

Electric Motor Werks CHAdeMO Controller Datasheet / Quick Start Guide

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This document is always available here: <http://goo.gl/pQQ1A1>

Additional relevant materials:

1. [SmartCharge-12000 Quick Start Guide](#)
2. [QuickCharge-25000 Quick Start Guide](#)
3. [EMotorWerks Serial Charger Control Protocol](#)

Products described in this document are listed in [EMotorWerks online store](#)

PLEASE read this quick guide in its entirety BEFORE powering up anything!

WARNING: This document describes circuitry that is directly connected to the AC mains, and contact with any part of the circuit may result in death or serious injury. By reading past this point, you explicitly accept all responsibility for any such death or injury, and hold Electric Motor Werks, Inc. harmless against litigation or prosecution even if errors or omissions in this warning or the document itself contribute in any way to death or injury. All mains wiring should be performed by suitably qualified persons, and it may be an offence in your country to perform such wiring unless so qualified

Packing list:

- CHAdeMO controller (alum box, 11x7x3)
- If ordered with the eMotorWerks CHAdeMO cable featuring SB175 high-current connector, the following parts will also be included:
 - SB175 gray Anderson connector with AWG6 / AWG4 / AWG2 pins
 - SB50 black Anderson connector with AWG6 pins
 - 12" of black and red AWG6 wire (to make an adapter between SB50 and SB175)

Introduction:

- EMotorWerks CHAdeMO controller is designed to be a bridge between a CHAdeMO-equipped vehicle and a compliant non-CHAdeMO charger

- Compliant non-CHAdeMO charger has to implement EMotorWerks Serial Charger control protocol described below
- CHAdeMO cable and plug are required to connect the CHAdeMO controller to a vehicle. These items are sold separately by EMotorWerks

Specifications:

- Input - defined by the charger used in conjunction with the controller
- Output
 - Up to 450VDC, 60A (optional upgrade to 125A protocol limit - if you choose this option, do not forget to also upgrade your _charger_)
 - Max voltage and current are configured in firmware prior to shipping. You can specify lower limits if necessary - see instructions below in this document
- Input & output connections
 - Controller's power lines are terminated with Anderson connectors
 - SB50 in base 60A version: gray connector for input, black - for output.
 - SB175 in a 125A version: gray (input), red (output)
- Start-of-Charge control
 - single-switch (START / STOP charge) semi-automatic
- Vehicle-side communication
 - CHAdeMO protocol v0.9
 - Bi-directional over CANbus, 500kbps
- Charger-side communication
 - EMotorWerks Serial Charger Protocol (described below)
- Internal precharge / output discharge circuit
 - Circuit voltage shall drop below 25% of circuit voltage, which is monitored before EV contactors are opened, within 1 second after the charger terminates charging output and EV contactors are opened.
- Architecture
 - Atmel ARM-Cortex-M3 MCU ATSAM3X8E (84Mhz)
 - EMotorWerks control board
- Physical
 - Size: die cast aluminum enclosure 11x7x3"
 - Weight: 4lbs (or less)
 - Size & weight can be lower at EMotorWerks discretion

Available customizations (not all are immediately available - inquire):

- Any type of input and output I/O (e.g., BMS input)
- Second CANbus network
- High-current I/O (up to 5A 12V drive)
- WiFi / BlueTooth connectivity
- Fiber Optics link to the charger for [electrically] noisy environments

Requirements for Compliant non-CHAdeMO charger to work with EMotorWerks CHAdeMO controller:

1. Implement [EMotorWerks Serial Charger Control Protocol](#). Important points to note:
 - a. Charger status reports shall be sent at least 10 times per second in order to meet CHAdeMO protocol timings
 - b. The charger shall verify the checksum on all commands and discard command if checksum is not valid
 - c. If the charger runs a different control protocol, that protocol will have to be implemented in the Controller or a standalone transcoder. EMotorWerks can perform such work, however the cost of such a modification will likely be substantial
2. Ensure power stage is compliant with CHAdeMO requirements
 - a. Latency of response to controller commands: <100ms
 - b. Current ramp (up or down) rate: >20A/second
 - c. Max voltage: $\geq 410V$
 - d. Charger shall have internal protections against the following conditions:
 - i. Sudden removal of load
 1. The charger shall recognize this condition and reset back into no-output state within 5 seconds or less
 2. This requirement is designed to allow restart of charging in case of unexpected interruption
 - ii. Power-on into an open circuit (no load). WARNING: some chargers used in EV industry are not capable of this mode of operation
3. Ensure charger control & monitoring system is compliant with CHAdeMO requirements
 - a. Accuracy of current CONTROL by the charger: $\pm 2.5A$ or $\pm 5\%$ of the charge current request, whichever is larger. E.g. for a 60A output (standard rating of EMotorWerks' QC-25 units) allowed deviation of the actual current from the requested output current is $5\% \times 60A = 3A$
 - b. Accuracy of current MEASUREMENT by the charger (for the purposes of reporting to the controller): $\pm (1.5\% + 1.0A)$. E.g., for a 60A output, allowed deviation of reported current from the actual output current is $0.9 + 1.0A = 1.9A$
 - c. Accuracy of voltage measurements: $\pm 5V$

Quick Start Guide for EMotorWerks CHAdeMO controller

1. Connect all cables to the controller (if your controller shipped with the CHAdeMO charger system, your system will be pre-wired from the eMotorWerks factory)
 - a. Logic power - 12V via a barrel connector from the supplied 12V power supply
 - b. Serial - connect serial lines between controller and the charger. The following assumes that the charger has a 3-pin serial connector with black wire (GND), white wire (TX) and green wire (RX).
 - i. There are two options for connecting this to the controller side:
 1. A single 6-pin connector provided at the controller end
 2. A dedicated 3-pin connector provided at the controller end
 - ii. In both cases, connect black to black, green to white, and white to green
 - c. Output CHAdeMO
 - i. Comms: small metal locking connector from the CHAdeMO cable to the controller
 - ii. Power: SB50 / SB120 / SB175 Anderson connector from the CHAdeMO cable to the controller.
 1. There are 2 Anderson connectors, the one that goes from the CHAdeMO controller to the vehicle-side CHAdeMO cable is the one that has 2 low-current wires going into in addition to the high current wires.
 - d. Input CHAdeMO
 - i. Connect the output anderson from the DC-Charger (red anderson) to the input of the CHAdeMO controller (red anderson).
 1. From time to time, the anderson colors could be different however the CHAdeMO bundle will be made such that all connections go together correctly.
2. Configure the controller (optional)
 - a. Connect the controller to PC via a supplied USB cable
 - b. Install the Arduino IDE for proper driver installation of the CHAdeMO controller
 - c. Power up the controller (12V)
 - d. Connect to controller
 - i. Open the terminal session on your PC. TeraTerm is a good program to use on Windows
 - ii. Connect to the controller by specifying the correct COM port
 1. You might need to try a couple of different ports before you hit the right one
 2. When you hit the right one, you will see the controller prompt
 - e. Configure the controller
 - i. Most likely, the controller will be configured to the max output of 450V, 60A (~25kW). If this is ok for your purposes, no need to do anything. Most users should not have to change this setting.

- ii. In some cases, your controller will be set to the lower power at the factory
 - 1. This is normally the case when your input voltage is higher than 380V 3-phase
 - 2. The higher the input voltage, the higher the heat dissipation in the charger, therefore we have to apply derating
 - iii. If you need to reduce the power advertised by the controller to the car:
 - 1. Issue the following command during the timeout at start-up (indicated by printed to the terminal screen):
"M,V450,C040,E" (no quotation marks in your actual command) - this would reduce the power to 40A
 - 2. The controller should respond with acknowledgement of your settings. If you attempt to specify settings higher than the rating of the charger, your settings will be automatically constrained
 - iv. The configuration will be written out into the non-volatile memory of the controller and kept there for the next run. You will be able to override them again after the power-cycle of the controller
3. Power up your charger
- a. Make sure a small black button to the right of the screen is not pressed in. It is a toggle button so you simply press on it to change its state
 - b. If your charger has a separate thin power cord coming out of the charger box, connect that one first - it will power only fans and logic boards inside the unit. Use only 100-260VAC single phase power to connect this!
 - c. Power up the entire charger.
 - i. Follow instructions in the Quick Start Guide for your specific charger (see the links on top of this document)
 - ii. Make sure you are using supplied inrush resistors to connect main power lines to your charger - 0.5R for up to 240VAC input voltage, 2R for 380 / 400 VAC, 2x 2R for 480 / 600 VAC
 - d. [Optional] Confirm comms with charger
 - i. Connect an [optional] FTDI cable to your PC
 - ii. Connect FTDI cable to the charger using the same 3-pin connector (the one designed to be connected to the controller)
 - 1. Connect RX of the FTDI to white (TX) line of the charger
 - 2. TX of the FTDI cable to green (RX) line of the charger
 - 3. GND of the FTDI cable to black (GND) line of the charger
 - iii. Open terminal, select the correct COM port (it will be different from the COM port you used to connect to the controller)
 - iv. Test Serial control of the charger
 - 1. Observe reports coming from the charger
 - 2. Try issuing commands, watch response
 - 3. For details on protocol, refer to the Quick Start Guide corresponding to your charger
 - v. Reconnect the charger to the controller

4. Plug in the CHAdeMO plug into your car. Make sure the plug is in all the way - failure to do so may result in incomplete contact and may result in error codes set in your vehicle
5. Launch a charging session
 - a. [optional] set up your test measurement tools if desired
 - i. 100A+ clamp meter on one of the output lines of the charger or controller
 - ii. 600V+ voltage measurement on output lines of the charger or controller. This may require building a small pass-through Anderson cable with 2 additional SB50/SB175 connectors - none of this is supplied with the controller
 - b. Flip the toggle switch on the controller to 'ON' position
 - c. Within ~10 seconds, there should be an audible click from the car - this is the main battery contactor allowing access to the car's battery (these timings are given for Nissan Leaf specifically, other cars' timing may vary)
 - d. Within another ~5 seconds, the charger should start ramping current. This will generally be accompanied by high-frequency (8-16kHz) sound from the charger
 - e. [optional] confirm current ramp with your tools
6. Observe session data on your PC
 - a. This assumes you are still connected to the controller over USB
 - b. Controller should be outputting data in the following format:
 - i. M,020,410,430,E --- 5285563 - this means car is asking for 20A until battery voltage hits 410V
 - ii. M,S:D600,C204,V380,T31,O000,t5285637,E - this means charger is reporting 60% duty cycle, 20.4A output current, 380V output voltage, 31C heatsink temperature
 - iii. OUT: -2 dA, 382V - this is optional and shows controller's own measurements of output current and voltage
7. Terminate charging session
 - a. Flip the toggle switch back to 'OFF' position
 - b. Unplug CHAdeMO cable from car
 - c. Do NOT touch any exposed pins on the plug. The controller has protection circuit designed to remove high voltage from the pins as soon as the charging session finishes but you should treat any exposed pins as live pins regardless for your own safety

TROUBLESHOOTING GUIDE

Before reporting ANY issues to EMW, please connect to the Controller over USB and record all messages into the text file. Attach text file to your email to EMW

Problem: No communication with charger

Likely Cause: mixed RX / TX pins in the 3-pin connector between the charger and the controller

Potential Solution: swap green and white wire

Chademo Controller and Plug Pinout

For interfacing with a non EMW chademo plug

CHAdEMO controller side

looking from the outside of the controller enclosure; numbering is counterclockwise 1-6 and 7 on the middle:

1. [CAN-L] - connects to [C1L] on the controller PCB
2. [Charger start/stop 2 (Ground)] - connects to [G']
3. [Ground wire] - connects to [G]
4. [Ground wire - used to simulate a connection check] - connects to [G]
5. [Charger start/stop 1 (+12V)] - connects to [+12']
6. [CAN-H] - connects to [C1H]
7. Not Connected / Do not Use

CHAdEMO plug side

Looking from the pin side of the chademo cable; numbering is clockwise 1-6 and 7 on the middle (also marked on the connector)

1. [CAN-L]
2. [Charger start/stop 2 (Ground)]
3. [Ground wire] - connects to [G]
4. [Ground wire - used to simulate a connection check]
5. [Charger start/stop 1 (+12V)]
6. [CAN-H]
7. Not Connected / Do not Use

Connector interface

