



88 串+8 串机器人锂电池保护板规格书
88+8 Series Robot Lithium Battery Protection Board
Specification

产品型号: ZB300V-0001

Product Model: ZB300V-0001

文件编号 Document No		生效日期 Effective date	
版本 Edition	V0	页数 Page	27
审批 Approved		检查 Checked	设计 Designed

福建臻格科技有限公司
Fujian Geekey Technology LTD

修改记录
Modification Record

修订日期 Modification Date	修订内容 Revision Details	版次 Edition	修订人 Modifier
2026. 08. 27	首次发行	V0	郑恩亮

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1.应用范围 Application Scope

本产品为 8 串低压 + 88 串高压双组磷酸铁锂电池一体化保护板，专用于特种工业机器人动力供电场景，适配勘探、消防、重载协作机械臂、AGV 特种机器人设备。内置多路 PDU 功率分配单元，支持高低压电池独立管理，搭载被动均衡功能；搭载 CAN2.0 工业总线、蓝牙透传通信，可对接机器人整机控制器与配套充电装置，实现整机实时数据采集、分级告警、远程控制；支持硬件端口定制开发。

This product is an integrated protection board for dual-group lithium iron phosphate batteries (8-series low voltage + 88-series high voltage), specially designed for power supply of special industrial robots, applicable to exploration, fire-fighting, heavy-duty collaborative manipulators, AGV special robot equipment. Built-in multi-channel PDU power distribution unit, supporting independent management of high and low voltage batteries, equipped with passive cell balancing function; equipped with CAN2.0 industrial bus and Bluetooth transparent transmission communication, which can connect with the robot main controller and supporting charging device to realize real-time data collection, hierarchical alarm and remote control of the whole machine; reserved RS485 backup extended communication interface to support customized hardware port development.

2.功能特性 Functional Features

2.1 电芯均衡功能

Cell balancing function

本产品采用被动均衡技术，充电阶段实时采集 8 串低压、88 串高压两组磷酸铁锂电芯单体电压；当单节电芯电压或模组内电芯压差达到设定阈值时，对电压偏高电芯进行耗能放电，以热量形式释放多余电量，缩小整组电芯压差，保障电池组一致性，延长循环使用寿命。均衡开启阈值可通过机器人主控 CAN 总线下发指令配置。

This product adopts passive balancing technology. During charging, it collects the cell voltage of two groups of lithium iron phosphate batteries (8-series low voltage & 88-series high voltage) in real time. When the single cell voltage or cell voltage difference in the module reaches the set threshold, the cells with higher voltage will be discharged to release excess energy in the form of heat, reduce the voltage difference of the whole battery pack, ensure battery consistency and extend cycle life. The balance enable threshold can be configured via CAN bus commands

sent by robot main controller.

2.2 电压检测与分级告警保护功能

Voltage monitoring and two-stage alarm protection function

BMS 同步采集 8 串 24V 低压模组、88 串 300V 高压模组每一节单体电压及两组总电压，区分一级预警、二级故障两级保护机制；单体过压、单体欠压、模组总压异常可通过 CAN 总线向机器人整机控制器上传告警报文，同时支持上位机配置各级电压保护阈值、告警阈值。系统内置绝缘监测功能，实时检测电池包绝缘阻抗，绝缘阻值低于阈值同步上报故障。

The BMS synchronously collects the single cell voltage and total pack voltage of 8-series 24V low-voltage module and 88-series 300V high-voltage module, with two-stage protection mechanism including primary warning and secondary fault. Abnormal single cell overvoltage, undervoltage and total pack voltage will upload alarm messages to robot main controller via CAN bus, and users can configure voltage protection & alarm thresholds through upper computer. Built-in insulation monitoring function detects battery pack insulation resistance in real time and reports faults synchronously when insulation resistance is lower than threshold.

2.3 电流检测与分级过流保护功能

Current monitoring and two-stage over-current protection function

板载多路霍尔电流采样，分别监测 8 串低压回路、88 串高压回路充放电电流、4 路 24V 低压输出支路、2 路 300V 动力支路电流；具备分级放电过流、充电过流、短路检测保护，故障信息经 CAN 总线上报整机控制器，保护动作阈值、延时参数可通过工业总线远程配置。充电回路增加防反接硬件电路，充电碳刷极性接反时自动阻断充电回路，无电流输出。

Multi-channel Hall current sampling is integrated on board to monitor charge/discharge current of 8-series low voltage loop & 88-series high voltage loop, 4-channel 24V low voltage output branches and 2-channel 300V power branches separately. It supports two-stage discharge overcurrent, charging overcurrent and short-circuit detection protection. Fault information is uploaded to main controller via CAN bus, and protection threshold & delay parameters can be remotely configured through industrial bus. Anti-reverse hardware circuit is added to charging loop to block charging automatically with no output when charging carbon brush is reversed.

2.4 多通道温度检测与过温保护功能

Temperature monitoring and over-temperature protection function

BMS 搭载不少于 12 路电芯温度采样点，同时采集 MOS 功率管温度；分别设置充电高温、放电高温、低温预警、MOS 管超温四级温度保护，高低温故障分级上传控制器。密闭环

形安装结构依靠板载散热片自然散热，无内置散热风扇，高温时自动切断充放电回路，温度回落至安全区间后自动恢复输出。

The BMS is equipped with no less than 12 cell temperature sampling points, and collects temperature of MOS power tubes simultaneously. Four-level temperature protection including charging high temperature, discharge high temperature, low temperature warning and MOS over-temperature are configured, and high/low temperature faults are uploaded to controller by level. The closed ring installation structure relies on on-board heat sink for natural heat dissipation without built-in cooling fan. Charge/discharge loop will be cut off automatically at high temperature, and output recovers automatically after temperature drops to safe range.

2.5 本地 / 远程双模式急停保护功能

Local & remote dual-mode emergency stop protection

硬件本地急停：物理急停按钮直接切断两路 300V 高压动力回路，响应时间 $\leq 10\text{ms}$ ；远程蓝牙急停：通过机器人控制器蓝牙模块下发急停指令，远距离切断全部高压动力输出；急停触发后锁止高压回路，消除急停信号后可通过 CAN 总线复位解除保护。

Hardware local emergency stop: physical stop button directly cuts off two 300V high-voltage power loops with response time $\leq 10\text{ms}$. Remote Bluetooth emergency stop: send stop command via robot controller Bluetooth module to cut off all high-voltage power output remotely. The high-voltage loop will be locked after emergency stop trigger, and protection can be reset via CAN bus after stop signal is removed.

2.6 多路 PDU 独立功率分配控制

Multi-channel PDU independent power distribution control

内置集成 PDU 功率分配单元，支持 4 路独立 24V 低压输出、2 路独立 300V 高压动力输出；每一路输出均配备独立 MOS 开关与电流检测，机器人控制器通过 CAN 下发上下电指令，可单独控制液压驱动、感知模组、散热风扇、动力单元各路电源通断；放电继电器由独立 24V 辅助回路供电，满足整机严格上电、下电时序逻辑。

Integrated PDU power distribution unit is built in, supporting 4 independent 24V low-voltage outputs and 2 independent 300V high-voltage power outputs. Each output channel is equipped with independent MOS switch and current detection. The robot main controller sends power on/off commands via CAN to separately control power supply of hydraulic driver, sensing module, cooling fan and power unit. Discharge relay is powered by independent 24V auxiliary loop to meet strict power-on and power-off sequence logic of the whole machine.

2.7 电池组容量精准计算功能

Battery pack capacity calculation function

通过电流对时间积分算法精准计算 8 串、88 串两组电池独立 SOC 剩余电量、SOH 健康状态；两组电池额定容量可通过 CAN 总线配置，完整充放电循环完成后系统自动校正、更新容量参数，SOC 估算误差 $\leq 3\%$ 。

Accurately calculate independent SOC (State of Charge) and SOH (State of Health) of 8-series and 88-series batteries through current-time integration algorithm. The rated capacity of two battery groups can be configured via CAN bus, and the system automatically calibrates and updates capacity parameters after a complete charge-discharge cycle, with SOC estimation error $\leq 3\%$.

2.8 CAN 总线工业通信控制

CAN bus industrial communication control

采用 CAN2.0 标准帧协议，通信波特率 500kbps，支持 120 Ω 终端匹配电阻硬件切换；周期 100ms 主动上报两路电池电压、电流、温度、SOC、故障告警报文；接收整机控制器下发的充电启停、各路 PDU 上下电、远程急停、参数配置、软件升级指令。支持蓝牙透传对接外部充电机，下发充电电压、电流、加热模式控制指令。

Adopt CAN2.0 standard frame protocol with baud rate 500kbps, support hardware switch of 120 Ω terminal matching resistor. It actively uploads messages of two groups' battery voltage, current, temperature, SOC and fault alarm every 100ms; receive commands from main controller including charge start/stop, PDU channel power on/off, remote emergency stop, parameter configuration and software upgrade. Bluetooth transparent transmission is supported to connect external charger and send control commands of charging voltage, current and heating mode.

2.9 故障存储与诊断功能

Fault storage and diagnosis function

本地存储最多 100 条带时间戳故障记录，包含故障类型、触发时刻、触发时电芯电压 / 电流 / 温度数据；开机自动自检电芯采样、温度通道、CAN 通信、MOS 驱动硬件状态；支持通过总线导出故障码，便于设备运维排查故障。

Locally store up to 100 fault records with timestamp, including fault type, trigger time, cell voltage/current/temperature data when triggered. It automatically self-checks cell sampling, temperature channel, CAN communication and MOS driver hardware status after power on; support fault code export via bus for equipment maintenance and troubleshooting.

2.10 远程 OTA 软件升级

Remote OTA software updates

支持通过 CAN 总线或串口本地下发升级包完成 BMS 主控程序 OTA 升级，无需拆卸电路板，便于现场调试与程序迭代优化。

Support OTA upgrade of BMS main control program by sending upgrade package via CAN bus or serial port locally without disassembling circuit board, convenient for on-site debugging and program iteration optimization.

2.11 智能休眠唤醒功能

Intelligent sleep & wake-up function

满足静态低电流（输出电流 $<15\text{mA}$ 持续 2min）或低电量（SOC $<10\%$ ）任一条件时自动进入休眠，休眠整机功耗 $\leq 5\text{mA}$ ；接入充电碳刷、按下电源开关可唤醒 BMS 恢复正常工作。

It automatically enters sleep mode when static low current (output current $<15\text{mA}$ for 2min) or low SOC (SOC $<10\%$) is satisfied, with overall sleep power consumption $\leq 5\text{mA}$. The BMS can be woken up to normal operation by connecting charging carbon brush or pressing power switch.

2.12 三防硬件与 EMC 抗干扰防护

Three-proof hardware & EMC anti-interference protection

PCB 电路板做防潮、防霉、防盐雾三防涂层处理；端口优化设计抑制上电打火；板载 TVS 二极管、共模电感抑制浪涌、静电尖波，可承受 $\pm 15\text{kV}$ 静电冲击，适配工业机器人复杂电磁环境。整机壳体满足 IP65 防护等级。

PCB circuit board is coated with three-proof coating for moisture-proof, mildew-proof and salt spray-proof. Optimized port design suppresses spark during power-on. On-board TVS diode and common-mode inductor restrain surge and static spike, withstand $\pm 15\text{kV}$ electrostatic impact, adapting to complex electromagnetic environment of industrial robots. The whole shell meets IP65 protection level.

2.13 充电协同控制功能

Charging cooperative control function

充电碳刷具备电压检测，仅高压区间 240~350V、低压区间 23~29V 时允许闭合充电继电器；控制器经蓝牙下发充电指令后，BMS 同步闭合 24V、300V 两路充电继电器对两组电芯同时充电；单组电池充满后自动断开对应充电回路，全部充满或接收停止指令后切断两路继电器，保证充电碳刷无残余带电。支持充电机加热模式控制，可驱动电池内部加热膜低温

预热。

Voltage detection is equipped on charging carbon brush, charging relay can only be closed when high voltage ranges from 240~350V and low voltage ranges from 23~29V. After controller sends charging command via Bluetooth, BMS closes 24V and 300V charging relays synchronously to charge two cell groups at the same time. Corresponding charging loop will be disconnected automatically when single group is fully charged. Two relays are cut off after full charge or stop command received to ensure no residual electricity on carbon brush. Support charger heating mode control to drive internal heating film for low-temperature preheating.

2.14 按键激活及复位功能

Button activation and reset functions

电源按键可唤醒休眠状态 BMS；整机运行时长按按键 5 秒可完成系统整机重启复位。

Power button can wake up BMS from sleep mode; long press the button for 5 seconds during operation to complete system full reset and restart.

3.参数设置 Parameters setting

3.1 额定参数 Rated parameters

项目 project	规格 specification	单位 unit	备注 remark
充电电流 charging current	10A(8 串); 10A(88 串) 10A(8S); 10A(88S)	A	持续充电电流 Sustained charging current
放电电流 discharge current	15A(8 串持续 /8SContinuous) 30A(8 串瞬时峰值 /instantaneous peak); 5A (88 串持续 /88S Continuous), 70 A(88 串瞬时峰值 /Instantaneous peak)	A	持续放电 / 开机瞬时峰值 Continuous discharge / Instantaneous peak at startup
工作温度 operating temperature	-20~60	°C	整机正常工作区间 Normal operating range of the whole unit
贮存温度 storage temperature	-40~85	°C	长期存放环境 Long-term storage environment
工作湿度 operating humidity	0%~90%	RH	无凝露环境 Non-condensing environment
电流 / 电压 / 温度采样 误差 Sampling error of current, voltage and temperature	<±5%		高精度采集 High-precision acquisition

项目 project	规格 specification	单位 unit	备注 remark
CAN 总线通信 CAN2.0 communication	支持标准 11 位帧，波特率 500kbps，支持 120Ω 终端电阻切换 Supports standard 11-bit frames, baud rate of 500 kbps, and 120 Ω termination resistor switching.		机器人主控交互主通信 Main communication with robot main controller
蓝牙通信 Bluetooth communication	支持与充电机透传指令，遥控急停 Supports transparent command transmission to charger, remote emergency stop		充电控制、远程急停 Charging control & remote emergency stop
电芯温度采样 Cell temperature sampling	12 路 12-channel		高低压模组多点测温 Multi-point temperature measurement for high & low voltage modules
MOS 管温度采样 MOSFET temperature sampling	1 路 1-channel		功率管过热保护采样 Sampling for power tube overheat protection
单体电芯电压采样 Cell single voltage sampling	0~5.1	V	适配磷酸铁锂 Adapted to lithium iron phosphate
低压模组总体电压采样 Low voltage pack total sampling range	0~30	V	8 串 24V 系统 8-series 24V system

项目 project	规格 specification	单位 unit	备注 remark
高压模组总体电压采样 High voltage pack total sampling range	0~400	V	88 串 300V 系统 88-series 300V system
电池组组合 Battery pack configuration	8 串低压 + 88 串高压 双模组 8S low-voltage + 88S high-voltage		一体化同步管理 Integrated synchronous management
电池类型 Battery type	磷酸铁锂 lithium iron phosphate battery		专用动力电芯 Special power cell
休眠功耗 Sleep power consumption	≤5	mA	静态待机功耗 Static standby power consumption
绝缘监测阈值 Insulation monitoring threshold	预警 500kΩ, 故障 50kΩ Insulation pre-alarm: 500 kΩ; fault: 50 kΩ	Ω	电池包绝缘检测 Battery pack insulation detection
输出通道配置 Output channel configuration	4 路独立 24V/2 路独立 300V 4-way independent 24V / 2-way independent 300V		PDU 多路功率分配 Multi-channel power distribution of PDU

3.2 基础保护参数(注: 以下参数无特殊注明均为 25℃环境下磷酸铁锂电芯测试)

项目 project	默认状态 Default state	是否可设 Configurable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
电压保护 Voltage protection	开启	可设	8 串一级单体过充预警 Primary overvoltage warning for 8S	最高单节 > 3.55V, 持续 500ms Single cell > 3.55V, hold 500ms	仅上报告警, 不切断回路 Only upload alarm, no loop cut-off	最高单节电压 < 3.45V 自动清告警 Auto clear alarm when max cell voltage < 3.45V
	开启	可设	8 串二级单体过充保护 Secondary overvoltage protection for 8S	最高单节 > 3.65V, 持续 500ms Single cell > 3.65V, hold 500ms	切断 24V 充电回路 Cut off 24V charging loop	最高单节回落至 3.45V 以下恢复充电 Resume charging when cell < 3.45V
	开启	可设	8 串一级单体欠压预警 Primary undervoltage warning for 8S	最低单节电压 < 2.65V, 持续 3 秒 3s Single cell < 2.65V, hold 3s	上报预警 Upload warning	最低单节电压 > 2.9V 消除预警 Cancel warning when cell > 2.9V
	开启	可设	8 串二级单体欠压保护 Secondary undervoltage protection for 8S	最低单节电压 < 2.5V, 持续 3 秒 Single cell < 2.5V, hold 3s	切断 24V 放电回路, 30S 后进入休眠 24V discharge cutoff, sleep mode after 30s	充电激活/ CAN 清除故障标志 Charge activation / CAN fault clear
	开启	可设	88 串一级单体过充预警 Primary overvoltage warning for 88S	最高单节电压 > 3.55V, 持续 500ms Single cell > 3.55V, hold 500ms	仅上报告警, 不切断回路 Only upload alarm, no loop cut-off	最高单节电压 < 3.45V 自动清告警 Clear alarm when cell < 3.45V

项目 project	默认 状态 Default state	是否 可设 Configu rable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
	开启	可设	88 串二级单 体过充保护 Secondary overvoltage protection for 88S	最高单节电压 >3.65V, 持续 500ms Single cell > 3.65V, hold 500ms	切断 300V 充电回路 Cut off 300V charging loop	最高单节电压 回落至 3.45V 以下恢复充电 Resume charging when cell < 3.45V
	开启	可设	88 串一级单 体欠压预警 Primary undervoltage warning for 88S	最低单节电压 <2.65V, 持续 3S Single cell < 2.65V, hold 3s	上报预警, 限 制峰值放电 Upload warning, limit peak current	最低单节电压 >2.95V 消除 预警 Cancel warning when cell > 2.95V
	开启	可设	88 串二级单 体欠压保护 Secondary undervoltage protection for 88S	最低单节电压 <2.5V, 持续 3 秒 Single cell < 2.5V, hold 3s	切断 300V 放电回路, 可 休眠 Cut 300 discharge, support sleep	充电激活 / CAN 清除故障 标志 Activate by charging / CAN clear fault
	开启	可设	8 串模组总压 一级欠压预警 8S pack total voltage warning	总压 < 21.6V Total voltage < 21.6V	上报告警 Upload alarm	总压回升至 23.2V 以上解 除 Release when total voltage > 23.2V
	开启	可设	8 串模组总压 二级欠压保护 8S pack total voltage protection	总压 < 21V Total voltage < 21V	切断 24V 全 部充放电 Cut all 24V charge & discharge	充电补电至阈 值以上恢复 Resume after charging up to threshold

项目 project	默认状态 Default state	是否可设 Configurable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
	开启	可设	88 串模组总压一级欠压预警 88S pack total voltage warning	总压<240V Total voltage <240V	上报告警 Upload alarm	总压回升至 255V 以上解除 Release when total voltage > 255V
	开启	可设	88 串模组总压二级欠压保护 88S pack total voltage protection	总压<211V Total voltage <211V	切断 300V 全部充放电 Cut all 300V charge & discharge	充电补电至阈值以上恢复 Resume after charging up to threshold
电流保护 Current protection	开启	可设	8 串一级放电过流预警 8S primary discharge overcurrent warning	放电电流 > 20A, 持续 2s Discharge > 20A, hold 2s	上报告警 Upload alarm	电流回落至 15A 以下解除 Release when current < 15A
	开启	可设	8 串二级放电过流保护 8S secondary discharge overcurrent protect	放电电流 > 25A, 持续 3s Discharge > 25A, hold 3s	切断 24V 放电 MOS, 故障锁止 Cut 24V MOS, lock fault	CAN 清除故障标志 Activate by charging / CAN clear fault
	开启	可设	88 串一级放电过流预警 88S primary discharge overcurrent warning	放电电流 > 10A, 持续 2s Discharge > 10A, hold 2s	上报告警 Upload alarm	电流回落至 8A 以下解除 Release when current < 8A

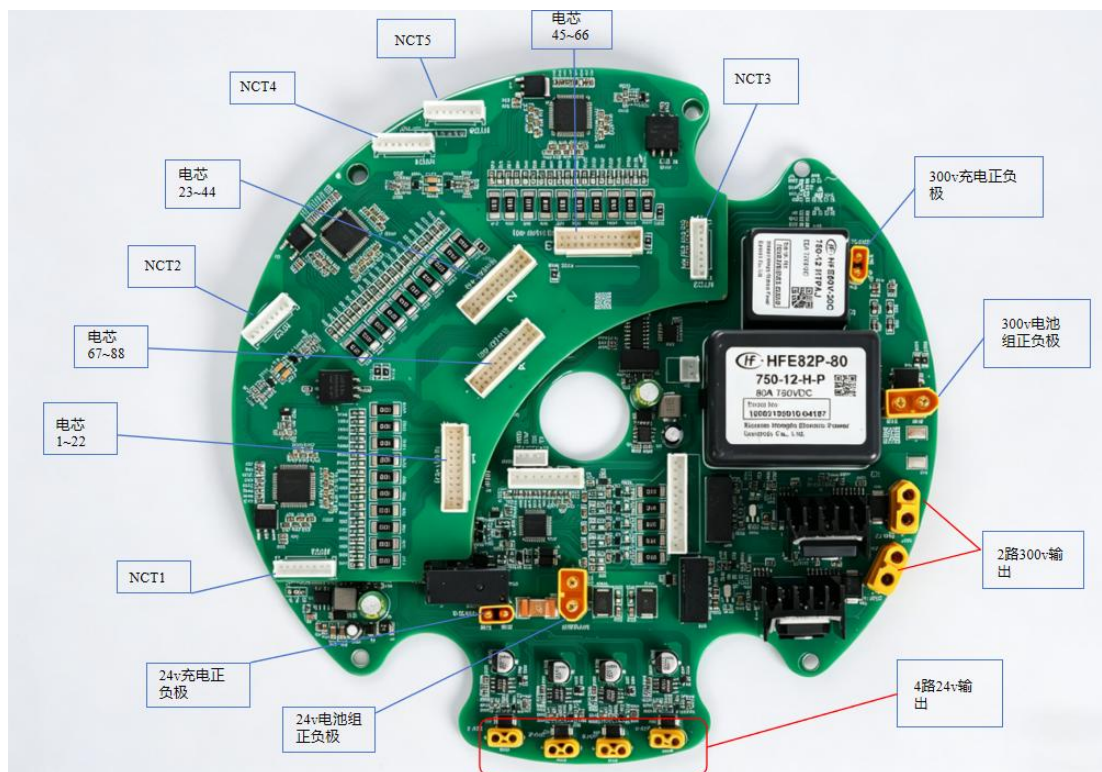
项目 project	默认状态 Default state	是否可设 Configurable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
	开启	可设	88 串二级放电过流保护 88S secondary discharge overcurrent protect	放电电流 > 70A, 持续 100ms Discharge > 70A, hold 100ms	切断 300V 放电 MOS, 故障锁止 Cut 300V MOS, lock fault	CAN 清除故障标志 Activate by charging / CAN clear fault
	开启	可设	充电过流保护 Charging overcurrent protection	8 串 > 15A / 88 串 > 15A, 持续 4s 8S > 15A / 88S > 15A, hold 4s	关闭对应模组充电继电器 Turn off corresponding charging relay	3 分钟后自动重试, 3 次失败锁死 Auto retry after 3min, lock after 3 fails
	开启	可设	放电短路保护 Discharge short-circuit protection	冲击触发, 响应 ≤ 50μs Trigger by surge, response ≤ 50μs	立即切断全部高压回路, 临时锁止 Cut all HV instantly, temp lock	充电激活 / CAN 清故障; 最多 3 次重试后永久锁死 Charge / CAN clear; permanent lock after 3 retries
温度保护 Temperature protection	开启	可设	电芯一级低温预警 Cell low temp warning	电芯 < -5°C, 持续 3s Cell temp < -5°C, hold 3s	上报低温告警 Upload low temp alarm	电芯温度 > 0°C 自动解除 Release when cell temp > 0°C
	开启	可设	电芯二级低温保护 Cell low temp protection	电芯 < -10°C, 持续 3s Cell temp < -10°C, hold 3s	切断全部充放电回路 Cut all charge & discharge loops	电芯回升至 0°C 以上恢复 Resume when cell temp > 0°C

项目 project	默认状态 Default state	是否可设 Configurable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
	开启	可设	电芯一级高温预警 Cell high temp warning	电芯 $>55^{\circ}\text{C}$, 持续 3s Cell temp $>55^{\circ}\text{C}$, hold 3s	上报高温告警, 限制充放电峰值 Upload high temp alarm, limit power	电芯 $\leq 50^{\circ}\text{C}$ 自动解除 Release when cell temp $\leq 50^{\circ}\text{C}$
	开启	可设	电芯二级高温保护 Cell high temp protection	电芯 $>60^{\circ}\text{C}$, 持续 3s Cell temp $>60^{\circ}\text{C}$, hold 3s	切断全部充放电回路 Cut all charge & discharge loops	电芯 $\leq 50^{\circ}\text{C}$ 自动恢复输出 Resume output when cell temp $\leq 50^{\circ}\text{C}$
	开启	可设	MOS 管过温保护 MOSFET overtemp protection	MOS $>75^{\circ}\text{C}$, 持续 3s MOS temp $>75^{\circ}\text{C}$, hold 3s	切断 24V/300V 所有功率输出 Cut all 24V & 300V power	MOS 降温至 60°C 以下恢复 Resume when MOS temp $\leq 60^{\circ}\text{C}$
压差 & 绝缘保护 Voltage difference & insulation protection	开启	可设	被动均衡启动条件 Passive balance trigger	单体电压 $>3.2\text{V}$ 或模组压差 $>20\text{mV}$, 持续 3s Cell $>3.3\text{V}$ or $\Delta V>20\text{mV}$, hold 3s	开启 100 Ω 被动均衡电阻 Turn on 100 Ω balance resistor	模组最大压差 $<10\text{mV}$ 关闭均衡 Stop balance when $\Delta V<10\text{mV}$
	开启	可设	电芯压差故障保护 Cell voltage difference fault	模组最大压差 $>0.4\text{V}$ Max cell $\Delta V>0.4\text{V}$	关闭均衡 + 切断对应模组充放电 Stop balance & cut pack charge/discharge	压差回落至 0.3V 以内恢复全部功能 Full recovery when $\Delta V<0.3\text{V}$

项目 project	默认状态 Default state	是否可设 Configurable	工况描述 operating conditions description	默认设定值 default setting	执行动作 execute action	恢复条件 restoration conditions
	开启	可设	绝缘一级预警 Insulation warning	绝缘电阻 < 500kΩ Insulation resistance < 500kΩ	上报绝缘异常 Upload insulation alarm	绝缘 ≥ 500kΩ 自动消除告警 Clear alarm when insulation ≥ 500kΩ
	开启	可设	绝缘二级故障保护 Insulation fault protection	绝缘电阻 < 50kΩ Insulation resistance < 50kΩ	切断全部 300V 高压动力输出 Cut all 300V HV output	绝缘检测合格后 CAN 复位解锁 Unlock via CAN after qualified test
急停保护 Emergency stop protection	开启	不可设	本地 / 蓝牙远程急停 Local & Bluetooth E-stop	物理按钮 / 蓝牙信号瞬时触发 Instant trigger by button/Bluetooth	立刻切断两路 300V 高压，响应 ≤ 10ms Cut dual 300V within 10ms	撤销急停信号，CAN 下发复位解锁高压 Cancel E-stop + CAN reset to unlock HV
休眠保护 Sleep protection	开启	可设	静态低功耗休眠 Static sleep	总输出电流 < 15mA，持续 2min Total output < 15mA, hold 2min	整机进入 ≤ 5mA 低功耗休眠 Enter ≤ 5mA low-power sleep	接入充电碳刷 / 电源按键唤醒 Wake up by charger or power button
	开启	可设	低电量深度休眠 Low SOC deep sleep	模组 SOC < 10% Pack SOC < 10%	进入深度休眠保护电芯 Deep sleep for cell protection	接入充电器充电唤醒 Wake up by charging

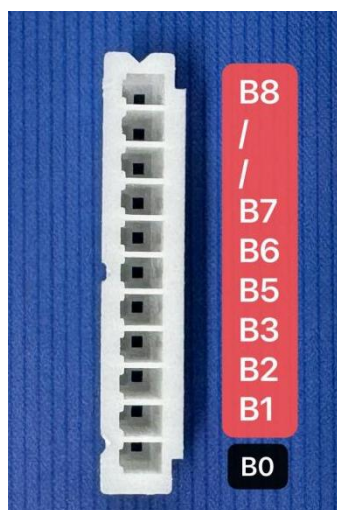
4.接口定义 Interface Definition

4.1 接口示意图 Diagram of an Interface



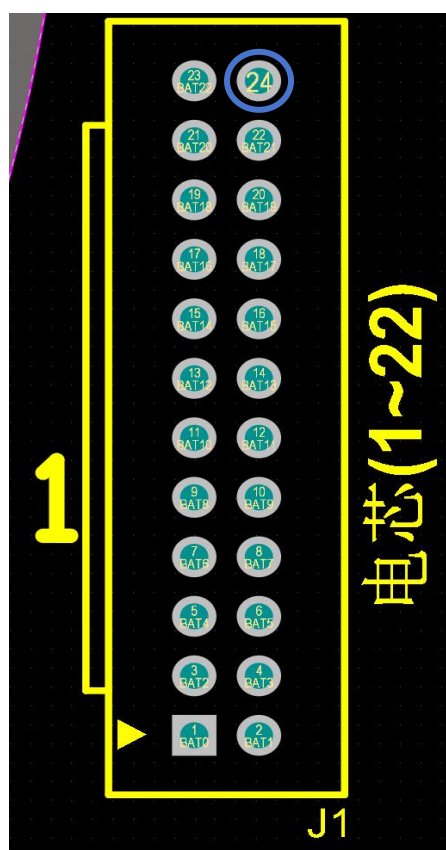
4.2 机器人保护板接线图 Robot Protection Board Wiring Diagram

(1) 24V 电芯采样线接口定义 24V Cell Sampling Cable Interface Definition

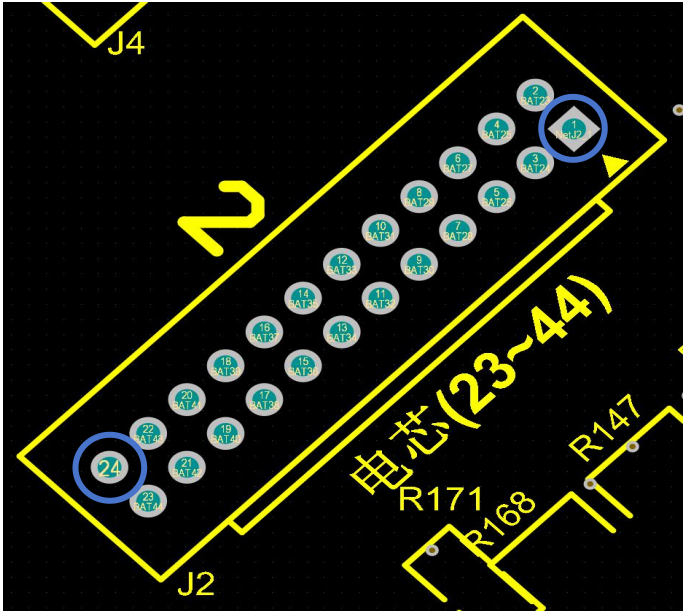


(2) 300V 电芯采样线定义 300V Cell Sampling Cable Definition

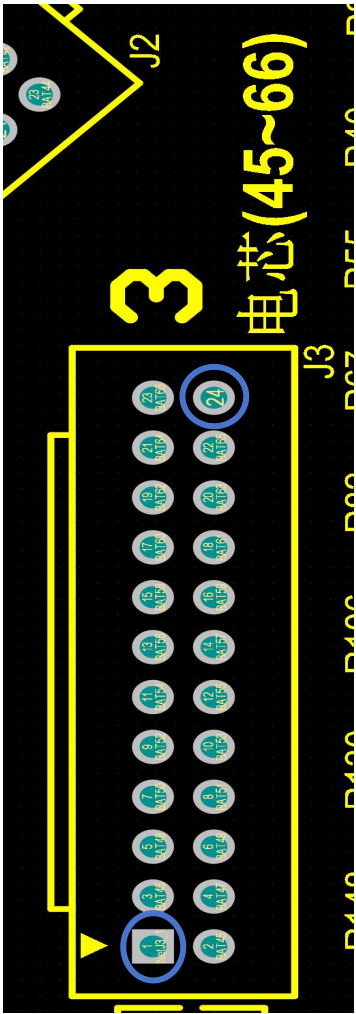
1-22 串

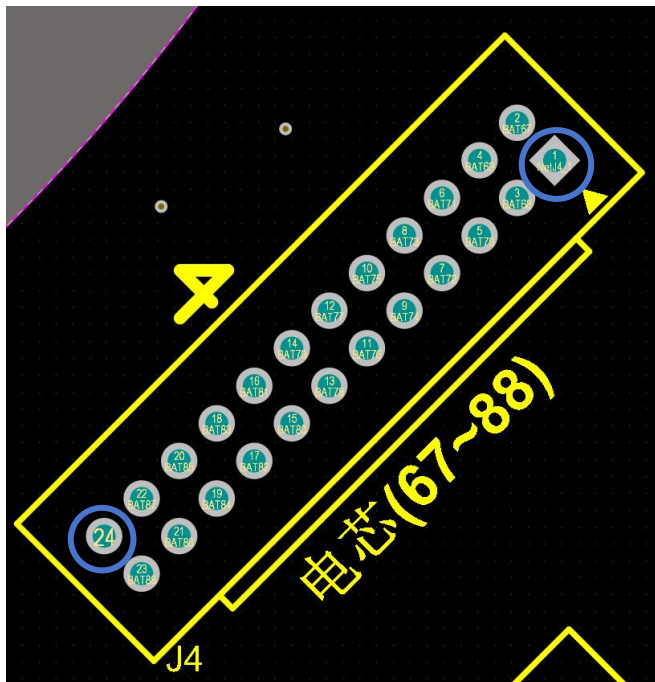


23-44 串



45-66 串





注：图中蓝色圆圈部分不接线，接线底座黄色突起部分对应采样接头胶壳的卡扣方



(3)CAN，急停，启动：

CAN 通信线红线为 CANH 黑线为 CANL。

急停线与按钮启动线没有极性区分。

(3) CAN, Emergency Stop, and Start:

For the CAN communication cable, the red wire is CANH and the black wire is CANL.

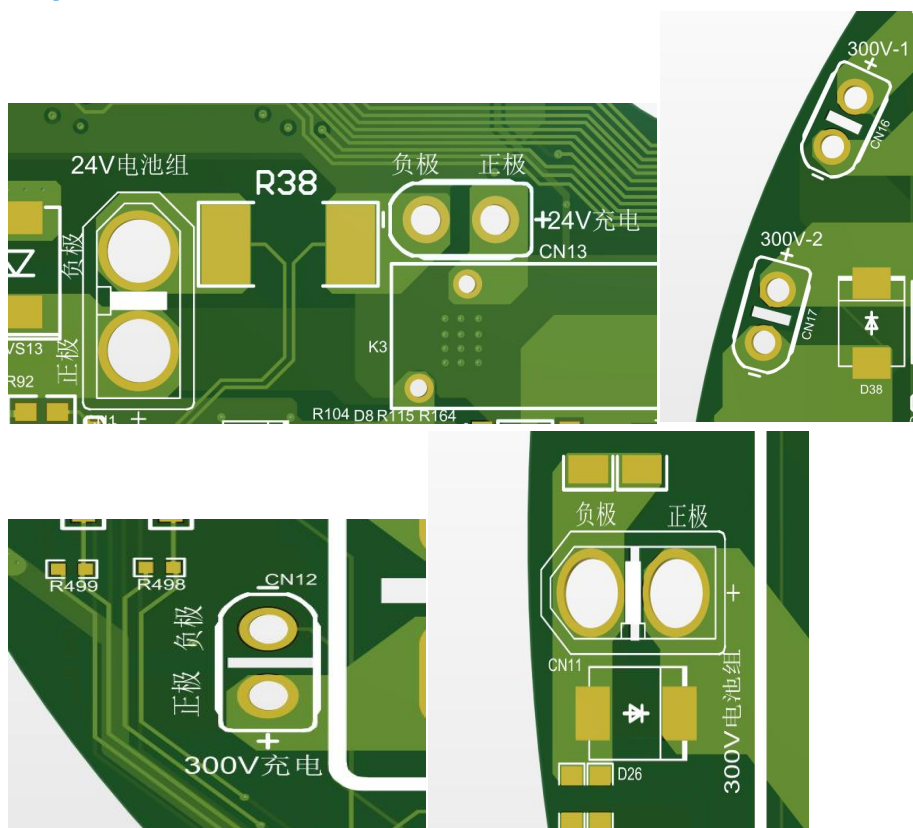
The emergency stop cable and start button cable have no polarity requirement.

(4)功率线：

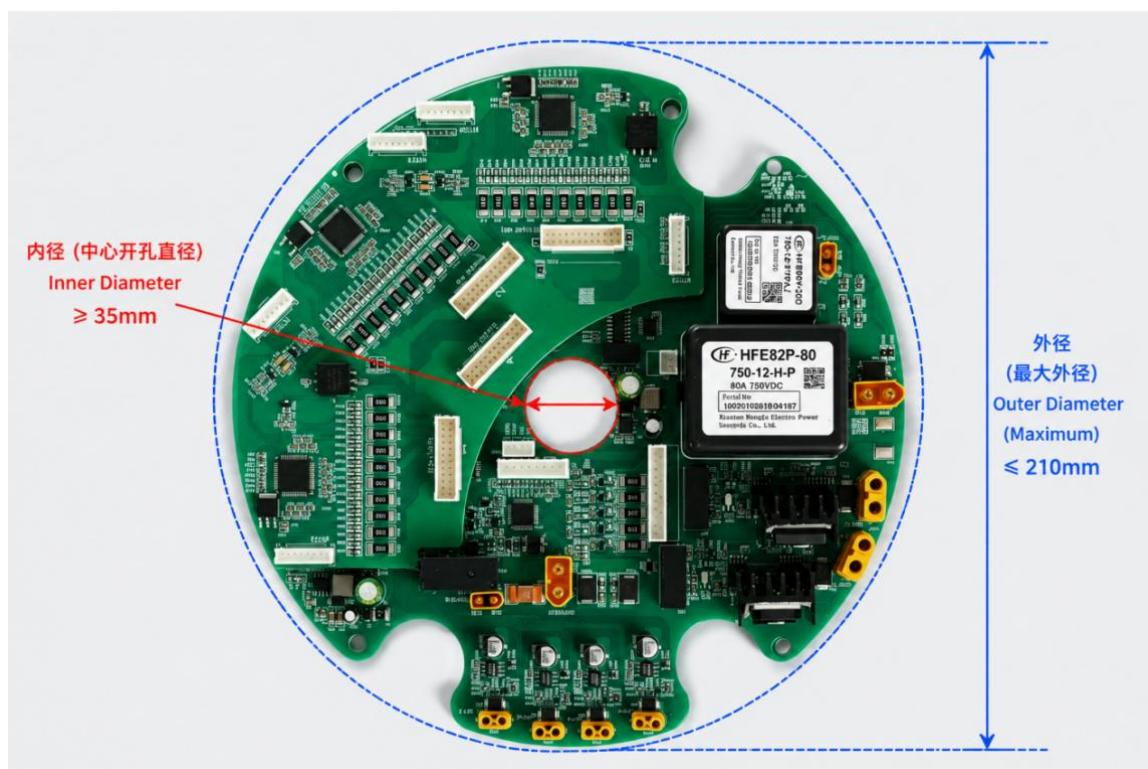
PCB 板上功率线接口定义正负极性均有注明，请严格按照注明的正负极性方向与对应功能接线。

(4)Power Cable:

The positive and negative polarities are marked on the PCB power cable terminals. Please connect the cables strictly according to the indicated polarity and corresponding functions.



5.BMS 保护板尺寸 BMS protection board size



6 安装连接顺序 Installation and Connection Sequence

6.1 上电连接步骤 Power-on Connection Procedure

（上电前检查 PCB 板底部，接触部分应做好绝缘处理不与金属接触以免发生短路。上电前先接 NTC、CAN 通信线、按键启动与 300V 急停，NTC 无接线顺序。）

1.300V 电芯采样线，按照丝印标记好的序号由 1 组到 4 组依次接线

2.300V 电池组功率线与 300V 充电线

3.300V PDU 放电功率线

4.24V 电芯采样线

5.24V PDU 功率线

6.24V 电池组功率线与 24V 充电线

（24V 电池组功率线为整个系统的供电线路，所以上电最后接，下电时最先断开）

下电顺序与上电顺序相反

(Before powering on, check the bottom side of the PCB. The contact area must be properly insulated and must not touch any metal parts to prevent short circuits. Before power-on, connect the NTC, CAN communication cable, start button, and 300V emergency stop. The NTC has no specific wiring sequence.)

1.300V cell sampling wires: Connect groups 1 to 4 in sequence according to the marked labels on the PCB.

2.300V battery pack power cable and 300V charging cable

3.300V PDU discharge power cable

4.24V cell sampling wires

5.24V PDU power cable

6.24V battery pack power cable and 24V charging cable

(The 24V battery pack power cable is the main power supply line for the entire system, therefore it must be connected last during power-on and disconnected first during power-off.)

The power-off sequence is the reverse of the power-on sequence.

6.2 下电拆卸步骤

- 1.断开充电机与所有机器人负载；
- 2.拆除充电碳刷接线；
- 3.依次断开 300V、24V 功率主线，最后拆下 B-；
- 4.拔除全部通讯、开关、温度信号线；
- 5.取下 NTC 探头，最后拔下电芯采样插座再拆电芯端线束。

- 1.Disconnect charger and all robot loads.
- 2.Remove charging carbon brush wires.
- 3.Disconnect 300V and 24V power cables in sequence, then remove B-.
- 4.Unplug all communication, button and temperature wires.
- 5.Take off NTC probes, pull out cell sampling sockets before removing cell-side harnesses.

注：全程做好静电防护，高压回路操作前等待电容释放残余电压。

Note: Implement ESD protection during all operations. Wait for capacitor residual voltage discharge before handling high-voltage circuits.

7 注意事项 Precautions

1. 整机各类线束、端子需与板载标识一一对应接线，高压、低压线束分开布设，严禁采样线、功率线、通讯线反接、错接，否则会击穿采集芯片、烧毁功率 MOS 管，造成保护板永久损坏。
2. 装配与检修作业时，不可让 PCB 金属区域接触电芯极柱、金属外壳，防止发生短路，导致电芯电压异常、鼓包报废；电路板三防涂层避免尖锐金属刮伤。
3. 设备上电前清理电路板与接插件内锡渣、铜丝、金属碎屑等导电杂物，确认无异物后方可通电，杜绝短路起火隐患。
4. 设备使用及存放环境做好防潮、防水、防静电；整机壳体防护等级 IP65，但禁止长期浸水、露天淋雨；拆装电路板必须佩戴防静电手环， $\pm 15\text{kV}$ 静电会损毁主控芯片。
5. 过压、欠压、过流、过温、电芯压差、绝缘保护等参数仅能在本规格额定区间内设置，不得人为放宽保护阈值，否则设备失去安全防护能力。
6. 单节电芯电压低于 2.0V 深度亏电状态下，禁止大电流充放电，极易引发热失控起火；亏电电芯采用小电流预充修复，无法修复则直接更换。
7. 仅适配本系统专用 24V/340V 双路充电机，禁止使用铅酸充电器、不匹配第三方快充；充电碳刷完成机械定位贴合后，再闭合充电继电器，避免打火烧蚀接线端子。

8. 运行过程出现异常升温、焦糊异味、冒烟、频繁保护停机，需立即断开所有功率线缆，整机下电隔离排查，不可继续通电使用。
 9. 严禁私自对保护板、电池包做串并联扩容、飞线改路、拆除 MOS 管 / 继电器、裁剪采样线束，私自改装直接取消质保，同时存在重大安全隐患。
 10. 全部线路接完上电后，若设备无法唤醒、持续告警、无功率输出，先检查各类线束、温度探头连接状态；线路无问题仍故障，立即断电联系厂家售后检修。
 11. 操作 300V 高压回路前必须完全断电，等待电容残余电压释放完毕再施工；电池包绝缘阻值低于 500k Ω 时禁止投入运行。
 12. 电池长期静置存放时，SOC 电量保持 30%~60% 最优，避免满电、深度亏电长期休眠，有效延长电芯循环寿命。
- 注：全部装配、检修操作均需落实静电防护措施；高压线路操作须由持证工作人员完成。

1. All wiring harnesses and terminals shall be connected according to the marks on PCB. Separate high-voltage and low-voltage cables. Reversed or wrong connection of sampling, power and communication wires will break sampling IC and burn power MOSFETs, leading to permanent damage of protection board.
2. During assembly and maintenance, avoid contact between PCB metal area and cell poles or metal shell to prevent short circuit, cell abnormal voltage and swelling. Do not scratch the three-proof coating on circuit board with sharp metal.
3. Clear conductive debris such as tin slag, copper wires and metal scraps from PCB and connectors before power on. Power-on is allowed only after inspection to eliminate short-circuit and fire risks.
4. The equipment shall be protected against moisture, water and static electricity during storage and operation. Although the shell reaches IP65 protection grade, long-term water immersion and outdoor rain exposure are prohibited. Anti-static wristband must be worn when disassembling PCB, as $\pm 15\text{kV}$ static electricity may damage main control chip.
5. Protection parameters including overvoltage, undervoltage, overcurrent, overtemperature, cell voltage difference and insulation can only be set within the rated range of this specification. Manually loosening protection thresholds will disable the safety function.
6. High-current charging and discharging are forbidden for cells with voltage lower than 2.0V to prevent thermal runaway and fire. Severely depleted cells shall be recovered by low-current pre-charging or replaced directly if unrecoverable.
7. Only the special 24V/340V dual-channel charger matched with this system can be used.

Lead-acid chargers and mismatched third-party fast chargers are prohibited. Close charging relay only after charging carbon brush is fully positioned to avoid spark and terminal ablation.

8. If abnormal temperature rise, burnt smell, smoke or frequent protection shutdown occurs during operation, disconnect all power cables, power off the whole unit for isolation and inspection, and do not keep it powered on.

9. Unauthorized series-parallel expansion, circuit rewiring, removal of MOSFETs/relays and cutting of sampling harnesses are prohibited. Any modification will void the warranty and bring serious safety hazards.

10. If the device fails to wake up, keeps alarming or has no power output after full wiring, check all cables and temperature probes first. Contact the manufacturer for maintenance after power off if the fault persists.

11. Cut off power completely and wait for residual voltage release of capacitors before operating 300V high-voltage circuit. The battery pack cannot be put into operation when insulation resistance is lower than 500kΩ.

12. For long-term storage, the optimal SOC range of the battery is 30%~60%. Avoid long-time dormancy under full charge or deep discharge to extend cell cycle life.

Note: Electrostatic protection shall be implemented in all assembly and maintenance operations.

High-voltage circuit operation must be completed by certified personnel.