***EMotorWerks SmartCharge-12000***

**V12-V14 QUICK START GUIDE**

**(For a Fully Built Unit, PFC and NON-PFC)**

Last Revision: October 29, 2014

**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 |

1. Quick specs:
   1. Four voltage options to cover all world’s AC voltages from 100VAC (Japan) to 600V 3-phase (e.g., Canadian industrial mains). Note that rated power of the charger will drop as the voltage rating is increased due to rapid rise of the switching losses.
      1. 375V option - standard
         1. Input voltage: 85-260VAC
         2. Output voltage: 12-360VDC (12-330V for a 100A output option)
         3. Output power: 12kW / 70A (whichever is achieved first; 100a option is possible - inquire)
      2. 475V option - suitable for CHAdeMO output (CHAdeMO would require a purchase of a separate CHAdeMO controller and cable)
         1. Input voltage: 85-260VAC (single or 3-phase)
         2. Output voltage: 12-410VDC (to match Nissan Leaf’s battery voltage range)
         3. Output power: 10kW / 50A (whichever is achieved first)
      3. 675V option - suitable for 415V input (Europe, Australia, etc)
         1. Input voltage: 85-415VAC (single or 3-phase)
         2. Output voltage: 12-625VDC
         3. Output power: 8kW / 40A (whichever is achieved first)
      4. 875V option - suitable for 600V input (Europe, Australia, etc)
         1. Input voltage: 85-600VAC (single or 3-phase)
         2. Output voltage: 12-825VDC
         3. Output power: 6kW / 40A (whichever is achieved first)
   2. Features
      1. Microprocessor - controlled
      2. BMS-ready
      3. Precharge-ready
      4. Remote / PC control over UART serial lines
      5. Oerheating protection
      6. Fully programmable in field
      7. Open source firmware, schematics, and PCB files
2. Inspect unit for possible damage in transit. If you see any signs of damage, do not power up. Contact us at charger@emotorwerks.com for further instructions. It is very helpful to have photos of the damage when you contact us.
3. Place unit so that the mounting tabs are on the bottom. Any other orientation will likely damage the charger over time
4. [OPTIONAL] Connect BMS to the unit. There is a 5-pin connector broken out from the box. It normally has a jumper installed between the first 2 positions. In your actual system, if you want to use BMS, you would remove that jumper and connect a normally closed BMS loop (such as CleanPowerAuto’s miniBMS system) between those 2 terminals
5. Connect AC wiring to the unit – observe markings on the unit. Incorrect connection WILL damage the charger. DO NOT connect the battery yet.
   1. **As always with HV wiring, observe necessary precautions**
      1. Wear protective goggles & rubber sole shoes
      2. Try not to use both hands at the same time (to reduce the possibility to run any currents through your body)
      3. Treat every HV terminal / wire as live even if you ‘know’ it’s not energized.
   2. **IMPORTANT: use included inrush resistors in series with the AC lines – one per each hot wire**
6. Plug in the AC wiring into mains. In a few seconds, the fans should spin up. If they don’t, we advise you to NOT PROCEED as this indicates fan failure and the unit will overheat if run at over 2-3kW output
7. If you have already configured the charger (see appropriate step below), you can let it time out (5 seconds). Similarly, if you have already set the charger power in one of the previous runs, you can let the next screen time out, as well (10 sec). **Essentially, once your charger is fully configured, you do not need to do anything on the next power-up – after 20 sec timeout, the charger will proceed with the parameters from the last run (stored in non-volatile EEPROM).**
8. [To be performed ONLY ONCE for a given battery pack] Charger setup
   1. The first thing you will see on each power-up is an the greeting on the screen. If this is the first time you run the charger, press any button during the 5-second countdown to set up your battery parameters. The series of screens will follow, allowing you to set up (one of the buttons is used to cycle through values, another – to confirm selections):
      1. CV cutoff. You can enter the number from 000 to 399. The actual CV voltage used will be your entered number divided by 100. So, to set CV to 3.5V (recommended setup for CALB batteries), enter 350.
      2. Number of cells – from 000 to 399
      3. Capacity of cells – from 000 to 399. This parameter used to determine CV cutoff current (set in the code to 0.05C – standard for many LiFePo4 batteries)
   2. After the setup, the charger will give you an option to calibrated its sensors. These are required to get the specified precision of the voltage measurements
      1. Zero-point calibration:
         1. If the output voltage is close to zero when the charger is powered up, the charger will display that voltage and will ask to drain from output.
         2. Measure the output voltage first to ensure there is no high-voltage (>30V) present on the output. Then drain the output and press any button as instructed (you can drain low voltage by just shorting the output).
      2. Sensitivity calibration
         1. Next, charger will ask to connect the battery. OBSERVE POLARITY! Wrong polarity will result in extensive damage to the charger.
         2. Note that it does not have to be the exact battery you will be using the charger with. Ideally, however, it should have voltage close to or above the voltage of the battery that you will be using the charger with (the higher the voltage, the more precise the calibration will be – up to the max rating of the charger).  
            If possible, use a 0.5-10 Ohm power resistor for your first connection to limit inrush current into the output caps (you can use one of the inrush resistors that you can temporarily remove from the AC circuit)
         3. Upon connection of the battery, the charger will detect the presence of a battery and display the voltage it detects (this step will take 5-10 seconds to ensure stability of the readout). Measure the actual battery voltage with a good multi-meter and enter it on prompt.
9. Once you are done with the setup, the charger will enter the runtime countdown (10 sec). If this is the first time you are running the charger, press any button to program output power. You will enter into the runtime configuration menu. Press left (normally red) button to cycle through menu options (‘run’, ‘pwr’, ‘timer’), confirm selections with right (normally green/black) button:
   1. Enter input current. The charger will not allow you to exceed its ratings. WARNING: ensure proper fusing / breaker on your mains power line.
   2. Enter output current.
      1. Maximum possible output current is limited to 40-100A (depending on charger version) and your settings will be capped to that maximum.
      2. However, for a 100A option, use extra caution when charging low voltage batteries (below 100V) - it is recommended not to exceed 80A even with a 100A option
   3. Once power level (if needed) & timeout (if needed) are set, navigate to ‘Run’ menu item and confirm. The charger will display the settings of the charging step for 5 sec and will start. It will stop automatically when the charging is complete, displaying AH delivered. WARNING: to achieve max rated power, ensure adequate access to [reasonably] cool air to the charger’s fans (i.e. do not mount charger near your motor or in open sunlight, etc). Upon completion, the charger will set End-of-Charge wire on BMS dongle to TTL “LOW”.
   4. You can terminate the charge at any time by setting BMS input to TTL “LOW”. You can also terminate the charge by disconnecting input power. Our chargers are protected from both AC mains and battery disconnection during charging
10. Finally, you can now (as of V12 firmware after September 20, 2013) control the charger remotely via a Serial TTL line. **For details, please refer to a** [**separate document**](https://docs.google.com/document/d/1nypFyufYRoCPqEchbHtbwJr0jy9mnf_Ihicz-BpDQR0/edit?usp=sharing)**.**

Thank you again for purchasing a SmartCharge-12000 intelligent open-source charger! We hope you will enjoy the freedom of open source and will contribute to the community by sharing your adjustments to the charger firmware.

Please let us know if you have any questions / suggestions / comments by emailing to charger@emotorwerks.com

Thank you,

Valery Miftakhov

Founder, Electric Motor Werks