



ZVPP Energy Storage Controller Datasheet

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Zhuhai Virtual Power Plant Technology Co., Ltd

Declaration

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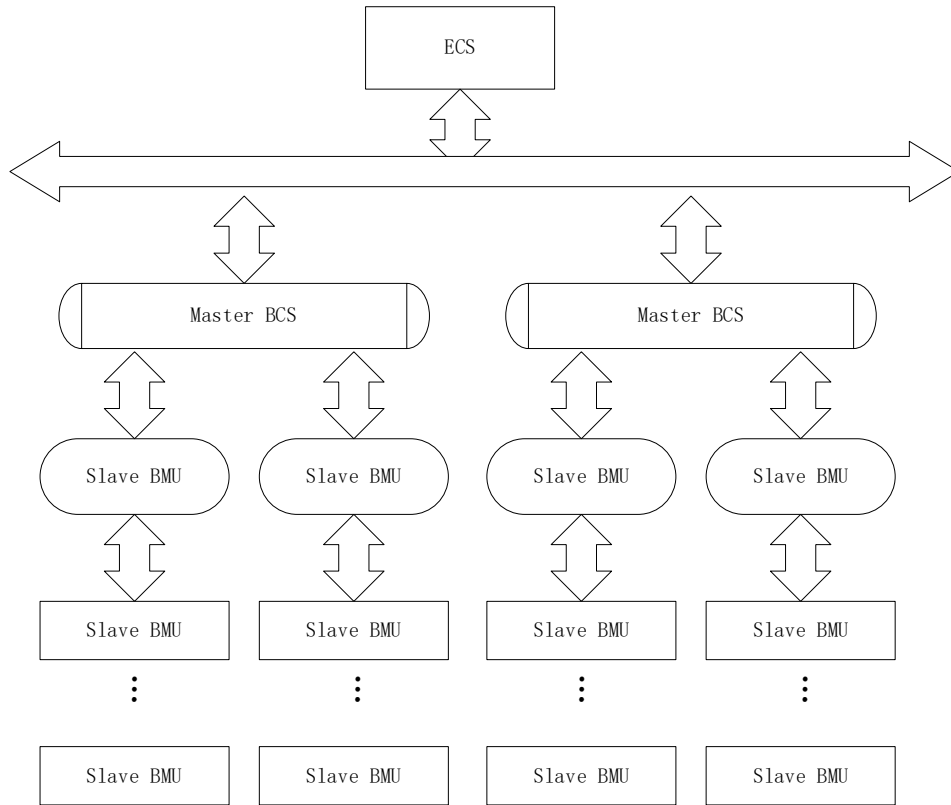
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1 System Overview

1.1 System Architecture



1.2 System Functions and Features

1. The system operates at a rated voltage of 24V, with a working voltage range of 18V to 36V, meeting the requirements of various energy storage applications.
2. The system supports both Single-cell voltage and battery pack terminal voltage acquisition, featuring high accuracy and speed. Reliability is ensured through comparison between cumulative cell voltages and pack terminal measurements.
3. The system provides temperature and current acquisition capabilities, allowing flexible configuration of temperature sensor quantities and current measurement methods (shunt or Hall sensor). All acquisitions are characterized by high precision and reliability.

4. The system includes accurate insulation detection to ensure the safety and reliability of the battery system.
5. Using proprietary integrated algorithms based on collected battery data, the system calculates State of Charge (SOC) and State of Health (SOH) in real-time, delivering high accuracy under both dynamic and static conditions.
6. The passive balancing system employs a self-developed balancing algorithm capable of high-current balancing. It offers high efficiency, high reliability, ultra-low standby power consumption, and supports cascading and easy expansion.
7. Based on collected and computed battery data, the system monitors the operating status and fault levels of the battery pack in real-time, enabling alarm and protection functions.
8. The system features a wide range of interfaces to support various application scenarios, facilitating charge/discharge control and thermal management of the battery pack.
9. The system is equipped with multiple CAN and RS485 communication interfaces for data exchange and control with devices such as PCS and ECS, as well as communication with display modules. It also supports 4G, GPS, Bluetooth, and Wi-Fi for remote monitoring, control, and system upgrades.
10. The system uses high-reliability components and incorporates multiple redundant protection measures. It is designed to withstand harsh electromagnetic environments, high temperatures, and vibrations, ensuring high reliability, stability, and strong anti-interference performance.
11. The system is suitable for various energy storage applications, including power plant storage, residential energy storage, and echelon utilization, offering excellent scalability and adaptability.

2 Energy Storage System Integrated Control Unit ECS

2.1 ECS Product Description

ECS, the energy storage systems integrated control unit is a local monitoring and management unit for containerized energy storage systems or distributed energy storage cabinet systems. It features integrated real-time aggregation, display, and coordinated control of information from various components of the energy storage system. It provides local monitoring, protection, and energy management functions, supports multiple communication protocols such as IEC61850, MODBUS, 104, and MQTT, and offers

advanced diagnostic capabilities for the safety and health of energy storage system equipment and battery systems. It also enables local smart operation and maintenance, making it a cost-effective, integrated, and intelligent local control and management device for energy storage system

2.2 Scope of Application

The ECS is suitable for integrated centralized monitoring and management of energy storage systems, including containerized and outdoor cabinet types, in application scenarios such as generation-side, grid-side, user-side, and microgrids.

2.3 Functional Description

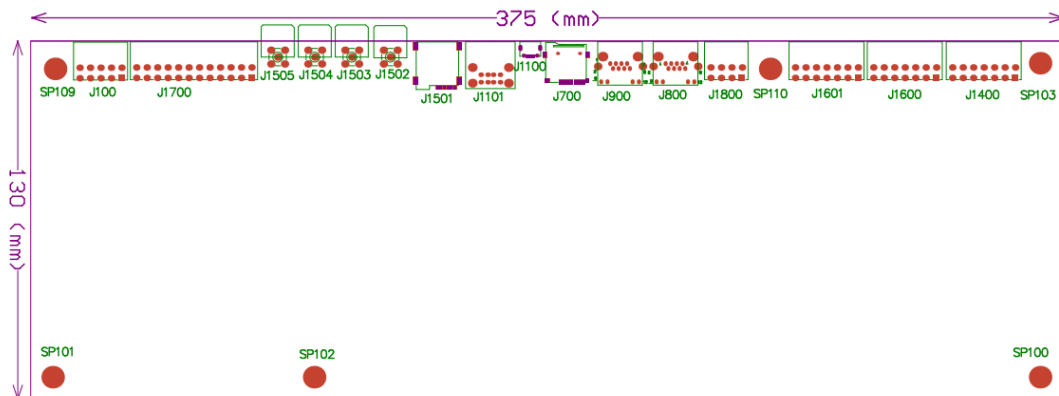
- Supports the integration and aggregation of information from various components of containerized energy storage systems or distributed energy storage cabinet systems, with local display, monitoring, and energy management.
- Supports demand control, anti-reverse power flow functionality, and reverse power flow control for PCS.
- Supports the integration and control of auxiliary information from BMS, PCS, fire protection systems, air conditioning, temperature and humidity sensors, and I/O interfaces.
- Supports the integration of information from up to 10 distributed energy storage systems (cabinets).
- Supports real-time storage and historical querying of lifecycle monitoring data for energy storage systems.
- Supports interaction control between load and storage, as well as metering and revenue management.
- Provides advanced diagnostic capabilities for the health and safety status of energy storage battery systems.
- Supports fire protection strategies for energy storage systems and fault diagnosis for system equipment.
- Enables smart diagnosis, operation, maintenance, and evaluation of dispersion in energy storage battery systems.
- Self-adapts to and supports protocols such as IEC61850, MODBUS, and MQTT.
- Supports cloud-edge collaboration and remote operation and maintenance hosting services.
- Provides an SDK for secondary development.

2.4 Technical Parameters

Configuration	Specification
---------------	---------------

CPU	Quad-core ARM Cortex-A7 and RISC-V MCU, 1.5GHz
Memory / External Storage	1GB DDR4 / 8GB EMMC
OS	Linux
SD/SSD	TF (microSD) Card, 128GB
Detectable Battery Units	Maximum: 17 modules (with busbar per module) × 16 clusters
LCD Screen	10.1-inch LCD (16:9 aspect ratio), 1280×800 resolution
Interface	H5
Communication Interfaces	2 × 100/1000M LAN (RJ45), 3 × Isolated CAN, 3 × Isolated RS485, 3 × USB, 4G
DO/DI Interfaces	12-channel opto-isolated digital input, 12-channel relay dry contact output
Event Log Database	>100,000 event records, including anomaly type, occurrence time, and protection actions
Communication Baud Rates	9600bps/RS485、250Kbps/CAN、100Mbps/LAN
Insulation Resistance	500MΩ 1500VDC
Power Frequency Withstand Voltage	2500VAC
Operating Environment	Ambient Temperature: -0°C~+80°C; Relative Humidity: <95% (non-condensing); Ambient Magnetic Field: <400 A/m, No corrosive, flammable, or explosive gases permitted.

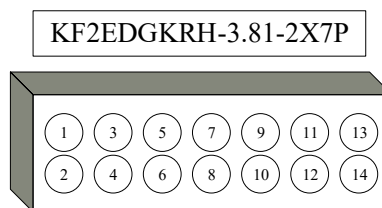
2.5 Dimensional Drawing



Note: The socket numbers correspond to the following pin definitions

2.6 Terminal Interface Definition

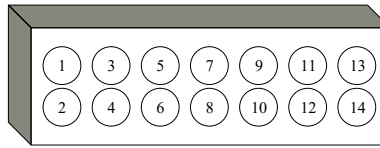
J1400_KF2EDGKRG-3.81-2X7P



Pin	Name	Description
J1400-1	CAN0_L	Channel 1 CAN_L
J1400-2	CAN0_H	Channel 1 CAN_H
J1400-3	CAN1_L	Channel 2 CAN_L
J1400-4	CAN1_H	Channel 2 CAN_H
J1400-5	CAN2_L	Channel 3 CAN_L
J1400-6	CAN2_H	Channel 3 CAN_H
J1400-7	1_RS485_A	Channel 1 RS485A
J1400-8	1_RS485_B	Channel 1 RS485B
J1400-9	2_RS485_A	Channel 2 RS485A
J1400-10	2_RS485_B	Channel 2 RS485B
J1400-11	3_RS485_A	Channel 3 RS485A
J1400-12	3_RS485_B	Channel 3 RS485B
J1400-13	4_RS485_A	Channel 4 RS485A
J1400-14	4_RS485_B	Channel 4 RS485B

J1600_KF2EDGKRG-3.81-2X7P

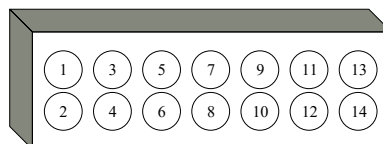
KF2EDGKRH-3.81-2X7P



Pin	Name	Description
J1600-1	DI+1	Channel 1 DI+
J1600-2	DI-1	Channel 1 DI-
J1600-3	DI+2	Channel 2 DI+
J1600-4	DI-2	Channel 2 DI-
J1600-5	DI+3	Channel 3 DI+
J1600-6	DI-3	Channel 3 DI-
J1600-7	DI+4	Channel 4 DI+
J1600-8	DI-4	Channel 4 DI-
J1600-9	DI+5	Channel 5 DI+
J1600-10	DI-5	Channel 5 DI-
J1600-11	DI+6	Channel 6 DI+
J1600-12	DI-6	Channel 6 DI-
J1600-13	DI+7	Channel 7 DI+
J1600-14	DI-7	Channel 7 DI-

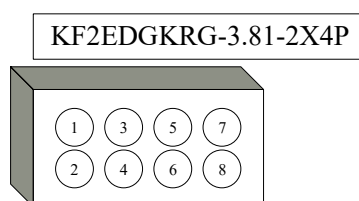
J1601_KF2EDGKRG-3.81-2X7P

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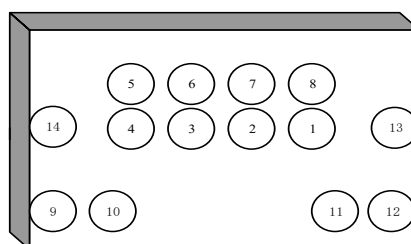
Pin	Name	Description
J1601-1	DI+8	Channel 8 DI+
J1601-2	DI-8	Channel 8 DI-
J1601-3	DI+9	Channel 9 DI+
J1601-4	DI-9	Channel 9 DI-
J1601-5	DI+10	Channel 10 DI+
J1601-6	DI-10	Channel 10 DI-
J1601-7	DI+11	Channel 11 DI+
J1601-8	DI-11	Channel 11 DI-
J1601-9	DI+12	Channel 12 DI+
J1601-10	DI-12	Channel 12 DI-
J1601-11	PWM_OUT	PWM Output+
J1601-12	VOUT_GND	PWM Output-(GND)
J1601-13	PWM_VIN	PWM Input+
J1601-14	VOUT_GND	PWM Input-(GND)

J1800_KF2EDGKRH-3.81-2X4P



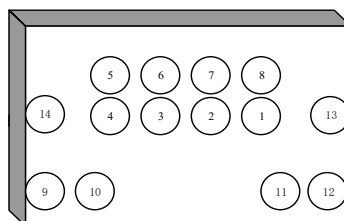
Pin	Name	Description
J1800-1	PE1	Channel 1 AI sampling-
J1800-2	Test Voltage1	Channel 1 AI sampling+
J1800-3	PE2	Channel 2 AI sampling-
J1800-4	Test Voltage2	Channel 2 AI sampling+
J1800-5	EXT_RT1	Channel 1 NTC sampling+
J1800-6	GND	Channel 1 NTC sampling-
J1800-7	EXT_RT2	Channel 2 NTC sampling+
J1800-8	GND	Channel 2 NTC sampling-

J800_RJ45_R08P-C000



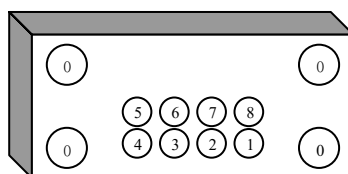
1000M Ethernet port

J900_RJ45_R08P-C000



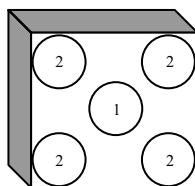
100M Ethernet port

J1101_XDUF-0426-081

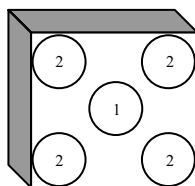


USB2.0*2

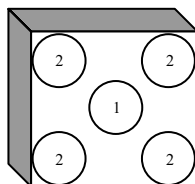
J1505_SMA/WIFI Diversity antenna socket



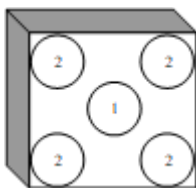
J1502_SMA/4G Antenna socket



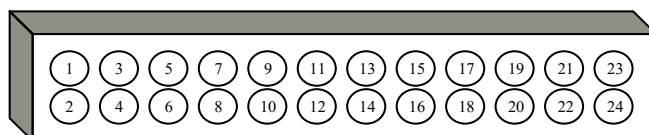
J1502_SMA/4G Diversity antenna socket



J1502_SMA/4G Antenna socket

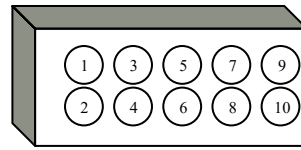


J1700_KF2EDGKRG-3.81-2X12P



Pin	Name	Description
J1700-1	HSD_OUT1	Channel 1 high-side relay drive output +
J1700-2	24V_GND	Channel 1 high-side relay drive output -
J1700-3	HSD_OUT2	Channel 2 high-side relay drive output +
J1700-4	24V_GND	Channel 2 high-side relay drive output -
J1700-5	HSD_OUT3	Channel 3 high-side relay drive output +
J1700-6	24V_GND	Channel 3 high-side relay drive output -
J1700-7	HSD_OUT4	Channel 4 high-side relay drive output + (Only for positive output relay)
J1700-8	24V_GND	Channel 4 high-side relay drive output -
J1700-9	HSD_OUT5	Channel 5 high-side relay drive output +
J1700-10	24V_GND	Channel 5 high-side relay drive output -
J1700-11	HSD_OUT6	Channel 6 high-side relay drive output + (Only for pre-charge relay)
J1700-12	24V_GND	Channel 6 high-side relay drive output -
J1700-13	HSD_OUT7	Channel 7 high-side relay drive output +
J1700-14	24V_GND	Channel 7 high-side relay drive output -
J1700-15	HSD_OUT8	Channel 8 high-side relay drive output +
J1700-16	24V_GND	Channel 8 high-side relay drive output -
J1700-17	HSD_OUT9	Channel 9 high-side relay drive output +
J1700-18	24V_GND	Channel 9 high-side relay drive output -
J1700-19	HSD_OUT10	Channel 10 high-side relay drive output +
J1700-20	24V_GND	Channel 10 high-side relay drive output -
J1700-21	HSD_OUT11	Channel 11 high-side relay drive output +
J1700-22	24V_GND	Channel 11 high-side relay drive output -
J1700-23	HSD_OUT12	Channel 12 high-side relay drive output +
J1700-24	24V_GND	Channel 12 high-side relay drive output -

J100_KF2EDGKRG-3.81-2X5P



Pin	Name	Description
J100-1	EN-	Power supply enable negative
J100-2	EN	Power supply enable positive
J100-3	24V_VIN	24Vdc power input+
J100-4	24V_VIN	24Vdc power input+
J100-5	24V_VIN	24Vdc power input+
J100-6	24V_VIN	24Vdc power input+
J100-7	24V_GND	24Vdc power input-
J100-8	24V_GND	24Vdc power input-
J100-9	24V_GND	24Vdc power input-
J100-10	24V_GND	24Vdc power input-

Note:

[1] The board is equipped with an integrated termination resistor for CAN.

[2] The board is equipped with an integrated termination resistor for RS485.

3 Battery Management System Master Control Unit BCS

3.1 BCS Product Description

BCS, the Master Control Unit serves as the core of the battery management system. It communicates with Slave Units to monitor individual cell voltages and temperatures, measures battery pack characteristics (total voltage, charge/discharge current, insulation resistance to ground), and estimates internal battery states (capacity, SOC, SOH, etc.) using sophisticated algorithms. On this bases, it manages battery pack charging/discharging, thermal processes, insulation detection, and fault alarms. It enables data exchange with devices like PCS, ECS, and HMI via communication buses, and communicates with BMUs via CAN.

3.2 BCS Composition

BCS primarily consists of the following components: auxiliary power conversion, MCU and peripheral circuits, real-time clock, total voltage and insulation monitoring,

charge/discharge current detection, external relay (contactor) drive and detection, and communication interfaces (3x CAN, 3x RS485, 1x Ethernet, 1x Daisy-chain).

3.3 BCS Features

1. High-Reliability Design: Product software, hardware, and structural design comply with relevant professional standards.
2. High Safety: Comprehensive protection functions with multiple redundant safeguards protect the battery under various exceeding-limit and unexpected conditions.
3. Strong Anti-Interference Capability: Designed from the outset for the electromagnetic environment of high-power energy storage systems with complex wiring. All components meet high-reliability requirements. Input/output and communication interfaces employ effective isolation and filtering, meeting demands of harsh real-world EM environments.
4. Accurate Signal Acquisition & SOC Estimation: Utilizes high-precision sampling chips from internationally renowned brands, combines strengths of multiple industry SOC algorithms, and features intelligent learning capabilities to ensure sampling precision and SOC estimation accuracy.
5. Abundant External Interfaces: Extensive digital I/O, analog I/O, and communication ports meet interface requirements for various projects.
6. High Scalability: employs a CAN architecture; the quantity of Slave Units can be flexibly configured from 1 to 30 based on the number of battery strings.
7. Flexible Configuration & Upgrade: Product can be flexibly configured via PC software for different application needs and supports rapid firmware upgrades via the CAN communication port.
8. UL-94 V0 Flame Retardant Rating: All materials meet the UL-94 V0 flame retardant standard.
9. Comprehensive Self-Diagnostics: Features extensive self-diagnostic functions and supports functional safety certification requirements.

3.4 BCS Main Functions

Includes, but is not limited to, the following functions:

1. Battery pack total voltage detection.
2. Battery pack charge/discharge current detection.
3. Battery pack insulation resistance detection (to PE).
4. Battery pack charge/discharge management.
5. Battery pack thermal management.
6. Monitors cell temperatures during system operation; generates alarms for excessive high/low cell temperatures or excessive temperature differentials. Reports level 2 alarms actively; automatically cuts off contactors for level 1 alarms.
7. Real-time dynamic estimation of SOC and SOH.

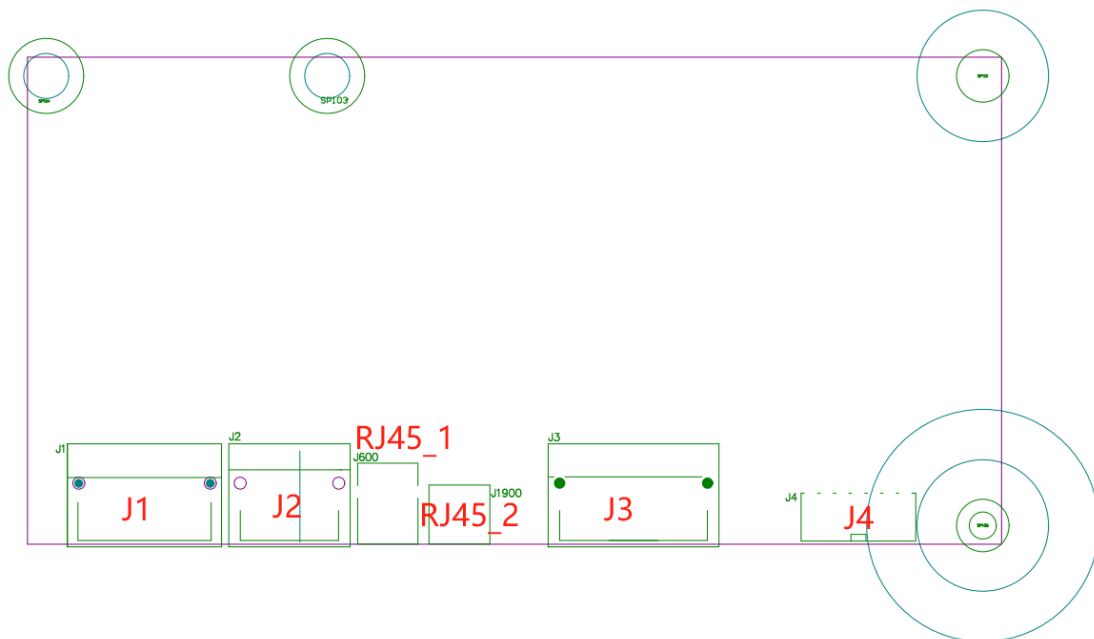
8. System self-test and fault diagnosis/alarm.
9. Battery pack fault diagnosis and alarm.
10. Safety protection under various abnormal and fault conditions.
11. Communication with other equipment (e.g., PCS, ECS).
12. Data storage, transmission, and processing.
13. Storage of recent alarm information, reset events, and sampling anomalies; stored information can be exported as needed.
14. Powerful system self-test function ensures proper operation of the system itself.
15. Automatic address assignment.
16. Supports rollback upgrades.
17. Supports USB flash drive upgrades and data recording.

3.5 BCS Technical Parameters

Item	Qty	Description	Min	Typ	Max	Unit	Comments
Auxiliary Power	1	Operating Voltage	18	24	36	V	DC24V or no battery; external load
		Operating Current	-	80	-	mA	
	1	Auxiliary Power Detection	-	-	-	V	Requires 1 auxiliary power detection circuit
Total Voltage Sampling	2	Voltage Range	50	-	1500	V	Total voltage, pre-charge
		Accuracy	-	-	±0.5	%	
Shunt Sampling	1	Voltage Range Accuracy	-75	-	75	mV	Depends on shunt current and model
		Voltage Range Accuracy	-	-	0.5	%	
Hall Current Sampling	3	Sensor Supply Voltage 1	±15	-	±24	V	Supports voltage-type Hall, CAN Hall, and current-type Hall sensors (current-type is optional). Supply voltage must be >12V for normal output.
			-	24	-	mA	
		Sensor Supply Voltage 2	-	24±10%	-	V	
			-	-	20	mA	
Analog Input	4	Voltage Range	0	-	3.3	V	2 channels for temperature

		Voltage Sampling Accuracy	-	-	±10	mV	(NTC) sampling; 2 channels for voltage-type Hall sensor input. NTC accuracy is ±1°C @ -20~65°C, ±2°C elsewhere.
		Temperature Range	-40	-	125	°C	
		Temperature Sampling Accuracy	-	±1	±2	°C	
Digital I/O	24	VIL (Input Low)	0	-	1	V	24 channels of DI/DO, configurable via software
		VIH (Input High)	2	-	5	V	
		VOL (Output Low)	0	0.04	0.4	V	
		VOH (Output High)	2.5	2.9	-	V	

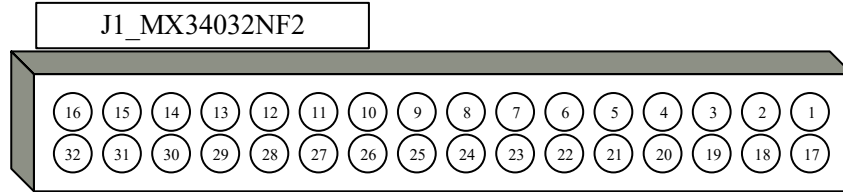
3.6 Dimensional Drawing



Note: The socket numbers correspond to the following pin definitions

3.7 Terminal Interface Definition

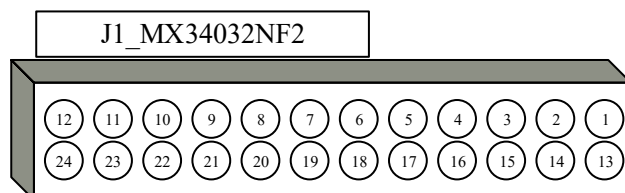
J1_MX34032NF2



Pin	Definition	Description
J1-1	HSD_OUT9	Channel 9 high-side relay drive output +
J1-2	HSD_OUT10	Channel 10 high-side relay drive output +
J1-3	HSD_OUT11	Channel 11 high-side relay drive output +
J1-4	HSD_OUT12	Channel 12 high-side relay drive output +
J1-5	HSD_OUT1	Channel 1 high-side relay drive output +
J1-6	HSD_OUT2	Channel 2 high-side relay drive output +
J1-7	HSD_OUT3	Channel 3 high-side relay drive output +
J1-8	HSD_OUT4	Channel 4 high-side relay drive output + (Only for positive output relay)
J1-9	HSD_OUT5	Channel 5 high-side relay drive output +
J1-10	HSD_OUT6	Channel 6 high-side relay drive output + (Only for pre-charge relay)
J1-11	HSD_OUT7	Channel 7 high-side relay drive output +
J1-12	HSD_OUT8	Channel 8 high-side relay drive output +
J1-13	24V_VIN	24Vdc power input+ (18V~36V)
J1-14	24V_VIN	24Vdc power input+ (18V~36V)
J1-15	24V_VIN	24Vdc power input+ (18V~36V)
J1-16	24V_VIN	24Vdc power input+ (18V~36V)
J1-17	24V_GND	Channel 9 high-side relay drive output -
J1-18	24V_GND	Channel 10 high-side relay drive output -
J1-19	24V_GND	Channel 11 high-side relay drive output -
J1-20	24V_GND	Channel 12 high-side relay drive output -
J1-21	24V_GND	Channel 1 high-side relay drive output -
J1-22	24V_GND	Channel 2 high-side relay drive output -

J1-23	24V_GND	Channel 3 high-side relay drive output -
J1-24	24V_GND	Channel 4 high-side relay drive output -
J1-25	24V_GND	Channel 5 high-side relay drive output -
J1-26	24V_GND	Channel 6 high-side relay drive output -
J1-27	24V_GND	Channel 7 high-side relay drive output -
J1-28	24V_GND	Channel 8 high-side relay drive output -
J1-29	24V_GND	24Vdc power input-
J1-30	24V_GND	24Vdc power input-
J1-31	24V_GND	24Vdc power input-
J1-32	24V_GND	24Vdc power input-

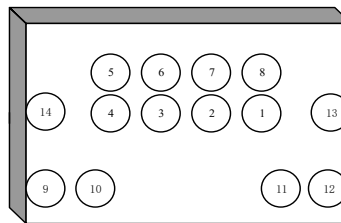
J2_MX34024NF1



Pin	Definition	Description
J2-1	A0	Hall Analog Sampling+
J2-2	EXT_RT1	Channel 1 NTC sampling+
J2-3	EXT_RT2	Channel 2 NTC sampling+
J2-4	Test Voltage1	Channel 1 AD sampling+
J2-5	-	-
J2-6	1_RS485_A	Channel 1 TIA-485/EIA-485-A Communication Differential A
J2-7	2_RS485_A	Channel 2 TIA-485/EIA-485-A Communication Differential A
J2-8	3_RS485_A	Channel 3 TIA-485/EIA-485-A Communication Differential A
J2-9	CAN0_H	Channel 1 CAN_H
J2-10	CAN1_H	Channel 2 CAN_H
J2-11	CAN2_H	Channel 3 CAN_H
J2-12	IPA/COMHP	Daisy-Chain Communication P
J2-13	AO_GND	Hall Analog Sampling-

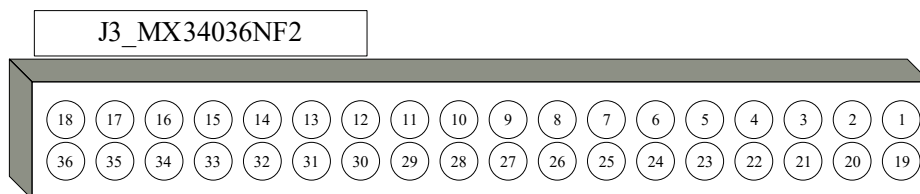
J2-14	EXT_RT-	Channel NTC sampling- (NTC common ground)
J2-15	-	-
J2-16	PE1	Channel 1 AD sampling-
J2-17	-	-
J2-18	1_RS485_B	Channel 1 TIA-485/EIA-485-A Communication Differential B
J2-19	2_RS485_B	Channel 2 TIA-485/EIA-485-A Communication Differential B
J2-20	3_RS485_B	Channel 3 TIA-485/EIA-485-A Communication Differential B
J2-21	CAN0_L	Channel 1 CAN_L
J2-22	CAN1_L	Channel 2 CAN_L
J2-23	CAN2_L	Channel 3 CAN_L
J2-24	IPA/COMHN	Daisy-Chain Communication N

J1900_RJ45_R08P-C000



100M Ethernet port

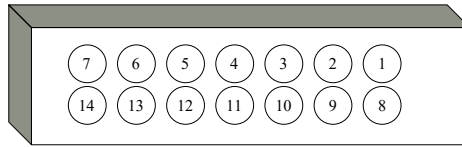
J3_MX34036NF2



Pin	Definition	Description
J3-1	DI+1	Channel 1 DI+
J3-2	DI+2	Channel 2 DI+
J3-3	DI+3	Channel 3 DI+

J3-4	DI+4	Channel 4 DI+
J3-5	DI+5	Channel 5 DI+
J3-6	DI+6	Channel 6 DI+
J3-7	DI+7	Channel 7 DI+
J3-8	DI+8	Channel 8 DI+
J3-9	DI+9	Channel 9 DI+
J3-10	DI+10	Channel 10 DI+
J3-11	DI+11	Channel 11 DI+
J3-12	DI+12	Channel 12 DI+
J3-13	Addr_IN	Address Input Signal
J3-14	Addr_OUT	Address Output Signal
J3-15	PWM_VIN	PWM Input Signal+
J3-16	PWM_OUT	PWM Output Signal+
J3-17		
J3-18		
J3-19	EARTH	Chassis Ground
J3-20	DI-1	Channel 1 DI-
J3-21	DI-2	Channel 2 DI-
J3-22	DI-3	Channel 3 DI-
J3-23	DI-4	Channel 4 DI-
J3-24	DI-5	Channel 5 DI-
J3-25	DI-6	Channel 6 DI-
J3-26	DI-7	Channel 7 DI-
J3-27	DI-8	Channel 8 DI-
J3-28	DI-9	Channel 9 DI-
J3-29	DI-10	Channel 10 DI-
J3-30	DI-11	Channel 11 DI-
J3-31	DI-12	Channel 12 DI-
J3-32	Addr_GND	Address Signal Input_GND
J3-33	Addr_GND	Address Signal Output_GND
J3-34	GND_OUT	PWM Input Signal-
J3-35	GND_OUT	PWM Output Signal-
J3-36		

J4_C4201WR_2X7P



Pin	Definition	Description
J4-1	PACK+	Total Voltage Output+
J4-2	NC	
J4-3	NC	
J4-4	PACK-	Total Voltage Output-
J4-5	NC	
J4-6	NC	
J4-7	SHUNTP	Shunt Sampling+
J4-8	BAT+	Battery Voltage+
J4-9	NC	
J4-10	NC	
J4-11	BAT-	Battery Voltage-
J4-12	NC	
J4-13	NC	
J4-14	SHUNTN	Shunt Sampling-

Note:

[1] The board is equipped with an integrated termination resistor for CAN.

[2] The board is equipped with an integrated termination resistor for RS485.

3.8 Wiring Guide

3.8.1 Group Terminal Collection Usage

BCS supports battery terminal voltage collection, load voltage collection, relay weld diagnosis, and insulation resistance detection.

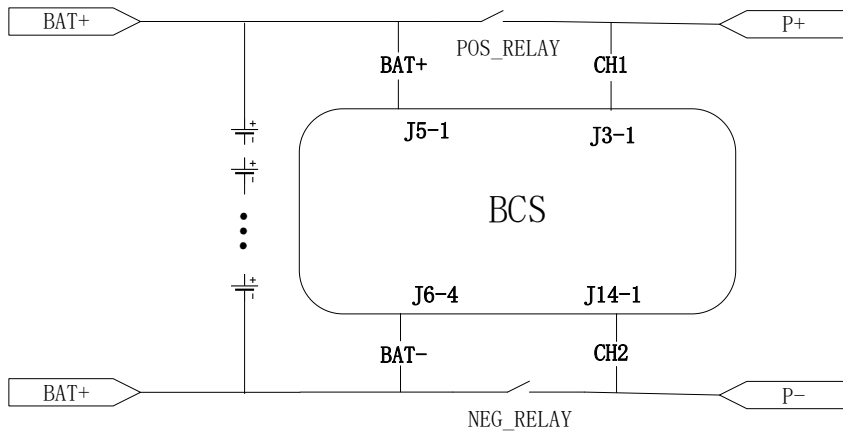
“BAT+ ”is used for positive terminal voltage collection of the battery pack.

“CH1” is used for load terminal voltage collection and positive main relay weld diagnosis.

“CH2” is used for negative main relay weld diagnosis.

The battery pack's total voltage collection and insulation resistance detection share the

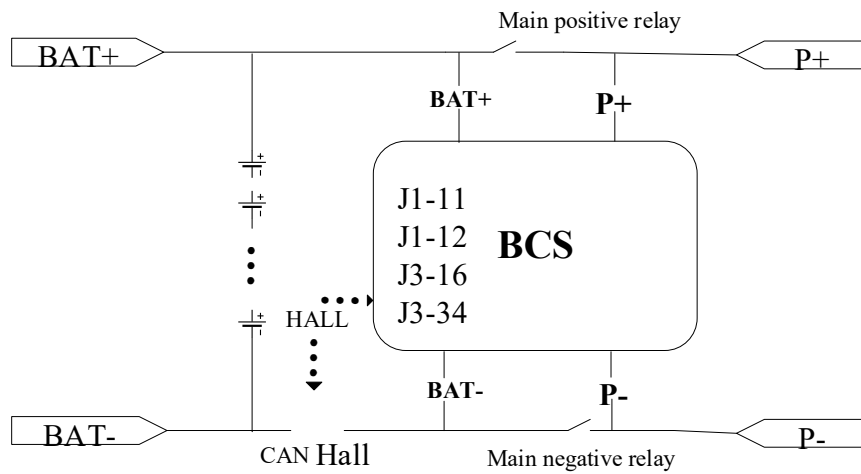
“BAT+ ”and “BAT- ”terminals. A wiring diagram is shown below:



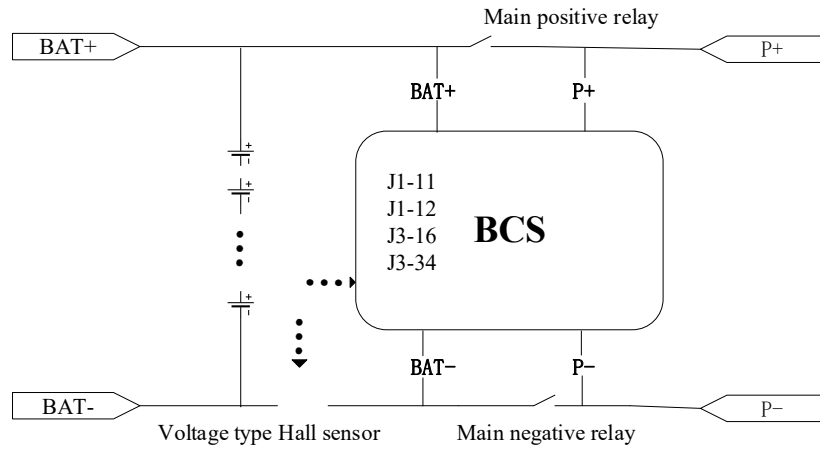
3.8.2 Current Collection Usage

BCS supports three types of Hall current sensors and one shunt current collection. The use of a shunt for current sampling is recommended. The wiring diagrams for each current collection method are as follows:

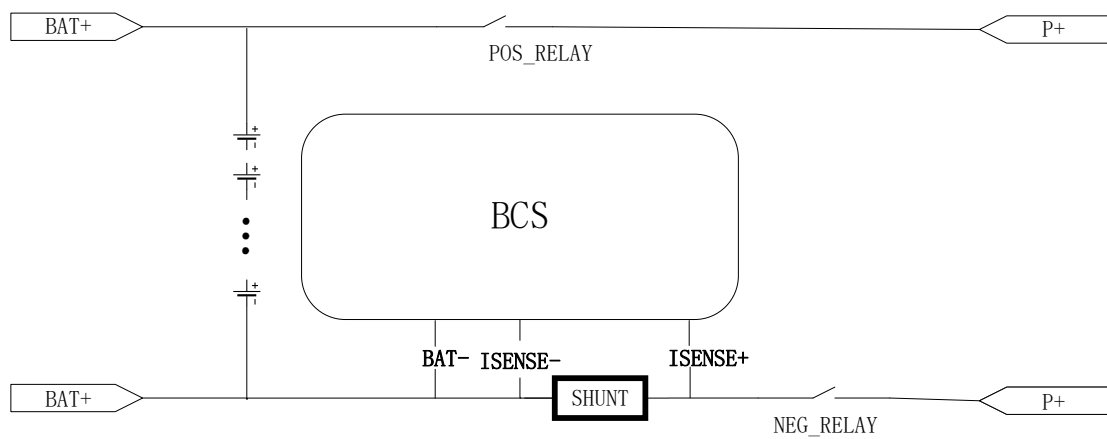
(1) Hall Sensor (CAN communication type)



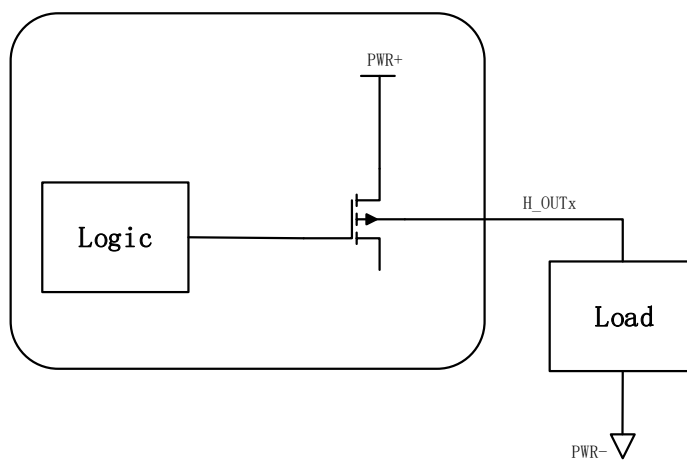
(2) Voltage-type Hall Sensor



(3) Shunt (Recommended)



(4) High-side Output



4 Battery Management System Slave Unit BMU

4.1 BMU Product Description

BMU, the Slave Unit is a critical component of the Energy Storage Battery Management System (BMS). It plays a decisive role in the safe application and extended service life of battery packs. BMU precisely collects the voltage and temperature of individual battery cells, enabling real-time monitoring of the battery status. The module features reliable data communication functionality, allowing it to communicate with BCS or other necessary equipment during system operation. The design utilizes highly reliable automotive-grade control chips and the latest acquisition technology, ensuring high measurement accuracy and providing a solid physical foundation for SOC estimation.

4.2 BMU Functions and Features

Includes, but is not limited to, the following functions and features:

1. Cell Voltage Measurement: Compatible with various battery types (LFP, LMO, LTO, NMC). Acquires data from 18 series-connected battery cells.
2. Temperature Sampling: Supports temperature sampling for 18 battery cells and up to 9 external temperature points.
3. Balancing: Features passive balancing with a maximum balancing current of 100mA.
4. CAN Communication: BMU sampling data is uploaded to BCS via CAN communication. Supports automatic address assignment (via 1 set of I/O pins for ID configuration). Up to 30 slave units can be connected in series on a single CAN bus; custom solutions are available for larger quantities. Also used for firmware upgrades.
5. Daisy-Chain Communication: Used for uploading individual cell voltages and temperatures.
6. Channel High-Side Output: A single high-side output supports a maximum continuous output of 1A. Includes status detection for hardware self-test (e.g., for fan and heater control).
7. GPIO Output and Input: 1 Channel open-drain I/O output (supports PWM) and 1 I/O input.
8. Reserved Functions: Includes reserved circuitry for smoke detection sensors and fire protection drive functionality.
9. Comprehensive Self-Diagnostics: Features extensive self-diagnostic functions and supports functional safety certification requirements.
10. Flame Retardant Materials: All materials meet the UL-94 V0 flame retardant standard.

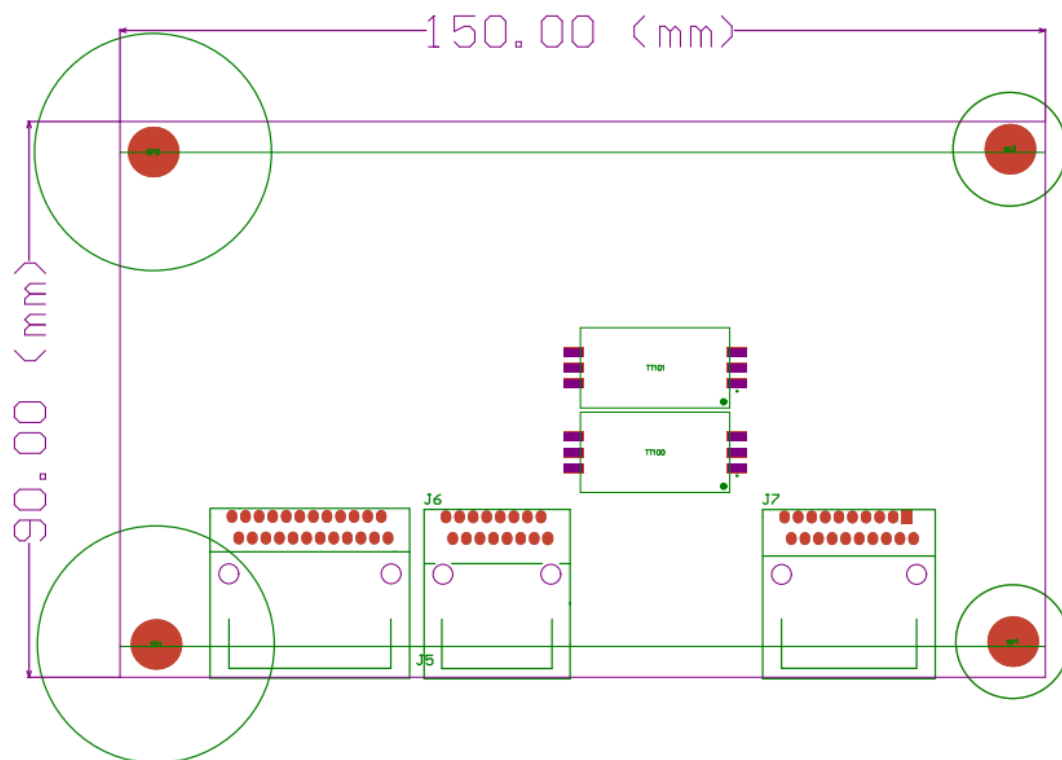
11. High-Voltage Compliance: Meets 1500V safety standards and supports UL certification for systems over 1500V.

4.3 Electrical Characteristics

Parameters		Min	Typ	Max	Unit	Comments
Low-Voltage Power Supply	Voltage	18	12/24	36	V	-
	Current	-	0.01	1	A	Max. 1A when high-side output is enabled
Cell Voltage	Voltage Range	0	-	5	V	-
	Accuracy	-	-	±0.1	mV	2.5V~4.5V, -30°C~85°C
Temperature Sampling	Temperature Range	-40	-	85	°C	Storage temperature
	Sampling Points	-	-	9	PCS	-
	Accuracy	-	1	±2	°C	-30°C~85°C
High-Side Output	Continuous Current	-	-	1	A	-
	Output Voltage	-	24	-	V	Consistent with power input
Digital Input	Input Voltage	0	-	5	V	Internal 150K pull-up to 5V
	Input Current	-	1	-	mA	
Digital Output	Output Voltage	-	-	3.3	V	Open-drain output, supports PWM, max. frequency 25kHz
	Output Current	-	-	20	mA	
Passive Balancing	Current	-	-	200	mA	-
Active Balancing	Current	-	-	1000	mA	-

Operating Power Consumption	Low-Voltage Section	-	225	-	mW	-
	High-Voltage Section	-	120	-	mW	-
Sleep Mode Power Consumption	High-Voltage Section	-	6.0	-	μA	-
Insulation & Withstand Voltage	Insulation Resistance	100	-	-	MΩ	Between voltage sampling terminals, enclosure, and digital interface
	Rated Working Voltage	-	-	1500	V	-

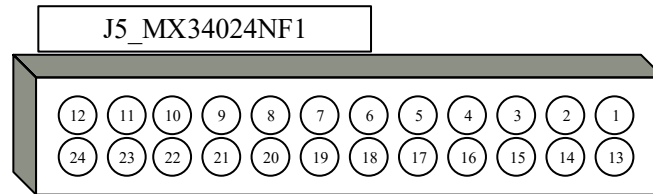
4.4 Dimensional Drawing



Note: The socket numbers correspond to the following pin definitions

4.5 Terminal interface Definition

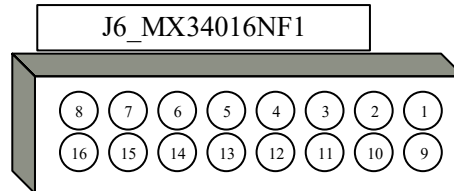
J5_MX34024NF1



Pin	Definition	Description
J5-1	ETA_A4	Channel 4 NTC sampling+
J5-2	ETA_A5	Channel 5 NTC sampling+
J5-3	ETA_A6	Channel 6 NTC sampling+
J5-4	ETA_A7	Channel 7 NTC sampling+
J5-5	ETA_A8	Channel 8 NTC sampling+
J5-6	ETA_A9	Channel 9 NTC sampling+
J5-7	-	-
J5-8	BAT_A10	Battery sampling cell 10 positive
J5-9	BAT_A12	Battery sampling cell 12 positive
J5-10	BAT_A14	Battery sampling cell 14 positive
J5-11	BAT_A16	Battery sampling cell 16 positive
J5-12	BAT_A18	Battery sampling cell 18 positive
J5-13	AGT_GND	Channel 4 NTC sampling-
J5-14	AGT_GND	Channel 5 NTC sampling-
J5-15	AGT_GND	Channel 6 NTC sampling-
J5-16	AGT_GND	Channel 7 NTC sampling-
J5-17	AGT_GND	Channel 8 NTC sampling-
J5-18	AGT_GND	Channel 9 NTC sampling-
J5-19	BAT_A9	Battery sampling cell 9 positive
J5-20	BAT_A11	Battery sampling cell 11 positive
J5-21	BAT_A13	Battery sampling cell 13 positive
J5-22	BAT_A15	Battery sampling cell 15 positive

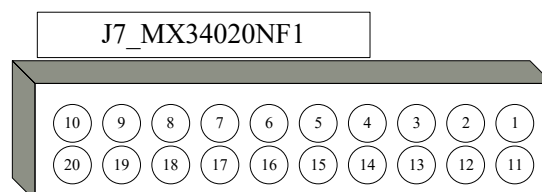
J5-23	BAT_A17	Battery sampling cell 17 positive
J5-24	PWA+	AFE power input +

J6_MX34016NF1



Pin	Definition	Description
J6-1	ETA_A1	Channel 1 NTC sampling+
J6-2	ETA_A2	Channel 2 NTC sampling+
J6-3	ETA_A3	Channel 3 NTC sampling+
J6-4	PWA-	AFE power input -
J6-5	BAT_A1	Battery sampling cell 1 positive
J6-6	BAT_A3	Battery sampling cell 3 positive
J6-7	BAT_A5	Battery sampling cell 5 positive
J6-8	BAT_A7	Battery sampling cell 6 positive
J6-9	AGT_GND	Channel 1 NTC sampling-
J6-10	AGT_GND	Channel 2 NTC sampling-
J6-11	AGT_GND	Channel 3 NTC sampling-
J6-12	BAT_A0	Battery sampling cell 1 negative
J6-13	BAT_A2	Battery sampling cell 2 positive
J6-14	BAT_A4	Battery sampling cell 4 positive
J6-15	BAT_A6	Battery sampling cell 6 positive
J6-16	BAT_A8	Battery sampling cell 8 positive

J7_MX34020NF1



Pin	Definition	Description
J7-1	24V_VIN	24Vdc Input+ (18V~36V)
J7-2	24V_GND	24Vdc Input-
J7-3	CAN0_H	CAN_H
J7-4	CAN0_L	CAN_L
J7-5	Addr_IN	Address Assignment Input
J7-6	Addr_GND	Address Assignment Input Ground
J7-7	IN_IPA	Daisy Chain Input+
J7-8	IN_IMA	Daisy Chain Input-
J7-9	FAN_24V	Fan Power Supply Output+ (24V)
J7-10	OUT_FAN_PWM	Fan Speed Control PWM Output
J7-11	LED_OUT2	LED Output 2
J7-12	LED_OUT1	LED Output 1
J7-13	CAN0_H	CAN_H
J7-14	CAN0_L	CAN_L
J7-15	Addr_OUT	Address Assignment Output
J7-16	Addr_GND	Address Assignment Output Ground
J7-17	IPB_OUT	Daisy Chain Output+
J7-18	IMB_OUT	Daisy Chain Output-
J7-19	24V_GND	Fan Power Supply Output-
J7-20	FB	Fan Fault Feedback Signal