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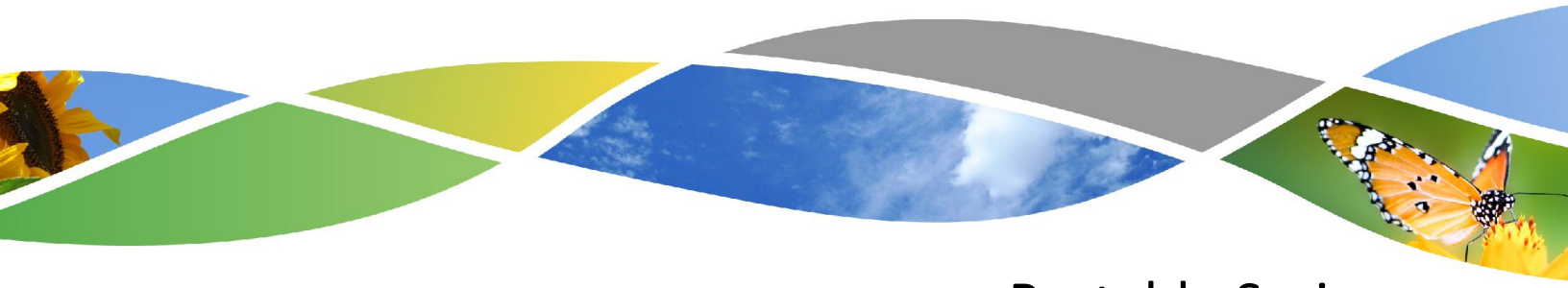
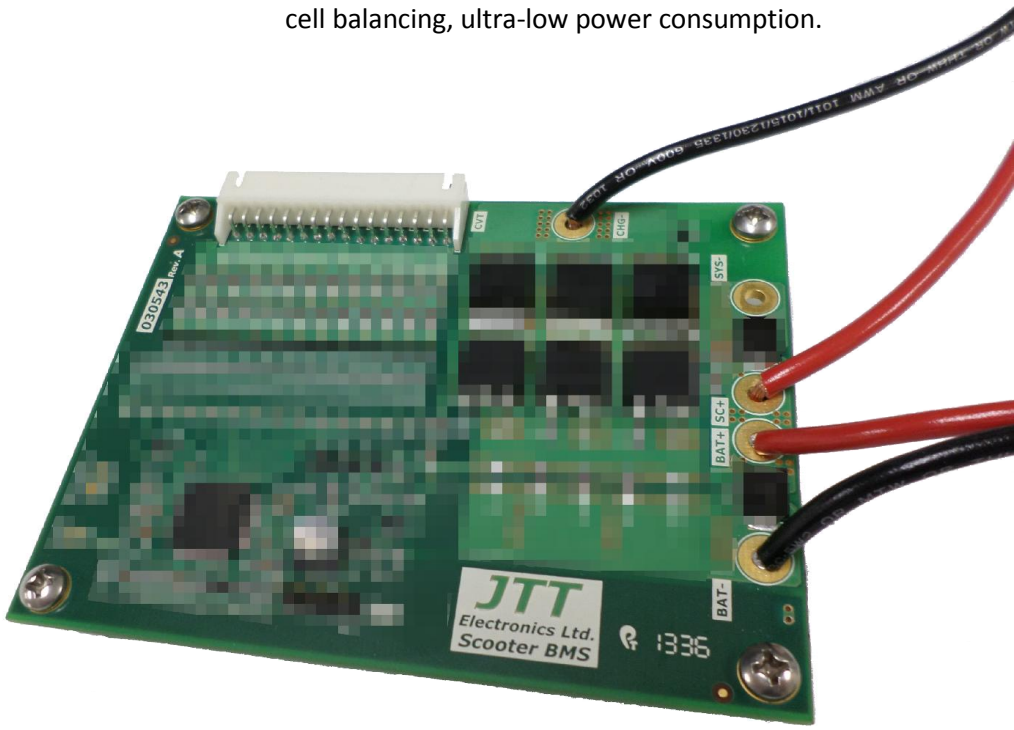


Portable Series
Lithium-ion Battery Management System
Data Sheet

Models: pBMS-1A

5 to 13 lithium-ion cells, intelligent battery protection,
cell voltage and temperature monitoring,
cell balancing, ultra-low power consumption.



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1. Features

- Supports 5 to 13 lithium-ion battery cells in series
- Protects against: short circuit, cell overvoltage, cell undervoltage, charge overcurrent, discharge overcurrent, over temperature and under temperature
- Secondary fault protection in case of MOSFET failure or extreme cell overvoltage event
- Monitors 5 to 13 cell voltages
- Monitors pack and PCBA temperatures
- Designed, built and tested to the highest automotive standards
- 25 A continuous charge and discharge current
- 85 mA passive cell balancing
- BMS powered directly from the battery, 12-58 V input with high and low voltage protection and high voltage transient immunity
- Extremely low power consumption
- Manufactured in ISO 9001 facility and Class 100,000 SMT cleanroom

2. Description

The JTT P-Series lithium-ion battery management system (BMS) is compact, economical, and ensures the safe operation of low voltage lithium-ion battery packs. This standalone BMS controller was designed specifically for consumer electronics, to automotive standards. No additional equipment is needed for the safe operation of 5 to 13 cell lithium-ion battery packs. The controller is compatible with all LFP and NMC lithium-ion cell chemistries and form factors. Please see section 8 for details on available P-Series BMS configurations.

In extreme operating conditions, the controller's primary fault protection will disconnect the battery by opening solid state relays. This helps ensure safe operation and protects the battery pack against short circuits, over-charge, over-discharge, overcurrent, over temperature and under temperature events.

The BMS's secondary fault protection ensures that even in the most extreme cases of cell overvoltage, or if the primary protection system is compromised, the battery will still be safely disconnected from the system.

The BMS passively balances the charge between all cells in the battery pack. Energy is discharged from the cells with the highest charge in the pack, which maximizes the runtime of the battery pack and extends its life.

3. Applications

- E-scooters
- E-bikes
- Backup power applications
- Portable battery packs
- Consumer electronics

4. Related Products

- **pJIL-48V25Ah-PA5-1A:** 48V 25Ah E-Scooter Portable Lithium-ion Battery Pack

5. Operations

MODES OF OPERATION

The P-Series controller has two modes of operation: active mode and low power mode. In active mode the controller operates normally. Active mode is entered automatically when battery use is detected.

Low power mode maintains all battery and safety protections, but with a reduced measurement frequency. This reduces power consumption without sacrificing safety.

CURRENT CAPABILITIES

While closed, the onboard relays can conduct up to 25 A continuous charge and discharge current. The BMS is compatible with fast chargers up to that current.

CURRENT SENSOR

The bi-directional shunt current sensor has a 16-bit analog front end that allows the BMS to monitor current in and out of the battery pack with high accuracy and fast response time.

CELL VOLTAGE MONITORING

The P-Series BMS monitors cell voltages with a resolution of 1.22 mV, accurate to 1%. The measurement period is 1 second in active mode and 8 seconds in low power mode.

CELL AND PCBA TEMPERATURE MONITORING

Cell and PCBA temperature sensor monitoring ensures that battery pack safety is always maintained and cell lifetime is maximized by avoiding high temperature events that deteriorate cell performance.

PASSIVE CELL BALANCING

Depending on cell voltages, the passive balance circuitry can discharge at up to 85 mA.

Cell balancing is achieved by discharging energy from the highest charged cells, and is required to keep all cells within the battery pack equally charged. This ensures that cells with slightly weaker performance are not degraded further by over-charging or over-discharging during operation. A well balanced battery pack will have higher capacity and longer runtime than an unbalanced one.

PRIMARY FAULT PROTECTION

The P-Series controller monitors the battery to ensure safe operation. Protections include: cell undervoltage and overvoltage, low and high temperature, short circuit, charging overcurrent, and discharging overcurrent.

If a protection is triggered, solid state relays will be opened to disconnect the battery from the system until the protection condition is resolved. All battery pack protection thresholds, timing and recovery conditions are listed in section 10. The cell thresholds are configured according to the lithium-ion cell chemistry.

SECONDARY FAULT PROTECTION

The P-Series BMS has a secondary layer of fault protection that permanently disconnects the battery pack from the system in the event of extreme cell overvoltage events or if the primary protection system is compromised.

6. Block Diagram

Below is a block diagram of a P-Series model pBMS-NMC-13-1A BMS controller. The block diagram is conceptual, and does not represent physical hardware implementation.

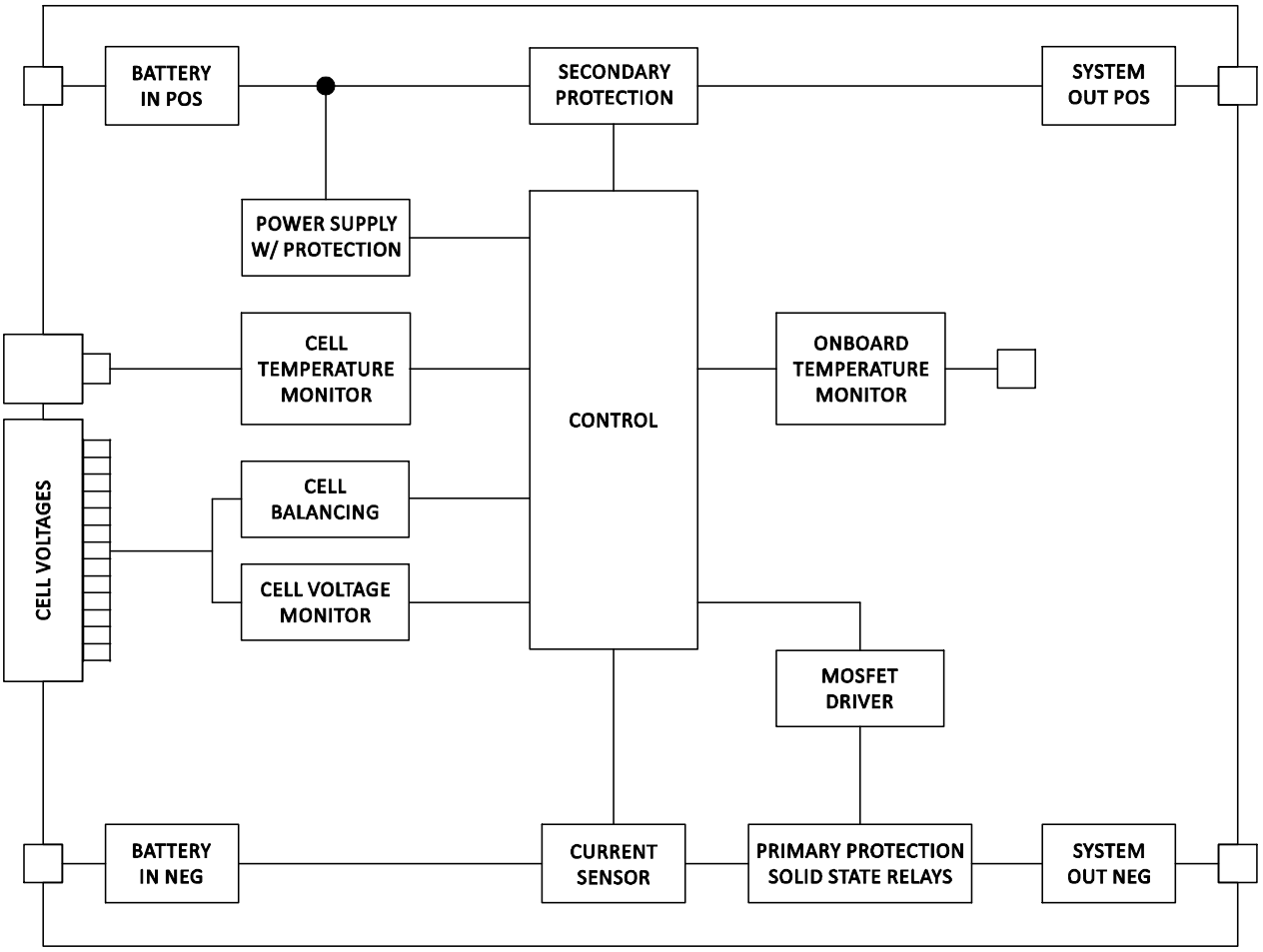


Figure 6.1 P-Series BMS controller block diagram.

7. Typical Application

The P-Series product line is typically used on low voltage (24-48 V) battery packs that contain 5 to 13 lithium-ion cells in series. The P-Series BMS is designed for use with battery packs for backup power applications, portable battery packs, e-bikes and electric scooters, as well as consumer electronics.

Depending on the specific application and cell chemistry, the BMS will be configured differently. The following is an example of a P-Series BMS used in a 48 V electric scooter battery pack made up of 13 cells in series.

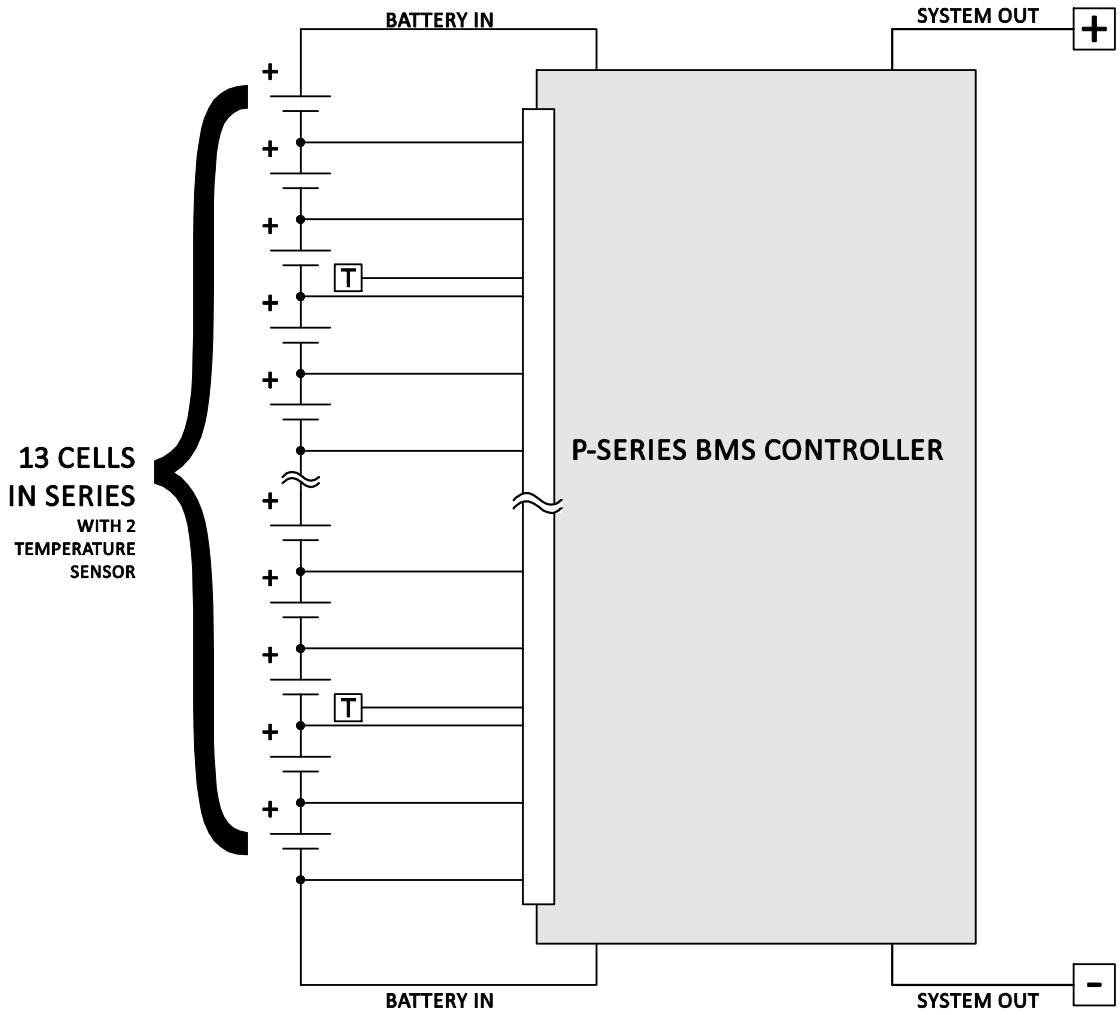


Figure 7.1 P-Series BMS controller connected to a 48 V, 13 cell NMC battery pack for an electric scooter.

8. Configurations Available

The P-Series BMS controller models are available for 5 to 13 cell systems with LFP or NMC cell chemistries. The following table lists the different models available.

BMS Model	Cell Chemistry	Cells in Series
pBMS-NMC-13-1A	NMC	13
pBMS-NMC-12-1A	NMC	12
pBMS-NMC-11-1A	NMC	11
pBMS-NMC-10-1A	NMC	10
pBMS-NMC-9-1A	NMC	9
pBMS-NMC-8-1A	NMC	8
pBMS-NMC-7-1A	NMC	7
pBMS-NMC-6-1A	NMC	6
pBMS-NMC-5-1A	NMC	5
pBMS-LFP-13-1A	LFP	13
pBMS-LFP-12-1A	LFP	12
pBMS-LFP-11-1A	LFP	11
pBMS-LFP-10-1A	LFP	10
pBMS-LFP-9-1A	LFP	9
pBMS-LFP-8-1A	LFP	8
pBMS-LFP-7-1A	LFP	7
pBMS-LFP-6-1A	LFP	6
pBMS-LFP-5-1A	LFP	5
pBMS-LMO-13-1A	LMO	13
pBMS-LMO-12-1A	LMO	12
pBMS-LMO-11-1A	LMO	11
pBMS-LMO-10-1A	LMO	10
pBMS-LMO-9-1A	LMO	9
pBMS-LMO-8-1A	LMO	8
pBMS-LMO-7-1A	LMO	7
pBMS-LMO-6-1A	LMO	6
pBMS-LMO-5-1A	LMO	5

9. Control Logic

The primary functions of the P-Series BMS are protecting against unsafe operating conditions and maximizing battery pack performance and lifetime. This is achieved by detecting battery system faults and balancing cell voltages. The BMS operates according to the diagram below.

The secondary fault protection system for extreme cell overvoltage conditions or control failure will permanently disable battery pack charge and discharge, and turn off the BMS. This adds an additional layer of protection to ensure safety.

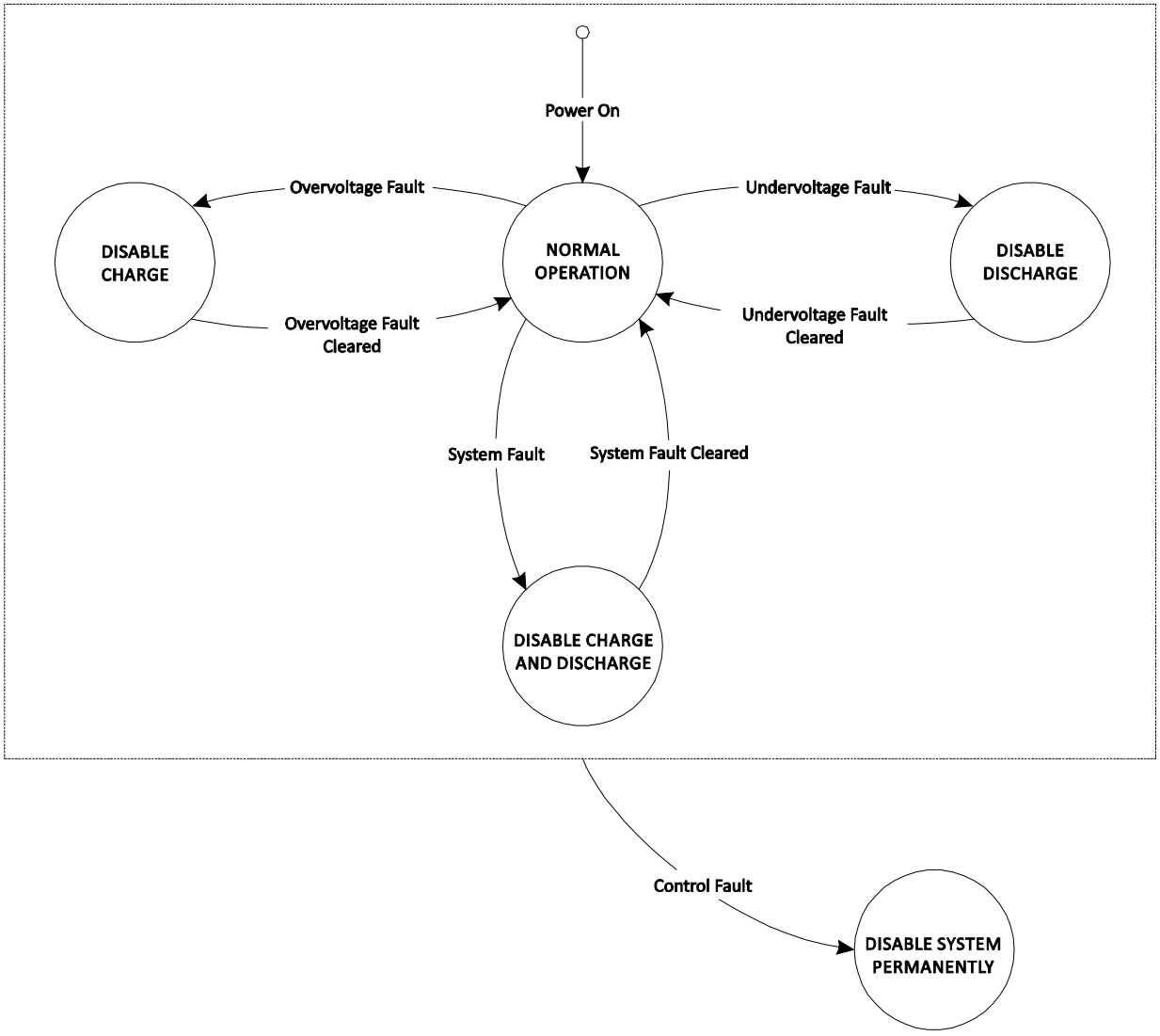


Figure 9.1 P-Series BMS controller state flow diagram showing controller logic.

The following table lists details the controller state changes from Figure 9.1. See section 10 for more details on fault responses.

State Change	Change Trigger	Initial State → Final State	
Overvoltage Fault	Cell overvoltage fault detected	Normal Operation	Disable Charge
Overvoltage Fault Cleared	Cell overvoltage fault resolved	Disable Charge	Normal Operation
Undervoltage Fault	Cell undervoltage fault detected	Normal Operation	Disable Discharge
Undervoltage Fault Cleared	Cell undervoltage fault resolved	Disable Discharge	Normal Operation
System Fault	Charge overcurrent **OR** discharge overcurrent **OR** high temperature **OR** low temperature **OR** short circuit fault detected	Normal Operation	Disable Charge and Discharge
System Fault Cleared	Charge overcurrent **AND** discharge overcurrent **AND** high temperature **AND** low temperature **AND** short circuit faults resolved	Disable Charge and Discharge	Normal Operation
Control Fault	Primary fault protection failure **OR** extreme cell overvoltage fault detected	Normal Operation	Disable System Permanently

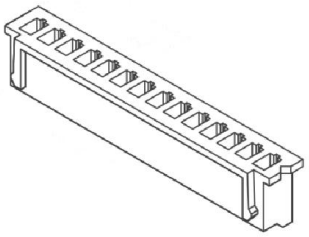
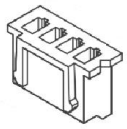
10. Primary Fault Protection Parameters

Protection Parameter	Value	
Cell Overvoltage	NMC	LFP
Detection threshold	4.25 V	3.90 V
Release threshold	4.15 V	3.80 V
Response time	1 s	
Accuracy	± 10 mV	
Cell Undervoltage	NMC	LFP
Detection threshold	2.90 V	2.00 V
Release threshold	3.00 V	2.30 V
Response time	1 s	
Accuracy	± 10 mV	
Charging Overcurrent		
Detection threshold	21 A	
Response time	50 ms	
Release delay	16 s	
Accuracy	± 3 A	
Discharging Overcurrent		
Detection threshold	30 A	
Response time	50 ms	
Release delay	16 s	
Accuracy	± 3 A	
High Temperature		
Detection threshold	65°C	
Response time	8 ± 2 s	
Release threshold	60°C	
Accuracy	± 1°C	
Low Temperature		
Detection threshold	-30°C	
Response time	8 ± 2 s	
Release threshold	-25°C	
Accuracy	± 1°C	
Short Circuit		
Detection threshold	48 A	
Response time	750 µs	
Release delay	30 s	
Accuracy	6 A	

11. Product Characteristics

Parameter	Min	Typ	Max	Units
BMS Power Specifications				
Supply voltage	12	48	58	V
Supply current, active mode (@ 48V)		1000		µA
Supply current, low power mode (@ 48V)		130		µA
Supply current, permanent shutdown (@ 48V)		50		µA
Battery Power Output Specifications				
Discharging current continuous			25	A
Charging current continuous			25	A
Charging voltage			58	V
Cell Voltage Monitoring Specifications				
Measurement resolution		1.22		mV
Measurement accuracy		0.1		%
Cell voltage range	0		5	V
Measurement period, active mode		1		s
Measurement period, low power mode		8		s
Cell Temperature Monitoring Specifications				
Measurement resolution		0.1		°C
Measurement accuracy		1.0		%
Cell temperature range	-30		80	°C
Response time		6		s
Cell Balancing Specifications				
Passive balancing current		75	85	mA
Current Sensor Specifications				
Measurement range (charge/discharge)	-100		100	A
Measurement accuracy		1.0		%
Measurement resolution (high/low current)		5		mA
Onboard Temperature Sensor Specifications				
Measurement resolution		0.1		°C
Measurement accuracy		1.0		%
Temperature range	-30		80	°C
Response time		6		s

12. Connectors and Pin Out

Connector	Connector P/N	Contact P/N	Hand Crimp Applicator	
Cell Voltages	JST XHP-14	JST SXH-001T-P0.6 (chain) (26 AWG)	JST SEH-001T-P0.6	
Cell Temperatures	JST XHP-4	JST SXH-001T-P0.6 (chain) (26 AWG)	JST SEH-001T-P0.6	
Battery and System Cables	NONE	(14 AWG)	NONE	

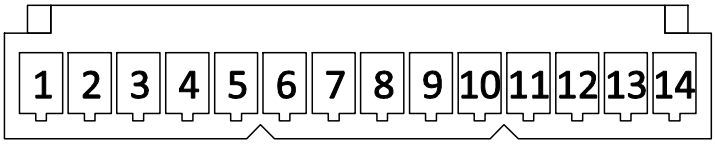


Figure 12.1 Cell voltages plug (as seen from wire side).

Cell Voltage and Temperature Monitoring			
Pin	**Tag**	**AWG**	**Description**
1	Cell 13	26	Cell 13 positive terminal voltage input
2	Cell 12	26	Cell 12 positive terminal voltage input
3	Cell 11	26	Cell 11 positive terminal voltage input
4	Cell 10	26	Cell 10 positive terminal voltage input
5	Cell 9	26	Cell 9 positive terminal voltage input
6	Cell 8	26	Cell 8 positive terminal voltage input
7	Cell 7	26	Cell 7 positive terminal voltage input
8	Cell 6	26	Cell 6 positive terminal voltage input
9	Cell 5	26	Cell 5 positive terminal voltage input
10	Cell 4	26	Cell 4 positive terminal voltage input
11	Cell 3	26	Cell 3 positive terminal voltage input
12	Cell 2	26	Cell 2 positive terminal voltage input
13	Cell 1	26	Cell 1 positive terminal voltage input
14	Cell 0	26	Battery pack negative voltage input

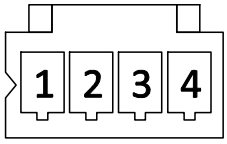


Figure 12.2 Cell temperatures plug (as seen from wire side).

Cell Voltage and Temperature Monitoring			
Pin	**Tag**	**AWG**	**Description**
1	TEMP GND1	26	Cell temperature sensor 1 ground
2	TEMP1	26	Cell temperature sensor 1 input
3	TEMP GND2	26	Cell temperature sensor 2 ground
4	TEMP2	26	Cell temperature sensor 2 input

13. Size and Mounting

- All measurements are given in mm.
- All four mounting holes are ∅3.5 mm with 7 mm pads for M3 mounting screws.
- 3D CAD file is available with connector, mounting and wire locations.

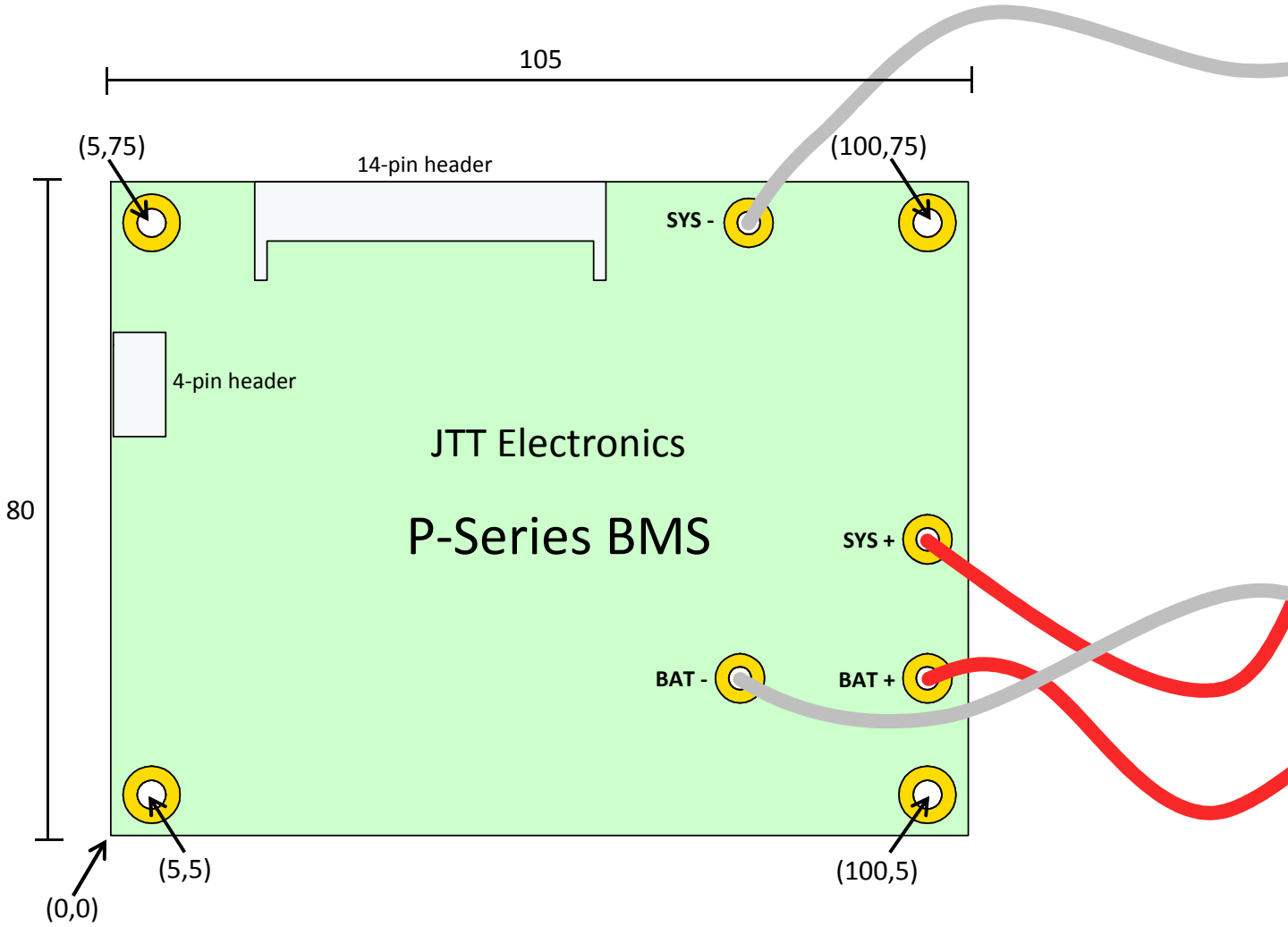


Figure 13.1 P-Series BMS controller front view with dimensions and mounting hole coordinates.