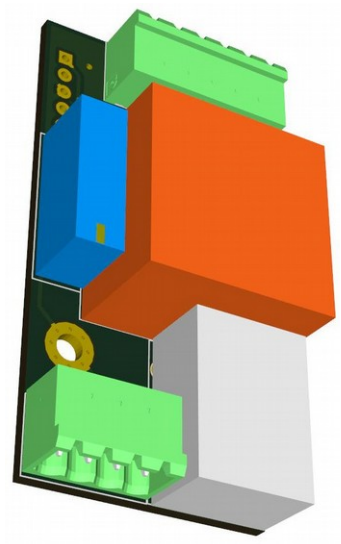
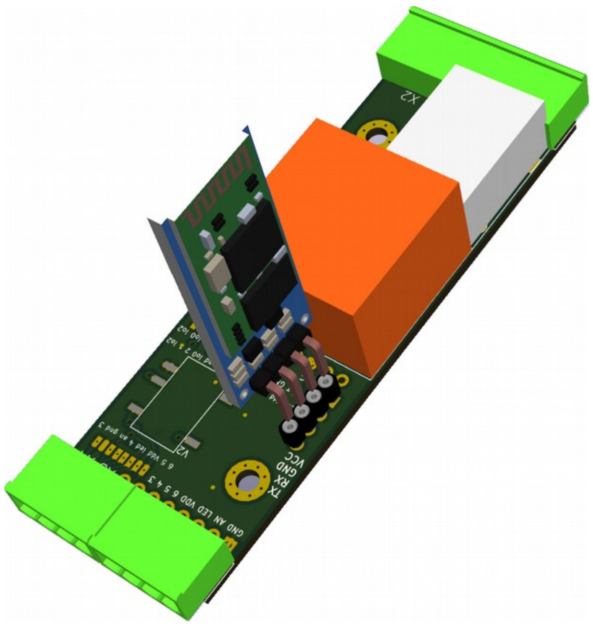
EVSE Wallbox, EVSE DIN

datasheet





Last document update: June 11, 2018

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Introduction

EVSE stands for *electric vehicle supply equipment.* It is an element that supplies electric energy for the recharging of electric or plug-in vehicles.

Read me first

The EVSE board is supplied with default 32A settings. Please check the chapter “Customizations” for more information about further possibilities of changing maximum charging current. 220 Ohm R_{PP} is included with the kit (EVSE WB).

Theory of operation

Pilot signal duty cycle provided by EVSE defines maximum charging capacity. The car can define several states by pulling the pilot signal down to certain voltage levels (3V, 6V, 9V). Based on this feedback EVSE will trigger the relay for the vehicle to charge or evaluate the state as an error (electricity will not be provided to the output socket/connector).

For more information please check:

- http://en.wikipedia.org/wiki/IEC_62196
- http://en.wikipedia.org/wiki/SAE_J1772
- https://github.com/kortas87/simple-evse/wiki (https://code.google.com/p/simple-evse/)

Resistance PP-PE (max cable throughput)		
Resistance [ohm]	**Current limit [A]**	**Wire cross-section [mm^2]**
> 1500 *	6	--
1500	13	1.5
680	20	2.5
220	32	6
100	63	16
<100 **	80	–

* no resistor connected

** recommended ~50 Ohm

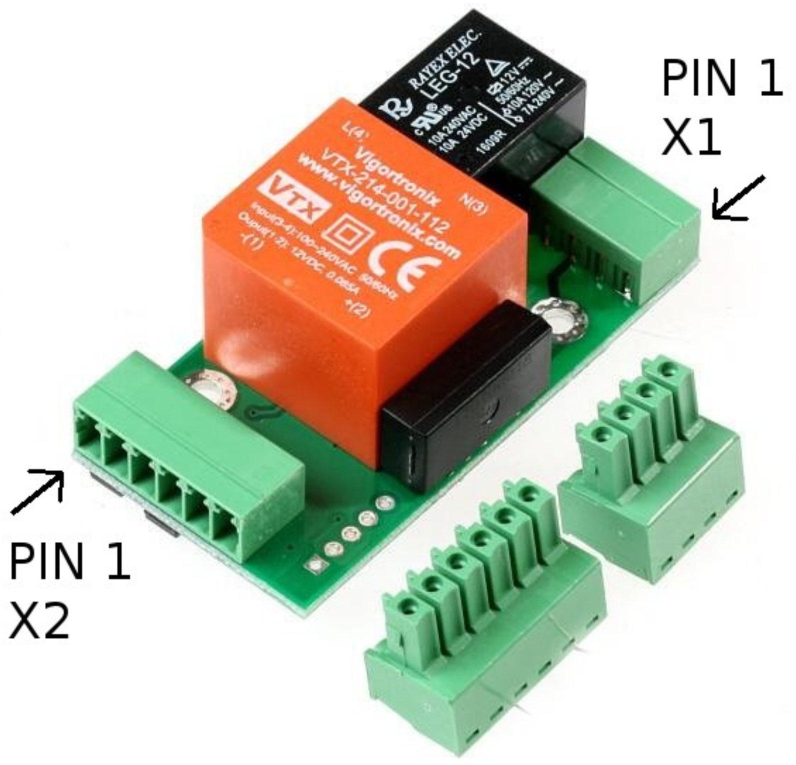
Compatibility

- Tesla Model S
- Nissan Leaf
- Mitsubishi iMiev (Peugeon iOn, Citroen cZero)
- Opel Ampera
- eGolf
- Mitsubishi Outlander PHEV
- Citroen Berlingo Electrique
- and others

Board description EVSE WB

Parameters	
Dimension (without connectors)	60 x 30 x 25 mm
Mounting holes spacing	30 x 20 mm
Supply voltage	90 – 265 VAC
Power consumption	<1W
Relay	5A 250V
Operating temperature	-20 to 80 °C
Protection index	IP00
Weight	80 g
Onboard resistor for external LED	1k
Order code	EVSE-WB
Options	HC06 bluetooth, UART-USB converter

EVSE WB board has 2 connectors. 4-pin X1 for high voltage side and 6-pin for signaling wires and control purposes. There is also PROG connector used for flashing new firmware (ICSP), additional communication and can be further used for adjusting EVSE current (see “Customizations” chapter).



Picture 1: EVSE WB

X1 connector = 4pins		
pin	**name**	**description**
1: L	phase	230V power supply for EVSE board and external contactor
2: N	neutral	
3: PE	protection-earth	Ground reference
4: rel	relay output	This output drives coil of an external contactor Maximum allowed current is 3A.

X2 connector = 6pins		
pin	**name**	**description**
1: CP	control pilot	To vehicle connector
2: PP	proximity pilot	To vehicle connector
3: 5V	5V power output	Used as a power supply for external components (max 40mA)
4: GND	ground	Ground reference
5: LED	external LED	Includes 1k resistor onboard, connects to LED anode against ground
6: AN	analog input	Used for button or current sensor input

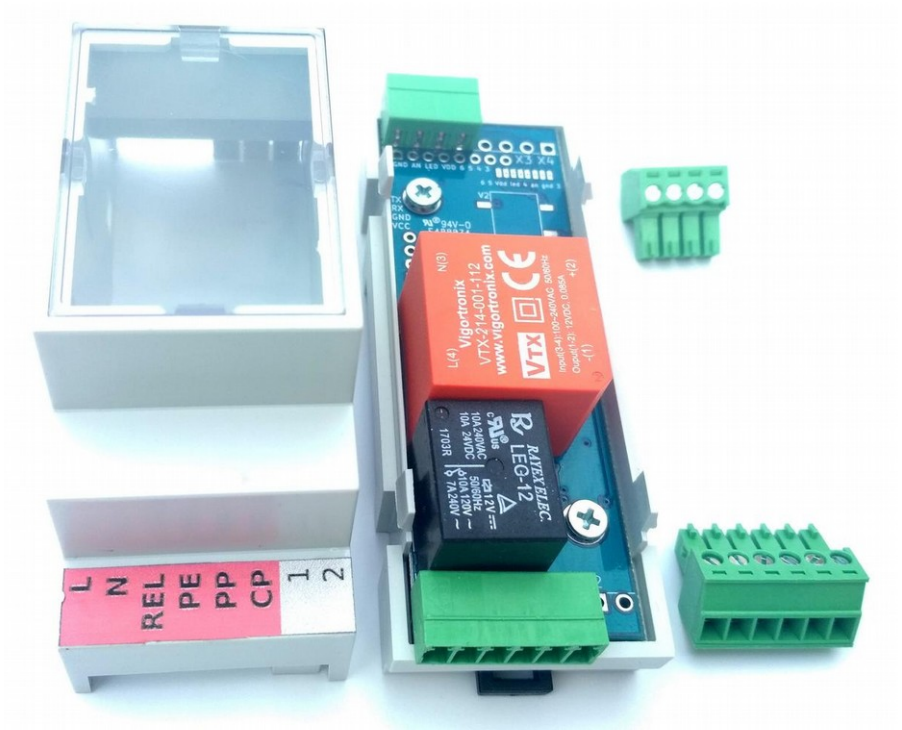
PROG connector = 5pin header		
pin	**name**	**description**
1	V_{PP}	ICSP** / RFU* [marked by rectangle] from Jan 2018 bootloader enable pin
2	V_{DD}	5 V
3	GND	Ground
4	DAT / TX	ICSP** / current boost / communication function
5	CLK / RX	ICSP** / current limit / communication function

* reserved for future use

** firmware upgrade interface

Board description EVSE DIN

Parameters	
Dimension (without connectors)	86 x 29 x 25 mm
Mounting holes spacing	54 x 18 mm
Supply voltage	90 – 265 VAC
Power consumption	<1W
Relay	5A 250V
Operating temperature	-20 to 80 °C
Protection index	IP00
Weight	85 g
Onboard resistor for external LED	1k
Order code	EVSE-DIN
Options	RS485 driver, HC06 bluetooth, UART converter, 3W AC/DC



Picture 2: EVSE DIN

X1 connector = 6pins		
pin	**name**	**description**
1: L	phase	230V power supply for EVSE board and external contactor
2: N	neutral	
3: rel	relay output	This output drives coil of an external contactor Maximum allowed current is 3A
4: PE	protection-earth	Ground reference
5: PP	proximity pilot	To vehicle connector
6: CP	control pilot	To vehicle connector

X2 connector = 2pins (OPTION)		
pin	**name**	**description**
1:1		function defined by extension module
2:2		function defined by extension module

X3 connector = 4pins		
pin	**name**	**description**
1: 5V	5V power output	Used as a power supply for external components (max 40mA)
2: LED	external LED	Includes 1k resistor onboard, connects to LED anode against ground
3: AN	analog input	Used for button or current sensor input
4: GND	ground	Ground reference

X4 connector = 4pins (OPTION)		
pin	**name**	**description**
1:3		function defined by extension module
2:4		function defined by extension module
3:5		function defined by extension module
4:6		function defined by extension module

PROG connector = 5pin header (OPTION)
same function as EVSE WB

UART connector = 4pin header (OPTION)
can be used for direct connection of HC06 (female header)

Customizations

Current limitation A – using PROG pin 5

Check the table for details of how you can set the maximum current. This settings will override PIN 4 settings.

PROG connector	connection	current limit
pin5 > 4.5 V	open (internal pull-up only)	32 A [default]
2.5 V < pin5 < 4.5 V	100-200k* resistor to GND	25 A
0.2 V < pin5 < 2.5 V	~3-20k* resistor to GND	16 A
pin5 < 0.2 V	tied to GND	10 A

* resistor value may differ since internal pull-up has no defined value from production (~50k supposed), in most cases 100k for 25A and 5k for 16A is recommended

Current limitation B – using PROG pin 4

Check the table for details of how you can set the maximum current.

PROG connector	connection	current limit
pin4 > 4.5 V	open (internal pull-up only)	32 A [default]
2.5 V < pin4 < 4.5 V	100-200k* resistor to GND	48 A
0.2 V < pin4 < 2.5 V	~3-20k* resistor to GND	63 A
pin4 < 0.2 V	tied to GND	80 A

* resistor value may differ since internal pull-up has no defined value from production (~50k supposed), in most cases 5k for 63A and 100k for 48A is recommended

Precise current setting with Analog Input

Press and hold button connected to Analog input AN of for a few seconds until LED starts to blink rapidly. Then count LED blinks which correspond to number of ampers. Please note that this limit will be set until you reboot the EVSE (make a power cycle). Button is connected the way that it pulls the signal down to ground (level <1V).

Current limitation based on PV production

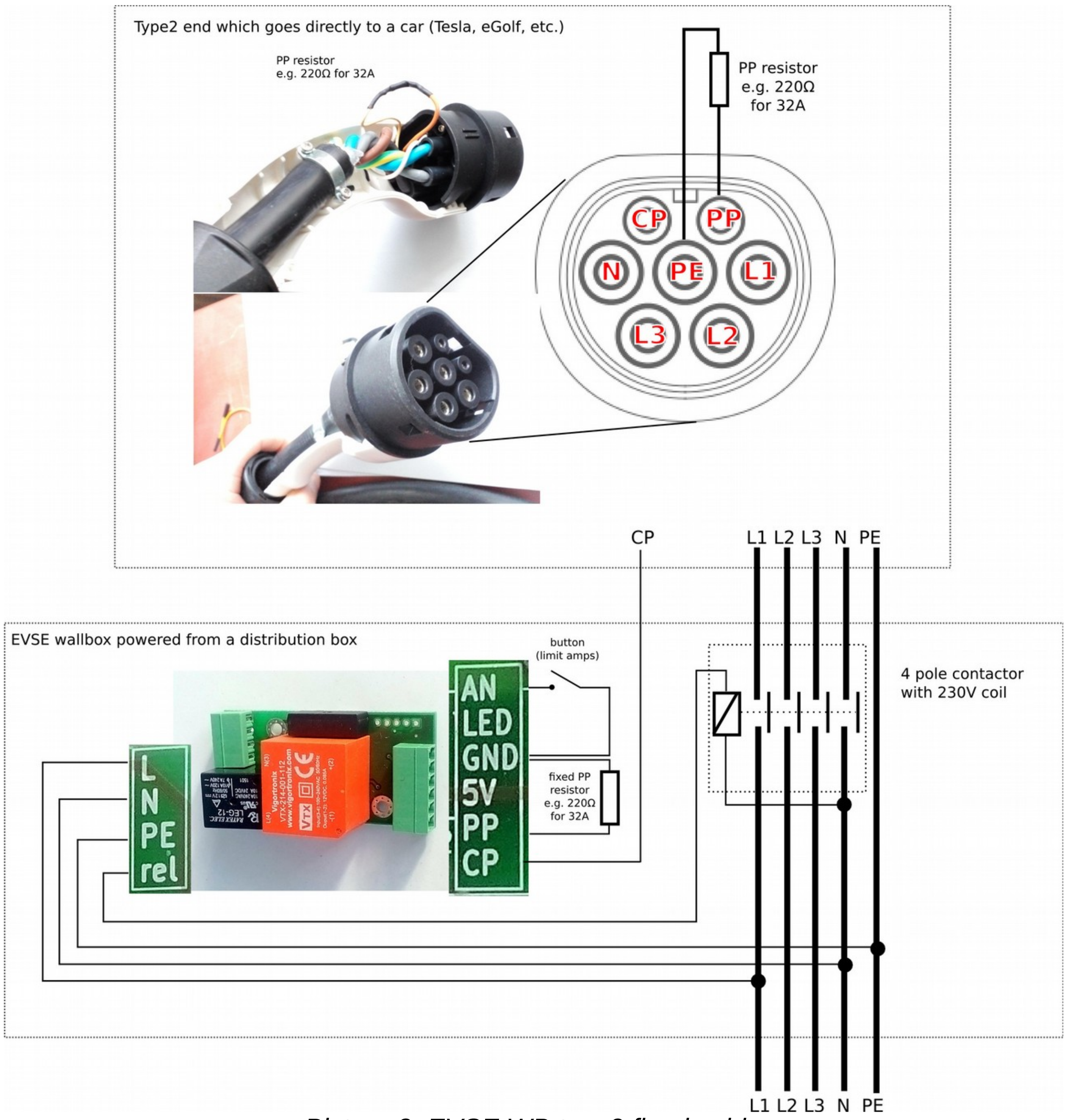
We recommend to use any kind of control system (smart home PLC, Beaglebone with RS485 and SDM630 electricity meter, SDS micro...) and control the EVSE current continuously either by voltage input AN, via data communication (UART/RS485), or simply in 2 or more steps by relay outputs (EVSE is off, EVSE current low, EVSE current high). Each system is different as well as customer needs.

Application examples

In these application examples we suppose that customer uses appropriate contactor with 230V coil. Please check section “Recommended contactors”.

3phase wallbox including a cable and plug

In this example we make 3 phase Wallbox using DSIEC-2E cable. PWM duty will be limited by the size of R_{PP} (refer to the *Theory of operation* chapter). If you do not connect any R_{PP} current will be limited to only 6A. If your EVSE includes a cable which is fixed then you can hard-wire R_{PP} resistor for cable's nominal value.

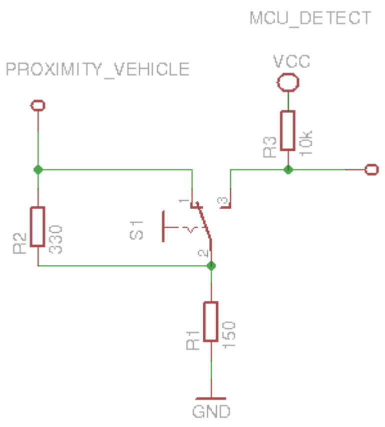


Picture 3: EVSE WB type2 fixed cable

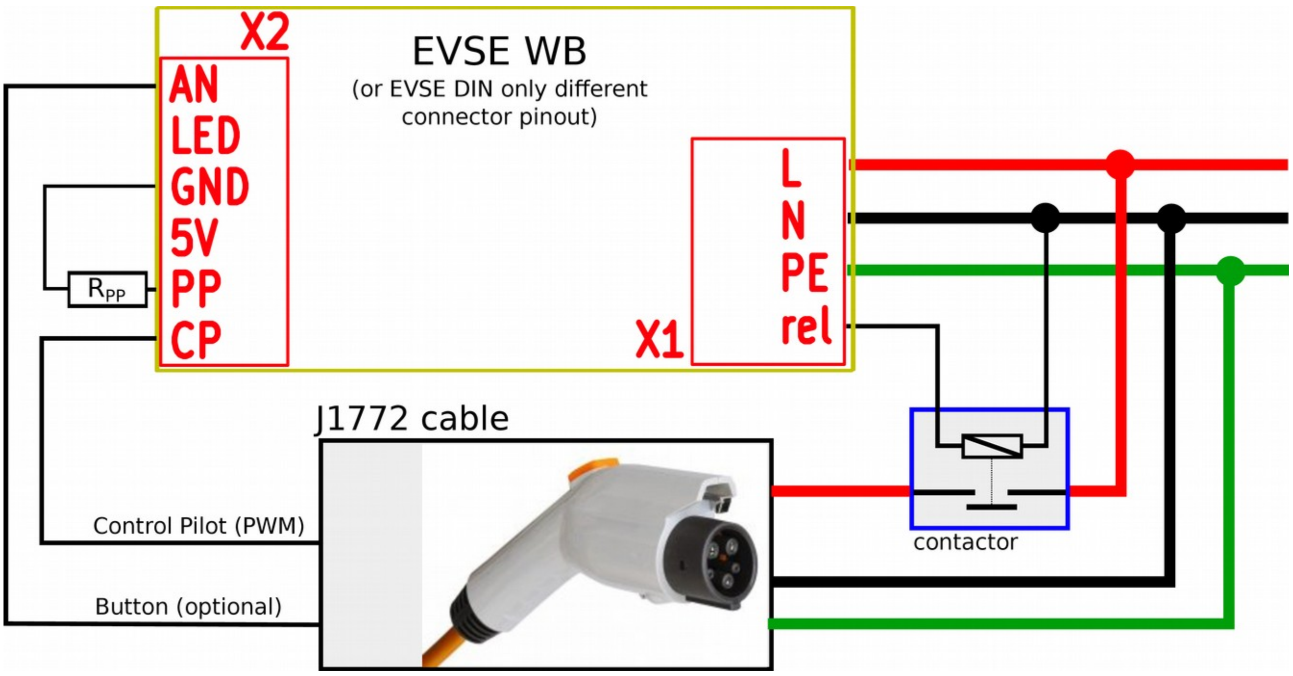
32A EVSE with connector J1772

With EVSE Wallbox board you can quickly build a charging station for your Nissan Leaf 6.6kW or any other vehicle equipped with J1772 plug.

Optional Analog Input connection:
The internal J1772 connection allows to use S1 proximity button as an auxiliary button for EVSE. With the help of this button you can easily change charging current with the smallest step of 1A (see Features - Precise current setting).



Picture 4: J1772 proximity button connection detail



Picture 5: J1772 connector - signal and power wires

Recommended contactors

You should use relays / contactors equipped with 230V coil and connect them directly to the board connector X1. Here are some examples which relays can be used. The most common one (4pole contactor 25A) can be easily obtained in local electrical accessories shop (Conrad, K&V Elektro...)

- 3-phase, maximum current 20A (e.g. Tesla 11 kW):
  Noark Ex9CH25 40, Elko VS420
- 3-phase, maximum current 40A (e.g. Tesla 16.5 / 22 kW, ZOE 22 kW):
  Elko VS440, Eaton Z-SCH 230V/25-40
- 1-phase, maximum current 16-20A (e.g. Peugeot iOn 3 kW, Tesla 3-4kW):
  Eaton Z-R230/S
- 1-phase, maximum current 40A (e.g. Nissan Leaf 6.6 kW):
  RELPOL R40N
  or use normal 4-pole contactor

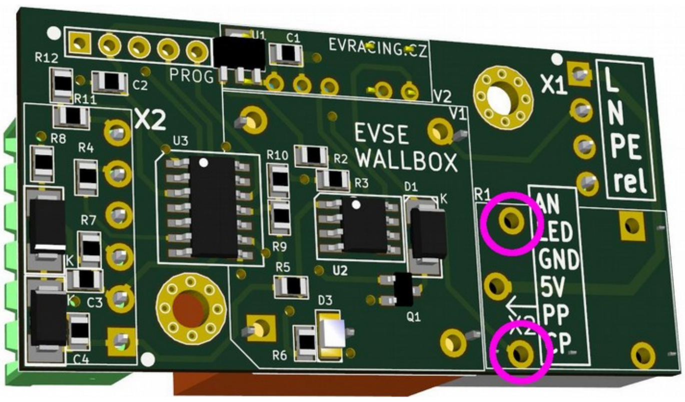
Picture 7: 40A 1phase relay

Picture 6: 20A 3phase relay

Using external 12V relay

In some cases it would be possible to use another 12V coil relay (maximum 0.8W coil consumption), however this approach requires desoldering of the original relay and is recommended only to advanced users. Automotive relays can handle sufficient currents however their voltage rating is not high enough.

Pins marked by pink are connected to a 12V relay coil:

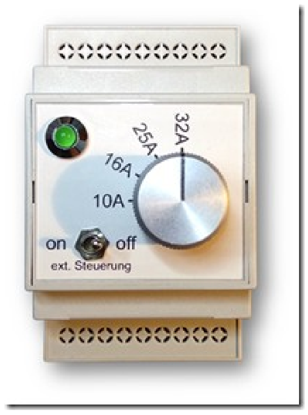


Picture 8: EVSE WB - connecting 12V relay directly

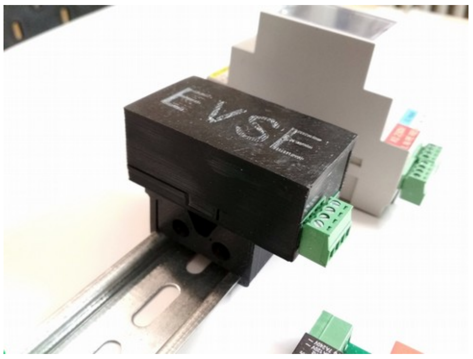
Continuous current regulation 6-32A using a pot

Use AN as EVSE voltage input and connect a potentiometer wiper. The other two terminals are to be connected to GND and 5V. Minimum 6A and maximum 32A can be adjusted in registers as needed.

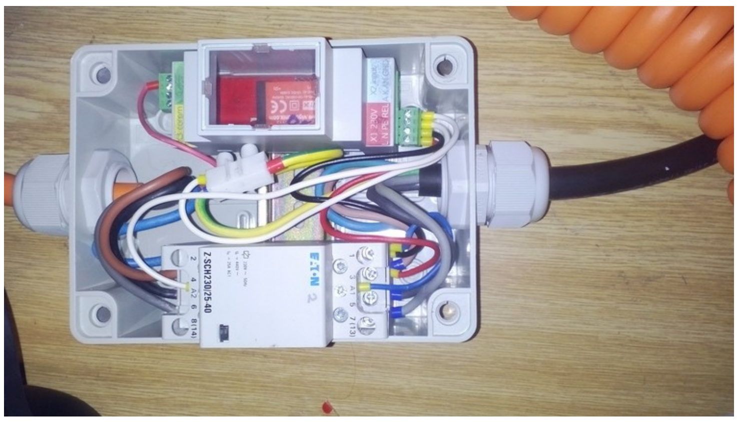
Customer solutions and projects



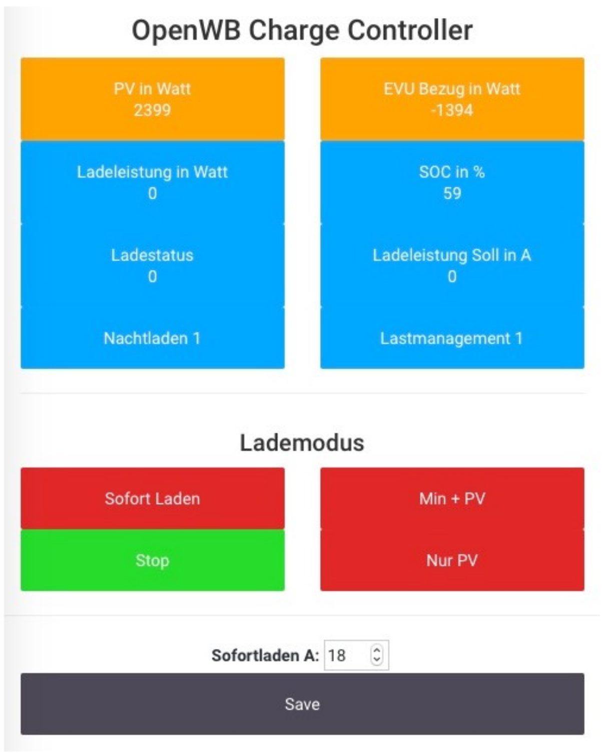
Picture 9: EVSE WB in custom box with 4position current switch



Picture 10: 3D printer box for EVSE WB in comparison to EVSE DIN



Picture 11: Charging cable made with EVSE DIN together with 4pole contactor in a box

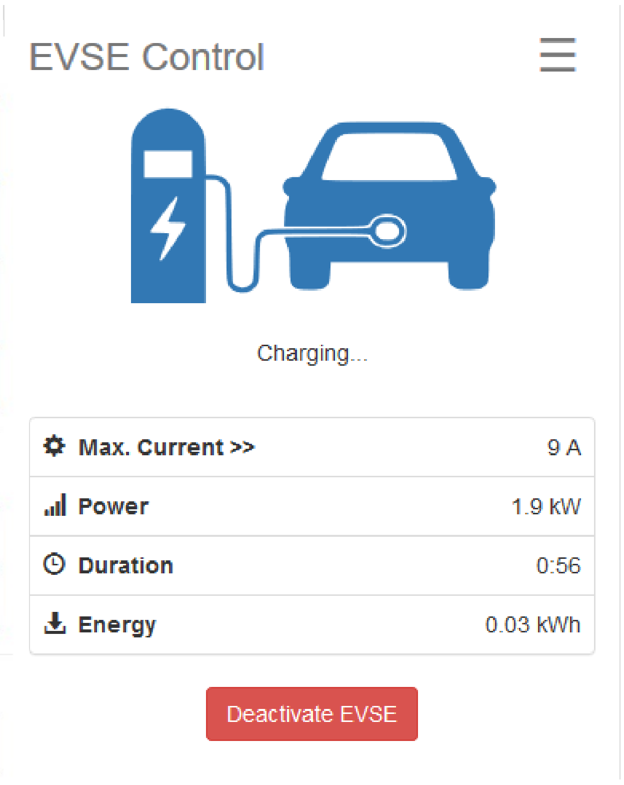

OpenWB Charge Controller

PV in Watt 2399
EVU Bezug in Watt -1394
Ladeleistung in Watt 0
SOC in % 59
Ladestatus 0
Ladeleistung Soll in A 0
Nachtladen 1
Lastmanagement 1

Lademodus

Sofortladen A: 18

Picture 12: SDM630 electric meter + EVSE DIN RS485, web interface (http://openwb.de)


EVSE Control

Charging...

Max. Current >> 9 A
Power 1.9 kW
Duration 0:56
Energy 0.03 kWh

Picture 13: Wifi interface for EVSE WB (https://github.com/CurtRod/SimpleEVSE-WiFi)

FAQ

1) How many PP resistors do I need?

As described in more detail above in the schematic (page 9), there must be one resistor in Type2 female (car side) and other resistor connected to an EVSE. Both are usually part of the extension cable Typ2 female (car side) to Type2 male (EVSE side). When using a fixed cable (not possible to disconnect from the EVSE) then the size of EVSE PP resistor can be “hardcoded” (modbus versions only, see register 2007 below) or a resistor of a fixed size have to be connected (usually 220 ohm for 32A cable).

2) EVSE does not work (config problem)

Make sure that the EVSE is not turned off (2005 configuration register). If the board does not respond at all, make sure the the UART parameters are correct (9600 baudrate, RX/TX+GND wired correctly). Did not the Modbus address change by accident (reg. 2001)?

3) LED indication explained

Using the pin LED you can directly connect LED to indicate EVSE status. The output includes 1k resistor. External LED has the same indication function as on-board LED.

LED	connection
1x fast every 2s	pilot signal is steady +12V, no vehicle connected
2x fast every 2s	PWM signal is generated, vehicle is present
1x long every 2s	vehicle requested power, contactor is ON
20x fast in 0.5s	enter or leave current setting mode
1x each 0.3s	current setting mode – one more amper set
3x fast with pause	EVSE is disabled in software, FW >=6
5x fast with pause	diode check error (no charging), FW >=10

Advanced configuration

Beginning January 2018 all boards can be configured by MODBUS. By default MODBUS interface is disabled and old functions of PROG pins are kept. However you can enable it ~~by grounding PIN4 and PIN5 of PROG connector while powering the board up~~. (please see NOTE#1 instead).

Physical layer is not galvanically isolated UART (0-5V) or optionable isolated RS485 EVSE DIN only.

The default device ID is 1 (can be changed in register 2001).

Some values can be then read or written over MODBUS protocol. PROG pin header is used for this purpose with following pinout:

PROG connector	connection
pin3	GND
pin4	TX
pin5	RX

This feature is useful for further development and testing with EVSE Wallbox board and can be also a great way to interface other devices such as Raspberry PI, Ethernet UART bridges (e.g. WIZnet or USR serial-to-ethernet boards), various WiFi modules etc.

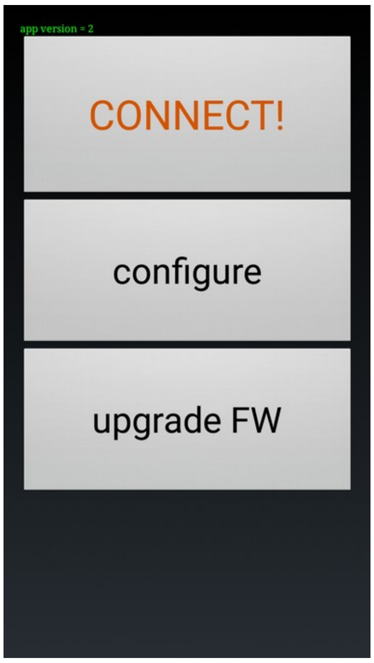
HC06 bluetooth module + Android app

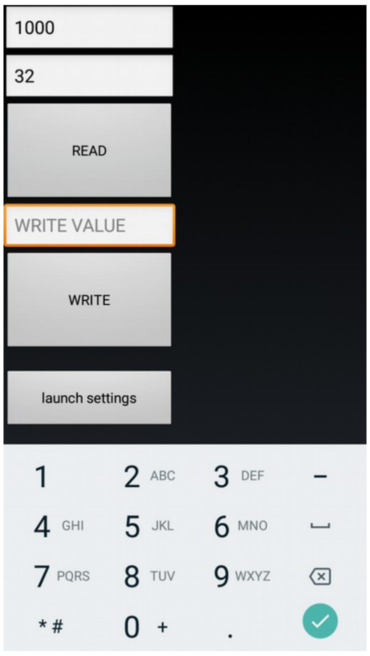
Preferred way is to use HC06 Bluetooth converter and Android application developed for this purpose.

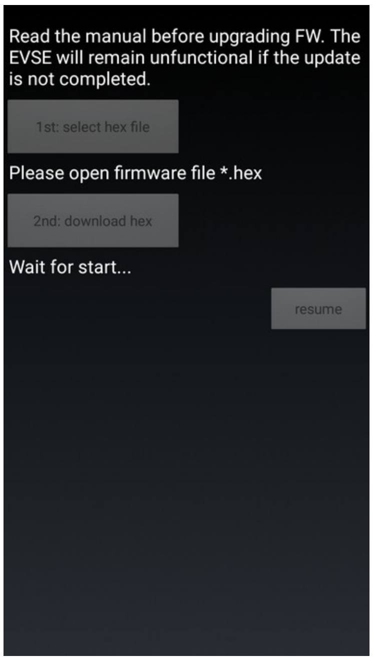
You can download and install the app from here (*.apk extension): http://evracing.cz/evse/evse-wallbox/

HC06 is connected to PROG connector.

1. power up the board, HC06 should start blinking
2. pair your Android device with the adapter (default pin 1234)
3. open the EVSE app and choose the paired bluetooth adapter in its settings
4. hit connect button and wait for connection
5. read & write registers you need




1000
32


Read the manual before upgrading FW. The EVSE will remain unfunctional if the update is not completed.

Please open firmware file *.hex

Wait for start...

Flashing new firmware

Flashing new firmware using Android phone is supported (with bluetooth adapter) on all EVSE DIN devices and on EVSE Wallbox devices only with “modbus firmware”. In order to flash new version of firmware bootloader mode must be enabled (last bit of the register 2005 - see the below).

Bootloader mode

If bootloader mode is activated the LED is solid on or off and it toggles when there is active communication. Bootloader mode can be turned off by changing the configuration register or it happens automatically after successful flashing of new firmware or there is a timeout of approximately 4 minutes.

When bootloader mode is activated, modbus slave address is set to 1.

~~The other way to enter bootloader mode is to keep analog input down when the device is booting (before powering on) for about 12 seconds~~ (CHECK: or some more complicated way to prevent accidental bootloader turn on? CONCLUSION: if divider 1:1 used for AN => colision, result: this option disabled)

Bootloader change with board having initial revision 10: bootloader can be enabled by pulling MCLR (pin 1 PROG header) down for at least 12 seconds. This is needed for the case that software upgrade fails and there is no possibility to enable bootloader by changing the register.

Troubleshooting

If the download of a new firmware was not completed then you need to try it again, otherwise the board will not function properly. Last chance to fix badly programmed board is using PICKIT programmer.

How to determine firmware version?

If you power up the EVSE board and the LED is on for about 2 - 3 seconds you have Modbus firmware onboard and it is disabled. You can enable it this way NOTE#1. Firmware revision can be then read from register 1005.

Analog input control

Charging current can be changed based on analog input AN voltage (when register 2003 = 0). Minimum value is set in register 2002 and maximum in register 2000. Default supported range is 0 - 5V. Analog input is referenced to GND and is not isolated

Charging current ($\mathbf{I_{PWM}}$) for the vehicle is calculated:

$$I_{PWM} = U_{AN} / 5 * I_{MAX}$$

Where $\mathbf{U_{AN}}$ is the voltage measured at the input AN and $\mathbf{I_{MAX}}$ is actual maximum current.

Default is 32A, however it can be adjusted by settings or “current boost” / ”current limit” feature or change in configuration register.

If the resulting current is smaller than 6A then the EVSE state will change to “pilot steady 12V” and vehicle stops charing. Minimum current can be also adjusted in the register.

0 - 10V configuration

Add a 1k resistor R12. R11 is also 1k and it will create a divider 1:1. Please not that this setup is recommended to use only with I/O modules having **0-10V analog output galvanically isolated.**

Register table

Register address	R/W	default	Description
1000	R/W		Actual configured amps value (from reg 2002 to 80A)
1001	R		Actual amps value output
1002	R		Vehicle state: 1: ready 2: EV is present 3: charging 4: charging with ventilation
1003	R		6 / 13 / 20 / 32 / 63 / 80 A Maximum current limitation according to a cable based on PP resistor detection
1004	R/W		**bit0:** turn off charging now **bit1 - bit15:** not used
1005	R		Firmware revision
1006	R		EVSE state 1: steady 12V 2: PWM is being generated (only if 1000 >= 6) 3: OFF, steady 12V
...			...
2000	R/W	32	**Default amps value** after boot (max 80A, min 6A)
2001	R/W	0	**Function of PROG PIN 4 + 5, slave address** (default 0: current limit or boost functions available) 0: analog inputs enabled > 0: MODBUS communication enabled This value also means the slave address.
2002	R/W	5	Minimum amps value, allowed 0 - 13 if set to 0 the EVSE will completely stop charging during analog input mode (2003 = 0) and AN = 0V

Register address	**R/W**	**default**	**Description**
2003	R/W	1	**Analog input config:** 0: analog input current regulation, input 0 - 5V corresponds to the range: minimum amps --> default amps note that there is a weak pullup resistor enabled for this input (no input connected --> 5V) 1: each blink 1 amp step (default), starts from 0 2: each blink 2 amps step, starts from 0 3: each blink 3 amps step, starts from 0 ..... 10: each blink 10 amps step, starts from 0 11: mapping table: registers 2010 - 2017 1x blink = value from 2010 2x blink = value from 2011 ...
2004	R/W	0	Amps settings after power on (applies only to a changes made by the button), whether to save amps settings to eeprom each time it changes or not 0 - do not save amps value (default) 1 - save amps value to register 2000 every time it changes
2005	R/W	1	**bit0**: Enable button for current change (no sense when 2003 = 0) 0: disabled 1: enabled (default) **bit1**: Stop charging when button pressed 0: disabled (default) 1: enabled charging will automatically start after you manually unplug and plug the cable to the vehicle **bit2-11**: reserved **bit12**: pilot diode check enabled (write 4096) **bit13**: disable EVSE after charge (write 8192) **bit14**: disable EVSE (write 16384) **bit15:** enable bootloader mode (write 32768) **NOTE:** if both bit0 and bit1 are enabled then “interrupt charging” will have higher priority, when charging
2006	R/W	0	RFU: Current sharing mode is active (two or more EVSEs connected to a single breaker) 0 - charging current is half of the default current amps > 0: this amps value will be used
2007	R/W	0	PP detection 0: PP detection enabled (default) value > 0: detection disabled, fixed PP limit entered [A]

Register address	**R/W**	**def ault**	**Description**
2008	R/W		reserved
2009	R		Bootloader firmware revision
2010	R/W	6	Amps value 1
2011	R/W	10	Amps value 2
2012	R/W	16	Amps value 3
2013	R/W	25	Amps value 4
2014	R/W	32	Amps value 5
2015	R/W	48	Amps value 6
2016	R/W	63	Amps value 7
2017	R/W	80	Amps value 8

Register addresses are in decimal format!

NOTE#1: By default MODBUS is NOT enabled, so the original analog input switches can be used (current limit and current boost functions). MODBUS can be enabled by pulling AN input down to GND while booting (= when you power the device up) at least 5 times within 3 seconds seconds (button activated). This will change register 2001 to the value 1, but it will not save the value permanently. Value will be saved after first successful R/W operation over MODBUS (register number >=2000).

NOTE#2: You can restore default settings of all registers by saving a value 65535 to the register 2010

NOTE#3: Only functions 03 (Read Holding Registers) and 16 (Preset Multiple Registers) are implemented. For more details please check: http://www.simplymodbus.ca/FAQ.htm

RFU: reserved for future use

Firmware updates

2018-06-xx revision 10 TODO:
- improved CP signal check voltage levels

2018-04-30 revision 9:
- combined code for EVSE DIN 485 and EVSE WB (but 2 different hex files)
- uart communication fix

2018-02-06 bootloader v3:
- fix: removed reconfiguration from bootloader code (causing rewriting reg 2002)

2017-11-18 bootloader v2:
- added possibility to turn bootloader on by hardware pin 1 (Vpp/MCLR)

2017-11-18 Androi app v2:

- fixed .hex file parser (firmware upgrade), always use latest app version for firmware flashing!

2017-10-31 revision 8:
- added “disable EVSE after charge” bit (register 2005)
- fixed issue with voltage AN input - now follows minimum amps and does not turn off

2017-06-23 revision 7:
- interrupt routine rewritten (modbus communication)
- correct vehicle status update, if pwm is not being generated

2017-06-07 revision 6:
- new configuration bits, register 2005 (disable EVSE, interrupt charging, change current)
- error code signalization

2017-05-03 revision 5:
- fixed current limit based on cable PP resistor (and analog pin input)

2017-04-26 revision 4:
- fixed amps value from AI (e.g. for max 32A reached only 31A and 5V input)
- fixed minimum amps value (was not taken into account)

2017-04-21 revision 3:
- added bootloader (Android application)
- fixed bug with analog input not working while modbus enabled
- added control register 1004

2017-04-13 revision 2:
- changeable slave address in reg 2001
- stop charging button function reg 2005 (no timeout, but wait for unplug & plug), bitfield introduced for more possible options
- added register 1005 (firmware revision number)

2017-02-17 revision 1:
- initial version

TODO list (possible future updates):
- write protection (write 0xabab 2001 and then change of address is possible)
- implement discovery function for android app
- bluetooth pin and name change mechanism

Examples

Read holding registers example

01 03 03 E8 00 02 AA 2D (request)

bytes	description
01	The slave address (always 01 unless changed by customer)
03	Function code (03 is for read holding registers function)
03 E8	The data address of the first register to read
00 02	The total number of registers requested.
AA 2D	CRC (cyclic redundancy check)

01 03 04 8F B5 8F BA B4 0F (answer)

bytes	description
01	The slave address (always 01)
03	Function code (03 is for read holding registers function)
04	The number of data bytes to follow (2 registers x 2 bytes each = 4)
8F B5	The contents of register 1000 (36789 → 3678.9 mV)
8F BA	The contents of register 1001 (36794 → 3679.4 mV)
B4 0F	CRC (cyclic redundancy check)

Reading the data out with Python (USB – serial adapter)

You can use almost any MODBUS master utility for Windows / Linux / Mac. For common users we recommend using **QModBus** (http://qmodbus.sourceforge.net/). There is also QModMaster (http://sourceforge.net/projects/qmodmaster/) utility, but there may be a problem with write multiple registers function (there is bug in the software which causes register shift) - so use it carefully.

Advanced users can use Python / pymodbus (https://github.com/bashwork/pymodbus) for further development or similar libraries.

In following example we read out first 7 registers

```
#!/usr/bin/python3
from pymodbus.client.sync import ModbusSerialClient
client = ModbusSerialClient(method = "rtu", port=”/dev/ttyUSB0, baudrate=9600,
stopbits=1, bytesize=8, timeout=1)
rq = client.read_holding_registers(1000,7,unit=1)
print(rq.registers)

#Reading the data out with Python (USB – serial adapter)
```