Energy Management System

--LGEMS03-B1 Instruction

Contents

1. Structure

Ehug Auto_EMS_V3.0 adopts the distributed system structure; A set of EMS is composed of one Central Control Module , several Data Collection Modules, a colorful touch screen a current sensor, an insulation test module(optional) and the related wires.

1.1 System Features

The data collection module of our energy management system is designed to detect the voltage, temperature of the batery pack. It also has the balancing function to raise the constancy of the cells during the charging process. The central control module, however, will receive information sent by the data collection module and analyse the datas to identify the battery errors at the moment and give off the related alarms. The functions of the central control module also include: current detection, the insulation test, charging and discharging control, thermal manangent system control, SOC estimation and battery evaluation. Also EMS has strong comunication function. When the vehicle is moving, the EMS can realize communition with the charger and the motor controller through CAN BUS. The energy management system can provide the SOC in real-time and provide the maximum allowed discharging current to optimize the use of the battery's energy. There is also communication between BMS and the display unit. This will display the detailed information of the battery in real-time. Whenever there is any problem with the EMS and the charger, the system will send alarms to remind the driver. When charging, the charger, as a joint on the CAN BUS, will abstract the statistics sent by the central contral module and change the parameters in real-time to protect the battery from being over chargerd and over discharged.

1.2 System wiring display

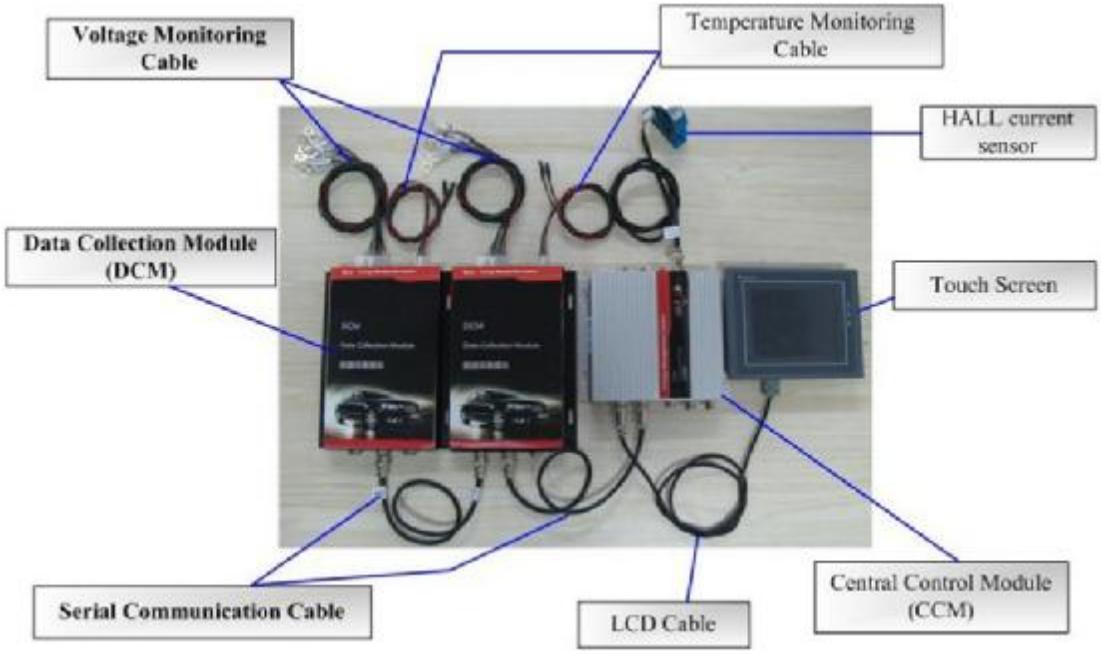


Fig1 system wiring

1.3 Central Control Module

Size：190mm×158mm×46mm

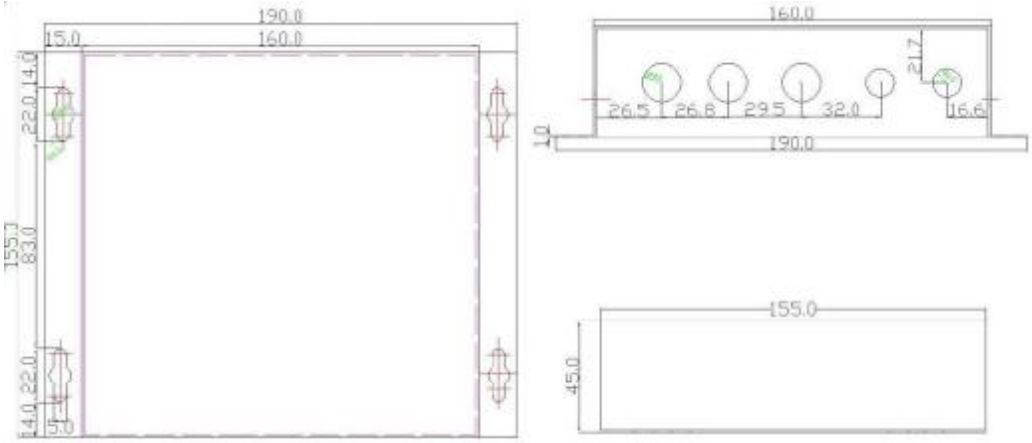


Fig2 Size of the central control module

Function：

(1)SOC estiamtion：What we have for SOC estimation is the latest Joint EKF algorithm, which is able to estimate the SOC dynamically by integrating the load voltage and the current integral values. The accuracy is 8-10%

(2) Current detection: detecting the current during the discharging process through the Hall current sensor.

(3)CAN BUS communication: there are CAN BUS interfaces on the central control module. They are used to communicate with the ECU or any other CAN BUS transmit-receive unit. The CAN BUS will transmit the total voltage , toatal current of the battery to these units.

(4)Display and alarm: the information of the battery, such as voltage , current, temperature ,SOC, insulation error, charging error will be displayed on the LCD. When there is an error, the buzzer will send alarms to the user and at the same time, the specific error type will be displayed on the LCD

(5)communicate with the PC software：The EMS is able to communicate with the PC software through the 485 interface. The information of the battery pack will be recorded in real-time. This will make it easier for the users to anyliaze the datas concerning the battery pack.

(6) System self-test: EMS is equipped with the self-test function. After the system is powered on, it will start to test the voltage, temperature, communication and memory units to endure a normal system operation.

Interface illustration:

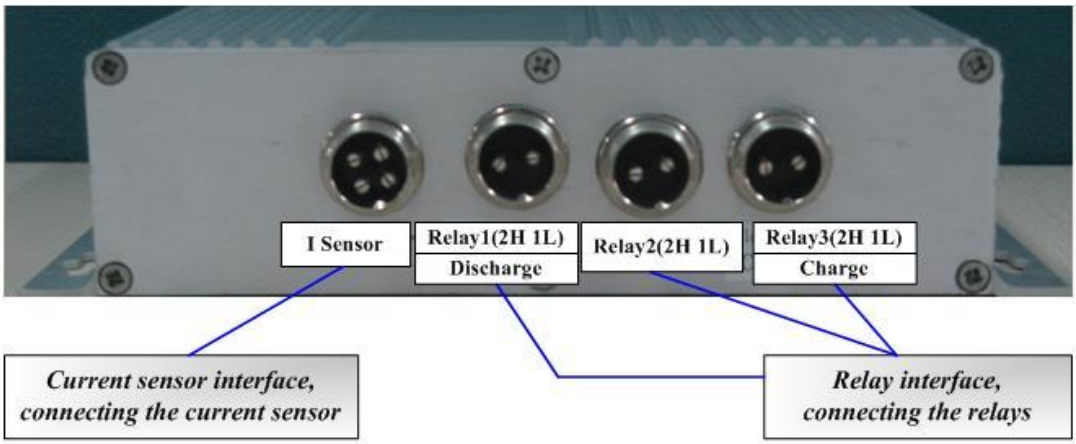


Fig3 the front side of the CCM

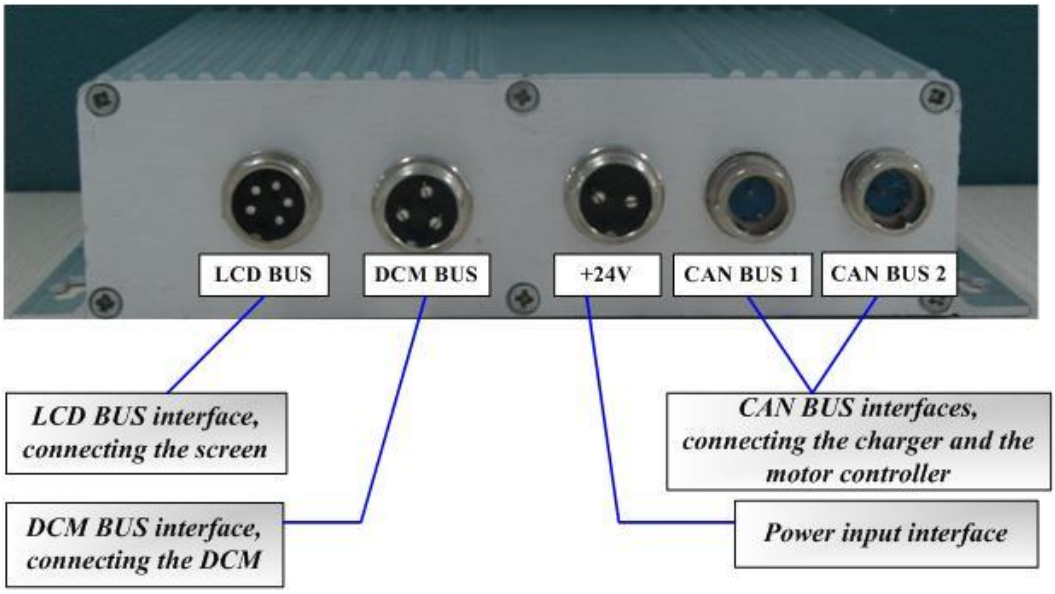


Fig4 the back side of the CCM

1.4 Data Collection Module

Size：225mm×170mm×25mm

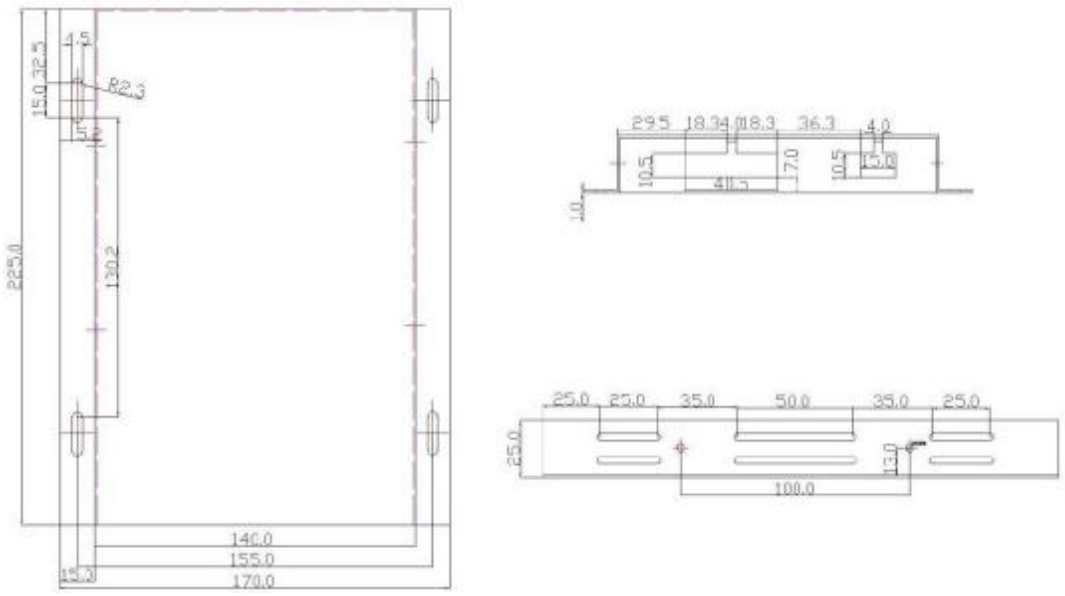


Fig5 Size of the data collection module

DCM should be connected with the battery pack. It is attached with the temperature sensors（each DCM has two or more temperature sensors） to detect the temperature of the battery. Usually a whole set of EMS needs several DCMs, The number of the single cell voltage monitored varies from 5 to 16 with the difference of the cell numbers in the battery pack. The data collection module also has the balancing function. When the voltage of a single cell reaches, for example, 3.4V, and the differnce between cells is 20mv to 800mv, the balancing function will automatically start. Each data collection module is able to balance three cells at a time. DCM needs to be provided with the outer power source of 12V (9V~18V) to activate, so that it can work to detect such information as the voltage of the battery and temperature of the battery pack, and then transmit these information to CCM through the Serial Communication Bus.

Function：

Single voltege detection: we can achieve the effect of detecting the single voltage in real-time by isolating and magnifying the in-series single voltage. Detection period of single voltage is 200ms, range of voltage detection is 0~5V, accuracy of detection is ±5mV.

Pack temperature detection: We set 2~8 temperature detectors in each battery pack, range of detection is-40℃~125℃, accuracy of detection is ±0.5℃.

RS 485 or CAN communication: We can send single voltage, pack temperature, charging failure information to CCM through the 485 BUS or CAN BUS.

Balanced charging: When the voltage of a single cell is higher than 3.4V and the voltage discrepancy is a value between 20mv and 800mv, the balancing function will start automatically. The balancing current can be 1 A, and the DCM can balance three

cells at a time. The balancing function will help to raise the consistancy of the cells in a batetry pack.

Interface Instruction:

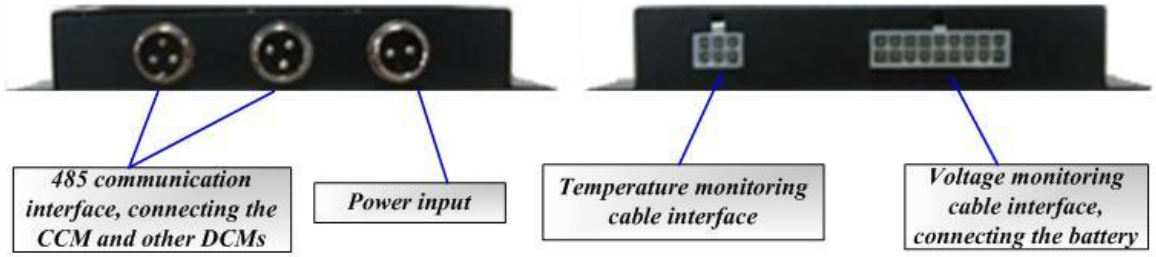


Fig6 Interfaces of the DCM

1.5. Insulation Test Module

Size: 165mm×120mm×25mm

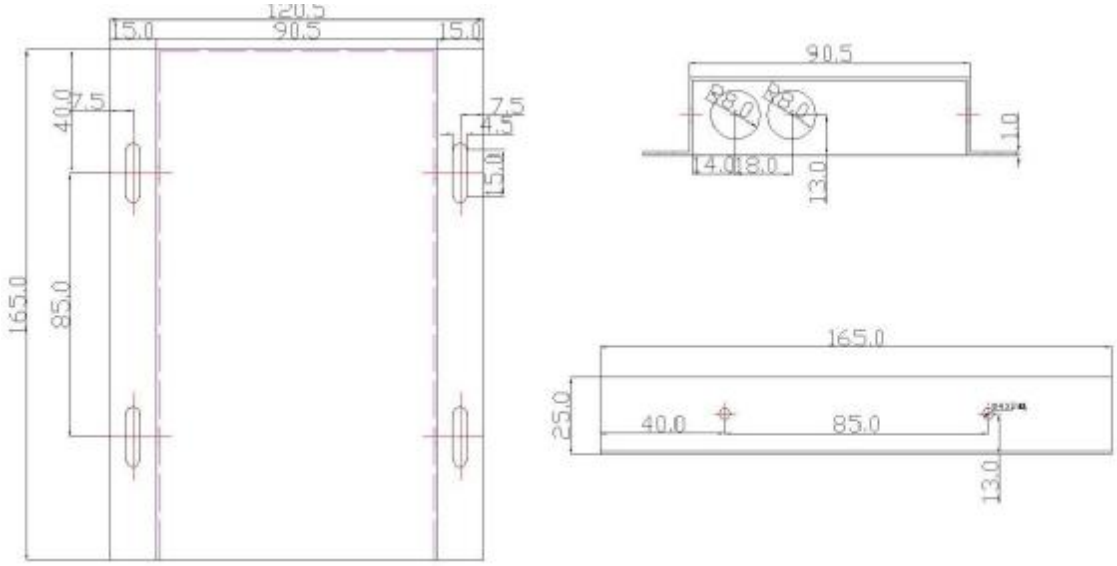


Fig7 Size of the insulation test module

Function:

The indulation test module is designed to test whether the battery has electric leakage to the vehicle. The module is directly connected with the datacollection module, and indirectly connected with the central control module. the central control module will give orders to the insulation test module, which will detect the leakage state and send the data back to the central control module,and as the central control module is connected with the screen, the screen will display the insulation state.

Interface Illustration:

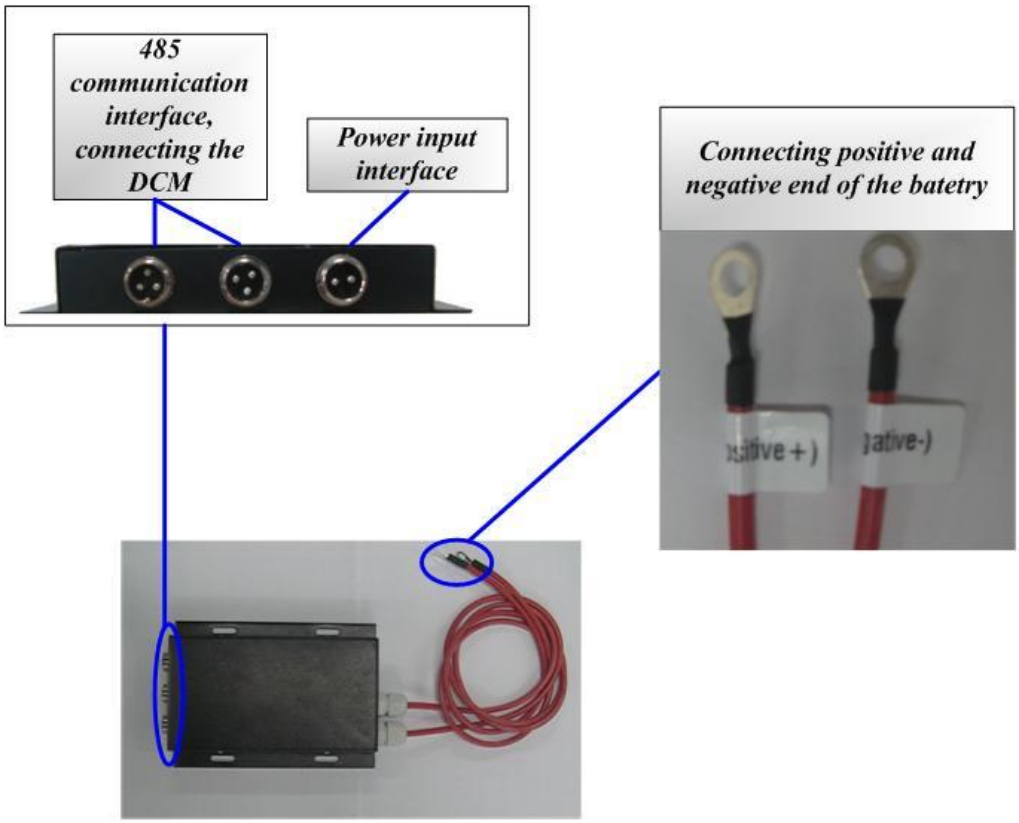


Fig8 Insulation Test Moudle

1.6 Touch Screen

Size:

5.7Inches: 172mm×140mm×60mm

3.5Inches： 96mm×81mm×46mm

Interface Illustration：

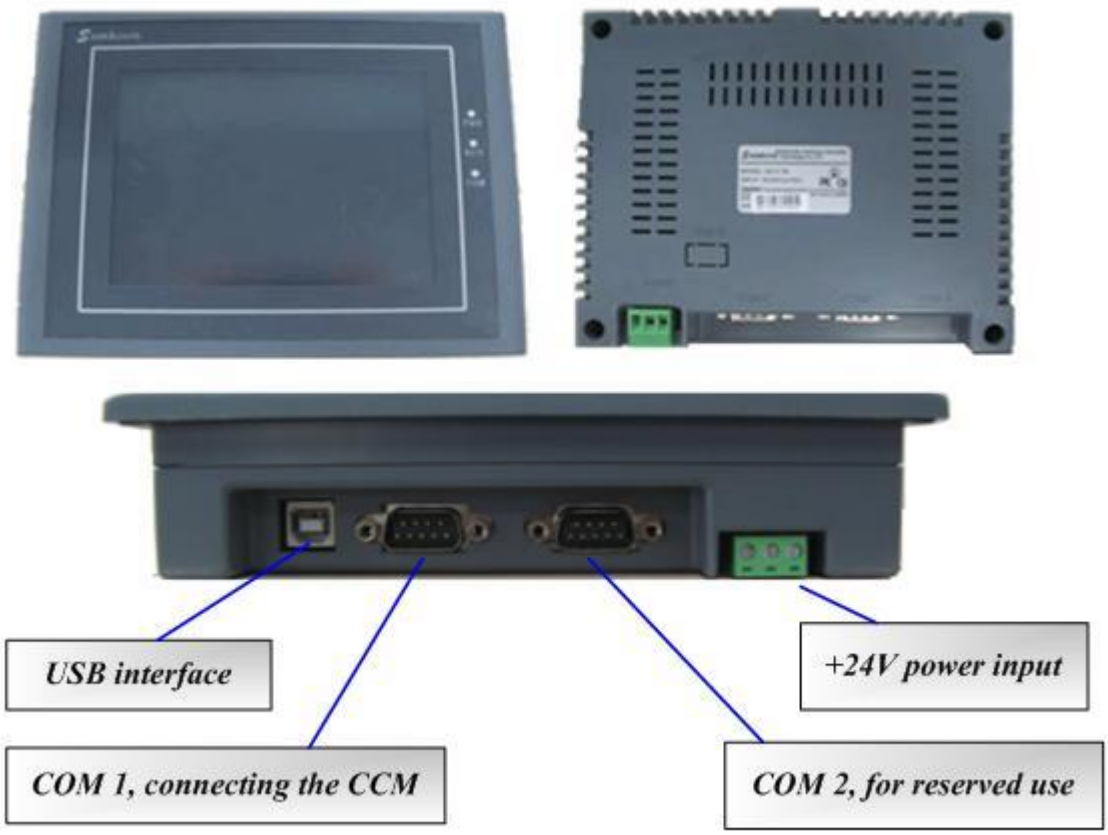


Fig9 Inerfaces of the touch screen

The touch screen is composed of the displaying area, indicator lights， power source，and the communication interface. Touch screen of all models adopt the standard industrial design. They are anti-dust, and are very suitable for the factory environment. The front side of the screen is equipped with indicator lights, which are applied to identify errors. The power source and the communication interface lie at the bottom of the device. The COM interfaces are the communication interface between CCM and the touch screen. Usually we only use the COM 1 interface.

Operation state indication：

The operation indicator lights of the touch screen include “PWR”, “RUN”, and “COM”, as is illustrated in the above picture. When the power is on, the “PWR” LED is constant ON; the “RUN” light is ever bright green. When the CPU operates normally, the “RUN” light appears to be ever bright yellow. Otherwise, when the CPU runs into some problems, the “RUN” light is gray. The “COM” light is flickering yellow once connected with the CCM of EMS.

Equipment condition	Green LED(PWR）	Yellow LED (RUN)	Yellow LED (COM)
No power	○	○	○
Power on	●		
CPU normally operates	●	●	
Communicating with connecting equipments	●	●	※
○ LED ON ● LED OFF ※ LED FLICKER			

Fig10 Indicator lights and state explanation

1.7 Current Sensor

Size: see the following picture

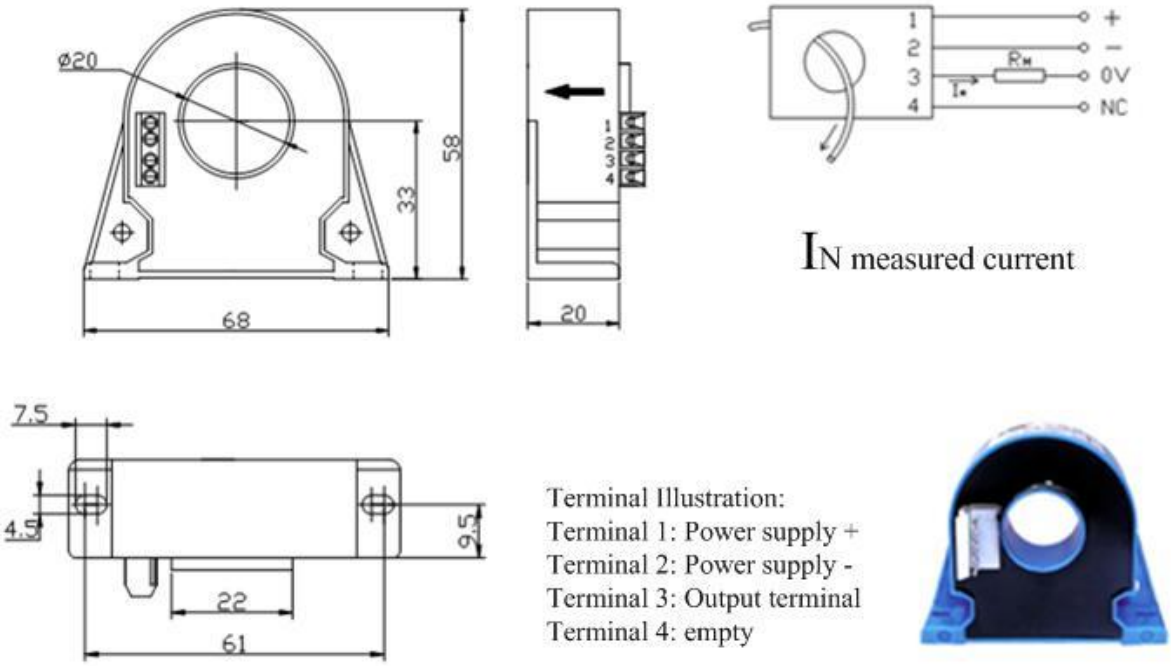


Fig11 Size and illustration of the current sensor

The current sensor of our EMS is the HALL open loop current sensor. The maximum current range can reach 1000A. It can be connected to either the “+” end or the “—”end of the battery pack’s output. The pictures below will give you a clear manifestation of the two ways of connections. (Pay attention to the direction of the

arrowhead above the current sensor.)

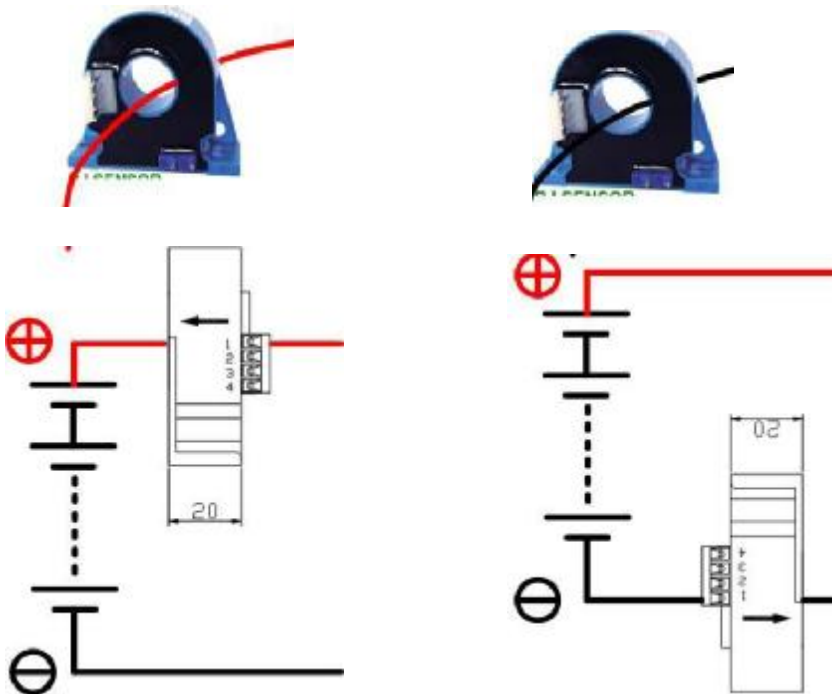


Fig12 current sensor connection method

1.8 Wires

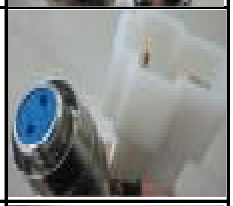
Pictures	Name	Usage	Port
	CAN BUS 1	connecting the charger	
	CAN BUS 2	connecting the motor controller	
	LCD Cable	using CCM to provide power for the touch screen and commmunicate with the screen	
	+12V power line(Blue"+", Black"-")	using CCM to provide power for DCM	
	Temperature Sensor(with two temperature detectors)	detecting the temperature of the battery pack	
	Voltage Monitoring Cable	connecting the battery with DCM	
	Connecting Cable of the Current Sensor(with a 4pin plug)	connecting CCM and the current sensor	
	Serial Communication Cable(with a 3pin plug on each side)	connecting CCM and DCM or connecting DCMs	

Chart 1 Illustration of the wires

2. System parameters cofiguration and application

2.1 Technical specifications

Accuracy of single voltage detection……±5mV
Accuracy of total voltage detection…… < 1‰
Accuracy of current detection……±0.5A
Accuracy of SOC estimation……≤8%
Accuracy of temperature detection……±1℃
Accuracy of insulation resistance detection……10K
Balancing current……0.6A-0.8A
Voltage detection delay……＜100ms
Operation power input……12V or 24V
Operation
Temperature……-45℃~85℃
Storage temperature……-45℃~110℃

2.2 Configuration parameters

Total capacity of the battery pack: The maximum energy the battery can release after fully charged. Usually we use the nominal capacity to do the initiation setting.

SOC: The battery's State-of-Charge at the present time. It can be set according to the parameters provided by the battery manufacturers.

Digital calibration of the current sensor: Under the circumstance of system default, the current is 0.0A. If the number read from the screen is x.xA when the system stops running (with no charging or discharging), then the number can be adjusted to 0A through digital calibration. The range of calibration is from -20.0A to 20.0A.

For example：When the system stops, the number on the screen is 0.8A; you can put the 0.8A in the "Current Cal" item, and then the current will be calibrated to 0.0A. (Before the calibration, you should first set the current calibration value as 0.0A)

The maximum charging current: If the chosen charger has the CAN communication protocol, then you can set a limit on the maximum charging current. If there is no such special illustration, then the maximum charging current can range from 1.0A to 0.3C(C stands for the total capacity of the battery pack)

The over charging protection voltage: single cell voltage may have potential safety problems when overcharged, so the charger output must be closed when the charging is done. Regarding the Lithium iron phosphate battery, the overcharging protection range is 3.65V~3.95V.

The overcharging release voltage: In order to protect the charger, you cannot restart the charger to charge the battery immediately when the charger output has been closed. As a result, we need to set a threshold value. Only when the maximum voltage

of single battery falls back to the threshold value, can the charger be restarted. (EMS reset is an exception; the charger can be restarted immediately after the reset.) For the Lithium iron phosphate battery, the release voltage ranges from 3.2V to 3.65V

Under-voltage alarm voltage: When the battery discharges in a very high rate, the consuming speed of the battery capacity will probably quicken. So users should try not to discharge the battery in a high rate. By setting the under-voltage alarm voltage, we can somehow remind users to use the battery in the right way. If the battery is always in the situation of under-voltage alarm when it's discharging in a low rate that means it needs charging. The range of the under-voltage alarm voltage of the Lithium iron phosphate battery is 2.65V~3.1V.

Under-voltage release voltage: To the Lithium iron phosphate battery, the range starts from the under-voltage alarm voltage and the maximum range is 3.3V.

Over discharging protection voltage: The over discharging of the battery will shorten its life span. Thus under the circumstance of over discharging, you must stop using the battery and charge it. The over-discharging protection voltage of the Lithium iron phosphate battery ranges from 2.45V to "the under-voltage alarm voltage -0.05V".

Over discharging release voltage: The release voltage ranges from "the over discharging protection voltage + 0.05V" to "the under-voltage alarm voltage -0.01V".

Overheat protection temperature: When the temperature of the battery is higher than this number, then you have to use the battery mildly or just stop using it straightforwardly. The setting range is from 50℃ to 90℃. Users should first consult the battery manufacturer.

Over heat release temperature: The available temperature is between 20℃and the "overheat protection temperature -10℃"..

2.3 EMS congiguration

EMS configuration is based on some corresponding authorities. We have set some limitations on General Users and Super Users when the system initializes, in order to protect the stability of the system. EMS configuration is only available for users who have an authority over 8. When lower level users enter this interface, the system will remind you to fill in the right password. After you have fill in the right password, you will get switched to the following page, please handle this cautiously to avoid system collapse. (EMS configuration needs certain time lag) If there is any communication signal interruption during the process, don't worry, just wait for a while. Try not to reset the parameters of the EMS when it's not necessary, because the power-fail during the configuration process will make the whole system unavailable.

To estimate the function of the battery in a relatively accurate way, you need to configure the EMS when the first time the system operates. The configuration includes

the total capacity of the battery pack (the nominal capacity), the SOC at the present state, digital calibration of the current sensor, charging current of the charger, the overcharging voltage, the overcharging release voltage, the under voltage, the under voltage release voltage, the over discharging voltage, the over discharging release voltage, the overheat temperature and the overheat release temperature of the single cell

Configuration Steps:

Step 1: connect the screen and the charger, the following interface will appear:

Fig13 main page of the screen

① The five signals () only appear when problems occur.

② The touch screen displays the current, voltage and the SOC of the battery. It's accurate and can update in real-time. And at the same time, it can display the maximum voltage, maximum current, maximum temperature of each single battery module, and the cycle times of the charging and discharging of the battery.

Step 2: Click the button "Menu"→ "Config", input the password "8888", and then get into the configuration interface.

Fig14 menu

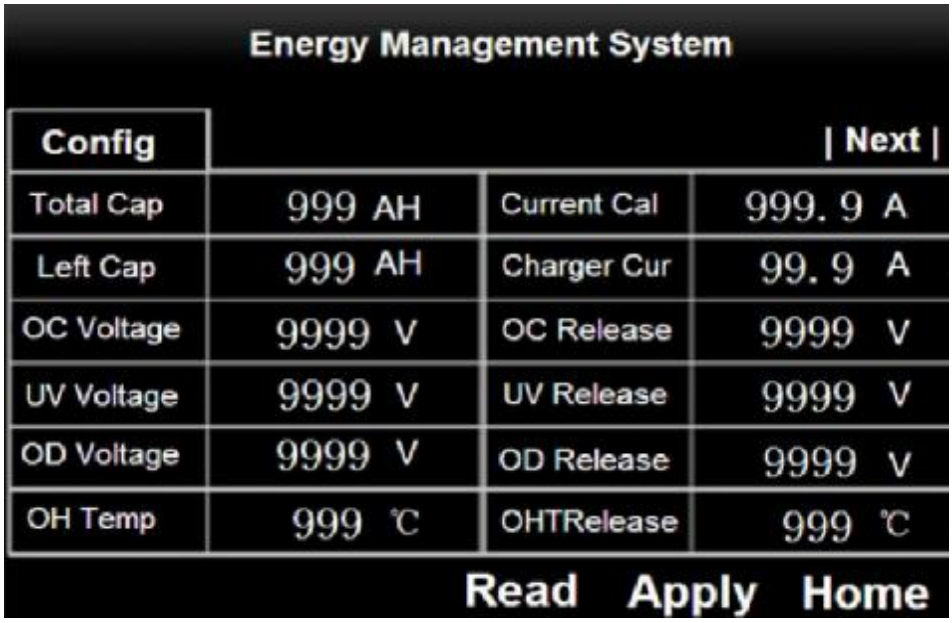


Fig15 configuration interface

Step 3: After the system initiates, the data you get from the interface is the data suggested by EMS. The actual EMS parameters can only be obtained by clicking the "Read"button. So please first read the EMS parameters before setting them.

Step 4: Start the initialization settings according to the actual parameters of the battery.

Step 5: Write the configuration numbers into EMS, click the button "Apply",

and stop all the operations. Wait about 10 seconds till the indicator light "COM" flickers normally. This means that the setting is done.

Step 6: Check whether the setting is successfully done. Push the button "Read", if the information displayed is exactly the same as what you have set, that means the whole process has succeed, or you have to repeat from step 4 to step 6.

Through the menu interface, we can enter other separate interfaces, click the button "Boxinfo",and information of the charger will be displayed in the following interface:

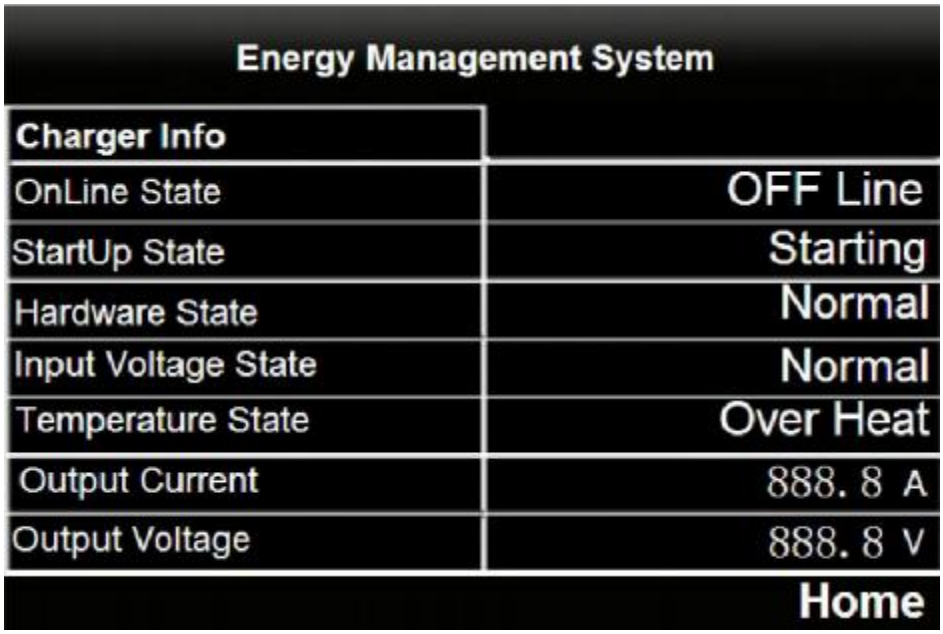


Fig16 charger information

Click the "Home" button and get back to the main page. Information of each single cell is as follows, just click "Boxinfo".

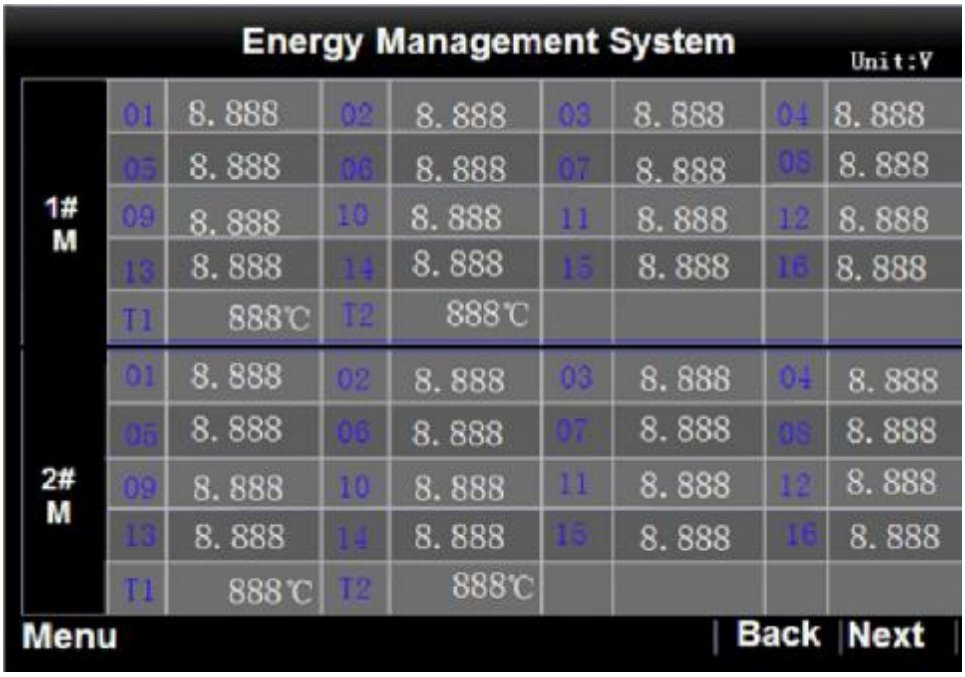


Fig17 Information of the single cells

You can get a panoramic view of the voltage and temperature of the 16s battery. The "Back" and "Next" buttons enable you to switch smoothly between modules.

Charging control explanation:

EMS can charge the battery by controlling the intelligent charger through the CAN communication cable.

The charging process of the charger is divided into three periods: pre-charge period, constant-current charge period, and constant-voltage charge period. EMS can only control the constant-current charge period and the constant- voltage charge period.

The current during the constant-current period can be set by setting the "Charger Cur" on the configuration interface. The range of the charging current varies from 1A to 0.3C. If the nominal current of the charger is less than the configured charging current, the actual current output of the charger during the constant-current charge period is the nominal current of the charger.

For Lithium iron phosphate battery, the process of EMS controlling the charger is below:

Step 1: After the broadcast message of the charger is detected, start the charger immediately. When the pre-charge stage is over, enter step 2.

Step 2: The constant-current charge period. The current in this stage is the minimum number between the configured current and the nominal current of the battery.

Having enough power supply, the maximum charging current can be set as the nominal current.

Step 3: If the maximum voltage of the single cell is higher than 3.65V, EMS will automatically adjust the charging current in order to avoid the single cell voltage rising to the over charging voltage.

Step 4: When the single cell voltage changes into over charging voltage, EMS will send controlling signals through the CAN Bus and turn off the charger.

Step 5: When the maximum single voltage fall back under the over charging release voltage, EMS will send controlling signals via the CAN Bus and restart the charger.

Related configuration parameters: **maximum charging current** (current during the constant-current charge stage), **over charging protection voltage**, **over charging release voltage.**

3. Trouble Resolution

Phenomenon	Reason	Measure
System can't start	wrong operation voltage	make sure the voltage is 12V or 24V
	the cathode and anode got reversed	check the power input port and make sure In"+",out"-" or 1"+",2"-"
Buzzer alarm	voltage overcharged or over discharged	check whether the voltage of the cell is between 2.5V~3.4V
	communication interrupt	check the communication port
No display of CCM	no voltage	check whether the power input port is well connected
The voltage of CCM is "0"	communication interrupt	check whether the communication port is well connected
The maximum temperature displayed is"-40℃	the temperature sensor has not been connected in the right way	check the connection status of the temperature sensor
The screen displays "charge" when the battery is discharging	the current sensor has been reversely connected	See 1.7 "current sensor and its installation instruction"
Wrong current display	current sensor is not connected	check and connect the current sensor
	the "Current Cal" hasn't been set	see 2.3 "EMS configuration"
Black screen	No power suply	Check the power suuply of the CCM,check whether the wire between the CCM and the touch screen is well connected
Wrong battery capacity	The current sensor is reverly connected	Transfer the direction of the current sensor and the problem will disappear

Chart 2 Problem resolution

4. Attentions

(1) EHUG EMS is water-proof, but it cannot be soaked in the water for a long time, or the inside components will be damaged, and that will affect the lifespan of the system.

(2) Our EMS has strict requirements on the power suppy, any vibrance on the power supply source should be avoided.

(3) The touch screen should be put in the shadow and avoid direct sunshine, or the

numbers won’t be read clearly. Don’t touch the screen with any sharp instruments.

(4) Please install the system according to the instruction in the right way to ensure a normal and stable operation of the system.

(5) Please take care of the wires when installing and disassembling the system, in order to avoid communication failure caused by wire damage.

(6) Please set the parameters in the right way to ensure the accuracy of the numbers. And do not change the set parameters when it’s not necessary.

Notes: Please contact us when there is any problem, try not to open the modules without any assitance.