

TECHNICAL NOTE:

AEBUS CAN PROTOCOL SPECIFICATION

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TABLE OF CONTENTS

1. Introduction	3	4.2.5 Total 0-10% DischargeTime	7
1.1 Purpose	3	4.2.6 Total 10-20% Discharge Time	7
1.2 Scope	3	4.2.7 Total 20-50% Discharge Time	7
1.3 Audience	3	4.2.8 Total 50-80% Discharge Time	8
1.4 Acronyms and Definitions	3	4.2.9 Total 80+% Discharge Time	8
2. References	4	4.2.10 Cycle Count	8
2.1 Notation	4	4.3 PGN: 126979 (0x01F003) - Fault Status (FaultSts)	8
3. Overview	5	4.3.1 Fault Type	8
3.1 J1939 Overview	5	4.3.2 Fault Severity	9
3.2 AEBus Overview	5	4.4 PGN: 65792 (0x010100) - Device Info (DevInfo)	9
3.3 J1939 and N2K Information	5	4.4.1 Firmware Version	9
3.3.1 J1939 PGN Fields Reference	5	4.4.2 Node Type	9
3.3.2 N2K Fast Packets	5	4.4.3 BMS Node Specific – Description of Field 3	10
4. PGN Listing	6	4.4.3.1 Battery Capacity	10
4.1 PGN: 126977 (0x01F001) - Battery Stats (BattSts)	6	4.4.3.2 Module Count	10
4.1.1 Pack Current	6	4.4.3.3 Module Type	10
4.1.2 Pack Temperature	6	4.4.3.4 Node Capacity	10
4.1.3 Board Temperature	6	4.4.3.5 RSVD	10
4.1.4 State of Charge	6	4.5 PGN: 69888 (0x011100) - Firmware Update (FWUpdate)	10
4.1.5 State of Health	6	4.6 PGN: 70144 (0x011200) - Firmware Update Req (FWReq)	11
4.1.6 Cell Voltage	6	4.6.1 Current Firmware Version	11
4.1.7 Terminal Voltage	6	4.6.2 Address of requested package	11
4.2 PGN: 126978 (0x01F002) - Datalog Status (DatalogSts)	7	4.7 PGN: 70400 (0x011300) - Firmware Update Finish (FWFinish)	11
4.2.1 Discharge Watt Hours	7	5. ISO PGNs	12
4.2.2 Charge Watt Hours	7	5.1 PGN: 59392 (0xE800) - ISO Acknowledgment (ISOAck)	12
4.2.3 Total Charge Time	7	5.2 PGN: 59904 (0xEA00) - ISO Request (ISORqst)	12
4.2.4 Total Idle Time	7	5.3 PGN: 60928 (0xEE00) - ISO Address Claim	12

1. INTRODUCTION

1.1 Purpose

This protocol specification outlines the J1939 communication interface for Discover Advanced Energy Systems (AES) lithium ion batteries.

1.2 Scope

The scope of this document specifies the AEBus interface of Discover AES batteries. It should be noted that some models of Discover AES batteries are equipped with 2 controller area networks (CAN), care should be taken to ensure that the correct network is being interfaced with. This document will define the protocol, signals and functionality that can be achieved through battery integration with the AEBus.

1.3 Audience

This document is intended for the use of engineers both internal and external to Discover Energy Corp. who intend to interface with Discover AES batteries through the AEBus. It is expected that the audience has a working knowledge of the CAN physical layer as well as the J1939 standard for communication.

1.4 Acronyms and Definitions

AES – Advanced Energy Systems

BMS – Battery Management System

CAN – Controller Area Network

PDU – Protocol Data Unit

PGN – Parameter Group Number

Acronyms	Definition
AES	Advanced Energy Systems
BMS	Battery Management System
CAN	Controller Area Network
PDU	Protocol Data Unit
PGN	Parameter Group Number

2. REFERENCES

Voss, Wilfried. A Comprehensive Guide to J1939. Copperhill Media Corporation, 2008.

2.1 Notations

Format	Meaning
0x1234	Hexidecimal Value
0b0101	Binary Value

All arrays are referenced via an index range from 0 to (length -1) (as opposed to 1 to length), unless otherwise stated.

When referencing bits within a byte, the most significant bit is labelled bit7, the least significant bit0

MSB							LSB
bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0

3. OVERVIEW

3.1 J1939 Overview

J1939 is a high-layer protocol based on CAN. It provides serial data communication between embedded systems. The particular characteristics of J1939 are:

- Extended CAN identifier (29 bit)
- Baud rate of 250.0 k bits / second
- Peer-to-peer and broadcast communication
- Network management

3.2 AEBus Overview

The purpose of the AEBus network is to allow real-time Discover AES battery information to be displayed, collected, and exchanged between batteries, as well as to third party nodes. The network protocol runs over J1939 at 250 kBaud and uses NMEA 2000 fast packets. The battery is auto-addressed so all nodes on the network that require active involvement in communications must support ISO address claims (PGN: 0xEE00).

3.3 J1939 and N2K Information

3.3.1 J1939 PGN Fields Reference

Priority	Extended Data Page	Data Page	PDU Format	PDU Specific	Source Address
3 bit	1 bit	1 bit	8 bit	8 bit	8 bit

3.3.2 N2K Fast Packets

Packet Number	Data 0	Data 1	Data 2-7
1	3 bit sequence	Packet Size	Data
	5 bit frame number		
2 – N	3 bit sequence	Data	Data
	5 bit frame number		

AEBus adds the Fast Packet N2K extension to J1939. In addition to regular data a fast packet contains a sequence ID and a frame number. The first frame also contains the packet size.

For example a 16 byte packet is sent as the following 3 J1939 frames. The sequence ID is randomly generated.

Frame	Data
1	A0 0F 01 02 03 04 05 06
2	A1 07 08 09 0A 0B 0C 0D
3	A2 0B 0C 0D FF FF FF FF

4. PGN LISTING

4.1 PGN: 126977 (0x01F001) - Battery Stats (BattSts)

Transmission Rate 250 msec

Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	32	Int32 (mA)	Pack Current
2	8	Int8 (C)	Pack Temperature
3	8	Int8 (C)	Board Temperature
4	8	UInt8 (%)	State of Charge
5	8	UInt8 (%)	State of Health
6 – 21	16	Int16 (mV)	Cell Voltage (0xFFFF – invalid)
22	16	Int16 (mV)	Terminal Voltage (0xFFFF – invalid)

4.1.1 Pack Current

Charge current of the pack is expressed as > 0 (i.e. positive value).

Discharge current of the pack is expressed as < 0 (i.e. negative value).

4.1.2 Pack Temperature

The temperature of the cells in the battery. This value must be below 50 degrees C for normal operation.

4.1.3 Board Temperature

The temperature of the control board. This value must be below 85 degrees C for normal operation.

4.1.4 State of Charge

This value is an estimation of the percentage of remaining capacity.

4.1.5 State of Health

This value is a placeholder. It will always be 100% regardless of the age of the battery.

4.1.6 Cell Voltage

There are 16 cell voltage fields each is a 16 bit unsigned value expressed in millivolts.

4.1.7 Terminal Voltage

The terminal voltage as measured by the on board ADC. This may be different than the sum of the cell voltages.

4.2 PGN: 126978 (0x01F002) - Datalog Status (DatalogSts)

Field #	Field Length (bits)	Field Type	Field Description
1	32	Uint32 (Wh)	Discharge Watt Hours
2	32	Uint32 (Wh)	Charge Watt Hours
3	32	Uint32 (s)	Total Charge Time
4	32	Uint32 (s)	Total Idle Time
5	32	Uint32 (s)	Total 0-10% Discharge Time
6	32	Uint32 (s)	Total 10-20% Discharge Time
7	32	Uint32 (s)	Total 20-50% Discharge Time
8	32	Uint32 (s)	Total 50-80% Discharge Time
9	32	Uint32 (s)	Total 80+% Discharge Time
10	32	Uint32 (#)	Cycle Count

4.2.1 Discharge Watt Hours

Total cumulated energy discharged (in Watt-Hours) over lifetime of the battery.

4.2.2 Charge Watt Hours

Total cumulated energy charged (in Watt-Hours) over lifetime of the battery.

4.2.3 Total Charge Time

Total cumulated time over the lifetime of the battery, that the battery current has been > 200 mA (i.e. charging).

4.2.4 Total Idle Time

Total cumulated time over the lifetime of the battery, that the battery current has been between -200 mA and 200 mA (i.e. idle).

4.2.5 Total 0-10% Discharge Time

Total cumulated time over the lifetime of the battery, that the battery discharge current has been > 200 mA and ≤ 10% of nominal current rating (1C).

4.2.6 Total 10-20% Discharge Time

Total cumulated time over the lifetime of the battery, that the battery discharge current has been > 10% of nominal current rating (1C) and ≤ 20% of nominal current rating (1C).

4.2.7 Total 20-50% Discharge Time

Total cumulated time over the lifetime of the battery, that the battery discharge current has been > 20% of nominal current rating (1C) and ≤ 50% of nominal current rating (1C).

4.2.8 Total 50-80% Discharge Time

Total cumulated time over the lifetime of the battery, that the battery discharge current has been > 50% of nominal current rating (1C) and ≤ 80% of nominal current rating (1C).

4.2.9 Total 80+% Discharge Time

Total cumulated time over the lifetime of the battery, that the battery discharge current has been > 80% of nominal current rating (1C).

Total Discharge Time is the sum of the five (5) discharge time values.

4.2.10 Cycle Count

This is an estimation of the number of cycles done by the battery. A discharge of more than 10% SOC will increment the counter.

4.3 PGN: 126979 (0x01F003) - Fault Status (FaultSts)

Transmission Rate 1 sec

Default Priority 6

This message has a variable length depending on how many fault codes are active at the same time. The following two fields will be repeated for each fault.

Field #	Field Length (bits)	Field Type	Field Description
1	8	enum	Fault Type
2	8	enum	Fault Severity

4.3.1 Fault Type

Fault type is an enum with the following possible values:

Field #	Description
0	
1	Low Module Voltage
2	High Module Voltage
3	Low Block Temperature
4	High Block Temperature
5	High Discharge Current
6	High Charge Current
7	Module out of Balance
8	Fuse Fault
9	High Board Temperature
10	
11	
255	No data available

4.3.2 Fault Severity

Fault severity is an enum with the following possible values:

Field #	Description
0	Normal. This indicates that the fault type is not active. This value should never be seen in the fault status message
1	Recovery. This indicates that the fault code is in a recovery mode and there is restricted set of conditions that the battery will be allowed to operate in. ie. Low voltage recovery will trigger a fault if the battery detects a discharge current
2	Warning. This indicates that the battery is operating close to outside of it's specifications.
3	Fault. This indicates that the battery has gone into a protection mode. All usage of the battery will be disallowed.
4	Lockout. This indicates that the battery cannot safely enter protection mode. A single lockout state overrides any fault conditions that may be present.
255	No data available

4.4 PGN: 65792 (0x010100) - Device Info (DevInfo)

Transmission Rate Request Only

Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	32	UInt32 (xx.yy.zz)	Firmware Version 8 bit reserved (set to 0) 8 bit major version number 8 bit minor version number 8 bit patch version number
2	8	Enum	Node Type 100 = BMS 200 = Terminal 300 = Diagnostic
3	64		Device specific

4.4.1 Firmware Version

Firmware version.

4.4.2 Node Type

Reports whether NodeType is BMS, Terminal tool, or Diagnostic tool.

4.4.3 BMS Node Specific – Description of Field 3

Subfield #	Field Length (bits)	Field Type	Field Description
1	16	Uint16 (Ah)	Battery Capacity
2	8	Uint8 (#)	Module Count
3	8	Enum	Module Type 1 – LiFePO4
4	8	Bit field	Node Capability 0x01 = Acts as master 0x02 = Acts as router 0x04 = Acts as updater
5	24	Rsvd	Rsvd

4.4.3.1 Battery Capacity

Rated battery capacity as specified on battery data sheet.

4.4.3.2 Module Count

Total number of cell modules in a battery pack. .

4.4.3.3 Module Type

Refers to the battery chemistry, e.g. Lithium Iron Phosphate (LiFePO4).

4.4.3.4 Node Capability

Node capability.

4.4.3.5 RSVD

Unused. Reserved for future development.

4.5 PGN: 69888 (0x011100) - Firmware Update (FWUpdate)

Transmission Rate Request Only (use FWReq)

Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	32	Uint32	Address of package transmitted from update server
2	32	Uint32	CRC
2	64*8	Data	Flash code (0xFF padded)

All fields used for firmware auto-update feature.

4.6 PGN: 70144 (0x011200) - Firmware Update Req (FWReq)

Transmission Rate N/A

Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	32	Uint32	Current Firmware Version
2	32	Uint32	Address of requested package

4.6.1 Current Firmware Version

Used for firmware auto-update.

4.6.2 Address of requested package

Used for firmware auto-update.

4.7 PGN: 70400 (0x011300) - Firmware Update Finish (FWFinish)

Transmission Rate N/A

Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	32	Uint32	Current Firmware Version
2	32		RSVD

5. ISO PGNS

Implementation of several ISO PGNs is required for a node wishing to actively participate on the network.

5.1 PGN: 59392 (0xE800) - ISO Acknowledgment (ISOAck)

Transmission Rate Request Only
 Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	8	Enum	Control Byte 0 = Positive Ack 1 = Negative Ack 2 = Access Denied
2	8		Group Function Value
3	24		Reserved Bits (0xFF)
4	24	PGN	PGN of Requested Information

5.2 PGN: 59904 (0xEA00) - ISO Request (ISORqst)

Transmission Rate N/A
 Default Priority 6

Field #	Field Length (bits)	Field Type	Field Description
1	24	PGN	PGN of Requested Information

5.3 PGN: 60928 (0xEE00) - ISO Address Claim

Transmission Rate 1 sec
 Default Priority 6

Field	Field Length (bits)	Field Type	Field Description
1	21		Unique Identifier
2	11		Manufacturer Code
3	3		Device Instance (Lower)
4	5		Device Instance (Upper)
5	8		Device Function
6	1		RSVD
7	7		Device Class
8	4		System Instance
9	3		Industry Group
10	1		Self-Configurable Address