BB51100A

BMS-CAN Protocol

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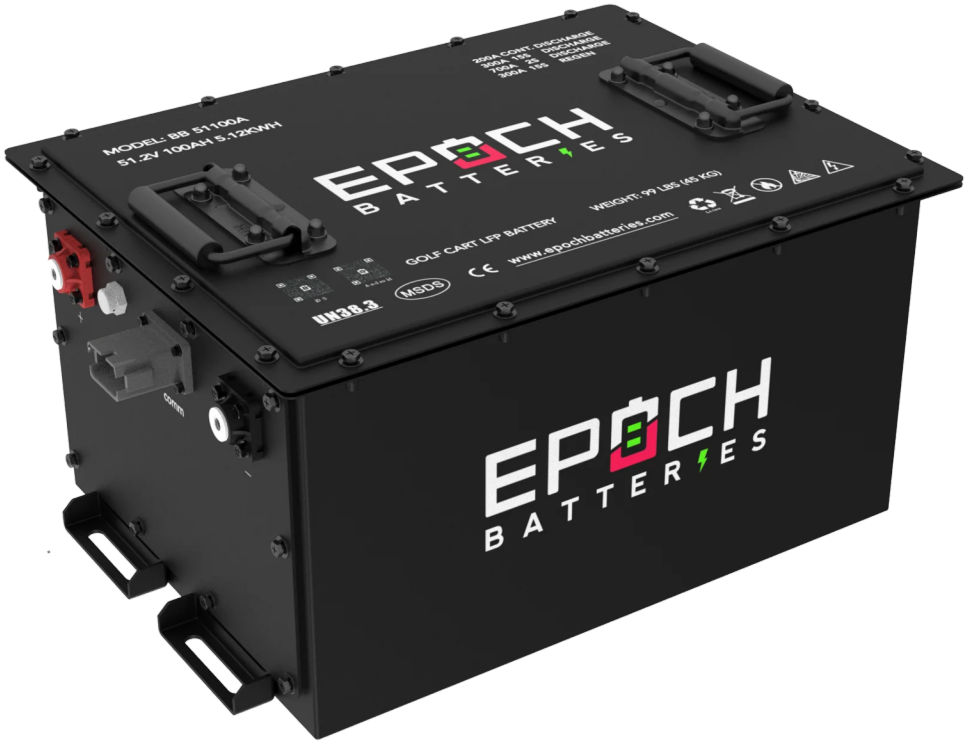

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Overview

The BMS-CAN Protocol establishes a reliable communication framework between the Battery Management System (BMS) and other nodes within a vehicle's Controller Area Network (CAN). It ensures seamless data exchange, accurate error detection, and timely system alerts, making it essential for managing battery performance and safety in electric vehicles (EVs).

Terminology Definitions

- **Battery Management System (BMS)**: Controls and protects battery cells to ensure optimal operation and longevity.
- **Controller Area Network (CAN)**: A robust communication system that enables real-time data exchange between electronic components in vehicles.

Physical Interface

- **Standard Compliance**: Follows the CAN 2.0B standard with an extended frame format, allowing for more detailed data transmission.
- **Baud Rate**: Set at 250 kbps, providing a balance between speed and stability.
- **Communication Mode**:
    - **Unidirectional, Point-to-Point**: The BMS transmits data to the instrument cluster, which only receives and displays the information, ensuring quick and efficient communication without feedback loops.

Data Conventions

- **Multi-byte Data Handling**: Utilizes little-endian format unless otherwise specified, with the least significant byte transmitted first.
- **Undefined Fields**: Other nodes are not required to parse undefined or reserved data fields, enhancing processing efficiency.
- **Battery Current Values**:
    - **Positive values** indicate discharge.
    - **Negative values** indicate charging.
- **Protocol Data Unit (PDU) Format**: Adheres to SAE J1939-21 standards for PDU2, supporting comprehensive data transmission for detailed battery monitoring and diagnostics.

Parameter Group Numbers (PGN) Allocation

The table below outlines the message types managed by the BMS, detailing their PGN assignments, identifiers, and transmission intervals:

No.	Name	Description	PGN	ID	Sender	Transmission Cycle
1	BATT_ST	Battery Status	0xFFA2	0x18FFA2F4	BMS	20 ms
2	CELL_VOLT	Cell Voltage	0xFFA4	0x18FFA4F4	BMS	100 ms
3	CELL_TEMP	Cell Temperature	0xFFA5	0x18FFA5F4	BMS	100 ms
4	ALM_INFO	Alarm Information	0xFFAF	0x18FFAFF4	BMS	Event-triggered

Note: Battery status, cell voltage, and cell temperature messages are sent at fixed intervals once the system is active. Alarm messages are transmitted only when specific events are triggered.

Message Definitions

Battery Status (BATT_ST) ID: 0x18FFA2F4

This message provides the overall status of the battery, covering voltage, current, and state of charge (SOC):

No.	Parameter	Start Bit	Bit Length	Range	Resolution	Offset	Unit	Description
1	BattVolt	0	16	0~1000	0.1	0	V	Total battery voltage
2	BattCurr	16	16	-400~1000	0.1	-400	A	Total battery current
3	SOC	32	8	0~100	1	0	%	State of charge

Example: `18FFA2F4 13 01 D7 11 33 XX XX XX`
(Voltage: 27.5V, Current: 56.7A, SOC: 51%)

Cell Voltage (CELL_VOLT) ID: 0x18FFA4F4

This message monitors the individual cell voltages, identifying both maximum and minimum values:

No.	Parameter	Start Bit	Bit Length	Range	Resolution	Offset	Unit	Description
1	MaxCellVolt	0	16	0–5000	1	0	mV	Maximum cell voltage
2	MaxCvNO	16	8	1–250	1	1		Position of max voltage
3	MinCellVolt	24	16	0–5000	1	0	mV	Minimum cell voltage
4	MinCvNO	40	8	1–250	1	1		Position of min voltage

Example: `18FFA4F4 8C 0A 05 92 09 08 XX XX`
(Max Voltage: 2700mV at Cell 5; Min Voltage: 2450mV at Cell 8)

Cell Temperature (CELL_TEMP) ID: 0x18FFA5F4

This message captures the temperature of individual battery cells, including maximum, minimum, and average values:

No.	Parameter	Start Bit	Bit Length	Range	Resolution	Offset	Unit	Description
1	MaxCellTemp	0	8	-50–200	1	-50	°C	Maximum cell temperature
2	MaxCtNO	8	8	1–250	1	1		Position of max temp
3	MinCellTemp	16	8	-50–200	1	-50	°C	Minimum cell temperature
4	MinCtNO	24	8	1–250	1	1		Position of min temp
5	AvrgCellTemp	32	8	-50–200	1	-50	°C	Average cell temperature

Example: `18FFA5F4 48 06 2F 01 3F XX XX XX`
(Max Temp: 22°C at Cell 6; Min Temp: -3°C at Cell 1; Avg Temp: 13°C)

Alarm Information (ALM_INFO) ID: 0x18FFAFF4

This message transmits alarms triggered by specific events, with up to four alarms displayed in sequence based on priority:

No.	Parameter	Start Bit	Bit Length	Range	Resolution	Offset	Description
1	Overvoltage	0	2	0~3	1	0	Alarm level
2	Undervoltage	2	2	0~3	1	0	Alarm level
3	Overcurrent	4	2	0~3	1	0	Alarm level
4	Undercurrent	6	2	0~3	1	0	Alarm level

Example: `18FFAFF4 43 00 20 00 XX XX XX XX`
(Overvoltage: Level 3, Undervoltage: Level 1, SOC Low: Level 2)

Test Cases

Normal State

In the normal operating state, only the State of Charge (SOC), voltage values, and hour meter data are displayed. The system transmits messages related to battery status, cell voltage, and cell temperature, with no alarm information sent.

CAN_ID	Data	Data Meaning	Instrument Display
0x18FFA2F4	13 01 D7 11 33 XX XX XX	Voltage: 27.5V, Current: 56.7A, SOC: 51%	Displays voltage as 27.5V, SOC as 51%, 2 battery bars, no current shown

Low Battery

When a low SOC alarm is triggered (SOC < 20%), the main display omits voltage values and shows the current alarm code. For cell-related alarms, the hour meter area indicates the corresponding cell number.

CAN_ID	Data	Data Meaning	Instrument Display
0x18FFA2F4	E1 00 8A 10 10 XX XX XX	Voltage: 22.5V, Current: 23.4A, SOC: 16%	Alarm code 11 displayed, "AL" symbol flashes, SOC as 16%, 1 battery bar, no current shown
0x18FFAFF4	00 00 30 00 XX XX XX XX	SOC Low, Level 3 Alarm	Displays SOC low alarm, Level 3

Cell Voltage – Overvoltage, Undervoltage

The main display alternates between overvoltage and undervoltage alarm codes, with corresponding cell positions shown on the hour meter.

CAN_ID	Data	Data Meaning	Instrument Display
0x18FFA4F4	8C 0A 05 92 09 08 XX XX	Max cell voltage: 2700mV (Cell 5), Min cell voltage: 2450mV (Cell 8)	Alternates alarm codes 1 and 2, "AL" symbol flashes, shows cell positions 5 and 8 on hour meter
0x18FFAFF4	0F 00 00 00 XX XX XX XX	Cell Overvoltage, Level 3 Alarm; Cell Undervoltage, Level 3 Alarm	Displays overvoltage and undervoltage alarms, both at Level 3

Cell Temperature – Over Temperature, Under Temperature

Displays alternating alarms for over-temperature and under-temperature, with the hour meter indicating corresponding cell positions.

CAN_ID	Data	Data Meaning	Instrument Display
0x18FFA5F4	48 06 2F 01 3F XX XX XX	Max temp: 22°C (Cell 6), Min temp: -3°C (Cell 1), Avg temp: 13°C	Alternates alarm codes 8 and 9, "AL" symbol flashes, shows cell positions 6 and 1 on hour meter
0x18FFAFF4	00 C0 03 00 XX XX XX XX	Cell Over Temperature, Level 3 Alarm; Cell Under Temperature, Level 3 Alarm	Displays over-temperature and under-temperature alarms, both at Level 3

Other Alarms

The instrument alternately displays relevant alarm codes, flashing the "AL" symbol, while the hour meter area shows the corresponding cell numbers.

Alarm Levels

The alarm levels for different parameters are categorized into four distinct levels based on severity:

Parameter	Level 0	Level 1	Level 2	Level 3
Cell Overvoltage	No alarm	Serious alarm	Important alarm	General alarm
Cell Undervoltage	No alarm	Serious alarm	Important alarm	General alarm
Total Overvoltage	No alarm	Serious alarm	Important alarm	General alarm
Total Undervoltage	No alarm	Serious alarm	Important alarm	General alarm
Current Overload	No alarm	Serious alarm	Important alarm	General alarm
SOC Low	No alarm	Serious alarm	Important alarm	General alarm

Alarm Levels Explained:

- **Level 0**: No alarm, normal operation.
- **Level 1**: Serious alarm; prioritized and displayed first.
- **Level 2**: Important alarm; displayed after Level 1.
- **Level 3**: General alarm; displayed last.

Communication Details

Communication Behavior

- **Normal Communication**: The BMS periodically transmits data to the instrument cluster, including messages on battery status, cell voltage, and cell temperature.
- **Event-Triggered Communication**: When specific conditions, such as alarms or faults, are detected, the BMS sends additional messages, such as alarm information. These messages are prioritized based on the sequence of events and displayed accordingly.

Data Transmission Requirements

- **Data Consistency**: Messages must be transmitted at consistent intervals:
    - Battery status: every 20 ms
    - Cell voltage: every 100 ms
    - Cell temperature: every 100 ms
- **Event Messages**: Alarm messages should be sent continuously during an active alarm condition. Once the alarm is resolved, transmission of these messages should stop.

Troubleshooting Guidelines

Common Communication Issues

- **No Data Transmission**: If data is not received by the instrument, inspect the CAN interface for disconnections, loose connections, or hardware malfunctions.
- **Incorrect Data Display**: If data appears inaccurate or inconsistent, verify the transmission rate, data format, message IDs, and frame formats to ensure they align with protocol specifications.

Alarm Condition Troubleshooting

- **High Cell Voltage**: If cell voltage exceeds specified limits, check for overcharging or imbalanced cells within the battery pack.
- **Low SOC**: If SOC falls below expected thresholds, assess battery load conditions and ensure there is no abnormal power consumption.
- **Communication Failure Alarms**: For alarms related to communication failures, examine CAN wiring, connectors, and ensure there are no interruptions or signal noise affecting data transmission.

Safety Measures

- **Abnormal Conditions**: In the event of issues such as overcharging, overheating, or critical alarms, ensure compliance with all safety protocols to protect the system and personnel.
- **Serious Alarms (Level 1)**: Take immediate action, such as disconnecting power sources or activating protective circuits, to prevent potential damage or hazards.

Version and Updates

- **Current Version**: This document outlines the 10/22/24 update of the BMS-CAN communication protocol.
- **Future Updates**: Subsequent updates will introduce new message definitions, extended parameters, and potential changes in transmission formats to improve compatibility and resolve known issues.