HV Energy Storage

BMS Solution Specification

(16S Each Pack)

Compiler: Sherry	Reviewer: Ethan	Approval: Gary
2025-4-25	2025-4-25	2025-4-25

Copyright © Shenzhen Tringo Control Co., Ltd. All rights reserved. Unauthorized reproduction is prohibited without written permission.

Revision History			
Date	Revision version	Reviewer Note	Reviser
2024-12-22	V1.0	Newly Formulate	Sherry
2025-4-25	V1.1	Optimized Communication Port	Sherry
2026-4-15	V1.2	Updated Parameters	Lin Chenghuai
2026-8	V1.3	Optimized wiring diagrams and other details; Added adapter board port description in Section 3.3.1;	Sherry
2026-9-1	V1.4	Removed the Host Computer chapter	Sherry
2026-9-17 2026-10	V1.5	Improve DO/DI CorrespondenceModify BCU parameter list description, modify overvoltage derating and balancing start voltage parameters	FanZhuolun, Sherry

Catalog

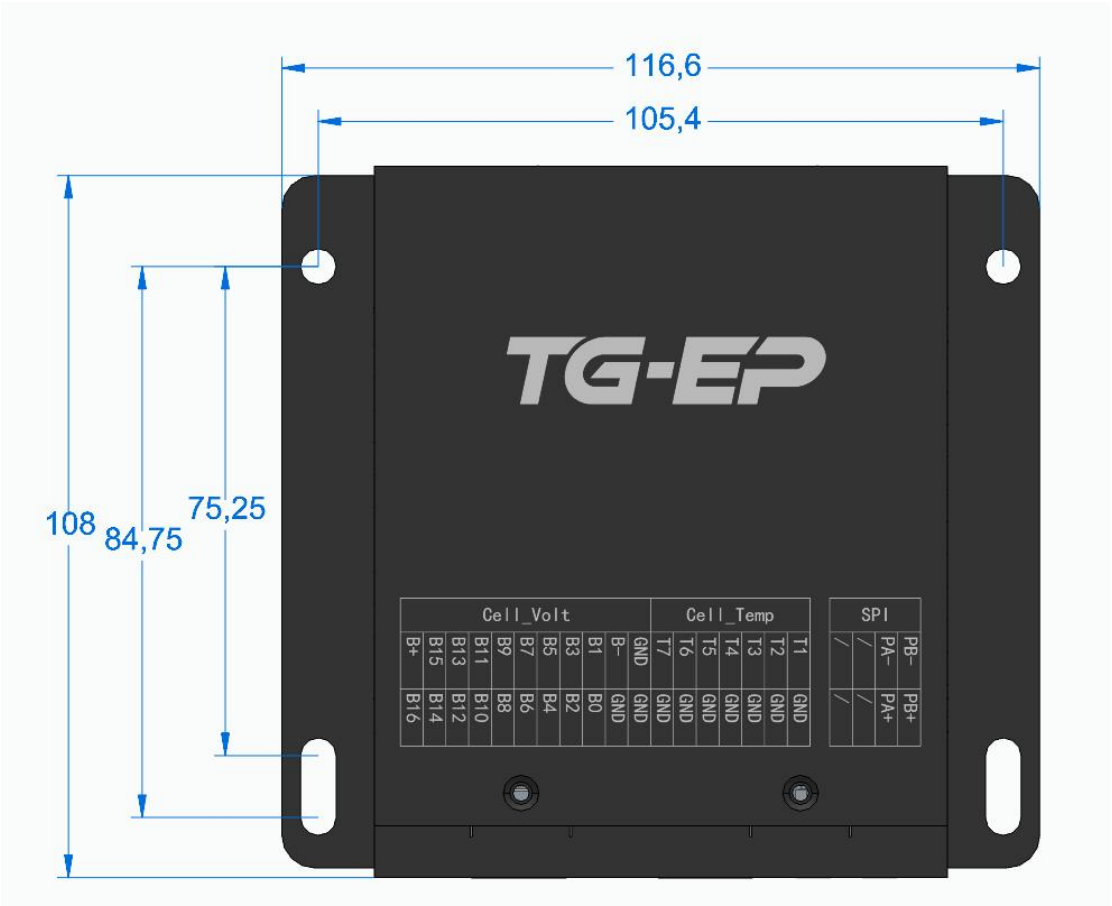
1. Overview of the solution 4
2. TB-M16S Hardware Description 4
2.1. Main board dimension drawing 4
2.2. Hardware parameters list 5
2.3. Board Port Function 6
2.3.1. Port Function diagram 6
2.3.2. Port definition table 7
2.4. BMU voltage sensing harness wiring method 8
2.5. Sampling Wiring Diagram 8
3. TB-C1500 Hardware description 9
3.1. Dimension drawing 9
3.1.1. Main board dimension drawing 9
3.1.2. Adapter board dimension drawing 9
3.2. Hardware parameter list 9
3.3. Main board port function 10
3.3.1. Port function diagram 10
3.3.2. Port definition table 10
3.4. Master-slave Communication Wiring Diagram 17
4. BCU Parameter list 18
4.1. Fault Trigger 18
4.2. Fault Derating 18
4.3. Charge/Discharge Alarm Parameter 19
4.4. General Alarm Parameter 32
5. BMS installation instructions 38
5.1. Safety regulations requirements 38

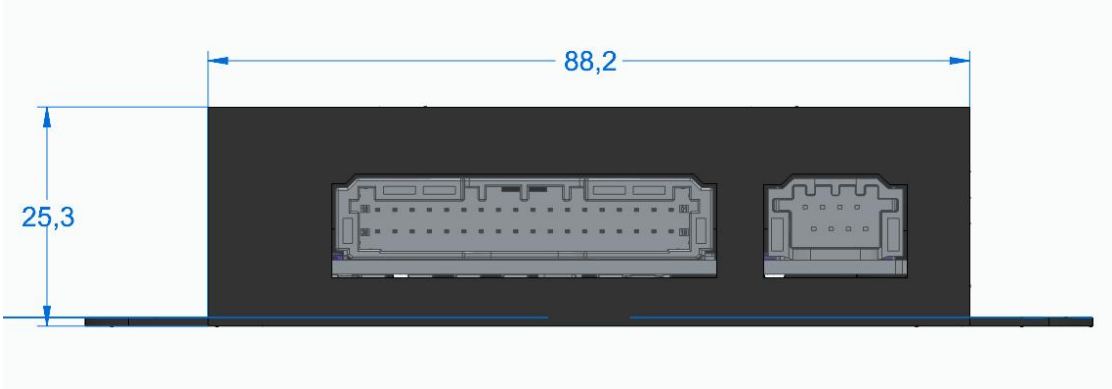
1. Overview of the solution

This battery management system (BMS) solution is designed for a two-tier architecture control in high-voltage energy storage systems, dedicated to managing battery clusters. It employs 16-series slave controllers, each supporting ≤16 cell voltage sampling channels and ≤7 temperature sampling channels. These slaves are connected via a daisy-chain communication network to the Battery Control Unit (BCU) master board installed within the high-voltage box. The high-voltage box supports configuration for different voltage and current specifications. The solution enables various battery-related fault alarms and protection functions, supports the optional integration of different display screens, allows for host computer operation, and offers optional WIFI/4G modules with cloud platform monitoring capabilities

2. TB-M16S Hardware Description

2.1.Main board dimension drawing





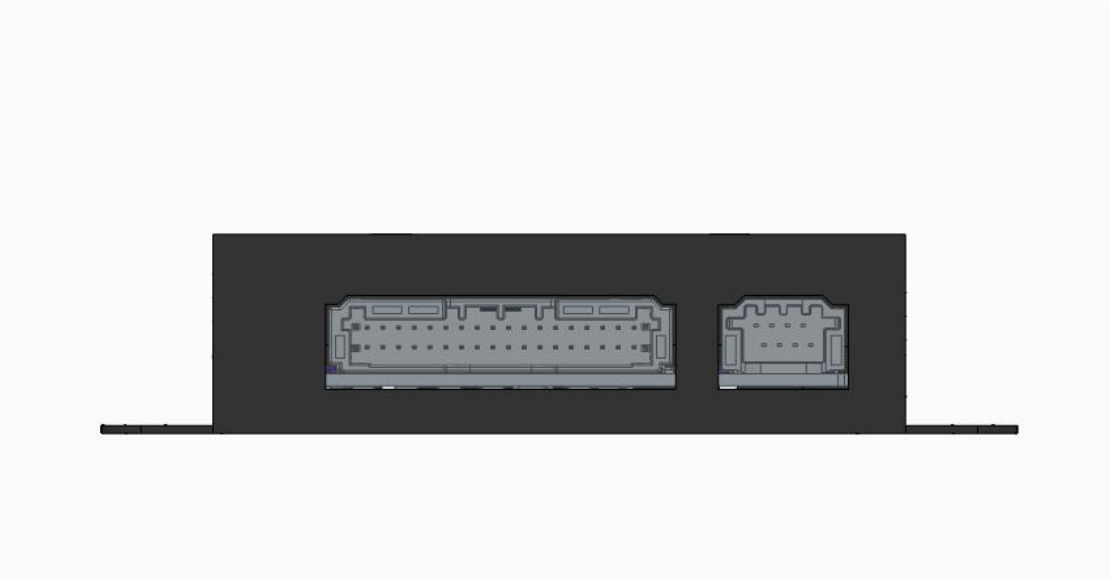
2.2.Hardware parameters list

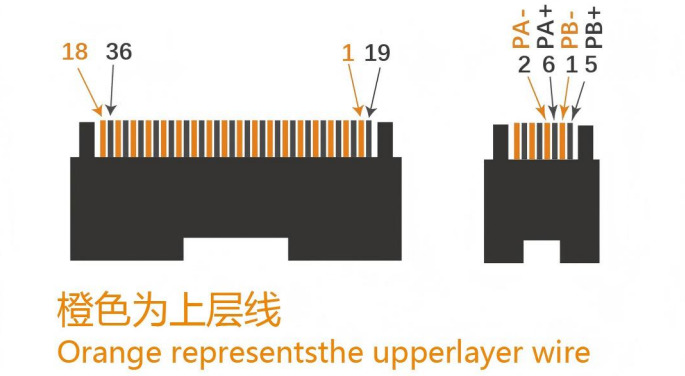
Index item	Parameter
Overall dimensions of main board	74.85*89.85mm
Operating voltage	16V ~ 70V
Working power consumption	Normal working power consumption ≤ 10mA; Sleep power consumption ≤300uA
Number of single cell voltage detection channels	16 Channel
Single voltage detection	0 ~ 5VDC，≤±10mV
Number of temperature detection channels	4 channels of battery cell temperature detection，≤±2℃，-40℃ ~ 125℃
Single cell equalization mode	Passive discharge Balance，100mA
Communication	Daisy chain

2.3.Board Port Function

2.3.1. Port Function diagram







2.3.2. Port definition table

J1：Sampling Port					
Board-side Connector		Model：WTB30-AB136HB1-001		Brand：Yixingtong	
Cable-side Connector		Model：WTB30-AW136HB1-001		Model：T-WTB30-W110-001	
Pin No.	Name	Description	Pin No.	Name	Description
J1-1	T1-M1	Temp-1 detection	J1-19	GND-M1	Temperature sensing ground
J1-2	T2-M1	Temp-2 detection	J1-20	GND-M1	Temperature sensing ground
J1-3	T3-M1	Temp-3 detection	J1-21	GND-M1	Temperature sensing ground
J1-4	T4-M1	Temp-4 detection	J1-22	GND-M1	Temperature sensing ground
J1-5	T5-M1	/	J1-23	GND-M1	Temperature sensing ground
J1-6	T6-M1	/	J1-24	GND-M1	Temperature sensing ground
J1-7	T7-M1	/	J1-25	GND-M1	Temperature sensing ground
J1-8	GND-M1	GND	J1-26	GND-M1	GND
J1-9	B-	1# cell negative pole	J1-27	GND	GND
J1-10	B1	1# cell positive pole	J1-28	B0	1# cell negative pole
J1-11	B3	3# cell positive pole	J1-29	B2	2# cell positive pole
J1-12	B5	5# cell positive pole	J1-30	B4	4# cell positive pole
J1-13	B7	7# cell positive pole	J1-31	B6	6# cell positive pole
J1-14	B9	9# cell positive pole	J1-32	B8	8# cell positive pole
J1-15	B11	11# cell positive pole	J1-33	B10	10# cell positive pole
J1-16	B13	13# cell positive pole	J1-34	B12	12# cell positive pole
J1-17	B15	15# cell positive pole	J1-35	B14	14# cell positive pole
J1-18	B+	16# cell positive pole	J1-36	B16	16# cell positive pole

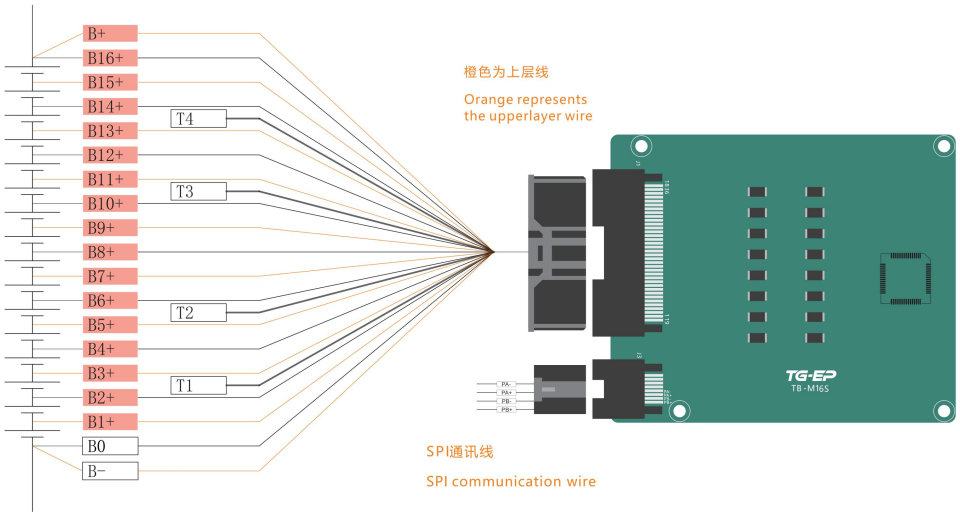
J3: Communication Port					
Board-side Connector		Model：WTB30-AB108HB1-001		Brand：Yixingtong	
Cable-side Connector		Model：WTB30-AW108HB1-001		Model：T-WTB30-W110-001	
Pin No.	Name	Description	Pin No.	Name	Description
J3-1	PB−	Daisy chain input negative	J3-5	PB+	Daisy chain input positive
J3-2	PA−	Daisy chain output negative	J3-6	PA+	Daisy chain output positive
J3-3	/	/	J3-7	/	/
J3-4	/	/	J3-8	/	/

2.4.BMU voltage sensing harness wiring method

Wiring Table for Reducing Cells per BMU Sampling Port:

16S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
15S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B15
14S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B14	B14
13S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B13	B13	B13
12S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B12	B12	B12	B12
11S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B11	B11	B11	B11	B11
10S	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B10	B10	B10	B10	B10	B10
9S	B0	B0	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B9	B9	B9	B9	B9
8S	B0	B0	B0	B1	B2	B3	B4	B5	B6	B7	B8	B8	B8	B8	B8	B8	B8

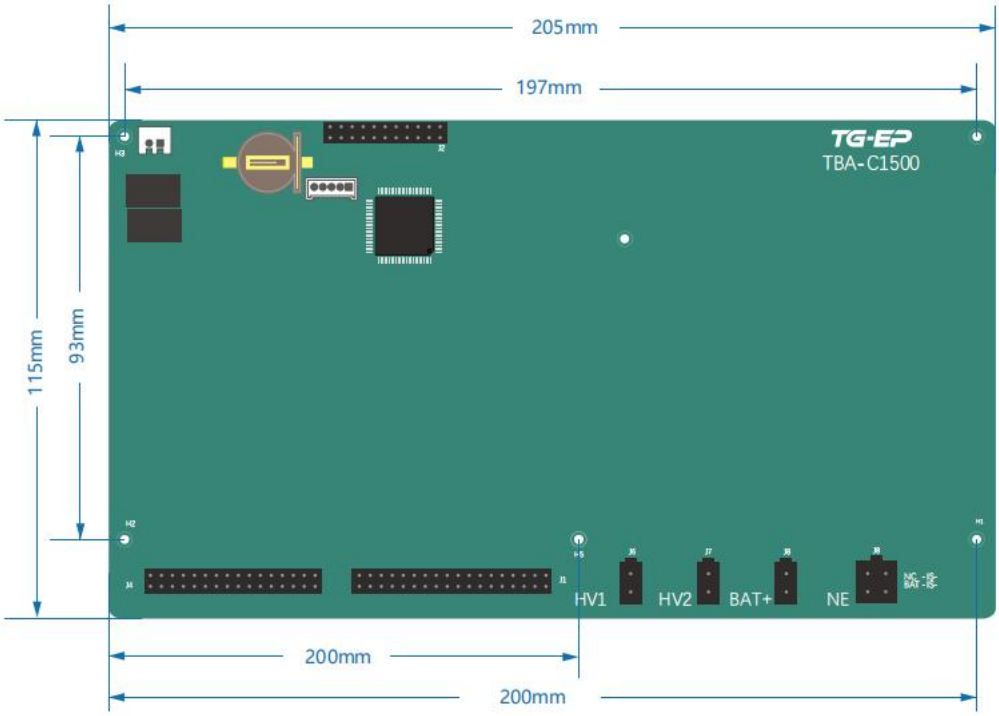
2.5.Sampling Wiring Diagram



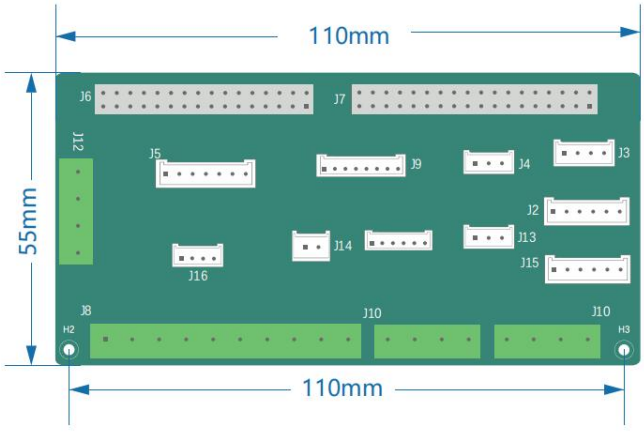
3. TB-C1500 Hardware description

3.1.Dimension drawing

3.1.1. Main board dimension drawing



3.1.2. Adapter board dimension drawing



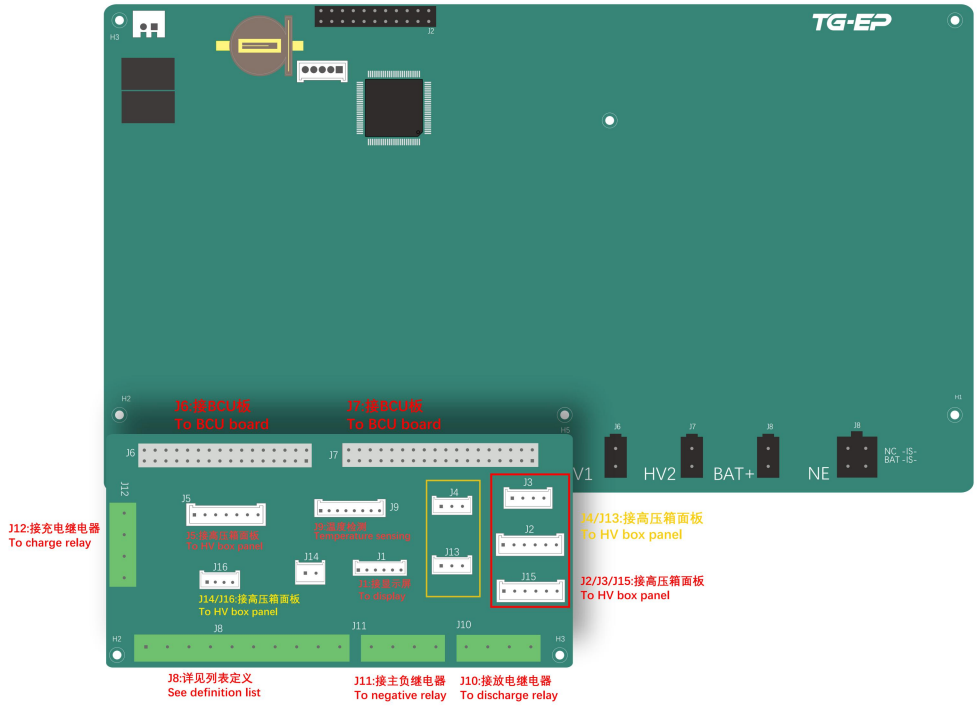
3.2.Hardware parameter list

Index Item	Parameter
Overall dimensions of main board	205*115mm

Operate Voltage	12 ~ 36 VDC
SOC accuracy	≤ 5%
Data storage	≥ 10,000 historical data records
Pre-charging function	Supported
Charging current limiting	Not supported
Upper computer	supported
Communication methods	CAN, RS485, WIFI (Expandable), 4G (Expandable)

3.3.Main board port function

3.3.1. Port function diagram



3.3.2. Port definition table

J6					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	NC	Not connected	17	PE	Enclosure protective earth (HV box)
2	HALL_I2	Hall current sensor input	18	HALL_I1	Hall current sensor input

		signal			signal
3	HALL_5V+	Hall sensor power supply positive	19	HALL_5V-	Hall sensor power supply negative
4	DIH1(DI1)	High-level input feedback signal 1	20	GND	System ground
5	DIH2(DI2)	High-level input feedback signal 2	21	SW1_OUTA(DO1)	Relay 1 control output
6	DIH3(DI3)	High-level input feedback signal 3	22	SW1_OUTB(DO1)	Relay 1 control output
7	WKUP	Wake-up signal input	23	SW2_OUTA(DO2)	Relay 2 control output
8	DOL1(DO8)	Low-level output control 1	24	SW2_OUTB(DO2)	Relay 2 control output
9	DOL2(DO9)	Low-level output control 2	25	SW3_OPA(DO3)	Relay 3 control output
10	DOL3(DO10)	Low-level output control 3	26	SW3_OPB(DO3)	Relay 3 control output
11	DOH1(DO4)	High-level output control 1	27	GND	System ground
12	DOH2(DO5)	High-level output control 2	28	GND	System ground
13	DOH3(DO6)	High-level output control 3	29	GND	System ground
14	DOH4(DO7)	High-level output control 4	30	GND	System ground
15	PW+	BCU power supply input positive	31	PW+	BCU power supply input positive
16	PW-	BCU power supply input negative	32	PW-	BCU power supply input negative

J7					
Pin No.	PIN Definition	Description	Pin No.	PIN Definition	Description
1	SPI_L1	Pack daisy-chain output 1 negative	19	SPI_H1	Pack daisy-chain output 1 positive
2	SPI_L2	Pack daisy-chain output 2 negative	20	SPI_H2	Pack daisy-chain output 2 positive
3	CAN1H	CAN1 communication high-level	21	CAN1R	CAN1 termination resistor control
4	GND_CAN1	CAN1 communication ground	22	CAN1L	CAN1 communication low-level
5	CAN2H	CAN2 communication high-level	23	CAN2R	CAN2 termination resistor control
6	GND_CAN2	CAN2 communication ground	24	CAN2L	CAN2 communication low-level
7	CAN0L	CAN0 communication low-level	25	CAN0H	CAN0 communication high-level
8	485A1	RS485 channel 1A	26	GND_CAN0	CAN0 communication ground
9	GND_4851	RS485 channel 1 ground	27	485B1	RS485 channel 1 B
10	485B2	RS485 channel 2 B	28	485A2	RS485 channel 2 A
11	DIL1(DI4)	Digital input feedback signal 1 (low level)	29	GND_4852	RS485 channel 2 ground
12	DIL3(DI6)	Digital input feedback signal 3 (low level)	30	DIL2(DI5)	Digital input feedback signal 2 (low level)
13	GND	System ground	31	DO_ADR(DO11)	Output control ADR
14	SW1_IN-(DI7)	Switch input 1 negative	32	SW1_IN+(DI7)	Switch input 1 positive
15	SW2_IN-(DI8)	Switch input 2 negative	33	SW2_IN+(DI8)	Switch input 2 positive
16	TEMP2	Temperature sensor input	34	TEMP1	Temperature sensor input

		2			1
17	TEMP4	Temperature sensor input 4	35	TEMP3	Temperature sensor input 3
18	TGND	Temperature sensor ground	36	TGND	Temperature sensor ground

HV1					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	HV1	High-voltage sensing input 1	2	NC	Reserved

HV2					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	HV2	High-voltage sensing input 2	2	NC	Reserved

BAT+					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	BAT+	Battery pack voltage positive sensing	2	NC	Reserved

NE					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	IS-	Shunt resistor input negative	2	BAT-	Battery pack voltage negative sensing
3	IS+	Shunt resistor input positive	4	NC	Reserved

J12 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	DO_ADR(DO11)	High-side output, charging relay control	2	GND/24V-	GND
3	GND/24V-	GND	4	DIL1	Low-side input, charging relay feedback

J8 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	DOL2(DO9)	Low-side output, alarm light control	2	DOL1(DO8)	Low-side output, running light control
3	GND/24V-	GND	4	DOH2(DO5)	High-side output, pre-charge relay control
5	GND/24V-	GND	6	DOH1(DO4)	High-side output, trip unit control
7	DIH1(DI1)	High-side input, trip feedback	8	PW-	BCU power supply input negative
9	PW+/24V+	BCU power supply input positive	10	PE	Chassis ground

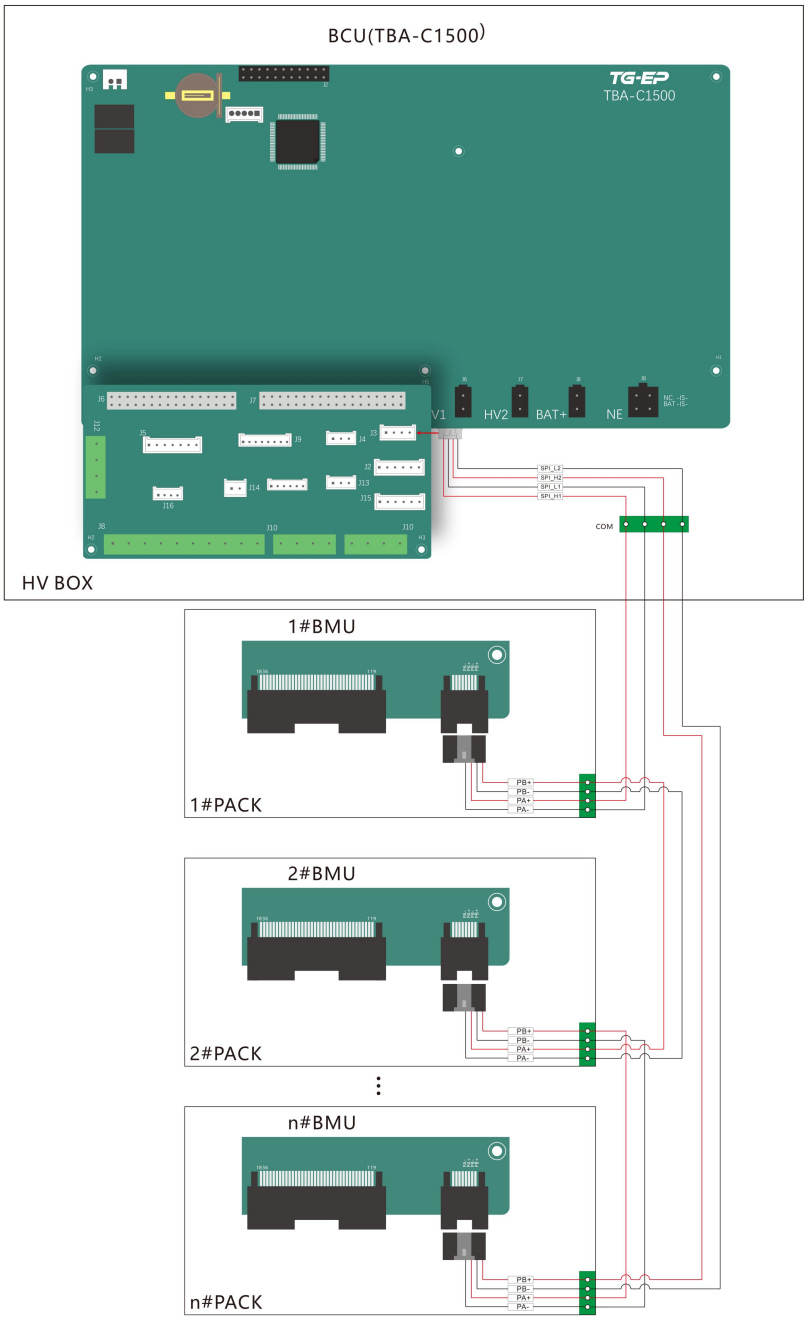
J11 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	DOH3(DO6)	High-side output, main negative relay control	2	GND/24V-	GND
3	GND/24V-	GND	4	DIL2(DI5)	Low-side input, main negative relay feedback

J10 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	DOH4(DO7)	High-side output, discharge relay control	2	GND/24V-	GND
3	GND/24V-	GND	4	DIL3(DI6)	Low-side input,

					discharge relay feedback
J5 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	DOL3(DO10)	Fan drive control	2	PW+/24V+	Power supply positive
3	PW+/24V+	Power supply positive	4	DIH3(DI3)	High-level input feedback signal 3
5	PW+/24V+	Power supply positive	6	GND/24V-	Power supply negative
7	DIH2(DI2)	High-level input feedback signal 2			
J9 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	TGND	Reserved	2	TEMP4	Reserved
3	TGND	Reserved	4	TEMP3	Reserved
5	TGND	Temperature sensing ground	6	TEMP2	Temperature sensor input 2
7	TGND	Temperature sensing ground	8	TEMP1	Temperature sensor input 1
J4/J13 Interface (J13 reserved)					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	GND_4851	RS485 channel 1 ground	2	485B1	RS485 channel 1 B
3	485A1	RS485 channel 1 A			
J3 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	SPI_L2	Daisy-chain channel 2 negative	2	SPI_H2	Daisy-chain channel 2 positive
3	SPI_L1	Daisy-chain channel 1 negative	4	SPI_H1	Daisy-chain channel 1 positive

J2/J15 Interface (J15 reserved)					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	CAN2_R	CAN2 termination resistor	2	CAN2H	CAN2 high-level signal
3	CAN2L	CAN2 low-level signal	4	CAN1_R	CAN1 termination resistor control
5	CAN1H	CAN1 high-level signal	6	CAN1L	CAN1 low-level signal
J16 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	SW1_IN+(DI7)	Wet contact input 1 positive	2	SW1_IN-(DI7)	Wet contact input 1 negative
3	SW2_IN+(DI8)	Wet contact input 2 positive	4	SW2_IN-(DI8)	Wet contact input 2 negative
J14 Interface					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	SW1_OUTB(DO1)	Dry contact 1 control output	2	SW1_OUTA(DO1)	Dry contact 1 control output
J1 Interface (Display Screen)					
Pin No.	**PIN Definition**	**Description**	**Pin No.**	**PIN Definition**	**Description**
1	PW+/24V+	24V display power supply positive	2	485A2	RS485 channel 2 A
3	NC	/	4	NC	/
5	485B2	RS485 channel 2 B	6	PW-	24V display power supply negative

3.4.Master-slave Communication Wiring Diagram



4. BCU Parameter list

Alarm (Level 1 minor fault): When the fault is triggered, the alarm status is reported; when the release conditions are met, the alarm status is cleared. (No current derating or action by default)

Current Derating (Level 2 moderate fault): When the fault is triggered, the alarm status is reported and current derating is requested; when the release conditions are met, the alarm status is cleared, and charging/discharging is restored.

Relay Disconnection (Level 3 severe fault): When the fault is triggered, the alarm status is reported, current derating is requested, and the relay disconnection operation is performed; when the release conditions are met, charging/discharging is restored and the relay is closed.

Restart Release (Level 3 severe fault): When the fault is triggered, the alarm status is reported and the relay disconnection operation is performed; when the release conditions are met, the alarm status is not cleared, the relay is not closed, and a power cycle is required.

4.1.Fault Trigger

1. During charging, monitor charging alarms and general alarms.

   Trigger the charging or general alarm :

   the current battery parameter value ≥ fault value and the duration ≥ delay time.

2. During discharging, monitor discharging alarms and general alarms.

   Trigger the discharging or general alarm :

   the current battery parameter value ≥ fault value and the duration ≥ delay time.

3. During standby, monitor general, charging, and discharging alarms.

   Trigger the charging/discharging or general alarm:

   the current battery parameter value ≥ fault value and the duration ≥ delay time.

4.2.Fault Derating

1. When a charging fault occurs, the maximum allowable charging current = rated charging current*derating ratio;

2. When a discharging fault occurs, the maximum allowable discharging current = rated discharging current*derating ratio;

3. When a general fault occurs, the maximum allowable charging current = rated charging

current*derating ratio, and the allowable discharging current = rated discharging current*derating ratio;

4.3.Charge/Discharge Alarm Parameter

No.	Parameter Item			Default Vault	Configurable	Remarks
1	Cell Over-voltage protection	Level 1	Cell over-voltage alarm voltage	3550mV	Yes	Alarm
			Cell over-voltage alarm delay	3.0s	Yes	
			Cell over-voltage recovery voltage	3450mV	Yes	
			Cell over-voltage recovery delay	3.0s	Yes	
		Level 2	Cell over-voltage alarm voltage	3600mV	Yes	Depends on rated current; reduce charging current to 5~10A by default
			Cell over-voltage alarm delay	3.0s	Yes	
			Cell over-voltage recovery voltage	3500mV	Yes	
			Cell over-voltage recovery delay	3.0s	Yes	
		Level 3	Cell over-voltage alarm voltage	3650mV	Yes	Relay disconnection
			Cell over-voltage alarm delay	3.0s	Yes	
			Cell over-voltage recovery voltage	3550mV	Yes	
			Cell over-voltage recovery	3.0s	Yes	

			delay			
2	Cell under-voltage protection	Level 1	Cell under-voltage alarm voltage	2900mV	Yes	Alarm
			Cell under-voltage alarm delay	3.0s	Yes	
			Cell under-voltage recovery voltage	3100mV	Yes	
			Cell under-voltage recovery delay	3.0s	Yes	
		Level 2	Cell under-voltage alarm voltage	2800mV	Yes	Reduce discharging current to 0
			Cell under-voltage alarm delay	3.0s	Yes	
			Cell under-voltage recovery voltage	3000mV	Yes	
			Cell under-voltage recovery delay	3.0s	Yes	
		Level 3	Cell under-voltage alarm voltage	2700mV	Yes	Relay disconnection
			Cell under-voltage alarm delay	3.0s	Yes	
			Cell under-voltage recovery voltage	2900mV	Yes	
			Cell under-voltage recovery delay	3.0s	Yes	
3	Pack over-voltage protection	Level1	Pack over-voltage alarm voltage	3550mV*series cell count	Yes	Alarm
			Pack Over-voltage alarm delay	3.0s	Yes	

			Pack over-voltage recovery voltage	3450mV*series cell count	Yes	
			Pack over-voltage recovery delay	3.0s	Yes	
		Level 2	Pack over-voltage alarm voltage	3600mV*series cell count	Yes	Depends on rated current; reduce charging current to 5~10A by default
			Pack Over-voltage alarm delay	3.0s	Yes	
			Pack over-voltage recovery voltage	3500mV*series cell count	Yes	
			Pack over-voltage recovery delay	3.0s	Yes	
		Level 3	Pack over-voltage alarm voltage	3650mV*series cell count	Yes	Relay disconnection
			Pack Over-voltage alarm delay	3.0s	Yes	
			Pack over-voltage recovery voltage	3550mV*series cell count	Yes	
			Pack over-voltage recovery delay	3.0s	Yes	
4	Pack under-voltage protection	Level1	Pack under-voltage alarm voltage	2900mV*series cell count	Yes	Alarm
			Pack under-voltage alarm delay	3.0s	Yes	
			Pack under-voltage recovery voltage	3100mV*series cell count	Yes	
			Pack under-voltage recovery delay	3.0s	Yes	
		Level2	Pack under-voltage alarm	2800mV*seri	Yes	Reduce discharging current

			voltage	es cell count		to 0
			Pack under-voltage alarm delay	3.0s	Yes	
			Pack under-voltage recovery voltage	3000mV*series cell count	Yes	
			Pack under-voltage recovery delay	3.0s	Yes	
		Level3	Pack under-voltage alarm voltage	2700mV*series cell count	Yes	Relay disconnection
			Pack under-voltage alarm delay	3.0s	Yes	
			Pack under-voltage recovery voltage	2900mV*series cell count	Yes	
			Pack under-voltage recovery delay	3.0s	Yes	
5	Charging over-current protection	Level1	Charging over-current alarm current	1.05C	Yes	Alarm
			Charging over-current alarm delay	3.0s	Yes	
			Charging over-current recovery current	0.9C	Yes	
			Charging over-current recovery delay	3.0s	Yes	
		Level2	Charging over-current alarm current	1.1C	Yes	Reduce charging current to 0
			Charging over-current alarm delay	3.0s	Yes	
			Charging over-current recovery current	1C	Yes	

			Charging over-current recovery delay	3.0s	Yes	
		Level3	Charging over-current alarm current	1.15C	Yes	Relay disconnection
			Charging over-current alarm delay	3.0s	Yes	
			Charging over-current recovery current	1.05C	Yes	
			Charging over-current recovery delay	3.0s	Yes	
6	Discharging over-current protection	Level1	Discharging over-current alarm current	1.05C	Yes	Alarm
			Discharging over-current alarm delay	3.0s	Yes	
			Discharging over-current recovery current	0.9C	Yes	
			Discharging over-current recovery delay	3.0s	Yes	
		Level2	Discharging over-current alarm current	1.1C	Yes	Reduce discharging current to 0
			Discharging over-current alarm delay	3.0s	Yes	
			Discharging over-current recovery current	1C	Yes	
			Discharging over-current recovery delay	3.0s	Yes	
		Level3	Discharging over-current alarm current	1.15C	Yes	Relay disconnection

			Discharging over-current alarm delay	3.0s	Yes	
			Discharging over-current recovery current	1.05C	Yes	
			Discharging over-current recovery delay	3.0s	Yes	
7	Charging cell over-temperature protection	Level1	Charging cell over-temperature alarm temperature	45℃	Yes	Alarm
			Charging cell over-temperature alarm delay	3.0s	Yes	
			Charging cell over-temperature recovery temperature	40℃	Yes	
			Charging cell over-temperature recovery delay	3.0s	Yes	
		Level2	Charging cell over-temperature alarm temperature	50℃	Yes	Reduce charging current to 0
			Charging cell over-temperature alarm delay	3.0s	Yes	
			Charging cell over-temperature recovery temperature	45℃	Yes	
			Charging cell over-temperature recovery delay	3.0s	Yes	
		Level3	Charging cell over-temperature alarm temperature	55℃	Yes	Relay disconnection

			Charging cell over-temperature alarm delay	3.0s	Yes	
			Charging cell over-temperature recovery temperature	50℃	Yes	
			Charging cell over-temperature recovery delay	3.0s	Yes	
8	Discharging cell over-temperature protection	Level 1	Discharging cell over-temperature alarm temperature	50℃	Yes	Alarm
			Discharging cell over-temperature alarm delay	3.0s	Yes	
			Discharging cell over-temperature recovery temperature	45℃	Yes	
			Discharging cell over-temperature recovery delay	3.0s	Yes	
		Level 2	Discharging cell over-temperature alarm temperature	55℃	Yes	Reduce discharging current to 0
			Discharging cell over-temperature alarm delay	3.0s	Yes	
			Discharging cell over-temperature recovery temperature	50℃	Yes	
			Discharging cell over-temperature recovery delay	3.0s	Yes	
		Level 3	Discharging cell over-temperature alarm	60℃	Yes	Relay disconnection

			temperature			
			Discharging cell over-temperature alarm delay	3.0s	Yes	
			Discharging cell over-temperature recovery temperature	55℃	Yes	
			Discharging cell over-temperature recovery delay	3.0s	Yes	
9	Charging cell under-temperature protection	Level 1	Charging cell under-temperature alarm temperature	5℃	Yes	Alarm
			Charging cell under-temperature alarm delay	3.0s	Yes	
			Charging cell under-temperature recovery temperature	10℃	Yes	
			Charging cell under-temperature recovery delay	3.0s	Yes	
		Level 2	Charging cell under-temperature alarm temperature	0℃	Yes	Reduce charging current to 0
			Charging cell under-temperature alarm delay	3.0s	Yes	
			Charging cell under-temperature recovery temperature	5℃	Yes	
			Charging cell under-temperature recovery delay	3.0s	Yes	
		Level 3	Charging cell under-	-5℃	Yes	Relay disconnection

			temperature alarm temperature			
			Charging cell under-temperature alarm delay	3.0s	Yes	
			Charging cell under-temperature recovery temperature	0℃	Yes	
			Charging cell under-temperature recovery delay	3.0s	Yes	
10	Discharging cell under-temperature protection	Level 1	Discharging cell under-temperature alarm temperature	-5℃	Yes	Alarm
			Discharging cell under-temperature alarm delay	3.0s	Yes	
			Discharging cell under-temperature recovery temperature	0℃	Yes	
			Discharging cell under-temperature recovery delay	3.0s	Yes	
		Level 2	Discharging cell under-temperature alarm temperature	-10℃	Yes	Reduce discharging current to 0
			Discharging cell under-temperature alarm delay	3.0s	Yes	
			Discharging cell under-temperature recovery temperature	-5℃	Yes	
			Discharging cell under-temperature recovery delay	3.0s	Yes	

		Level 3	Discharging cell under-temperature alarm temperature	-20℃	Yes	Relay disconnection
			Discharging cell under-temperature alarm delay	3.0s	Yes	
			Discharging cell under-temperature recovery temperature	-10℃	Yes	
			Discharging cell under-temperature recovery delay	3.0s	Yes	
11	Charging cell voltage difference protection	Level 1	Charging cell voltage difference alarm value	400mV	Yes	Alarm
			Charging cell voltage difference alarm delay	3.0s	Yes	
			Charging cell voltage difference recovery value	350mV	Yes	
			Charging cell voltage difference recovery delay	3.0s	Yes	
		Level 2	Charging cell voltage difference alarm value	600mV	Yes	Reduce charging/discharging current to 0
			Charging cell voltage difference alarm delay	3.0s	Yes	
			Charging cell voltage difference recovery value	550mV	Yes	
			Charging cell voltage difference recovery delay	3.0s	Yes	
		Level 3	Charging cell voltage difference alarm value	1000mV	Yes	Relay disconnection
			Charging cell voltage	3.0s	Yes	

			difference alarm delay			
			Charging cell voltage difference recovery value	950mV	Yes	
			Charging cell voltage difference recovery delay	3.0s	Yes	
12	Discharging cell voltage difference protection	Level 1	Discharging cell voltage difference alarm value	400mV	Yes	Alarm
			Discharging cell voltage difference alarm delay	3.0s	Yes	
			Discharging cell voltage difference recovery value	350mV	Yes	
			Discharging cell voltage difference recovery delay	3.0s	Yes	
		Level 2	Discharging cell voltage difference alarm value	600mV	Yes	Reduce charging/discharging current to 0
			Discharging cell voltage difference alarm delay	3.0s	Yes	
			Discharging cell voltage difference recovery value	550mV	Yes	
			Discharging cell voltage difference recovery delay	3.0s	Yes	
		Level 3	Discharging cell voltage difference alarm value	1000mV	Yes	Relay disconnection
			Discharging cell voltage difference alarm delay	3.0s	Yes	
			Discharging cell voltage difference recovery value	950mV	Yes	
			Discharging cell voltage difference recovery delay	3.0s	Yes	

13	Charging cell temperature difference protection	Level 1	Charging cell temperature difference alarm value	10℃	Yes	Alarm
			Charging cell temperature difference alarm delay	3.0s	Yes	
			Charging cell temperature difference recovery value	7℃	Yes	
			Charging cell temperature difference recovery delay	3.0s	Yes	
		Level 2	Charging cell temperature difference alarm value	13℃	Yes	Reduce charging/discharging current to 0
			Charging cell temperature difference alarm delay	3.0s	Yes	
			Charging cell temperature difference recovery value	10℃	Yes	
			Charging cell temperature difference recovery delay	3.0s	Yes	
		Level 3	Charging cell temperature difference alarm value	15℃	Yes	Relay disconnection
			Charging cell temperature difference alarm delay	3.0s	Yes	
			Charging cell temperature difference recovery value	12℃	Yes	
			Charging cell temperature difference recovery delay	3.0s	Yes	
14	Discharging cell temperature difference protection	Level 1	Discharging cell temperature difference alarm value	10℃	Yes	Alarm
			Discharging cell temperature difference alarm delay	3.0s	Yes	

			Discharging cell temperature difference recovery value	7℃	Yes	
			Discharging cell temperature difference recovery delay	3.0s	Yes	
		Level 2	Discharging cell temperature difference alarm value	13℃	Yes	Reduce charging/discharging current to 0
			Discharging cell temperature difference alarm delay	3.0s	Yes	
			Discharging cell temperature difference recovery value	10℃	Yes	
			Discharging cell temperature difference recovery delay	3.0s	Yes	
		Level 3	Discharging cell temperature difference alarm value	15℃	Yes	Relay disconnection
			Discharging cell temperature difference alarm delay	3.0s	Yes	
			Discharging cell temperature difference recovery value	12℃	Yes	
			Discharging cell temperature difference recovery delay	3.0s	Yes	
15	Discharging Low SOC Protection	Level 1	Discharging low SOC alarm value	15%	Yes	Alarm
			Discharging low SOC alarm delay	3.0s	Yes	

			Discharging low SOC recovery value	17%	Yes	
			Discharging low SOC recovery delay	3.0s	Yes	
		Level 2	Discharging low SOC alarm value	10%	Yes	Reduce current to 0，Disabled by default
			Discharging low SOC alarm delay	3.0s	Yes	
			Discharging low SOC recovery value	12%	Yes	
			Discharging low SOC recovery delay	3.0s	Yes	
		Level 3	Discharging low SOC alarm value	5%	Yes	Relay disconnection，Disabled by default
			Discharging low SOC alarm delay	3.0s	Yes	
			Discharging low SOC recovery value	7%	Yes	
			Discharging low SOC recovery delay	3.0s	Yes	

4.4.General Alarm Parameter

No.	Parameter Item			Default Vault	Configurable	Remarks
1	Insulation Fault Protection	Level 1	Insulation fault alarm insulation resistance	500Ω/V	No	Alarm
			Insulation fault alarm delay	3.0s	No	
			Insulation fault recovery	600Ω/V	No	

			insulation resistance			
			Insulation fault recovery delay	3.0s	No	
		Level 2	Insulation fault alarm insulation resistance	350Ω/V	No	Reduce charging/discharging current to 0
			Insulation fault alarm delay	3.0s	No	
			Insulation fault recovery insulation resistance	450Ω/V	No	
			Insulation fault recovery delay	3.0s	No	
		Level 3	Insulation fault alarm insulation resistance	200Ω/V	No	Relay disconnection
			Insulation fault alarm delay	3.0s	No	
			Insulation fault recovery insulation resistance	300Ω/V	No	
			Insulation fault recovery delay	3.0s	No	
2	T1 High Temperature	Level 3	T1 High Temperature Level 3 Alarm Temperature	60℃	Yes	Relay disconnection
			T1 High Temperature Level 3 Alarm Delay	3.0s	Yes	
			T1 High Temperature Level 3 Recovery Temperature	50℃	Yes	
			T1 High Temperature Level 3 Recovery Delay	3.0s	Yes	
3	T1 Low	Level	T1 Low Temperature Level 3	-5℃	Yes	Relay disconnection

	Temperatur e	3	Alarm Temperature			
			T1 Low Temperature Level 3 Alarm Delay	3.0s	Yes	
			T1 Low Temperature Level 3 Recovery Temperature	-2℃	Yes	
			T1 Low Temperature Level 3 Recovery Delay	3.0s	Yes	
4	T2 High Temperatur e	Level 3	T2 High Temperature Level 3 Alarm Temperature	60℃	Yes	Relay disconnection
			T2 High Temperature Level 3 Alarm Delay	3.0s	Yes	
			T2 High Temperature Level 3 Recovery Temperature	50℃	Yes	
			T2 High Temperature Level 3 Recovery Delay	3.0s	Yes	
5	T2 Low Temperatur e	Level 3	T2 Low Temperature Level 3 Alarm Temperature	-5℃	Yes	Relay disconnection
			T2 Low Temperature Level 3 Alarm Delay	3.0s	Yes	
			T2 Low Temperature Level 3 Recovery Temperature	-2℃	Yes	
			T2 Low Temperature Level 3 Recovery Delay	3.0s	Yes	
6	High Voltage Anomaly	Level 3	High Voltage Abnormal Alarm Threshold (difference between sampled pack voltage and summed cell voltage)	30V	Yes	Relay disconnection
			High Voltage Abnormal	15.0s	Yes	

			Alarm Delay			
			High Voltage Abnormal Recovery Threshold	10V	Yes	
			High Voltage Abnormal Recovery Delay	3.0s	Yes	
7	Master-Slave Communication Faul	Level 3	Trigger Condition: Configured number of slave units is inconsistent with number of online slave units		No	Relay disconnection Restart to release
			Master-Slave Communication Alarm Delay	20.0s	No	
			Recovery Condition: Configured number of slave units matches number of online slave units		No	
			Master-Slave Communication Recovery Delay	5.0s	No	
8	**Limit Fault**	Level 3	Trigger Condition: Cell voltage or temperature exceeds the allowed operating range for the corresponding battery type: Lithium Iron Phosphate (LFP)：1500mV~3800mV NCM (Ternary Lithium)：2000mV~4300mV Lithium Titanate (LTO)：1000mV~3000mV Lead-acid：1000mV~3000mV Supercapacitor ：0mV~3000mV		No	Relay disconnection Restart to release
			Cell Temperature Limits (All Battery Types):-30℃~65℃。		No	
			Alarm Delay	3.0s	No	

			Fault can only be cleared after voltage and temperature return to normal range AND the BCU is power-cycled (system reboot required)	No	
9	Feedback Abnormality	Trigger Condition: The DI feedback status of relays or circuit breakers is inconsistent with the expected control command state		No	Relay disconnection and Restart to release
10	Contact Adhesion Fault	1.When sampled pack voltage ≥ 30 V and main circuit is open, HV1 (P+ side) ≥ 90% of total sampled voltage 2.When circuit is open and current > 5 A is detected	Trigger Condition (any one condition):	No	Relay disconnection Restart to release
11	Open Circuit Fault	During normal operation: HV1 (P+ side) < 90% of total sampled pack voltage		No	Relay disconnection Restart to release
12	Cell Voltage Harness Fault	1.First cell under-voltage: Cell 1 voltage < 50 mV 2.Last cell under-voltage: Last cell voltage < 50 mV 3.Adjacent cell abnormality: One cell ≥ 4800 mV and adjacent cell ≤ 800 mV	Trigger Condition (any one condition):	No	Relay disconnection Restart to release
13	Cell Temperature Sensor Harness Fault	Trigger Condition: (GPIO sampled voltage + 50 mV) > reference V33T Fault Indication: Sensor short circuit: temperature displays 150°C Sensor open circuit: temperature displays -50°C		No	Relay disconnection Restart to release
14	Fan Control (Cooling)	Fan ON condition: Maximum cell temperature > 30°C		Yes	/
		Fan OFF condition: Maximum cell temperature < 25°C		Yes	/
15	Standby Mode	Standby Sleep Delay	1440min	Yes	/
		Standby Sleep Current	2A	Yes	/
16	Cell	Balancing Voltage (average cell	3350mV	Yes	/

	Balancing	voltage)			
		Balancing Stop Voltage	3000mV	Yes	/
		Balancing Start Voltage Difference	40mV	Yes	/
		Balancing Stop Voltage Difference	20mV	Yes	/
17	Full Charge Calibration	Calibration conditions: 1.Max cell voltage ≥3600 mV (configurable) AND average cell voltage ≥ 3450 mV (configurable) 2.Charging current < 0.05C AND pack voltage ≥ 3500 mV × number of cells (configurable) Result: SOC calibrated to 100% Recovery conditions: 1.Max cell voltage < SOC full-charge release cell voltage 3600 mV (settable) AND delay 1 min (settable)	Trigger Condition (any one calibration condition, maintained for 1 s):SOC shall be set to 100%		/
18	Full Discharge Calibration	Calibration conditions: 1.Min cell voltage ≤2800 mV (configurable) AND average cell voltage ≤ 2900 mV (configurable) 2.Pack voltage ≤ 2900 mV × number of cells (configurable) Result: SOC calibrated to 0% Recovery conditions: 1.Max cell voltage > SOC full-discharge release cell voltage 2750 mV (settable) AND delay 1 min (settable)	Trigger Condition (any one calibration condition, maintained for 1 s):SOC shall be set to 0%		/

5. BMS installation instructions

5.1.Safety regulations requirements

Before starting installation or operation, please read the operating instructions and precautions carefully to avoid accidents.When installing or operating our company's equipment, you must comply with the regulations:

- Safety regulation and engineering design specifications of the relevant industry
- Strictly follow the relevant equipment precautions and special safety instructions provided by our company.

Specific Operational Requirements:

Accessories and Connections:

- All accessories connected to the protection board must be standard components supplied by our company (refer to the "Product List").
- Unauthorized connection of unverified external devices or accessories is strictly prohibited. For special requirements, prior confirmation from our technical support department is mandatory. Our company assumes no responsibility for damage to the circuit board resulting from the connection of non-standard or unapproved equipment.

Assembly Operations:

- During assembly, ensure that no part of the protection board makes direct contact with the cell surfaces to prevent cell damage.
- All assemblies must be secure and reliable.

Operational Precautions:

- During operation, strictly prevent high-temperature or metallic items (e.g., wire ends, soldering irons, solder) from contacting components on the circuit board to avoid damage.
- Consistently observe and implement protective measures: anti-static, moisture-proof, and waterproof.

Parameters and Conditions:

- Strictly adhere to the equipment's design parameters and operating conditions.

All operational parameters (e.g., voltage, current, temperature) must not exceed the limits specified in this datasheet. Operation outside these parameters may damage the protection board or other circuit components. For special requirements, prior confirmation from our technical support department is required.

Power Operations:

- When performing power-on or power-off operations, the specified power sequence must be strictly followed.

Battery Connection:

- When connecting the battery pack, always verify correct polarity. Incorrect or reverse polarity connections are strictly prohibited.

Initial Power-On Check:

- After completing the assembly of the battery pack and protection board, if there is no voltage output or inability to charge upon initial power-on, immediately turn off the power and carefully inspect all wiring for correctness.

The final explanation right belongs to TG-EP.

Shenzhen Tringo Control Co., Ltd.

Company add（R&D center): Bldg.4, Nantai Yunchuang Valley, Fenghuang Str., Guangming Dist., Shenzhen, CN

Url： www.tg-ep.com

Our company reserves the right to modify the equipment parameters without prior notice.