Integrated Battery Management System

User Manual

BI51 TYPE

BI5116/BI5132/BI5148

Changsha Deligreen Electronics Co.,Ltd.

Contents

TERMS :

BIU	Battery Integrated-management Unit
BCU	Battery Control Unit
BMU	Battery Module-management Unit
CSU	Current Sample Unit
PDU	Power Distribution Unit (Also known as Strong Electric Control Unit and High Voltage Box)
HSD	High Side Drive
LSD	Low Side Drive
NTC	Negative Temperature Coefficient
SOC	State of Charge
SOH	State of Health
CAN	Controller Area Network
CHG	Charging Interface
RL	Relay
HV	High Voltage
CAN0	BMS Debugging/ Internal communication
CAN1	BMS communicate with VCU/MCU
CAN2	BMS communicate with charger

Document Description

Thanks for choosing JDI Battery Management System（BMS）; this manual introduced how to use the BMS, which has to be read carefully before installing, operating and maintaining.

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The BMS is a custom product. Client's requirements and system information are necessary.JDI will not be responsible for any injury or damage caused by incorrect information.

The features and functions of the product and accessories described in this manual depend on the product's application environment and user's needs, which may not completely corresponding with this manual.

Chapter 1 Product Applications

BMS is an important part of EV system. Adopting automobile grade components, JDI BI series can be well extended and widely applied to pure electric and hybrid vehicle, which not only can detect, manage, control the batteries in single box, but also can be extended through BMU to manage batteries in several boxes. The series fully meet the systematization management requirement of the automotive-grade power battery pack. The series is suitable for LiCoMnNiO2, LiFePO4,Ni-MH, super capacitor and other 0~5v cell.

The product is composed by a Battery Integrated-management Unit (BIU), a display, a current sensor/diverter, and cables. The series include BI5116, BI5132 and BI5148. Each BIU can collect and manage 16/32/48 cells, and can be extended to manage 160 cells at most. The system acquires real-time battery information through Daisy Chain Topology (DCT). BIU communicates with VCU, intelligent charger, instrument and other device through CAN-bus. The display shows the real-time information of state, power, SOC etc.VCU controls the motor through intelligent motor controller after reading BMS information. BIU can also communicate with intelligent charger and charge pile. There are temperature measurement of charging interface, CC, CP, CP2 and other required functions
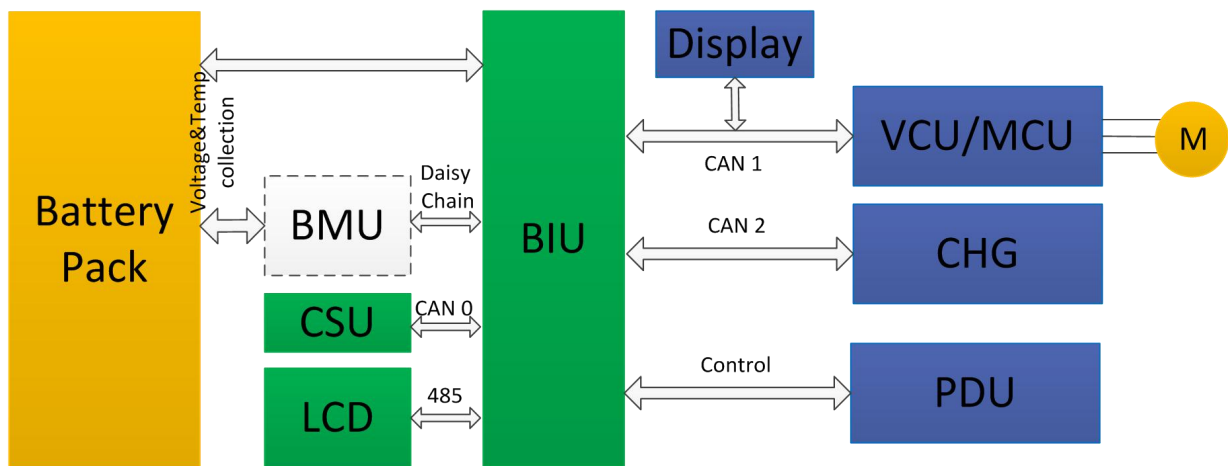

Figure 1 System topology

BI5116/BI5132/BI5148

Figure 2 Appearance and Application examples

Chapter 2 Product Manual

1. Foreword

1.1 First installation guide

1.1.1 Open-package checking

Please check all components according to the packing list to confirm the quantity and specification. Please confirm the surface of modules, cables and accessories well.

1.1.2 Safety confirmation

Please read the manual in detail, and prepare the instruments and installation environment accordingly.

1.1.3 Environment confirmation

Please read the operating environment in detail. If the environment not suitable to your requirements, please contact our service staff to get support.

1.1.4 Function Confirmation

Please read the system overview in detail to understand the function and interface of modules, cables and accessories

1.1.5 Components Installation

Please read the installation guide carefully, installing the module after confirming the station of hardware(please installing nearby, hardware would be installed near the batteries, charger or motor controller).

*Notice: The fastening degree of hardware installation needs to meet the vibration and impact demand of the application.

1.1.6 Cables installation

Please follow these steps to install the wire harness,

a) Communication cables, control cables, temperature cables connection, ensure to cut off the power of both high and low voltage circuit, connecting the module communication cables, control cables (relay, switch signal, CAN-bus of charge& discharge), temperature sensor cables and current sensor cables

b) Voltage collection cables connection, connect the voltage collection cables to cells orderly according to the system diagram and labels. After confirming all cables connected with correct order(very important), please connect the other side to module

c) Insulation detection cables, high voltage detection cables connection (optional accessories), connect the cables of insulation detection, high voltage detection and divider, and connect the other side after confirm all cables connected correctly

d) After all of the cables connected, please check each cable according to the system diagram to ensure all cables connected correctly and reliably.

*Notice:

✧ All connectors should be locked before connecting the detection cables

✧ Check the insulation of connectors; avoid conductive impurity such as water, dust, or metal particles.

✧ Ensure to cut off the power of high and low voltage circuits before all cables connected correctly

1.1.7 Adjusting confirmation

After all of the components connected correctly, BMS could connect to power. Observing the display information and relay state, if error happens, please check whether the module and cables connected correctly or not. If connected correctly, please contact our service staff to get support.

1.1.8 Power-on test

After confirming the function, please perform a charge-discharge experiment, observing the system operation condition, if errors happened please record, the system operates normally if no error.

1.2 Safety Notice

1.2.1 Danger level

For your safety, please read this part carefully, the danger level as below:

Danger level	
⚠ Caution	There may be unexpected results or property loss if ignore the notice or not take corresponding measures.
⚠ Carefully	Personal injury or a lot property loss may be caused if not carefully.
⚠ Danger	Serious injuries or death may occur if not carefully.

1.2.2 Reminders

Before installation	
⚠	Check if there is shortage of components, hardware or cables damage when open boxes, please don't install if any of above happened.
⚠	Check for water on the box, please don't install if water inflow.
⚠	Handle gently when unpacking and moving, otherwise equipments may be damaged.

Installation	
⚠	✧ To avoid system error, please stay away from water, dust and strong electromagnetic environment. ✧ To avoid accidents, the operator must be an electric engineer. ✧ The system is used for monitoring and managing battery pack. Please notice the usage.
⚠	✧ Please check voltage of power supply, the range of system working voltage is 9~32V ✧ To avoid system failure, please install the cables strictly in accordance with the order of batteries. ✧ To avoid system damage, please check and ensure the cables installed in correct order.
⚠	✧ To avoid accidents, power supply should be shut down during installation. ✧ To avoid serious accidents, please use insulating tools or insulate the tolls. ✧ Please focus on checking voltage collecting cables to make sure there is no damage at any cable or connector loosen. ✧ To avoid battery pack serious damage and fire, please ensure the relay cables installed correctly.

Operation	

| | ✧ To avoid personal injure and system damage, unauthorized person cannot test the signal during the system operating. |
| | ✧ To avoid serious accidents, please protect the system from water-drop, dust or other particle. |

	✧ To avoid personal injure, unauthorized person cannot repair or maintain the system. ✧ To avoid accidents, please do not repair or maintain when system power on.
	✧ To avoid system damage, non-authorized person cannot breake the module box. ✧ There are lots of high accuracy device, please prevent from static electric. Do not touch.
	✧ To avoid serious accidents, unauthorized changing of the system is forbidden.

1.3 Operating environment

1.3.1 Environmental parameters

Table 1 Parameters of operating environment

Item	Min	Max	Unit	Remark
Environment parameters				
Operating temperature	-30	85	℃	\
Storage temperature	-40	125	℃	\
Altitude	\	4000	m	\
Humidity	\	95	%RH	No droplet
Atmosphere pressure	57	101	kPa	\
Salt spray(Continued atomization time)	\	16	h	\
Mechanical parameters				
Vibration(Amplitude or acceleration)	\	30	m/S^2	Amplitude 1.2mm when 10~25Hz; Max 30 m/S2when26~500Hz
Drop(height)	\	1.5	m	Horizontal vertical direction
Impact(acceleration)	\	150	m/S^2	Adopting half sin shock wave
Dustproof& Waterproof (IP degree)	\	54	\	GB 4208

Electric environment				
Supply voltage	9	18	V	Direct current, typical value:12v
Detection range of total voltage	9	400	V	\
Detection range of single cell voltage	0	5	V	\
Detection range of current	-500	500	A	\
Series of battery	4	160	cell	Each board collects 16/32/48 cell at most, cascade extension is supported.

2. System overview

2.1 System components

Table 2 Components List

Item	Number	Function
BIU	Necessary, 1pce	Internal communication; External communication; State estimate; Safety management; Charge&discharge management; Input control; Output control; Total voltage detection; Insulation detection; Single cell voltage collection; Temperature collection
CSU	Necessary, 1pce	Current collection, hall current sensor and diverter are supported
Cables	Necessary, 1set	Voltage detection; Temperature detection; Communicating connection; Power connection; Sensor connection; Control connection
Optional components		
BMU	Max≤10 pcs	Cell voltage collection; temperature collection, DCT communication; suitable for numbers of batteries in several separated boxes
LCD	Optional, 1pce	Data display; Parameter configuration; Failure warning
DTU	Optional, 1pce	Data remote upload; Data remote download; Mobile application
PDU	Optional, 1set	Pre-charge circuit; Charging relay; Discharging relay, Main circuit over-current protection; Other power protector of the vehicle

2.2 System Structure
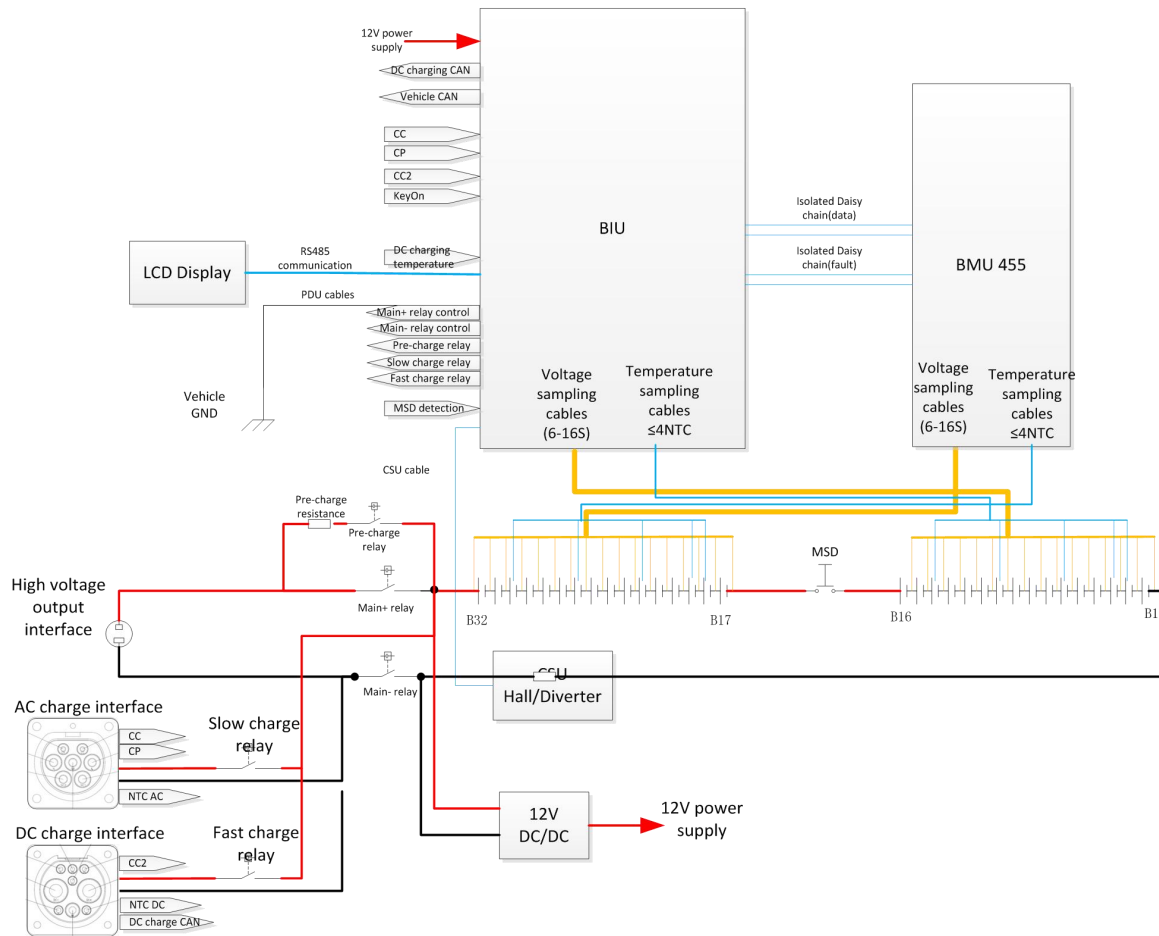
Figure 3 System wiring diagram

Notice: BIU have to be installed into the negative side of battery pack when using BIU +BMU combination. e.g: when using BI5116+BM5116 to collect a 32 cells pack, the cell of total negative is B1,the cell of total positive is B32.Then BI5116 should collect B1~B16,and BM5116 should collect B17~B32.It's very important to connect correctly, or the total voltage and insulation detection will be influenced.

2.3 System parameters

Table 3 System parameters

Parameter	Min	Typical	Max	Unit	Description
Detection range of total voltage	12	\	600	V	12~300V, rated voltage of battery pack
Detection accuracy of total voltage	\	\	\	%	≤0.2%
Total voltage detection channel	\	\	2	\	Two channels of relay could be used at same time.
Series of battery	4	\	160	S	BIU can collect 48s at most; BMU qty can be extended to 10.units.

Detection range of single cell voltage	0	\	5	V	\
Detection accuracy of single cell	\	\	\	%	≤0.2%，±5mV error
Current detection range	-500	\	500	A	Hall current sensor
Current detection error	0	0.5	3	A	≤0.5%FSR，typical value 0.5A
Temperature detection channel	\	4	\	\	There are 4 temperature sensors in every 16 cells.
Temperature detection range	-40		125	℃	\
Temperature detection accuracy	0	1	2	℃	NTC ,100K
Detection error Insulation resistance	0	10KΩ	10%	KΩ	0～200KΩ，error＜10KΩ；>200KΩ，error≤±10%
Balance current	\	50	120	mA	\
Min voltage difference of starting balance	30	50	800	mV	Configurable
CAN-bus channel	\	\	3	\	Charger/Vehicle/BIU&BMU, CAN2.0B
Serial port	\	\	1	\	Could be used to program software and connect display
Relay output channel	\	\	4	\	Active, continuous current 1A, instantaneous 5A
Input channel number	\	\	4	\	Input signal, such as: active High、 ACC、ON、Charging awaken
Charging connect confirmation	\	\	3	\	CC2,CC,CP
Max cascade of BIU and BMU	0	\	10	\	\
SOC estimation error	0	3%	5%	\	SOC≤20%，SOC≥80%:3%; 80%>SOC>20%:5%
SOH estimation accuracy	0	5%	10%	\	SOH>80%，error within 5%;SOH≤80%，error within 10%

2.4 Technical feature

(1) SPI Daisy chain topology structure

BIU and BMU connected by Daisy chain topology. They can collect information of 16~48(BIU collection number)+16(or 32 or 48)*n（n=BMU number）cells.

(2) Single cell voltage collection

BIU and BMU collect single cell voltage through voltage collecting module。

(3) Temperature collection

BIU and BMU collect each battery module temperature through NTC temperature modules.

(4)PACK total voltage detection

BIU can detect the total voltage of battery pack.

(5)CAN- bus communication

Each BMCU is equipped 3 ways of CAN-bus

CAN0: used for communicating with CSU and acquiring real-time total current

CAN1: used for communicating with charger.

CAN2: used for communicating with VCU/MCU, receiving order and status information from VCU/MCU.

(6)RS485 communication

External display shows SOC, voltage, current through RS485 communication. RS 485 communication can also be used to update the program.

(7)SOC，SOH、 SOP calculation

BIU calculates SOC,SOH and SOP on the basis of total current, total voltage, temperature and other parameters.

(8) State of battery capacity

BIU calculates residual capacity, and shows it on LCD display/vehicle instrument/software.

(9) Driven relay/fan

BIU control the load power on/off through high side driven.

(10) Pre-charge module

When BIU control the load charging, it will pre-charge the main circuit load through pre-charge module before charging the load.AUX+ could be used for controlling external pre-charge

(11)Onboard insulation monitoring

Monitor the insulation from high voltage positive and negative to vehicle case. Alarm when insulation resistance under a threshold value.

(12)Input signal detection

BIU estimates vehicle operation state and charging state through detecting Key-On wake-up signal and charger wake-up signal.。

(13) Key information power-down saving

BMS will save the system key data (such as Max&Min voltage and the corresponding cells, SOC, current, history error, etc) when detecting the battery pack power-down.

2.5 Technological superiority

The core members come from the top battery and BMS manufacturers, which have rich experience. We combine battery characteristics and BMS operating practice, devote to making battery thinking, create intelligent security of electric vehicle.

3. BIU Introduction

3.1 BIU function introduction

BIU is the core unit of BMS, which can collect battery information and analyze them to manage. The function includes: state estimate, current detection, external communication, internal communication, warning and protection, external control, signal join up, voltage collection. Description as below:

Table 4 BIU function

Function	Description
Voltage detection	Realize real-time voltage detection through collecting single cell voltage.
Temperature detection	Realize real-time temperature detection through 1~4 temperature sensor in battery pack.
SOC estimation	Based on SOC algorithm and calibration compensation strategy, the battery group SOC was estimated dynamically.
Current detection	The charge and discharge current is tested in real time through hall current sensor or diverter.
Communication	Communicate with other modules, charging devices, and vehicles of BMS system through 3 CAN interfaces.
Upper computer connecting	Communicate with Upper computer to display data and download program through RS485 interface.
Warning and protection	Conduct alarm and protection according to the sampling information and state estimation results through built-in alarm protection control strategy.
System self-check	Check function and state of each unit to ensure system safety
Control output	6relay control interfaces ensure the control signal output to charge, discharge and auxiliary equipment
Digital input	4 digital input interfaces can receive external digital control signal.
Analog input	3 analog input interfaces can receive external analog control signal.
Insulation detection	Test the total voltage and the positive&negative leakage current of the battery pack.

3.2 BIU interface definition

There are 3 types of BIU in BI51series: BI5116, BI5132, BI5148.They have same function except different collecting cells number. Below we take BI5148 as example.
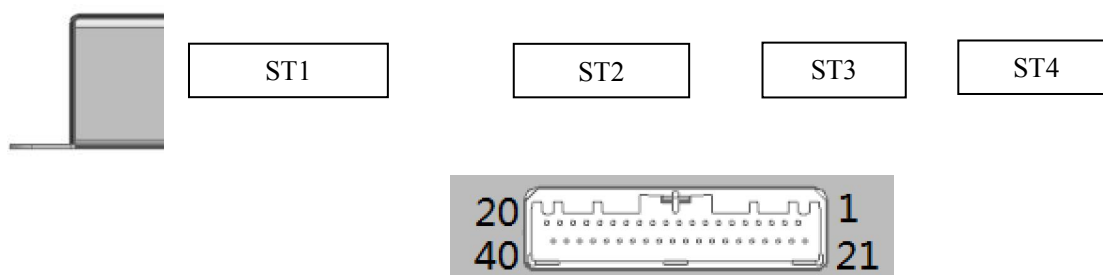
ST1~ST4 position and interface sequence

ST1 interface					
Board connector		Type : MX34040NF2		Brand : JAE	
Line connector		Type : MX34040SF1		Terminal type : M34S75C4F2	
Pin	Name in stick	Description	Pin	Name in stick	Description
40	12V+	BMS INPUT 12V+	20	12V+	BMS INPUT 12V+
39	CHG_12V+	12 V Charger Wakeup	19	CP	GB slow charge CP
38	KeyOn	Key-On	18	CC	GB slow charge CC
37	CC2	GB fast charge CC2	17	HALL_IN1	Hall signal input 1
36	HALL_IN2	Hall signal input 2	16	CS_5V-	Current sensor power 5V-
35	CS_5V+	Current sensor power 5V+	15	NTC1+	Charge interface temperature detection 1+
34	NTC1-	Charge interface temperature detection 1-	14	NTC2+	Charge interface temperature detection 2+
33	NTC2-	Charge interface temperature detection 2-	13	CAN0_H	Inner CAN-bus high
32	CAN0_L	Inner CAN-bus low	12	CAN1_H	Discharge CAN-bus high
31	CAN1_L	Discharge CAN-bus low	11	CAN2_H	Charge CAN-bus hign
30	CAN2_L	Charge CAN-bus low	10	485A	Display RS485A
29	485B	Display RS485B	9	485GND	Display RS485GND
28	V_GND	Vehicle Frame connection	8	LCD_12V-	Display power 12V-
27	12V-	BMS INPUT 12V-	7	CHG_12V-	Charger input 12V-
26	RL7_H	High level drive, default reserved	6	RL8_H	High level drive, default reserved
25	RL5_H	High level drive, default reserved	5	RL6_H	High level drive, default reserved
24	RL4-	Heating relay 12V-	4	RL4+	Heating relay 12V+
23	RL3-	Charge relay 12V-	3	RL3+	Charge relay 12V+
22	RL2-	Pre-charge relay 12V-	2	RL2+	Pre-charge relay 12V+
21	RL1-	Discharge relay 12V-	1	RL1+	Discharge relay 12V+

ST2 interface

Board connector		Type：MX34032NF		Brand：JAE	
Line connector		Type：MX34032SF1/JAE		Terminal type：M34S75C4F2/JAE	
Pin	**Name in stick**	**Description**	**Pin**	**Name in stick**	**Description**
32	B1-	Battery 1-	16	NC	Battery pack-
31	B2+	Battery 2+	15	B1+	Battery 1+
30	B4+	Battery 4+	14	B3+	Battery 3+
29	B6+	Battery 6+	13	B5+	Battery 5+
28	B8+	Battery 8+	12	B7+	Battery 7+
27	B10+	Battery 10+	11	B9+	Battery 9+
26	B12+	Battery 12+	10	B11+	Battery 11+
25	B14+	Battery 14+	9	B13+	Battery 13+
24	B16+	Battery 16+	8	B15+	Battery 15+
23	T1+	NTC 1+	7	T1-	NTC1-
22	T2+	NTC2+	6	T2-	NTC2-
21	T3+	NTC3+	5	T3-	NTC3-
20	T4+	NTC4+	4	T4-	NTC4-
19	COMMH_P	Daisy chain communication P	3	COMMH_N	Daisy chain communication N
18	FAULT_P	Daisy chain communication fault P	2	FAULT_N	Daisy chain communication fault N
17	HV1+	Insulation/total voltage detection+1	1	HV2+	Adhesive total pressure detection +2

ST3 interface					
Board connector		Type：MX34028NF2		Brand：JAE	
Line connector		Type：MX34028SF1		Terminal type：M34S75C4F2	
Pin	**Name in stick**	**Description**	**Pin**	**Name in stick**	**Description**
28	B17-	Battery 17-	14	NC	Undefined
27	B18+	Battery 18+	13	B17+	Battery 17+
26	B20+	Battery 20+	12	B19+	Battery 19+
25	B22+	Battery 22+	11	B21+	Battery 21+
24	B24+	Battery 24+	10	B23+	Battery 23+
23	B26+	Battery 26+	9	B25+	Battery 25+
22	B28+	Battery 28+	8	B27+	Battery 27+
21	B30+	Battery 30+	7	B29+	Battery 29+
20	B32+	Battery 32+	6	B31+	Battery 31+
19	NC	Undefined	5	NC	Battery pack+
18	T5+	NTC5+	4	T5-	NTC5-
17	T6+	NTC6+	3	T6-	NTC6-
16	T7+	NTC7+	2	T7-	NTC7-
15	T8+	NTC8+	1	T8-	NTC8-

ST4 interface					
Board connector	Type : MX34028NF2		Brand : JAE		
Line connector	Type : MX34028SF1		Terminal type : M34S75C4F2		
Pin	Name in stick	Description	Pin	Name in stick	Description
28	B33-	Battery 33-	14	NC	Undefined
27	B34+	Battery 34+	13	B33+	Battery 33+
26	B36+	Battery 36+	12	B35+	Battery 35+
25	B38+	Battery 38+	11	B37+	Battery 37+
24	B40+	Battery 40+	10	B39+	Battery 39+
23	B42+	Battery 42+	9	B41+	Battery 41+
22	B44+	Battery 44+	8	B43+	Battery 43+
21	B46+	Battery 46+	7	B45+	Battery 45+
20	B48+	Battery 48+	6	B47+	Battery 47+
19	NC	Undefined	5	NC	Battery pack+
18	T9+	NTC9+	4	T9-	NTC9-
17	T10+	NTC10+	3	T10-	NTC10-
16	T11+	NTC11+	2	T11-	NTC11-
15	T12+	NTC12+	1	T12-	NTC12-

3.3 BIU external dimensions and weight

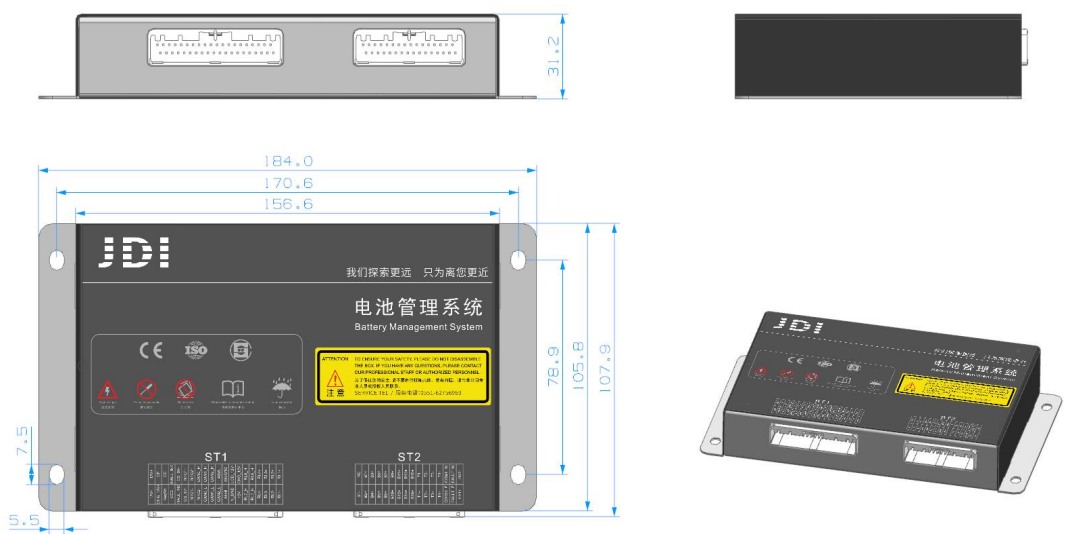| Item	Unit	Specific
BI5116 external dimensions	mm*mm*mm	184x 108.1x 31.2
BI5132 external dimensions	mm*mm*mm	230x 108.1x 31.2
BI5148 external dimensions	mm*mm*mm	276x 108.1x 31.2
BM5116 external dimensions	mm*mm*mm	117.76 x 80.73 x 24.88
BI5116 weight	g	490
BI5132 weight	g	620
BI5148 weight	g	750
BM5116 weight	g	120

3.4 BIU Installation dimensions
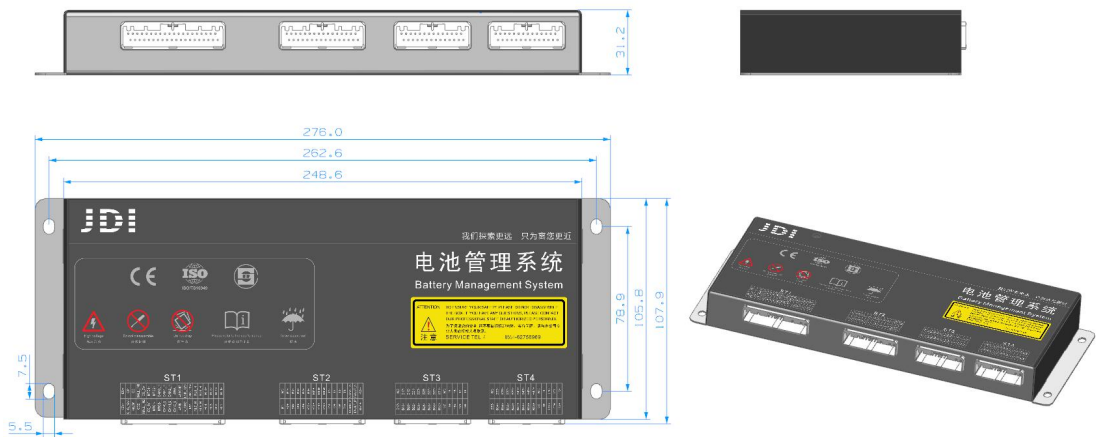
Figure5 BI5116 dimensions
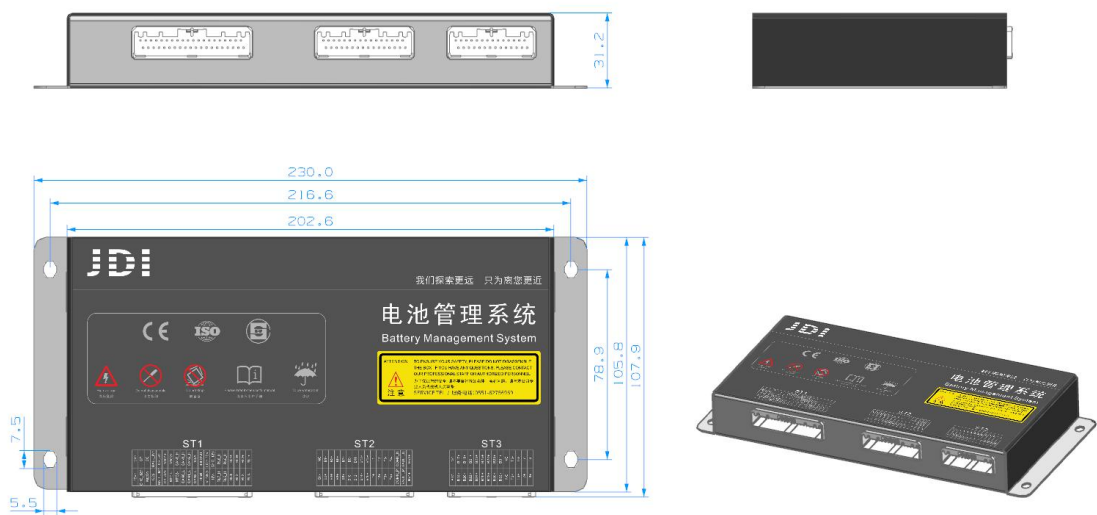
Figure 6-BI5132 dimensions

Figure7-BI5148 dimensions

3.5 CSU dimension

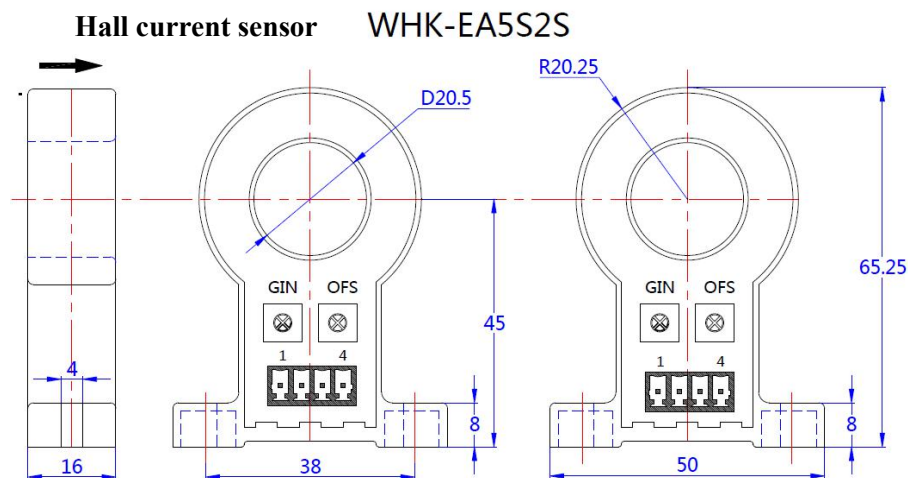**Hall current sensor** WHK-EA5S2S

Figure 9-CSU dimension

3.6 Voltage collection wires

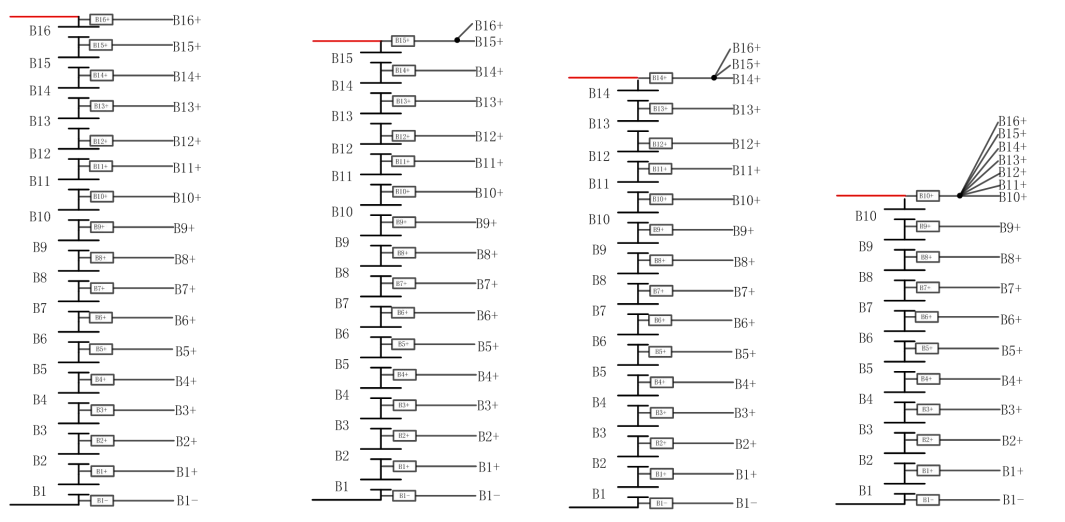Each detection interface of BIU&BMU can collect 6~16 cells information. The connection of different number as below:

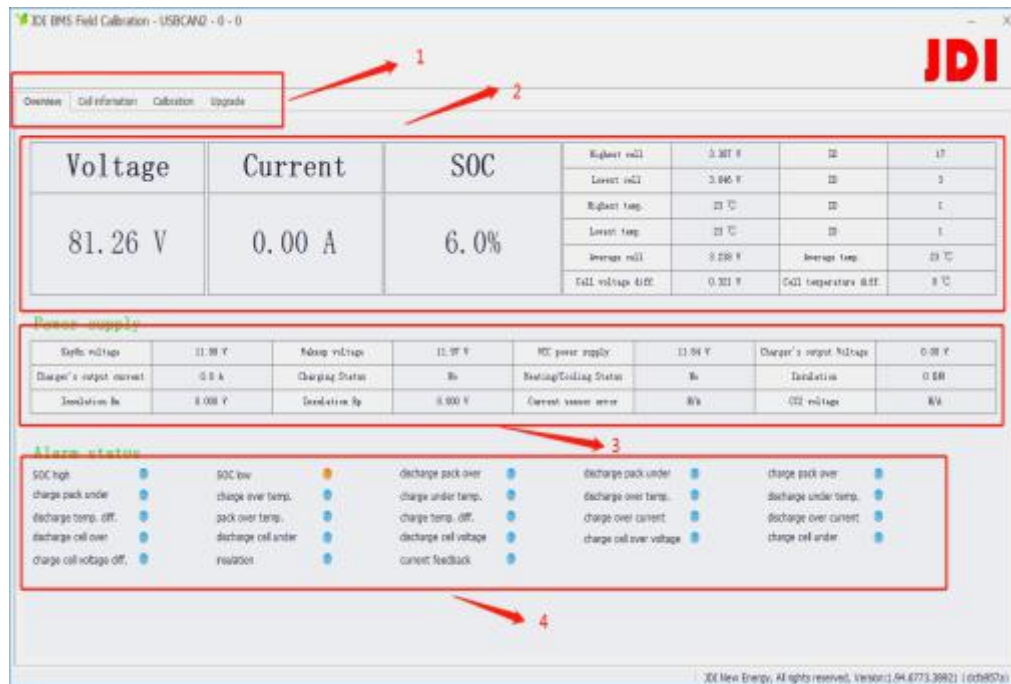Figure10- Connection diagram of different number

4. Software introduction

4.1 Introduction of software

4.1.1 Main interface

Click "Overview" to enter the main interface
It shows the basic information of batteries and BMS, the function windows of upper computer and system error information.

a) Upper computer function buttons: Overview / Cell information/ Calibration /Upgrade
b) BMS power and charger information
   KeyOn means the power is from DC-DC converter during discharging.
   Wakeup voltage means the power is from charger auxiliary power supply during charging.
   The voltage of VCC should be equal to Keyon voltage and Wakeup voltage. Please contact us if the voltage difference over 3V.
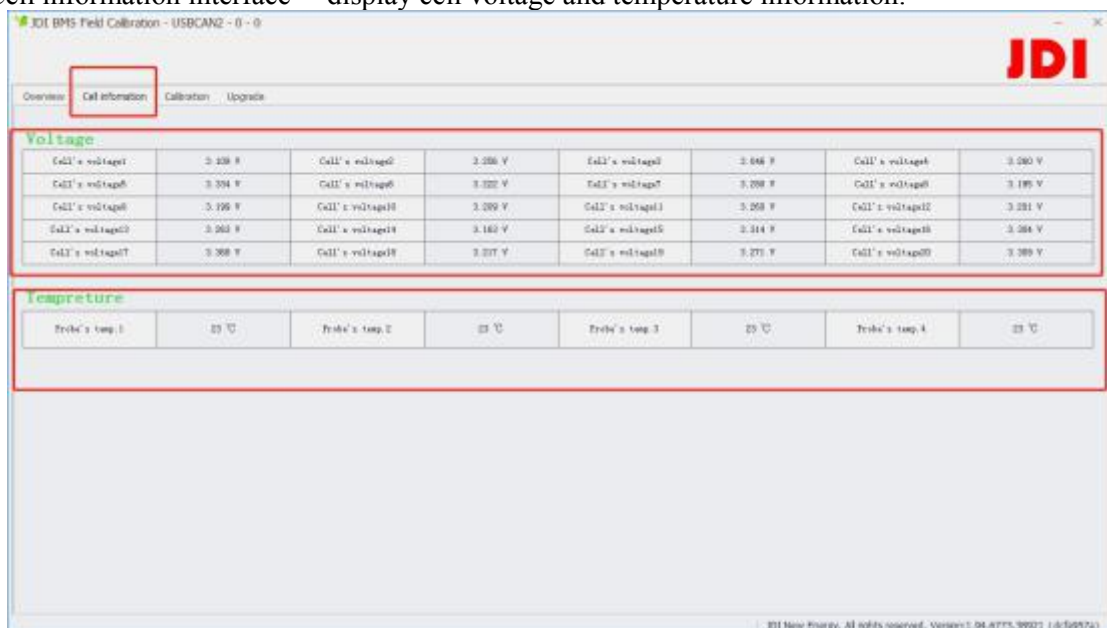   Charger output voltage/current: BMS get the charging data sent by charger (through CAN-bus). The data should be same to charger display.
c) Alarm status，Green---Normal; Orange—Alarm; Red ---Major fault

4.1.2 Cell information

Click "Cell information" to enter the batteries information interface.
Cell information interface— display cell voltage and temperature information.

Calibration interface—Click "Calibration" to enter calibration interface
Calibration interface—Function area of BMS parameter configuration, users can configure
parameters and simulated failure on this interface.

a) Function area: click the button to enter the corresponding parameter configuration interface
b) Parameter configuration interface: system supports manually modification and batch import parameters.
c) Import—Import the current parameters (".json") to BMS, click Calibration, and then click Flash.
d) Export—Export the BMS data to a ",json" file, it can be used to modify batched parameters.
e) Read—Read the BMS existing parameters. Default: automatic reading.
f) Calibration—It's necessary to click "Flash" after modifying the parameters. Otherwise, the new parameters are invalid.
g) Flash—Insure to click "Flash" after calibrating parameters. Otherwise, parameters will reset to the parameter after BMS restart.
h) Parameters display and modifying. Double click the data, and modify it.
i) eg: modifying the SCO to 30%, double click "65535"→enter 30→click "calibration"→click "flash".
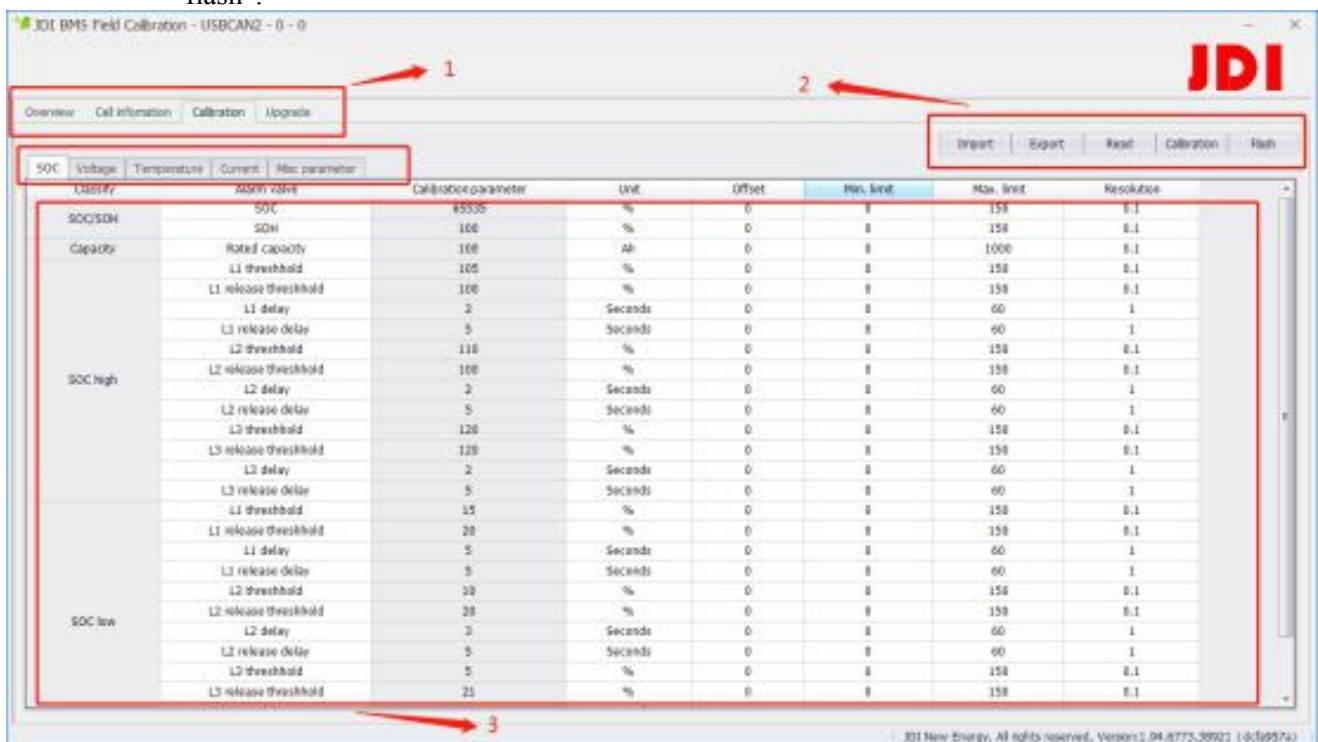
4.2 Upgrade the software

Open Upper computer software, click"Upgrade"→click "Burn"→choose the program→ click "Open"

21
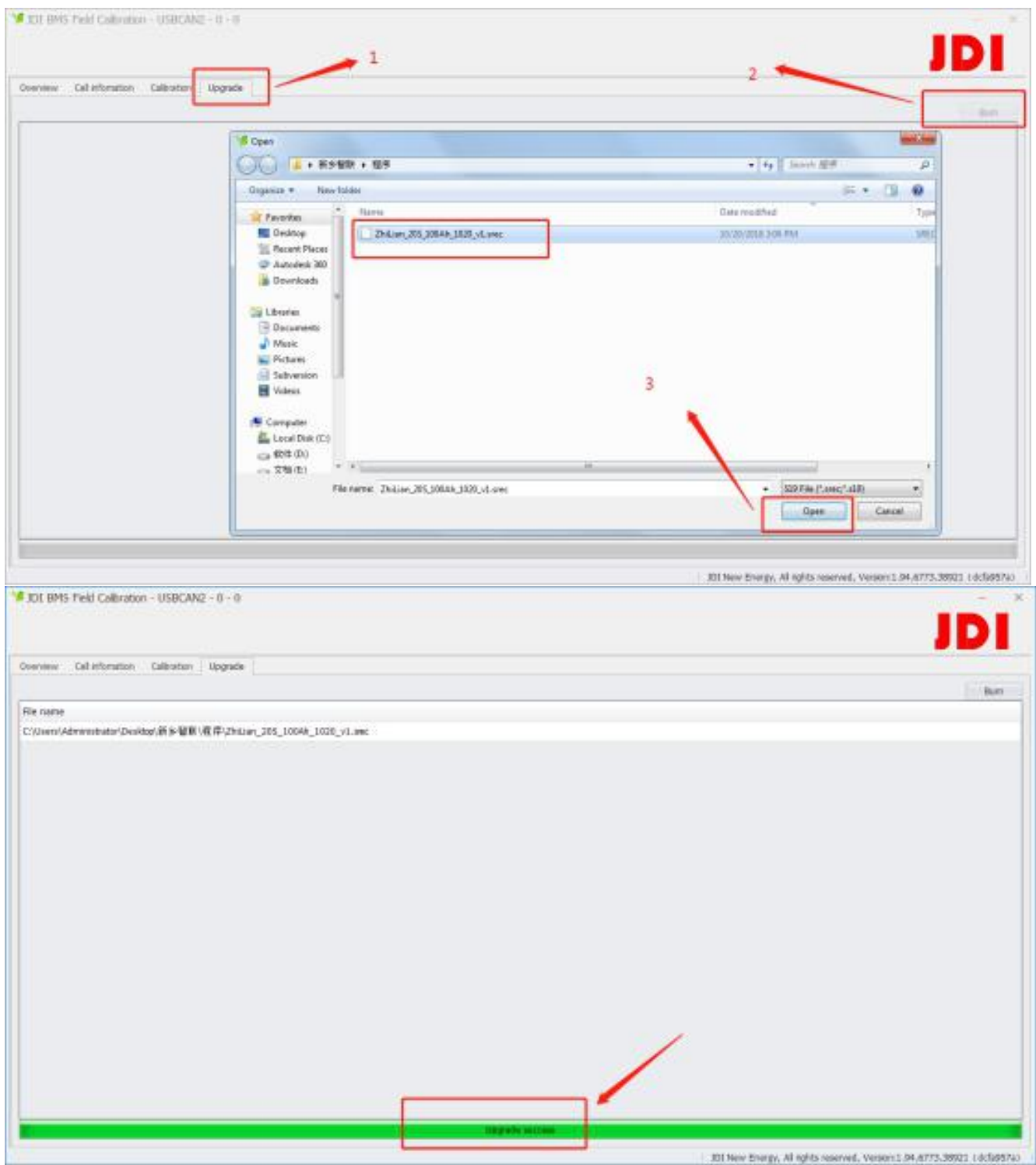
Thanks for reading.
Contact us for further information.

Email：info@deligreenpower.com