AYAA TECHNOLOGY CO., LTD

Datasheet

EF-002 Industrial Drone BMS

BMS Product Specification

Document No.	AYAA-20260120	**Revision**	V1.0.1
Product Name	28S 400A Lithium Battery Smart BMS		
Customer Model			
Product Model	EF-002 Industrial Drone BMS		
Date	2026-01-20		

Revision V1.0.1/ 2026-01-20

1. Introduction

This intelligent protection board supports 28-series battery configuration with parameterizable settings to accommodate different types of lithium batteries. It features CAN communication capability, battery protection, and state of charge (SOC) estimation functions.

2. Feature Specifications

No.	Item	Specification	No.	Item	Specification
1	Supported Series	28S	10	Temperature Accuracy	±2℃
2	Cell Voltage Detection Range	0-5V	11	Temperature Sensor Type	NTC
3	Cell Voltage Detection Accuracy	±5mV	12	SOC Estimation Accuracy	<5%
4	Total Voltage Detection Range	50-140V	13	Operating Temperature Range	-40℃ to 80℃
5	Total Voltage Detection Accuracy	≤±1%	14	Operating Humidity Range	5%-90%
6	Current Detection Accuracy	≤±100mA (<100A) ≤±3% (<50A)	15	Dimensions	273 x 167 x 25 mm
7	Weight	700g	16		
8	Temperature Sensors	4	17		
9	Temperature Detection Range	-40℃ to 105℃	18		

- Cell voltage and total voltage detection, overcharge/over-discharge alarm and protection functions, short circuit protection. At room temperature, static voltage sampling accuracy can reach ≤5mV.
- Charge and discharge current detection, charge/discharge overcurrent alarm and protection. Charging current displayed as positive, discharging current displayed as negative. Current sampling accuracy can reach ≤3% at room temperature.
- Cell, ambient, and MOS temperature detection, cell high/low temperature alarm and protection, MOS high temperature alarm and protection, ambient high/low temperature alarm. Temperature sampling accuracy can reach ≤2℃ at room temperature.
- Charging balancing function with 50mA balancing current.
- Cell capacity estimation function. Full charge capacity, current capacity, and design capacity can be set via the host software. Capacity can be automatically updated after a complete charge-discharge cycle.
- SOC static calibration function, calibrating SOC by comparing static voltage to reduce SOC calculation error.
- Host software control function, allowing parameter setting for overcharge, over-discharge, charge/discharge overcurrent, over-temperature, under-temperature protection, and capacity settings via the host software.

- CAN communication interface with isolated communication, supporting CAN 2.0B. Software upgrade via firmware package.

3. Electrical Characteristics

3.1 Protection Parameter Settings

(Note: Unless otherwise specified, all parameters below are tested at 25℃ ambient temperature)

No.	Parameter Item	Default Value	Configurable	Remarks
1	**Cell Overcharge Protection**			Cell overvoltage only turns off charging MOS
	Overcharge Warning Voltage	4200mV	Yes	
	Overcharge Protection Voltage	4280mV	Yes	
	Overcharge Protection Delay	1.0S	Yes	
	Overcharge Release Voltage	4200mV	Yes	Release condition: discharge current > 0.6A or voltage below release voltage
2	**Cell Over-discharge Protection**			Cell over-discharge turns off discharge MOS, inactive during flight
	Over-discharge Warning Voltage	3100mV	Yes	
	Over-discharge Protection Voltage	2600mV	Yes	
	Over-discharge Protection Delay	3.0S	Yes	
	Over-discharge Release Voltage	3000mV	Yes	Release when entering charging state (charging current > 0.6A). Activates when voltage exceeds release voltage
3	**Total Overcharge Protection**			Total overvoltage turns off charging MOS
	Overcharge Warning Voltage	4.2×28V	Yes	
	Overcharge Protection Voltage	4.28×28V	Yes	
	Overcharge Protection Delay	1.0S	Yes	

	Overcharge Release Voltage	4.2×28V	Yes	
	Overcharge Release Delay	3.0S	Yes	Release condition: discharge current > 0.6A or voltage below release voltage
4	**Total Over-discharge Protection**			Total undervoltage does not turn off discharge MOS
	Over-discharge Warning Voltage	3.1×28V	Yes	
	Over-discharge Protection Voltage	2.6×28V	Yes	
	Over-discharge Protection Delay	3.0S	Yes	
	Over-discharge Release Voltage	2.0×28V	Yes	Release when entering charging state (charging current > 0.6A). Activates when voltage exceeds release voltage
5	**Charge Overcurrent Protection**			Charge overcurrent protection turns off charging MOS
	Rated Current	≤400A		
	Charge Overcurrent Protection Current	200A	Yes	
	Charge Overcurrent Protection Delay	1.0S	Yes	
	Charge Overcurrent Release	Auto release		Auto releases after 10S
	Discharge Release Condition			Discharge current > 0.6A
6	**Discharge Overcurrent Level 1**			Inactive during flight
	Rated Current	≤400A		
	Level 1 Protection Current	\		
	Level 1 Protection Delay	\		
	Level 1 Protection Release	Auto release	\	
	Charge Release	\		
7	**Discharge Overcurrent Level 2**			Inactive during flight
	Level 2 Protection Current	\	\	

	Level 2 Protection Delay	\		
	Level 2 Protection Release	Auto release	\	
	Charge Release	\		
8	**Short Circuit Protection**			Effective in ground mode. Turns off discharge MOS after short circuit protection
	Short Circuit Protection Current	1500A		
	Short Circuit Protection Delay	200μS		
	Short Circuit Release	Remove load to release		Charge current > 0.6A
9	**MOS Over-temperature Protection**			MOS over-temperature turns off charging MOS. During flight, MOS over-temperature only alarms without protection
	MOS High Temperature Warning	80℃	Yes	
	MOS Over-temperature Protection	100℃	Yes	
	MOS Protection Release Temperature	70℃	Yes	
10	**Cell Temperature Protection**			Charge high/low temperature protection turns off charging MOS
	Charge Low Temperature Protection	0℃	Yes	
	Charge Low Temperature Release	5℃	Yes	
	Charge High Temperature Protection	55℃	Yes	
	Charge High Temperature Release	45℃	Yes	

	Discharge Low Temperature Warning	-20℃	Yes	Discharge high/low temperature only alarms during flight, does not turn off discharge MOS. If discharge high/low temperature protection is present, startup is not allowed
	Discharge Low Temperature Release	-15℃	Yes	
	Discharge High Temperature Warning	55℃	Yes	
	Discharge High Temperature Release	50℃	Yes	
	Temperature Protection/Release Delay	5.0S		
11	**SOC Accuracy**	3%~5%		Requires one charge-discharge cycle after initial power-on to achieve specified accuracy
12	**Quiescent Current**			
	Operating Self-consumption Current	≤15mA		
	Low Power Mode Current	≤150μA		
13	**Balancing Function**			
	Balancing On Voltage	3900mV		
	On Voltage Difference	30mV		
	Off Voltage Difference	15mV		
	Balancing Current	50mA		

3.2 Electrical Performance

(Note: Unless otherwise specified, all parameters below are tested at 25℃ ambient temperature)

No.	Item	Min	Typ	Max	Unit	Remarks
1	Operating Voltage	80	108	130	V	
2	Operating Power Consumption	-	15	20	mA	
3	Deep Sleep Current	-	100	150	μA	
4	CAN Interface Voltage Rating	-	-	30	V	
5	Charging MOS Voltage Rating	-	-	150	V	
6	Discharge MOS Voltage Rating	-	150	-	V	
7	Heating Interface Voltage Rating	-	-	150	V	
8	Heating Interface Max Current	-	5	10	A	
9	LED Drive Current	3	5	-	mA	
10	Peak Discharge Current	-	1000	-	A	
11	Rated Temperature Rise	-	5	-	℃	400A continuous discharge for 10min
12	Balancing and Self-discharge Time	-	0.5	-	S	Balancing time per second

3.3 LED Indication

The PCB board is equipped with one LED indicator. Normal operation: slow flashing; protection board abnormal: fast flashing.

The LED board layout is shown in Figure 1.

Figure 1: LED Board Layout

LED battery level display patterns (button query and discharge mode):

LED4 (Green)	LED3 (Green)	LED2 (Green)	LED1 (Green)	LED5 (Red)	SOC
●		●	●	○	95~100%
◎		●	●	○	90~94%
○		●	●	○	80~89%
○		◎	●	○	70~79%
○		○	●	○	60~69%
○		○	◎	○	50~59%
○		○	○	○	40~49%
○		○	◎	○	20~39%
○		○	◎	◎	0~19%

● = Solid on ◎ = Flashing (1Hz) ○ = Off

During button query, the battery level is displayed for 5 seconds according to the table above, then turns off.

LED patterns during charging:

LED4 (Green)	LED3 (Green)	LED2 (Green)	LED1 (Green)	LED5 (Red)	SOC
●		●	●	○	95~100%
◎		◎	◎	○	80~94%
○		◎	◎	○	60~79%
○		○	◎	○	40~59%
○		○	○	○	0~39%

← Marquee direction: LEDs light up sequentially based on battery level, then turn off, then cycle repeats. For example, at SOC=65%, LED1~LED3 light up sequentially, then turn off, then repeat. Frequency: 2Hz.

Special LED Patterns:

No.	LED Pattern Meaning	LED Display

1	Startup Success	LED5, LED1~4 sequential marquee lighting, 2Hz
2	Startup/Shutdown Failure	LED5 flashing, 2Hz
3	Shutdown Success	LED4~1, LED5 sequential marquee lighting, 2Hz
4	Undervoltage Warning	LED5, LED1 flash together, 2Hz
5	Undervoltage Protection	LED5, LED1 flash together, 3Hz
6	Overvoltage Warning	LED5, LED4 flash together, 2Hz
7	Overvoltage Protection	LED5, LED4 flash together, 3Hz
8	High Temperature Warning	LED5, LED2 flash together, 2Hz
9	High Temperature Protection	LED5, LED2 flash together, 3Hz
10	Low Temperature Warning	LED5, LED3 flash together, 2Hz
11	Low Temperature Protection	LED5, LED3 flash together, 3Hz
12	Charge Overcurrent Warning	LED5, LED4, LED3 flash together, 2Hz
13	Charge Overcurrent Protection	LED5, LED4, LED3 flash together, 3Hz
14	Discharge Overcurrent Warning	LED5, LED1, LED2 flash together, 2Hz
15	Discharge Short Circuit	LED5, LED1, LED2 flash together, 3Hz
16	Self-discharging	LED2, LED3 flash together, 2Hz
17	Firmware Upgrade in Progress	LED1~4 flashing to show upgrade progress, 2Hz
18	Charging Heating	LED3, LED4 flash together, 2Hz
19	Button-activated Heating	LED3, LED4 flash together, 3Hz

3.4 Operating Mode Description

Running Mode (Power On): Normal battery level display, battery can charge and discharge, communication available.

Idle Mode (Power Off): In running mode, when operating current is less than 100mA and no communication for 1 hour, automatically switches to idle mode. Alternatively, a short press + long press of the button in power-on state enters idle mode. In idle mode, short press button to check battery level, communication available, charging available, discharging not available.

Sleep Mode: In idle mode with no communication and no charging wake-up for 1 hour, enters sleep mode. Also enters sleep mode 1 minute after undervoltage protection. Idle sleep mode can be woken by button press, communication, or charging. Undervoltage sleep mode can only be woken by charging.

Running mode (power-on state) can be further divided into In-flight State and Ground State. The division can be determined by the following methods:

(1) If the aircraft can provide a presence signal, in-flight state is determined when the presence signal is active and discharge current exceeds the threshold. If no presence detection signal is available, in-flight state is determined solely by discharge current exceeding the threshold.

(2) If the flight controller can lock the battery via protocol, receiving the lock command from the flight controller determines in-flight state.

In in-flight state, all discharge protections only provide alarms without disconnecting the discharge switch, and the short press + long press shutdown command is disabled.

3.5 Historical Data Recording

State	Recording Conditions
Charging State	Records one entry each when charging switch opens/closes; records one entry when individual cell voltage fluctuates +25mV or -100mV
Discharging State	Records one entry each when discharging switch opens/closes; records one entry when individual cell voltage fluctuates -25mV or +100mV
Idle Mode	Records one entry when individual cell voltage fluctuates -100mV or +100mV

Total recording capacity: 10,240 entries. When exceeded, rolling overwrite is used in FIFO mode.

3.6 Charging MAP

The charging MAP is only applicable to smart chargers and is configured according to the cell specification sheet.

3.7 Heating Function

3.7.1 Charging Heating

In charging mode, if the temperature is below the allowable threshold, charging heating is activated. Heating stops and charging begins when the charging allowable temperature threshold is reached.

3.7.2 Pre-flight Heating

When pre-flight heating is required, press and hold the power button for 5 seconds to activate heating. Note that heating at this point uses the battery's own energy for self-heating. Heating stops when the heating threshold is reached or when the power button is pressed and held for 5 seconds again.

3.8 Self-discharge Function

3.8.1 Self-discharge Activation

When the protection board is in sleep mode, it wakes up every 7 days. If the battery level is greater than 50% and the lowest cell voltage is above 3.73V, self-discharge is activated. Self-discharge is implemented through the balancing function of each series, with a discharge current of 50mA. Self-discharge is activated for 0.5 seconds every 1 second, with odd and even series alternating discharge, until the self-discharge deactivation condition is met.

3.8.2 Self-discharge Deactivation

Self-discharge is deactivated when any of the following conditions is met:

1) The protection board enters charging or discharging state;

2) Battery level is checked via short button press;

3) Lowest voltage drops below 3.72V;

4) Battery temperature exceeds discharge high temperature warning threshold;

5) Battery level is less than or equal to 50%.

3.9 Balancing Function

The protection board has a built-in passive balancing function with approximately 50mA balancing current. It supports charging balancing and idle balancing. After activation, balancing targets the highest series, with each balancing session lasting 0.5 seconds, once per second.

3.9.1 Balancing Activation

Balancing is activated when any of the following conditions is met:

1) In charging state with voltage difference greater than 50mV, balancing of the highest series is activated;

3.9.2 Balancing Deactivation

Balancing is deactivated when any of the following conditions is met:

1) In discharging state;

2) In any state, when voltage difference is less than or equal to 20mV.

4. Communication Description

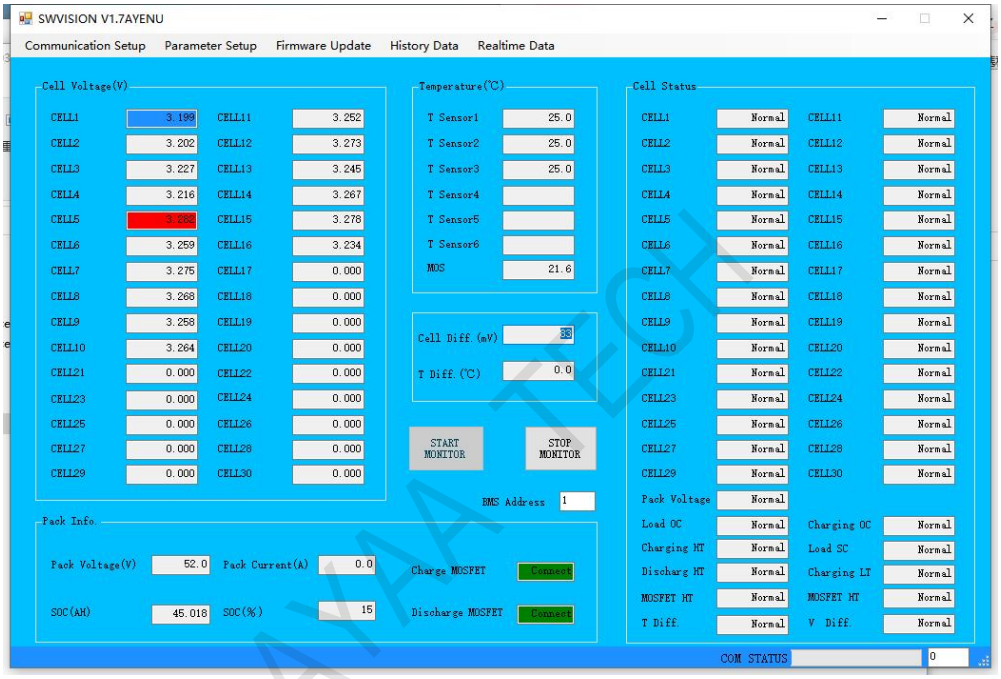
4.1 Custom CAN Communication

This BMS supports integration with UAVCAN, DroneCAN, Vik, JiYi, and BoYing flight controller protocols.

4.2 Host CAN Communication

4.2.1 Debug Host Software Description

The debug host software uses an RS485 interface. Software interface is as shown below. Baud rate: 19200, N, 8, 1.



The host software main interface is divided into individual cell voltage display (Cell 1 voltage is the first series voltage, i.e., the lowest series near the total negative B-), temperature display, battery information display (including total voltage, SOC, remaining capacity, charge/discharge current; charging current shown as positive, discharging current shown as negative), MOS status including charging MOS, discharging MOS, and heating MOS (conducting means MOS is on).

(1) Individual cell voltage can display each series battery voltage, as well as the highest and lowest voltage. Highest voltage has a red background, lowest voltage has a green background.

(2) Battery working status can display various protection flags and individual cell status. If it turns red and shows a fault, it indicates the corresponding fault has been triggered.

(3) Communication status can display the communication status. If no data is displayed, communication is abnormal.

(4) After opening the serial port, click "Start Monitoring" to begin communication. Some functions are only enabled after monitoring starts.

4.2.2 Parameter Settings

(1) Parameter settings are divided into voltage parameters, current parameters, temperature parameters, and system parameters.

(2) Voltage parameters include individual cell and total voltage overcharge/over-discharge protection voltage thresholds, release thresholds, and detection delays. (Warning parameters are only for specific customer requirements; if not needed, they can be ignored without affecting use)

(3) Current parameters include charging overcurrent protection threshold, detection delay, discharging overcurrent and short circuit protection thresholds and detection delays.

(4) Temperature parameters include charging high/low temperature protection release threshold settings, discharging high/low temperature protection/release threshold settings, heating switch temperature settings, and MOS high temperature settings.

(5) System parameters can set CAN communication address (invalid for custom protocols), CAN communication baud rate, battery pack rated capacity, battery voltage calibration (proportional calibration method), and

charge/discharge current calibration (it is recommended to perform current and voltage calibration after BMS assembly; calibration coefficient = actual current/voltage divided by displayed current/voltage).

4.2.3 Firmware Update

The BMS supports online firmware upgrade. When BMS communication is normal, open the firmware file (firmware type: .swg format) and the upgrade will start automatically. A success pop-up will appear after the upgrade is complete. Click to confirm completion.

4.2.4 Historical Fault Data

(1) The BMS has a historical fault and data recording function. Fault records and battery historical operating status can be viewed via the host software.

(2) After clicking "Read Faults", the corresponding fault trigger count and cycle count will be displayed, along with the last 10 shutdown code records.

(3) It is recommended that customers clear fault records before shipment after completing aging tests.

(4) Clearing historical records will clear faults and cycle counts, and will clear all historical data records.

4.2.5 Real-time Data

Real-time data can display battery status information read by the host software in real time, and can be exported in table format to the host software root directory.

4.2.6 Historical Discharge Data

(1) The BMS has a historical charge/discharge data recording function. When charging starts or power-on discharge begins, data is recorded once per second, including operating time, battery voltage, current, temperature, status flags, capacity, etc. Up to 5 hours of historical data can be recorded.

(2) Each time the system transitions from idle state to charging or discharging state, recording restarts.

(3) Click "Start Reading Historical Data" to display the historical data records stored in the BMS.

(4) Click "Export Data" to save historical data in table format to the host software directory.

(5) Clearing historical records will clear faults and historical count as well as cycle counts, and will clear all historical data records.

4.2.7 RTC Calibration

(1) RTC calibration is used to calibrate the internal RTC time of the BMS.

(2) RTC time resets after power loss, so RTC time must be calibrated after the first power-on.

5. Mechanical Data

5.1 Temperature Sampling Port

The temperature sampling terminal uses HY-4AW. The temperature probe uses 10K 1%, B-value 3435.

5.2 Sampling Port 1

Individual cell sampling port 1 uses HY-15AW. Pin definitions are as follows:

No.	Pin	Description
1	B0	Lowest series negative
2	B1	Lowest series positive
3	B2	2nd series positive
4	B3	3rd series positive
5	B4	4th series positive
6	B5	5th series positive
7	B6	6th series positive
8	B7	7th series positive
9	B8	8th series positive
10	B9	9th series positive
11	B10	10th series positive
12	B11	11th series positive
13	B12	12th series positive
14	B13	13th series positive
15	B14	14th series positive

5.3 Sampling Port 2

Individual cell sampling port 2 uses HY-14AW. Pin definitions are as follows:

No.	Pin	Description
1	B15	15th series positive
2	B16	16th series positive
3	B17	17th series positive
4	B18	18th series positive
5	B19	19th series positive
6	B20	20th series positive
7	B21	21st series positive
8	B22	22nd series positive
9	B23	23rd series positive
10	B24	24th series positive
11	B25	25th series positive
12	B26	26th series positive

13	B27	27th series positive
14	B28	28th series positive

5.4 Switch/Communication Port

No.	Pin	Description
1	SW1	Switch contact
2	SW2	Switch contact
3	GNDISO	Communication isolated ground
4	CANH	CAN High
5	CANL	CAN Low

The switch contacts can be used for presence detection, i.e., the aircraft end shorts the corresponding contacts.

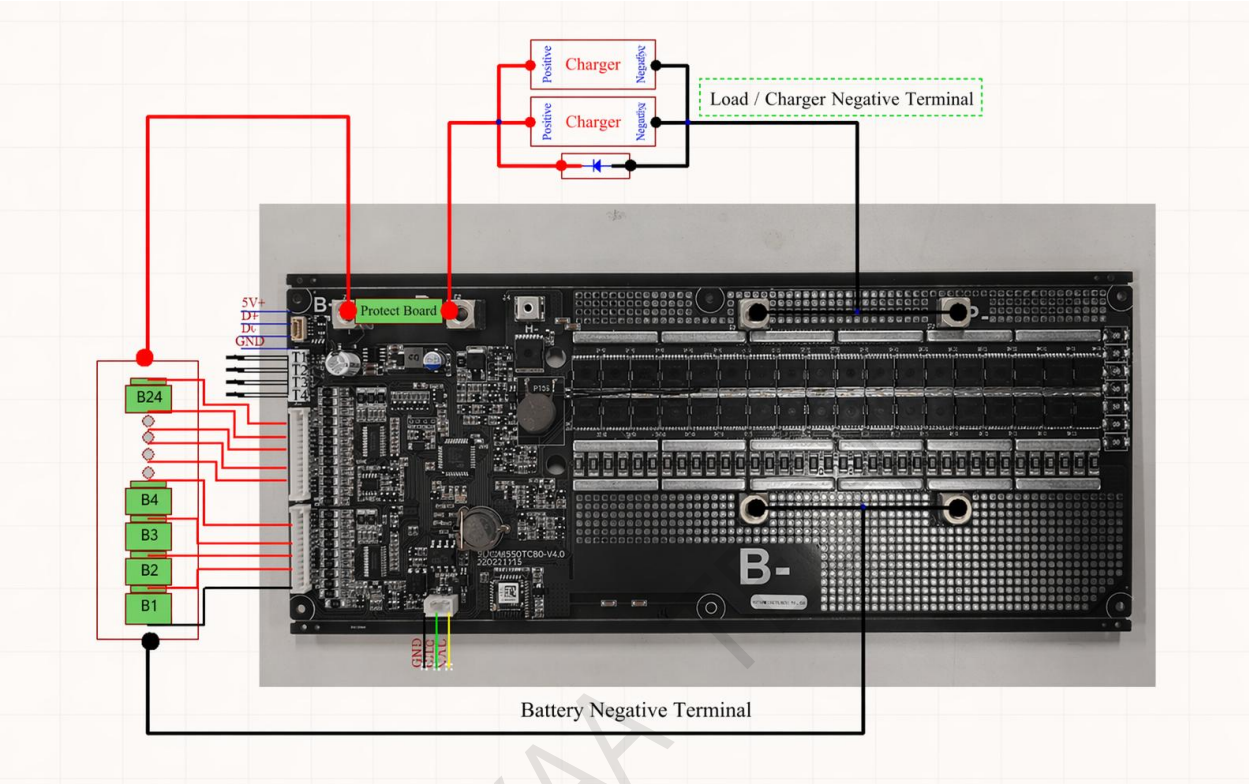
5.5 USB Type-C Port

The USB Type-C port is mainly used for debugging. It can connect to our host software for data monitoring, parameter adjustment, and historical data query and export. This Type-C port must not be used for any form of charging input or output.

5.6 Bluetooth Interface

Built-in Bluetooth module, battery data can be viewed via Bluetooth APP.

6.Charge and Discharge Wiring Diagram



7. Usage Notes

Note: When the actual number of connected cells is less than 28, this product will be pre-configured with jumper connections at the factory. Users only need to connect according to the wire sequence. B- and C- are configured with multiple power cables. Please ensure all cables are connected during wiring, otherwise the protection board current sampling accuracy will be affected, impacting normal use.

- When soldering battery leads, incorrect connection or reverse polarity must be strictly avoided. If incorrect connection has occurred, this circuit board may be damaged and must be re-tested and confirmed qualified before use.
- During assembly, the protection board must not directly contact the cell surface to avoid damaging the cells. Assembly must be firm and reliable.
- During use, ensure that wire ends, soldering iron, solder, etc. do not come into contact with components on the circuit board, as this may damage the board.
- During use, pay attention to anti-static, moisture-proof, and waterproof measures.
- During use, please follow the design parameters and usage conditions. Do not exceed the values specified in this specification, otherwise the protection board may be damaged.

- After assembling the battery pack and protection board, if no voltage output or inability to charge is found during initial power-on, please check whether the wiring is correct.