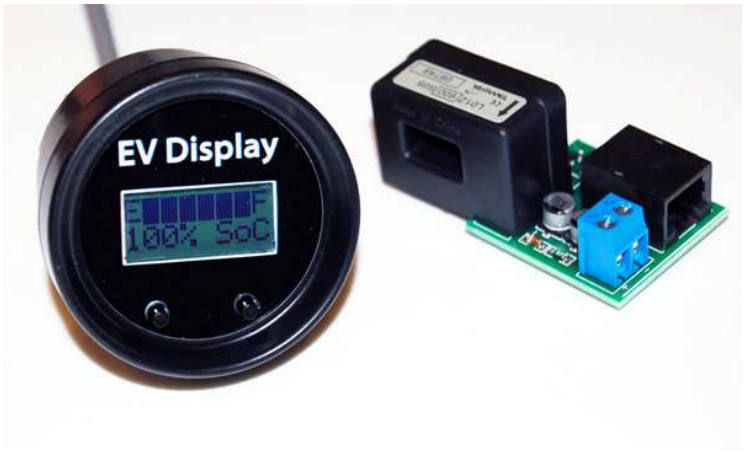
EV Display User Guide



CleanPowerAuto LLC

Brief Description: EV Display is designed to track battery state of charge and other related data in battery powered Electric Vehicle. EV Display is primarily designed for LiFePo4 battery, but can be used with any other battery if properly calibrated. Tracking state of charge requires a reference point when battery is considered full since EV Display can only assume what actual SOC is, based on initial setup parameters. SOC data will only be correct if current reading is correct and reference point is reached on the regular basis. Reference point can be full pack voltage or the fact that amount of full charge taken by the battery is always a little more than amount of discharge, to compensate of battery inefficiency. Display will be more accurate if the battery is fully charged on a regular basis. If battery is always partially charged then EV Display reading may drift long term and will become less reliable. Its recommended to do a full charge at least weekly.

Specifications:

- Nominal power voltage 12V. Exact power voltage should be equivalent of 4 LFP cells, which is 12.8V nominal or 14.4V – 15.2V at the end of full charge cycle, depending on your cell model.
- Power current 30mA without LCD backlight and 60mA with LCD backlight. LCD backlight comes on when any button is pressed and stays on for 60 minutes.
- Hall effect current sensor with the range of -600Amp to +600Amp.

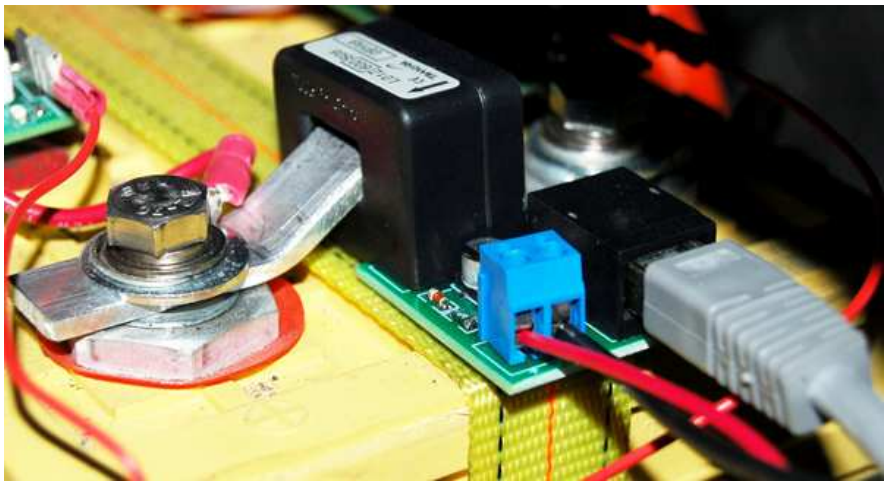
- Sender unit and the Display are connected with standard CAT5e or CAT6 Ethernet cable. 7ft shielded cable is supplied. If you need longer cable, replace with high quality shielded Ethernet cable of appropriate length. Poor cable quality may have negative effect on Display's accuracy.
- Normally Open relay contact pair is available at the back of the display in a form of 0.1" spaced male pins. Relay contacts are not polarized and have 400mA current and 60V voltage limit.

Installation procedure:

Display unit and sender unit are connected via shielded Ethernet cable. 7ft cable was supplied with your display, if you need a longer cable you can buy it from any computer store. Make sure you get CAT5 or CAT6 high quality shielded cable to avoid high noise levels in EV.

Display installs in a standard 2" gauge pod or appropriate size hole in the dash panel.

Sender unit has a Hall Effect sensor and temperature sensor and must be mounted as close as possible to the battery pack to better reflect battery temperature. If you have insulated battery boxes, you should mount sender unit inside the battery box. Battery current must pass thru the hole of the Hall Effect sensor, so you must find a way to fit a bus bar thru the sensor's hole. It's possible to fabricate a custom bus bar to replace the standard bus bar which connects any 2 adjacent cells in your pack. Or you can use a piece of straight copper or aluminum stock between any 2 connection points in your battery loop and thread the hall effect sensor thru that stock. Here is an example of sender unit installed on a custom bus bar between 2 cells.



Selecting a power source for EV Display:

Once the sender unit is installed, connect 12V nominal power to the blue terminal on the sender unit. Watch for correct polarity. You have 3 options to power EV Display:

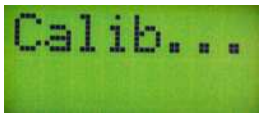
1. You can power the EV Display from aux 12V battery; just find the "always on" source of 12V power since EV Display must be always on. In this scenario the pack voltage and Watts reading

on EV Display will not be accurate, but it can still be calibrated to show correct approximate value for your pack. Since LFP has smaller voltage sag under load, Watts reported by EV Display will be reasonably accurate. This is most simple and most preferred option to power EV Display.

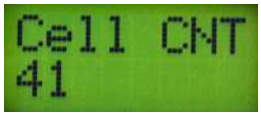
2. You can power EV Display from any 4 adjacent LFP cells in your pack. The downside of this option is that display will draw power from these cells and over a long time period these 4 cells will become imbalanced relative to the rest of your pack. EV Display takes 30mA power current, which is small, but can add up to significant imbalance over several months of use. If you have top balancing BMS, it will counteract such imbalance, but in some cases it may not provide enough balancing to completely recover charge level on those 4 cells at every charge cycle. If you "bottom balance" your pack, or don't balance at all, this power option is not recommended.

3. You can power EV Display from your entire pack voltage, hence avoid misbalancing issues, but you will need a voltage scaler to reduce high pack voltage to 12V nominal voltage. Voltage scaler is optional and is not included with EV Display.

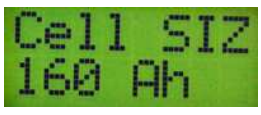
Initial setup procedure: When EV Display is first powered on it will present all configurable parameters, so you can set appropriate values for your EV. Once setup is completed those values are stored in EEPROM so you don't have to reconfigure all values every time EV Display is power cycled. Press Left button to scroll thru the range of values, press Right button to lock the value and move to the next screen. Below is the listing of all setup screens and their descriptions.



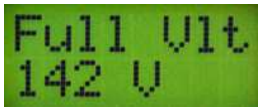
This is initial calibration screen, it takes a few seconds to determine zero current levels, so current sensor can properly distinguish current direction and value. Its critical that EV Display is powered on when there is no current flowing thru the battery pack, its best to completely turn off ignition and make sure the charger is turned off or disconnected from EV. There is no input on this screen, just wait until it's done and it will move to the next screen on its own.



Cell Count. Enter correct number of cells in your pack. Only enter number of cells connected in series. If you have groups of cells connected in parallel and those groups connected in series, then enter number of groups here. Press Left button to change the value, hold the Left button to scroll faster. Valid values are 4-150. Press Right button when done.



Cell Size. Enter the size of your cells in AmpHours. This value changes in increments of 10AH and valid range of 10AH – 500AH. Press Left button to change the value, press Right button to save and move to the next screen.

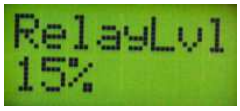


Full Voltage. Enter the pack voltage that represents a fully charged pack immediately at the end of charge. This would typically be CV voltage level of your charger or a few volts less. This is the value at which display will reset the AH counter to Full. The idea is to set it to a level which is consistently reached at the end of charge. This setting only works if EV Display is powered from the main pack, either from 4 cells or via voltage scaler. If the EV Display is powered by 12V aux battery, then you should set this value artificially high, so it won't interfere with display's functions.

Minimum State Of Charge. Enter the SOC level that you want to consider as "Empty Tank". At this level Fuel gauge will show zero percent and the fuel bar will show Empty. This is designed to prolong the battery life and create a safety buffer so you don't get stranded when the actual SOC gets to zero.

Current Direction. Hall effect sensor provided with EV Display has direction arrow for positive current direction. In case you must install the sensor backwards due to limited room around the battery compartment, just set this value to Reverse to tell EV Display which direction is considered positive current.

Temperature Compensation. EV Display sender unit contains a temperature sensor, which helps to gauge battery temperature and compensate available AH count when battery is cold. Please note that this feature is not an exact science and some experimentation is required to find the best value for your EV and your climate zone. Due to sensor location the battery temp is not precisely accurate. If you have insulated battery box, try to locate the sender unit inside to box, to better reflect actual battery temperature. Percentile value represents AH capacity reduction at freezing point 32F (0C). Reduction will be proportionally more at subfreezing temp and proportionally less until it reaches zero compensation at 77F (25C).

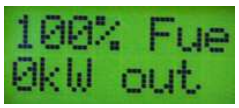


Relay Level. EV Display has Normally Open relay contacts to signal external devices when battery is low. This setting represents the Fuel Gauge level at which relay will close. Please note, this is not actual SOC level, but Fuel Gauge level, which is relative to MinSOC value. For example, if MinSOC is equal 20% and relay level is equal 15%, then relay will close at 35% actual SOC. Relay will open as soon as battery is charged over the set level. EV Display uses opto relay limited to 60V and 400mA commutation circuit. Please carefully design the rest of commutation circuit to avoid relay damage, which will not be covered by warranty. Its best to stay as far away from maximum ratings as possible. Typical commutation circuit should be 12V and under 100mA.

Temperature Unit. Set to either Celsius or Fahrenheit.

EV Display uses high quality hall effect sensors, but there might be a situation when current measured by EV Display does not match the current measured by your ammeter. If you trust your ammeter more, then you can use this setting to scale current measurements as shown by EV Display. Valid range of values is -10% - +10%. For example, if EV Display shows 100Amp current, but your ammeter shows 110Amp, then set this value to +10% to correlate EV Display to your ammeter.

Using EV Display. EV Display has 2 line LCD screen, capable of showing 2 pieces of data independently. Press Left button to scroll thru available data on upper line, press Right button to scroll thru available data on the lower line. Any combination of data is possible on 2 lines. Following list explains all available data counters.



Upper line shows digital Fuel Gauge. Fuel Gauge is relative to MinSOC, it will show zero when actual SOC reaches MinSOC. Lower line shows real time power, which is amps multiplied by volts. NOTE: Power and voltage data may not be accurate if your EV Display is not powered by the same battery which is being monitored. However, even if your display is powered by separate 12V source, you can still configure it to show nominal pack voltage, which would produce approximate power data.

Upper line shows actual State Of Charge. This is set to 100% when battery is fully charged or when EV Display is initially powered on. Lower line shows pack voltage. Pack voltage is calculated based on number of cells in the pack and the voltage from which EV Display is powered. EV Display was designed to be powered by 4 LFP cells, so it measures power voltage, divides by 4 and then multiplies by cell count to get approximate pack voltage. Even if you power display from separate 12V source you can set cell count correctly and calibrate EV Display to show correct nominal pack voltage. You can also use voltage scaler, calibrated to reduce the pack voltage to voltage of 4 cells.

Upper line shows remaining AH in the battery. This value equals the cell size when the AH counter is at 100%. Lower line shows temperature as reported by the sensor located on the sender unit. Temperature units (C or F) depend on the setup value.

Upper line shows remaining kWh in the battery. This value is calculated by multiplying AH counter and pack voltage. NOTE: accuracy of this value depends on how EV Display is

powered. See pack voltage description above for details. Lower line shows real time current in or out of the pack. During charging the current would flow In and during discharge the current will flow Out. If you see reversed direction, then you need to reverse current direction in the setup menu or check installation of your sender unit. When EV is turned off, you should see “0A Out”. If you see non zero value when EV is turned off and you know there is no load on the pack and no charging is going on, then you need to calibrate EV Display to set correct zero current level. Press and hold both Left and Right buttons for 5 seconds to force calibration process, or power cycle the EV Display.

Upper line shows graphical Fuel Gauge bar. Each of 6 bar segments corresponds to approximately 16% of available battery capacity. This bar corresponds to Fuel meter, not to SoC meter, so empty bar will equal to MinSOC level. Lower line is the same as in above paragraph.

Charge Current and Zero Point calibration:

In order to get 100% SOC reading after every full charge cycle you have to make sure that charging current level showing on the display is 1-2 Amp higher than actual charging current. This is required to compensate for charging losses and the fact that hall effect sensor can’t register currents lower than 3 Amps, so the final charging phase will likely show zero amps while charger is still pushing up to 3 Amps into the pack. EV Display software is setup for this compensation, but it may require one or two calibrations to get it right. Take a note of charging current during bulk charge phase using your trusted ammeter and compare with current level showing on EV Display. If EV Display shows less or equal number of amps, turn off the charger, then press and hold both buttons on EV Display for 5 seconds to start calibration. Once calibration is done, turn the charger back on and observe the current reading again. If EV Display shows 1-2 Amps more than actual bulk charge current, then setup is done correctly.

Pack voltage calibration:

EV Display is pre-calibrated to show the pack voltage, which is derived from the voltage level used to power the display, assuming it comes from 4 LFP cells. For example, nominal LFP cell voltage of 3.2V means that 4 cells will have a voltage of 12.8V. So, when EV Display is powered by 12.8V source, it divides that voltage reading by 4 and then multiplies by cell count which is configured in the setup procedure.

For example, if you have 45 cell pack and display is powered by 12.8V, then pack voltage on the display will show (12.8V / 4) * 45 = 144V

If you power your EV Display from aux 12V battery, then you may need to adjust the voltage trimpot on the back of the display unit to show correct nominal pack voltage which would correspond to your aux power voltage, so your display shows accurate Watts and Watthours, which are derived from voltage and amperage.