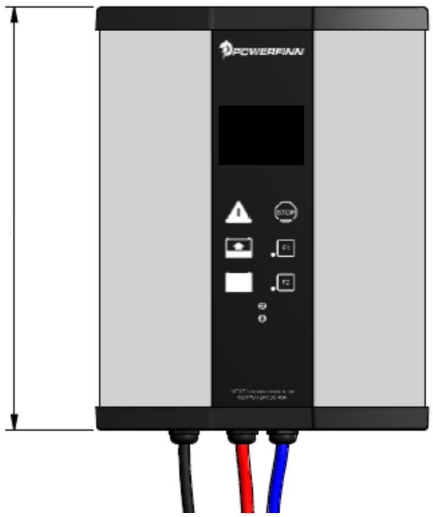
7.4 CAN cable with 9-pin D-sub socket

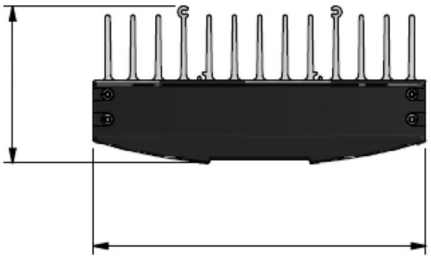
This cable fits directly to several commercially available CAN interfaces. Cable length 1.5 m.



HD26M pin	Signal	D9F pin
10	CAN_L	2
1	CAN_H	7

8. Dimensions





Approximate dimensions in mm.
Height excluding cable clamps.
Weight including standard cables, excluding accessories and package.

Model	Height	Width	Depth	Weight kg
Robust 888 passive	190	230	80	3.0
Robust 888 fan	230	230	80	3.2
Robust 1100 passive	290	230	110	5.8
Robust 1100 fan	330	230	80	3.9
Robust 2300 passive	330	230	110	8.5
Robust 2300 fan	370	230	80	6.1
Robust 3000 fan	370	230	80	6.7