Interface Design Description
for the
Xcelion 6T 56V Battery Controller

SAFT AMERICA, INC. **107 BEAVER COURT** **COCKEYSVILLE, MD 21030**		
SCO: 　　　15095	**Project:** Xcelion/6T/56V/ECU	
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Note: See SCO for release approval signatures.		**Page 1 of 64**

Revision Sheet

Date	Changes Made Since Previous Revision
11/14/2019	Initial Release

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1   SCOPE

1.1   Identification

This document describes the interface protocol for the 56V Xcelion 6T Battery Controller. The 56V Xcelion 6T Battery Controller is intended to independently monitor, balance, and protect the battery. The document defines the J1939 message set used to provide operational data from the battery to the outside world.

1.2   System Overview

Li-Ion cells require electronics to guarantee safe use, maximum capacity, and long life. In guaranteeing safe Li-Ion battery use, overcharge prevention is the paramount reason for having cell-level monitoring capability. The software designed for the 56V Xcelion 6T Battery Controller monitors every cell voltage, three cell temperatures (2 for LEV version), and two temperatures from the electronic components within the battery. This measurement data is then used for battery operation as well as being communicated over a CAN Bus interface in the J1939 specification.

The 56V Xcelion 6T Battery Controller is able to balance its cells in order to optimize useful battery capacity and performance. In addition, the 56V Xcelion 6T Battery Controller is capable of an extremely low power state when not in use to preserve capacity and allow for maximum safe storage time.

The complete battery system can contain up to (6) 56V battery packs, each with their own Li-Ion Battery Controller. Each Xcelion X6T Battery Controller will have a unique address on the CAN Bus.

1.3   Document Overview

This document is intended to provide a detailed description of the interface protocol of the 56V Li-Ion Battery Controller. The document is organized as follows:

•   Section 1 – System identification, purpose, and summary
•   Section 2 – Referenced Documents
•   Section 3 – J1939 Overview
•   Section 4 – PGN Identifier
•   Section 5 – Rx Message ID Filtering
•   Section 6 – Tx Frame Specification
•   Section 7 – Rx Frame Specification
•   Section 8 – Appendix

2   REFERENCED DOCUMENTS

2.1   Project Documents

Ref ID	Reference	Revision	Document
[SRS]	See DOORs	As revised	Software Requirements Specification (SRS)

2.2   Other Documents

Ref ID	Reference	Revision	Document
J1939-11	SAE J1939-11	As revised	Physical Layer - 250K bits/s, Shielded Twisted Pair
J1939-21	SAEJ1939-11	As revised	Data Link Layer
J1939-71	SAE J1939-72	As revised	Vehicle Application Layer
J1939-73	SAE J1939-73	As revised	Application Layer - Diagnostics
J1939-74	SAE J1939-74	As revised	Application—Configurable Messaging

3   J1939 OVERVIEW

The following is intended to give a brief overview of specific items of the J1939 specification that apply to the battery system:
The PDU format followed supported by the battery (defined in J1939) as follows:

J1939 PDU						
P	EDP	DP	PF	PS	SA	Data Field
3	1	1	8	8	8	0 - 64

Bits →
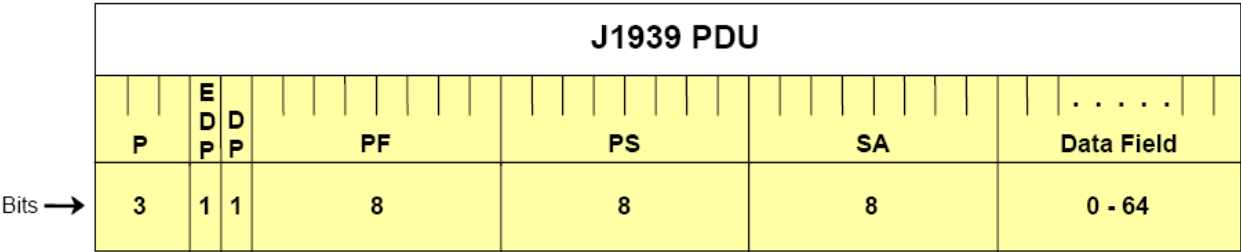
Definitions: P is Priority, EDP is Extended Data Page, DP is Data Page, PF is PDU Format,
PS is PDU Specific, and SA is Source Address

J1939 Battery Items:

Name	Value	Description		
		Pin D (Addr_2) [1]	Pin C (Addr_1) [2]	Pin B (Addr_0) [3]
No Battery Communications	N/A	0	0	0
Battery Pack Controller #1 Address	243	0	0	1
Battery Pack Controller #2 Address	244	0	1	0
Battery Pack Controller #3 Address	245	0	1	1
Battery Pack Controller #4 Address	246	1	0	0
Battery Pack Controller #5 Address	247	1	0	1
Battery Pack Controller #6 Address	248	1	1	0
Battery Pack Controller #7 Address	249	1	1	1
Saft Diagnostic Tool Address	250	Address reserved for the Xcelion 6T GUI.		
Vehicle Controller Address	216	Default address for an in-vehicle system communicating with the battery		
Vehicle Controller Address	217	Additional address for an in-vehicle system communicating with the battery		
Manufacture Code	269	Saft America Inc., Space & Defense Division, Cockeysville MD 21030		
ECU Instance	0	ID of the Li-Ion Battery Controller (used if multiple in single battery pack)		
Function Instance	0	Master, 1 – 3 Slaves		
Function	4	Battery Pack Monitor		
Vehicle System	0	Not a specific system		
Industry Group	1	On-Highway Equipment		
Arbitrary Address Capable	0	Not Arbitrary Address Capable		

Table 3-1: Battery Specific Values for J1939

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[1] Where 0 is floating / not connected, 1 is grounded

[2] Where 0 is floating / not connected, 1 is grounded

[3] Where 0 is floating / not connected, 1 is grounded

4   PGN IDENTIFIER LIST

PGN	PGN (16)	PGN Ref.	Direction	Parameter Group Name	Rate	Protocol	ACK/RSP
59392	E800	ACKM	TX	Acknowledgement	As Needed	Global	-
60160	EB00	TP-DT	TX	Transport Protocol – Data Transfer	As Needed	Global / Specific	
60928	EE00	AC	TX	Addressed Claimed	On Request	Global / Specific	-
64965	FDC5	ECUID	TX	ECU Identification Information	On Request	Transport	-
65226	FECA	DM1	TX	Active Diagnostic Trouble Codes	1s	Transport	-
65227	FECB	DM2	TX	Previously Active Diagnostic Trouble Codes	On Request	Transport	-
65242	FEDA	SOFT	TX	Software Identification	On Request	Transport	-
65254	FEE6	TD	TX	Time/Date	1s	Global	-
65483	FFCB	PropB_CB	TX	Generator Control	250ms	Global	-
65489	FFD1	PropB_D1	TX	Fault States	1s	Global	-
65490	FFD2	PropB_D2	TX	Battery ECU Status	500ms	Global	-
65491	FFD3	PropB_D3	TX	Battery BIT Status	500ms	Global	-
65492	FFD4	PropB_D4	TX	Battery Cell Status 1	250ms	Global	-
65493	FFD5	PropB_D5	TX	Battery Cell Status 2	250ms	Global	-
65494	FFD6	PropB_D6	TX	Battery Performance	250ms	Global	-
65495	FFD7	PropB_D7	TX	Battery Temperatures	500ms	Global	-
65496	FFD8	PropB_D8	TX	Battery Balancing Circuit Info	500ms	Global	-
65497	FFD9	PropB_D9	TX	Battery State of Health	500ms	Global	-
65498	FFDA	PropB_DA	TX	Battery Voltage	250ms	Global	-
65499	FFDB	PropB_DB	TX	Battery Storage Information	On Request	Global	-
65500	FFDC	PropB_DC	TX	Battery Cell Upper SOC 1	500ms	Global	-
65501	FFDD	PropB_DD	TX	Battery Cell Lower SOC 1	500ms	Global	-
65502	FFDE	PropB_DE	TX	Battery State-of-Charge	500ms	Global	-
65505	FFE1	PropB_E1	TX	Battery Cell Status 3	250ms	Global	-
65506	FFE2	PropB_E2	TX	Battery Cell Status 4	250ms	Global	-
65507	FFE3	PropB_E3	TX	Battery Cell Upper SOC 2	500ms	Global	-
65508	FFE4	PropB_E4	TX	Battery Cell Lower SOC 2	500ms	Global	-
59904	EA00	RQST	RX	Request	As Needed	Specific	RSP / ACK
60416	EC00	TP-CM	RX / TX	Transport Protocol - Connection Management	As Needed	Global / Specific	-
61184	EF00	PropA	RX	Battery Specific Command	As Needed	Specific	ACK
65523	FFF3	PropB_F3	RX	Battery Global Command	As Needed	Global	ACK

| 65228 | FECC | DM3 | N/A | Diagnostic Data Clear / Reset of Previously Active DTCs | - | - | ACK |

Table 4-1: J1939 PGN List

5 RX MESSAGE ID FILTERING

In order to prevent performance issues and inadvertant control of the battery, messages identified as receive (RX) inTable 4-1, J1939 PGN List, will be filtered by their source addresses as follows:

Message "Request" (PGN EA00h) will be processed from any source address (global). Message "Battery Global Command" (PGN FFF3h) will be processed from any source address (global). Messages "Battery Specific Command" (PGN EF00h) will be processed from any source address (global).

Source Address: **Any (255h)**
PGN EA00h -   Request

Source Address: **Any (255h)**
PGN FFF3h -   Battery Global Command

Source Address: **Any (255h)**
PGN EF00h -   Battery Specific Command

6 TX FRAME SPECIFICATION

6.1 Acknowledgement

Description:		Message acknowledges that a message was successfully received by the Battery ECU												
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			ACKM								
Receiver:		Any	**Parameter Group Number:**			59392 (E800h)								
Protocol:		Global	**Priority:**			6								
Transfer Rate:		On Need	**Extended Data Page / Data Page:**			0 / 0								
Data Length:		8	**PDU Format:**			232 (E8h)								
Source Address:		Battery ECU Address	**PDU Specific:**			255								

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Control Byte	ID	1 / bit	0	0	3	1							D1	D0
Reserved	-	-	-	-	-	1	-	-	-	-	-	-		
Group Function Value (if applicable)	ID	1 / bit	0	0	250	2	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	3	1	1	1	1	1	1	1	1
Reserved	-	-	-	-	-	4	1	1	1	1	1	1	1	1
Requestor Source Address	ID	1 / bit	0	0	250	5	D7	D6	D5	D4	D3	D2	D1	D0
Parameter Group Number (of message acknowledged)	ID	1 / bit	0	0	16,449,535	6	D7	D6	D5	D4	D3	D2	D1	D0
						7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D7	D6	D5	D4	D3	D2	D1	D0

Control Byte		
Type	**Value**	**Description**
ACK	0	Positive Acknowledgment
NACK	1	Negative Acknowledgment
Access Denied	2	PGN supported but security denied access
Busy	3	PGN supported but ECU is busy and cannot respond now. Re-request the data at a later time.

Table 6-1: ACK Control Byte Values

6.2   Address Claimed

Description:	Message used to claim an address for a Controller Application												
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**				AC							
Receiver:	Any	**Parameter Group Number:**				60928 (EE00h)							
Destination:	Global	**Priority:**				6							
Transfer Rate:	As Needed	**Extended Data Page / Data Page:**				0 / 0							
Data Length:	8	**PDU Format:**				238 (EEh)							
Source Address:	Battery ECU Address	**PDU Specific:**				DA or 255							

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	msb 7	6	5	4	3	2	1	lsb 0	Value
Identity Number	ID	1 / bit	0	0	2,097,151	1	D7	D6	D5	D4	D3	D2	D1	D0	BATT S/N
						2	D15	D14	D13	D12	D11	D10	D9	D8	
						3			D20	D19	D18	D17	D16		
Manufacturer Code	ID	1 / bit	0	269	269	3	D2	D1	D0						269
						4	D10	D9	D8	D7	D6	D5	D4	D3	
ECU Instance	ID	1 / bit	0	0	0	5						D2	D1	D0	0
Function Instance	ID	1 / bit	0	0	31	5	D4	D3	D2	D1	D0				SA - BEA
Function	ID	1 / bit	0	4	4	6	D7	D6	D5	D4	D3	D2	D1	D0	4
Reserved	-	-	-	-	-	7								-	0
Vehicle System	ID	1 / bit	0	0	0	7	D6	D5	D4	D3	D2	D1	D0		0
Vehicle System Instance	ID	1 / bit	0	0	0	8					D3	D2	D1	D0	0
Industry Group	ID	1 / bit	0	1	1	8		D2	D1	D0					1
Arbitrary Address Capable	Bit	1 / bit	0	1	1	8	D0								1

6.3 ECU Identification Information

Description:	Message for reporting identification and information about the physical ECU and its hardware															
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**				ECUID										
Receiver:	Any	**Parameter Group Number:**				64965 (FDC5h)										
Protocol:	Transport	**Priority:**				6										
Transfer Rate:	On Request	**Extended Data Page / Data Page:**				0 / 0										
Data Length:	40	**PDU Format:**				253 (FDh)										
Source Address:	Battery ECU Address	**PDU Specific:**				197 (C5h)										
						msb			bit #				lsb		
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Value**
ECU Part Number	ASCII String	ASCII	0	1	254	1-8	D7	D6	D5	D4	D3	D2	D1	D0	"nnnnnnnn"
Delimiter	ASCII	ASCII	0	42	42	9	D7	D6	D5	D4	D3	D2	D1	D0	2Ah
ECU Serial Number	ASCII String	ASCII	0	243	246	10-17	D7	D6	D5	D4	D3	D2	D1	D0	"nnnnnnnn"
Delimiter	ASCII	ASCII	0	42	42	18	D7	D6	D5	D4	D3	D2	D1	D0	2Ah
Battery Serial Number	ASCII String	ASCII	0	1	254	19-26	D7	D6	D5	D4	D3	D2	D1	D0	"nnnnnnnn"
Delimiter	ASCII	ASCII	0	42	42	27	D7	D6	D5	D4	D3	D2	D1	D0	2Ah
ECU Type	ASCII String	ASCII	0	1	254	28-47	D7	D6	D5	D4	D3	D2	D1	D0	"Battery Pack Monitor"
Delimiter	ASCII	ASCII	0	42	42	48	D7	D6	D5	D4	D3	D2	D1	D0	2Ah

6.4   Active Diagnostic Trouble Codes

Description:	Active DTCs are sent at no greater than a 1 second interval when one or more current DTC occurrences exist or change.													
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**					DM1							
Receiver:	Any	**Parameter Group Number:**					65226 (FECAh)							
Destination:	Transport	**Priority:**					6							
Transfer Rate:	1s	**Extended Data Page / Data Page:**					0 / 0							
Data Length:	Variable	**PDU Format:**					254 (FEh)							
Source Address:	Battery ECU Address	**PDU Specific:**					202 (CAh)							

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Protect Lamp	Status	2 states / 2 bit	0	0	1	1							D1	D0
Amber Warning Lamp	Status	2 states / 2 bit	0	0	1	1					D1	D0		
Red Stop Lamp	Status	2 states / 2 bit	0	0	1	1			D1	D0				
Malfunction Indicator Lamp	Status	2 states / 2 bit	0	0	1	1	D1	D0						
Flash Protect Lamp	Status	4 states / 2 bit	0	0	3	2							D1	D0
Flash Amber Warning Lamp	Status	4 states / 2 bit	0	0	3	2					D1	D0		
Flash Red Stop Lamp	Status	4 states / 2 bit	0	0	3	2			D1	D0				
Flash Malfunction Indicator Lamp	Status	4 states / 2 bit	0	0	3	2	D1	D0						
DTC1.Suspect_Parameter_Number	ID	1 / bit	0	0	524,287	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
						5	D18	D17	D16					
DTC1.Failure_Mode_Identifier	ID	1 / bit	0	0	31	5				D4	D3	D2	D1	D0
DTC1.Occurrence_Count	Count	1 / bit	0	0	126	6		D6	D5	D4	D3	D2	D1	D0
DTC1.SPN_Conversion_Method	ID	1 / bit	0	0	1	6	D0							
DTC2 (if more than 1 occurrence exists)						7-10	See DTC1 for data format							
DTCn (for each of n existing occurrences)						(4n-1) - (4n+2)	See DTC1 for data format							

6.5 Previously Active Diagnostic Trouble Codes

Description:	All Previously Active DTCs are sent upon Request (PGN 59904). Previously Active DTCs reflect all DTCs with an occurrence count greater than zero and will remain in memory until DM3 (PGN 65228) clears them. Lamp information should reflect the present state for the ECU.				
Transmitter:	Battery Pack Monitor #1-4	Parameter Group Name:	DM2		
Receiver:	Any	Parameter Group Number:	65227 (FECBh)		
Destination:	Transport	Priority:	6		
Transfer Rate:	On Request	Extended Data Page / Data Page:	0 / 0		
Data Length:	Variable	PDU Format:	254 (FEh)		
Source Address:	Battery ECU Address	PDU Specific:	203 (CBh)		

							msb			bit #				lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Protect Lamp	Status	2 states / 2 bit	0	0	1	1							D1	D0
Amber Warning Lamp	Status	2 states / 2 bit	0	0	1	1					D1	D0		
Red Stop Lamp	Status	2 states / 2 bit	0	0	1	1			D1	D0				
Malfunction Indicator Lamp	Status	2 states / 2 bit	0	0	1	1	D1	D0						
Flash Protect Lamp	Status	4 states / 2 bit	0	0	3	2							D1	D0
Flash Amber Warning Lamp	Status	4 states / 2 bit	0	0	3	2					D1	D0		
Flash Red Stop Lamp	Status	4 states / 2 bit	0	0	3	2			D1	D0				
Flash Malfunction Indicator Lamp	Status	4 states / 2 bit	0	0	3	2	D1	D0						
DTC1.Suspect_Parameter_Number	ID	1 / bit	0	0	524,287	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
						5	D18	D17	D16					
DTC1.Failure_Mode_Identifier	ID	1 / bit	0	0	31	5				D4	D3	D2	D1	D0
DTC1.Occurrence_Count	Count	1 / bit	0	0	126	6		D6	D5	D4	D3	D2	D1	D0
DTC1.SPN_Conversion_Method	ID	1 / bit	0	0	1	6	D0							
DTC2 (if more than 1 occurrence exists)						7-10	See DTC1 for data format							
DTCn (for each of n existing occurrences)						(4n-1) - (4n+2)	See DTC1 for data format							

Diagnostic Trouble Codes			
Suspect Parameter Name	**SPN**	**SPN Associated FMIs**	**FMI**
Cell Voltage	520192	Data Valid But Above Normal Operational Range - Most Severe Level	0
		Data Valid But Below Normal Operational Range - Most Severe Level	1
		Voltage Above Normal, Or Shorted To High Source	3
		Voltage Below Normal, Or Shorted To Low Source	4
		Data Valid But Above Normal Operational Range - Least Severe Level	15
		Data Valid But Above Normal Operational Range - Moderately Severe Level	16
		Data Valid But Below Normal Operational Range - Least Severe Level	17
		Data Valid But Below Normal Operational Range - Moderately Severe Level	18
Battery Voltage[1]	520193	Data Valid But Above Normal Operational Range - Most Severe Level	0
		Data Valid But Below Normal Operational Range - Most Severe Level	1
		Voltage Above Normal, Or Shorted To High Source	3
		Voltage Below Normal, Or Shorted To Low Source	4
		Data Valid But Above Normal Operational Range - Least Severe Level	15
		Data Valid But Above Normal Operational Range - Moderately Severe Level	16
		Data Valid But Below Normal Operational Range - Least Severe Level	17
		Data Valid But Below Normal Operational Range - Moderately Severe Level	18
Battery Temperature	520194	Data Valid But Above Normal Operational Range - Most Severe Level	0
		Data Valid But Below Normal Operational Range - Most Severe Level	1
		Temperature Above Normal, Or Shorted To High Source	3
		Temperature Below Normal, Or Shorted To Low Source	4
		Data Valid But Above Normal Operational Range - Least Severe Level	15
		Data Valid But Above Normal Operational Range - Moderately Severe Level	16
		Data Valid But Below Normal Operational Range - Least Severe Level	17
		Data Valid But Below Normal Operational Range - Moderately Severe Level	18
ECU BIT Failure	520195	Condition Exists	31

Table 6-2: DTC Values

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[1] Greyed out values are for future use / Not currently implemented

Protect Lamp	
Lamp Off	0
Lamp On	1

Table 6-3: Protect Lamp Values

Amber Warning Lamp	
Lamp Off	0
Lamp On	1

Table 6-4: Amber Warning Lamp Values

Red Stop Lamp	
Lamp Off	0
Lamp On	1

Table 6-5: Red Stop Lamp Values

Malfunction Indicator Lamp	
Lamp Off	0
Lamp On	1

Table 6-6: Malfunction Lamp Values

Flash Protect Lamp	
Slow Flash (1Hz)	0
Fast Flash (2Hz+)	1
Reserved	2
Unavailable / No Flash	3

Table 6-7: Flash Protect Lamp Values

Flash Amber Warning Lamp	
Slow Flash (1Hz)	0
Fast Flash (2Hz+)	1
Reserved	2
Unavailable / No Flash	3

Table 6-8: Flash Amber Warning Lamp Values

Flash Red Stop Lamp	
Slow Flash (1Hz)	0
Fast Flash (2Hz+)	1
Reserved	2
Unavailable / No Flash	3

Table 6-9: Flash Red Stop Lamp Values

Flash Malfunction Indicator Lamp	
Slow Flash (1Hz)	0
Fast Flash (2Hz+)	1
Reserved	2
Unavailable / No Flash	3

Table 6-10: Flash Malfunction Lamp Values

Note: Currently DTCs listed below will only cause a slow flash in the Flash Protect Lamp. No other lamp changes are made by this message. All other DTC's have no effect on lamp states.

Cell Voltage High Critical
Cell Voltage Low Critical
Cell Temperature High Critical
Electronics Temperature High Critical
Hardware, Software, or Fast Overload

6.6 Software Identification

Description:	Message for reporting identification and information about the software in the ECU.															
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**				SOFT										
Receiver:	Any	**Parameter Group Number:**				65242 (FEDAh)										
Protocol:	Transport	**Priority:**				6										
Transfer Rate:	On Request	**Extended Data Page / Data Page:**				0 / 0										
Data Length:	32	**PDU Format:**				254 (FEh)										
Source Address:	Battery ECU Address	**PDU Specific:**				218 (DAh)										
							msb			bit #				lsb		
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Value**
Number of Software Identification Fields	Count	1 / bit	0	3	3	1	D7	D6	D5	D4	D3	D2	D1	D0	3
Software Part Number	ASCII String	ASCII	0	1	254	2-9	D7	D6	D5	D4	D3	D2	D1	D0	"SWnnnnnn"
Delimiter	ASCII	ASCII	0	42	42	10	D7	D6	D5	D4	D3	D2	D1	D0	2Ah
Software Version	ASCII String	ASCII	0	1	254	11-20	D7	D6	D5	D4	D3	D2	D1	D0	"NN.nn.bbbb"
Delimiter	ASCII	ASCII	0	42	42	21	D7	D6	D5	D4	D3	D2	D1	D0	2Ah
Software Build Date	ASCII String	ASCII	0	1	254	22-31	D7	D6	D5	D4	D3	D2	D1	D0	"MM/DD/YYYY"
Delimiter	ASCII	ASCII	0	42	42	32	D7	D6	D5	D4	D3	D2	D1	D0	2Ah

6.7   Time/Date

Description:	Transmits the date and time as recorded by the real time clock.														
Transmitter:	Battery Pack Monitor #1-4		**Parameter Group Name:**			TD									
Receiver:	Any		**Parameter Group Number:**			65254 (FEE6h)									
Destination:	Global		**Priority:**			6									
Transfer Rate:	1s		**Extended Data Page / Data Page:**			0 / 0									
Data Length:	6		**PDU Format:**			254 (FEh)									
Source Address:	Battery ECU Address		**PDU Specific:**			230 (E6h)									
						msb			bit #						lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Seconds	Seconds	0.25 s / bit	0	0	59.75	1	D7	D6	D5	D4	D3	D2	D1	D0	
Minutes	Minutes	1 min / bit	0	0	59	2	D7	D6	D5	D4	D3	D2	D1	D0	
Hours	Hours	1 hr / bit	0	0	23	3	D7	D6	D5	D4	D3	D2	D1	D0	
Month	Month	1 month / bit	0	1	12	4	D7	D6	D5	D4	D3	D2	D1	D0	
Day	Day	0.25 days / bit	0	0.25	31.75	5	D7	D6	D5	D4	D3	D2	D1	D0	
Year	Years	1 year / bit	1985	1985	2235	6	D7	D6	D5	D4	D3	D2	D1	D0	
Spare	-	-	-	-	-	7	1	1	1	1	1	1	1	1	
						8	1	1	1	1	1	1	1	1	

6.8 Generator Control

Description:	Provides voltage level request to the generator.													
Transmitter:	Battery Pack Monitor #1-4		**Parameter Group Name:**			PropB_CB								
Receiver:	Any		**Parameter Group Number:**			65483 (FFCBh)								
Destination:	Global		**Priority:**			Any								
Transfer Rate:	250ms		**Extended Data Page / Data Page:**			0 / 0								
Data Length:	8		**PDU Format:**			255 (FFh)								
Source Address:	Lowest Battery ECU Address		**PDU Specific:**			203 (CBh)								

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Spare	-	-	-	FFh	FFh	1	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	2	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	3	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	4	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	5	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	6	1	1	1	1	1	1	1	1
Vehicle Bus Requested Voltage	Voltage	0.05 V / bit	0	0	3,212.75	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

6.9 Fault States

Description:	Provides all major and minor fault states. Fault Occurring = 1, Fault Not Occurring = 0												
Transmitter:	Battery Pack Monitor #1-4		**Parameter Group Name:**			PropB_D1							
Receiver:	Any		**Parameter Group Number:**			65489 (FFD1h)							
Protocol:	Global		**Priority:**			6							
Transfer Rate:	1s		**Extended Data Page / Data Page:**			0 / 0							
Data Length:	8		**PDU Format:**			255 (FFh)							
Source Address:	Battery ECU Address		**PDU Specific:**			209 (D1h)							

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Cell Overvoltage	Status	True / False	0	0	3	1							D1	D0
Critical Cell Overvoltage	Status	True / False	0	0	3	1					D1	D0		
Cell Undervoltage	Status	True / False	0	0	3	1			D1	D0				
Critical Cell Undervoltage	Status	True / False	0	0	3	1	D1	D0						
Cell Temperature High	Status	True / False	0	0	3	2							D1	D0
Critical Cell Temp. High	Status	True / False	0	0	3	2					D1	D0		
Critical Board Temp. High	Status	True / False	0	0	3	2			D1	D0				
Microcontroller Temp. High	Status	True / False	0	0	3	2	D1	D0						
Hardware Overload	Status	True / False	0	0	3	3							D1	D0
Fast Software Overload	Status	True / False	0	0	3	3					D1	D0		
Software Overload	Status	True / False	0	0	3	3			D1	D0				
Battery Voltage Low	Status	True / False	0	0	3	3	D1	D0						
Spare	-	-	-	-	-	4	1	1	1	1	1	1	1	1
						5	1	1	1	1	1	1	1	1
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

6.10   Battery ECU Status

Description:		Provides battery electronics control unit (ECU) information											
Transmitter:		Battery Pack Monitor #1-4	Parameter Group Name:			PropB_D2							
Receiver:		Any	Parameter Group Number:			65490 (FFD2h)							
Destination:		Global	Priority:			5							
Transfer Rate:		500ms	Extended Data Page / Data Page:			0 / 0							
Data Length:		8	PDU Format:			255 (FFh)							
Source Address:		Battery ECU Address	PDU Specific:			210 (D2h)							

							msb			bit #					lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Battery Mode	Status	5 states / 3 bits	0	0	4	1						D2	D1	D0
FET Array State	Status	6 states / 3 bits	0	0	5	1			D2	D1	D0			
SOC Mode	Status	4 states / 2 bits	0	0	3	1	D1	D0						
Fault Status	Status	2 states / 1 bit	0	0	1	2								D0
BIT Status	Status	2 states / 1 bit	0	0	1	2							D0	
Battery Enable	Status	2 states / 1 bit	0	0	1	2						D0		
SW Overload Detection	Status	2 states / 1 bit	0	0	1	2					D0			
Overload Latch Status	Status	2 states / 1 bit	0	0	1	2				D0				
Charge Overload Detection	Status	2 states / 1 bit	0	0	1	2			D0					
Overload Latch Clear Status	Status	2 states / 1 bit	0	0	1	2		D0						
Heater Control[5]	Status	2 states / 1 bit	0	0	1	2	D0							
Charge FET State	Status	2 states / 1 bit	0	0	1	3								D0
Discharge FET State	Status	2 states / 1 bit	0	0	1	3							D0	
Too Cold to Charge	Status	2 states / 1 bit	0	0	1	3						D0		
Battle Override Status	Status	2 states / 1 bit	0	0	1	3					D0			
Overcharge Protect Latch Status	Status	2 states / 1 bit	0	0	1	3				D0				
Ideal Diode State	Status	2 states / 1 bit	0	0	1	3			D0					
FET Power State	Status	2 states / 1 bit	0	0	1	3		D0						
Reserve Protect Enabled	Status	2 states / 1 bit	0	0	1	3	D0							
Reserve Protect Warn Reached	Status	2 states / 1 bit	0	0	1	4								D0
Reserve Protect Limit Reached	Status	2 states / 1 bit	0	0	1	4							D0	

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[5] Disabled in LEV

Name	Type	Resolution	Default	Min	Max	Word								
Arctic Heating Enabled[6]	Status	2 states / 1 bit	0	0	1	4						D0		
Heat Reason[7]	Status	8 states / 3 bit	0	0	7	4			D2	D1	D0			
Storage Delay Enabled	Status	2 states / 1 bit	0	0	1	4		D0						
Arctic Heating Temp Cap[8]	Celsius	1 C / 1 bit	-50	-50	25	4	D0							
						5			D6	D5	D4	D3	D2	D1
Reserve Protect Limit %	%	0.1% / 1 bit	0	0.0%	100.0%	5	D1	D0						
						6	D9	D8	D7	D6	D5	D4	D3	D2
Storage Delay Time Limit	Seconds	1 second / bit	0	0	32767	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

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[6] Disabled in LEV

[7] Disabled in LEV

[8] Disabled in LEV

Data	State	Value		Data	State	Value
Battery Mode	Enabled	0		**Discharge FET State**	Off	0
	Storage	1			On	1
	Disabled	2		**Too Cold to Charge**	Charging Temp Reached	0
	Maintenance	3			Too Cold for Charge	1
	Unknown/Invalid	4		**Battle Override Status**	Override Not Received	0
FET Array Control States	Low Power OFF	0			Override Received	1
	No Charge	1		**Overcharge Protect Latch Status**	Not Latched	0
	No Charge No Discharge	2			Latched	1
	All On	3		**Ideal Diode State**	Bypass	0
	Maintenance	4			On	1
	Unknown/Invalid	5		**FET Power State**	FET Power Off	0
SOC Mode	Unknown	0			FET Power On	1
	Init	1		**Reserve Protect Enabled**	Reserve Protect Disabled	0
	No Current	2			Reserve Protect Enabled	1
	CC	3		**Reserve Protect Warn Reached**	Warn Value Not Reached	0
Fault States	Normal	0			Warning Value Reached	1
	Problem Detected	1		**Reserve Protect Limit Reached**	Limit Not Reached	0
BIT Status	Normal	0			Limit Reached	1
	Problem Detected	1		**Arctic Heating Enabled**	Arctic Heating Disabled	0
Battery Enable State	Battery Disabled	0			Arctic Heating Enabled	1
	Battery Enabled	1		**Heat Reasons**	In Storage Mode	0
Software Overload Detection	No Overload Detected	0			FETs Opening	1
	Overload Detected	1			Faulted	2
Overload Latch Status	Unlatched	0			Arctic Heating	3
	Latched	1			Maintenance Heating	4
Charge Overload Detection	No Charge Overload	0			Charge Enabled	5
	Charge Overload	1			Charge Blocked	6
Overload Latch Clear Status	No Clear Attempted	0			Unknown	7
	Clear Latch Attempted	1		**Pending Storage Status**	P.S. Disabled	0
Heater Control	Off	0			P.S. Enabled	1
	On	1				
Charge FET State	Off	0				
	On	1				

Table 6-11: ECU Status Item Values

6.11 BIT Status

Description:	Provides the results from Built-In-Test functionality provided by the battery.													
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_D3									
Receiver:	Any	**Parameter Group Number:**			65491 (FFD3h)									
Destination:	Global	**Priority:**			5									
Transfer Rate:	500ms	**Extended Data Page / Data Page:**			0 / 0									
Data Length:	8	**PDU Format:**			255 (FFh)									
Source Address:	Battery ECU Address	**PDU Specific:**			211 (D3h)									

						Byte	msb 7	6	5	4	3	2	bit # 1	lsb 0
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**#**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Battery Calibrated (PBIT)	Status	1 / bit	0	0	2	1							D1	D0
Voltage Reference (PBIT)	Status	1 / bit	0	0	2	1					D1	D0		
Int EEPROM (PBIT)	Status	1 / bit	0	0	2	1			D1	D0				
Results Ready (PBIT)	Status	1 / bit	0	0	2	1	D1	D0						
Battery Calibrated (IBIT)	Status	1 / bit	0	0	2	2							D1	D0
Voltage Reference (IBIT)	Status	1 / bit	0	0	2	2					D1	D0		
Int EEPROM (IBIT)	Status	1 / bit	0	0	2	2			D1	D0				
Results Ready (IBIT)	Status	1 / bit	0	0	2	2	D1	D0						
Voltage Reference (CBIT)	Status	1 / bit	0	0	2	3							D1	D0
ROP (CBIT)	Status	1 / bit	0	0	2	3					D1	D0		
Delta State of Charge (CBIT)	Status	1 / bit	0	0	2	3			D1	D0				
Delta Temperature (CBIT)	Status	1 / bit	0	0	2	3	D1	D0						
Heater[9]	Status	1 / bit	0	0	2	4							D1	D0
FET Short	Status	1 / bit	0	0	2	4					D1	D0		
Analog Front End (AFE) Voltage Reference (CBIT)	Status	1 / bit	0	0	2	4			D1	D0				
AFE Communication Loss (CBIT)	Status	1 / bit	0	0	2	4	D1	D0						
Power Supply (CBIT)	Status	1 / bit	0	0	2	5							D1	D0
FET Stuck Open (CBIT)	Status	1 / bit	0	0	2	5					D1	D0		

[9] Not implemented in LEV

Temperature Wire Shorted High (CBIT)	Status	1 / bit	0	0	2	5			D1	D0				
Temperature Wire Shorted Low (CBIT)	Status	1 / bit	0	0	2	5	D1	D0						
Results Ready (CBIT)	Status	1 / bit	0	0	2	6							D1	D0
AFE Voltage Self-Test (SBIT)	Status	1 / bit	0	0	2	6					D1	D0		
AFE Temperature Self-Test (SBIT)	Status	1 / bit	0	0	2	6			D1	D0				
AFE Broken Wire (SBIT)	Status	1 / bit	0	0	2	6	D1	D0						
AFE Thermal Shutdown (SBIT)	Status	1 / bit	0	0	2	7							D1	D0
AFE Muxfail (SBIT)	Status	1 / bit	0	0	2	7					D1	D0		
RAM (SBIT)	Status	1 / bit	0	0	2	7			D1	D0				
Flash (SBIT)	Status	1 / bit	0	0	2	7	D1	D0						
ROP (SBIT)	Status	1 / bit	0	0	2	8							D1	D0
Results Ready (SBIT)	Status	1 / bit	0	0	2	8					D1	D0		
Under Voltage Lockout (CBIT)	Status	1 / bit	0	0	2	8			D1	D0				
Spare	-	-	-	-	-	8	1	1						

Values	
Pass	0
Fail	1
Can't (if aplicable)	2

Table 6-12: BIT State Values

6.12 Battery Cell Status 1

Description:		Provides cell voltage data for a specific battery, indicated by the source address field.											
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_D4							
Receiver:		Any	**Parameter Group Number:**			65492 (FFD4h)							
Protocol:		Global	**Priority:**			6							
Transfer Rate:		250ms	**Extended Data Page / Data Page:**			0 / 0							
Data Length:		8	**PDU Format:**			255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**			212 (D4h)							

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	msb 7	6	5	4	3	2	1	lsb 0
Cell Voltage 1	Voltage	0.0001 V / bit	0	0	6.4255	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 2	Voltage	0.0001 V / bit	0	0	6.4255	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 3	Voltage	0.0001 V / bit	0	0	6.4255	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 4	Voltage	0.0001 V / bit	0	0	6.4255	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

6.13 Battery Cell Status 2

Description:	Provides cell voltage data for a specific battery, indicated by the source address field.			
Transmitter:	Battery Pack Monitor #1-4	Parameter Group Name:	PropB_D5	
Receiver:	Any	Parameter Group Number:	65493 (FFD5h)	
Protocol:	Global	Priority:	6	
Transfer Rate:	250ms	Extended Data Page / Data Page:	0 / 0	
Data Length:	8	PDU Format:	255 (FFh)	
Source Address:	Battery ECU Address	PDU Specific:	213 (D5h)	

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	msb 7	6	5	4	3	2	1	lsb 0
Cell Voltage 5	Voltage	0.0001 V / bit	0	0	6.4255	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 6	Voltage	0.0001 V / bit	0	0	6.4255	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 7	Voltage	0.0001 V / bit	0	0	6.4255	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 8	Voltage	0.0001 V / bit	0	0	6.4255	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

6.14 Battery Performance

Description:	Provides parametric data for a specific battery, indicated by the source address field.			
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**	PropB_D6	
Receiver:	Any	**Parameter Group Number:**	65494 (FFD6h)	
Destination:	Global	**Priority:**	5	
Transfer Rate:	250ms	**Extended Data Page / Data Page:**	0 / 0	
Data Length:	8	**PDU Format:**	255 (FFh)	
Source Address:	Battery ECU Address	**PDU Specific:**	214 (D6h)	

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	msb 7	6	5	4	3	2	1	lsb 0
Battery Current	Amperes	1cA / 1 bit	-3,600A	-3,600.00	1,200.00	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
						3	D23	D22	D21	D20	D19	D18	D17	D16
						4	D31	D30	D29	D28	D27	D26	D25	D24
Battery Current Range	Status	Low = 0 High = 1	0	0	1	5								D0
Generator Control	Status	Disabled = 0 Enabled = 1	0	0	1	5							D0	
Generator Response Time	mS	0 = 250mS 1 = 500mS 2 = 750mS 3 = 1000mS	0	250mS	1000mS	5						D2	D1	
Spare	-	-	-	-	-	5						-		
Generator Control Trim Threshold	%	0 = 20.0% 1 = 12.5% 2 = 10.0% 3 = 8.3% 4 = 5.0% 5 = 2.5% 6 = 1.0% 7 = 10.0%	0	1.0%	20%	5	D2	D1	D0					
Generator Control Current Limit	Amperes	0.01A / 1 bit	0	0	655.35	6	D7	D6	D5	D4	D3	D2	D1	D0
						7	D15	D14	D13	D12	D11	D10	D9	D8
Maximum Generator Voltage	Volts	0.1V / bit	40.0V	0.0V	24.0V	8	D7	D6	D5	D4	D3	D2	D1	D0

6.15   Battery Temperatures

Description:			Provides temperature data for a specific battery, indicated by source address field.												
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**				PropB_D7								
Receiver:		Any	**Parameter Group Number:**				65495 (FFD7h)								
Destination:		Global	**Priority:**				6								
Transfer Rate:		500ms	**Extended Data Page / Data Page:**				0 / 0								
Data Length:		8	**PDU Format:**				255 (FFh)								
Source Address:		Battery ECU Address	**PDU Specific:**				215 (D7h)								
								msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	7	6	5	4	3	2	1	0
MCU Temperature	Celsius	1C / bit	-40	-40	210	1	D7	D6	D5	D4	D3	D2	D1	D0
Electronics Temperature 1	Celsius	1C / bit	-50	-50	200	2	D7	D6	D5	D4	D3	D2	D1	D0
Electronics Temperature 2	Celsius	1C / bit	-50	-50	200	3	D7	D6	D5	D4	D3	D2	D1	D0
Cell Temperature 1	Celsius	1C / bit	-50	-50	200	4	D7	D6	D5	D4	D3	D2	D1	D0
Cell Temperature 2	Celsius	1C / bit	-50	-50	200	5	D7	D6	D5	D4	D3	D2	D1	D0
Electronics Temperature 3[1]	Celsius	1C / bit	-50	-50	200	6	D7	D6	D5	D4	D3	D2	D1	D0
Cell Temperature 3[2]	Celsius	1C / bit	-50	-50	200	7	D7	D6	D5	D4	D3	D2	D1	D0
Spare	-	-	-	FFh	FFh	8	1	1	1	1	1	1	1	1

[1] Not implemented in LEV (0xFF)

[2] Not implemented in LEV (0xFF)

6.16   Battery Balancing Circuit Info

Description:	Provides cell balancing data for a specific battery, indicated by the battery instance field.				
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**	PropB_D8	
Receiver:	Any	**Parameter Group Number:**	65496 (FFD8h)	
Destination:	Global	**Priority:**	6	
Transfer Rate:	500ms	**Extended Data Page / Data Page:**	0 / 0	
Data Length:	8	**PDU Format:**	255 (FFh)	
Source Address:	Battery ECU Address	**PDU Specific:**	216 (D8h)	

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7 (msb)	6	5	4	3	2	1	0 (lsb)
Cell 1 Balancing Status	Status	2 states / 2 bit	0	0	3	1							D1	D0
Cell 2 Balancing Status	Status	2 states / 2 bit	0	0	3	1					D1	D0		
Cell 3 Balancing Status	Status	2 states / 2 bit	0	0	3	1			D1	D0				
Cell 4 Balancing Status	Status	2 states / 2 bit	0	0	3	1	D1	D0						
Cell 5 Balancing Status	Status	2 states / 2 bit	0	0	3	2							D1	D0
Cell 6 Balancing Status	Status	2 states / 2 bit	0	0	3	2					D1	D0		
Cell 7 Balancing Status	Status	2 states / 2 bit	0	0	3	2			D1	D0				
Cell 8 Balancing Status	Status	2 states / 2 bit	0	0	3	2	D1	D0						
Cell 9 Balancing Status	Status	2 states / 2 bit	0	0	3	3							D1	D0
Cell 10 Balancing Status	Status	2 states / 2 bit	0	0	3	3					D1	D0		
Cell 11 Balancing Status	Status	2 states / 2 bit	0	0	3	3			D1	D0				
Cell 12 Balancing Status	Status	2 states / 2 bit	0	0	3	3	D1	D0						
Cell 13 Balancing Status	Status	2 states / 2 bit	0	0	3	4							D1	D0
Cell 14 Balancing Status	Status	2 states / 2 bit	0	0	3	4					D1	D0		
Cell 15 Balancing Status	Status	2 states / 2 bit	0	0	3	4			D1	D0				
Cell 16 Balancing Status	Status	2 states / 2 bit	0	0	3	4	D1	D0						
Spare	-	-	-	FFh	FFh	5	1	1	1	1	1	1	1	1
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

Balancing Status	
Off	0
On (Discharging)	1

Table 6-13: Balancing Status Values

6.17   State of Health

Description:	Sends the current predicted state of health of the battery.												
Transmitter:	Battery Pack Monitor #1-4		**Parameter Group Name:**			PropB_D9							
Receiver:	Any		**Parameter Group Number:**			65497 (FFD9h)							
Destination:	Global		**Priority:**			6							
Transfer Rate:	1s		**Extended Data Page / Data Page:**			0 / 0							
Data Length:	8		**PDU Format:**			255 (FFh)							
Source Address:	Battery ECU Address		**PDU Specific:**			217 (D9h)							

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	msb 7	6	5	4	3	2	1	lsb 0
State of Health	% x 1,000,000	0.000001%/bit	0	0.000000%	100.000000%	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
						3	D23	D22	D21	D20	D19	D18	D17	D16
						4	D31	D30	D29	D28	D27	D26	D25	D24
Spare	-	-	-	-	-	5	1	1	1	1	1	1	1	1
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

6.18 Battery Voltage

Description:	Provides voltages for the battery measured at difference points.				
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**	PropB_DA	
Receiver:	Any	**Parameter Group Number:**	65498 (FFDAh)	
Protocol:	Global	**Priority:**	5	
Transfer Rate:	250ms	**Extended Data Page / Data Page:**	0 / 0	
Data Length:	8	**PDU Format:**	255 (FFh)	
Source Address:	Battery ECU Address	**PDU Specific:**	218 (DAh)	

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Battery Cell Voltage Sum	Voltage	0.0001 V / bit	0	0	104.8576	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
						3					D19	D18	D17	D16
Measured Battery Voltage	Voltage	0.0001 V / bit	0	0	104.8576	3	D3	D2	D1	D0				
						4	D11	D10	D9	D8	D7	D6	D5	D4
						5	D19	D18	D17	D16	D15	D14	D13	D12
Measured Vehicle Bus Voltage	Voltage	0.0001 V / bit	0	0	104.8576	6	D7	D6	D5	D4	D3	D2	D1	D0
						7	D15	D14	D13	D12	D11	D10	D9	D8
						8					D19	D18	D17	D16
Spare	-	-	-	-	-	8	1	1	1	1				

6.19 Battery Storage Information

Description:		Provides the amount of time last spent in Disabled/Shelf mode.											
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_DB							
Receiver:		Any	**Parameter Group Number:**			65499 (FFDBh)							
Protocol:		Global	**Priority:**			5							
Transfer Rate:		On Request	**Extended Data Page / Data Page:**			0 / 0							
Data Length:		8	**PDU Format:**			255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**			219 (DBh)							

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Minutes	Minutes	1 Minute	0	0	59	1			D5	D4	D3	D2	D1	D0
Hours	Hours	1 Hour	0	0	23	1	D1	D0						
						2						D4	D3	D2
Days	Days	1 Day	0	0	31	2	D4	D3	D2	D1	D0			
Months	Months	1 Month	0	0	255	3	D7	D6	D5	D4	D3	D2	D1	D0
Spare	-	-	-	FFh	FFh	4	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	5	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	6	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	7	1	1	1	1	1	1	1	1
Spare	-	-	-	FFh	FFh	8	1	1	1	1	1	1	1	1

6.20 Battery Cell Upper SOC 1

Description:		Provides the estimated state of charge of the specified cell.												
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_DC								
Receiver:		Any	**Parameter Group Number:**			65500 (FFDCh)								
Protocol:		Global	**Priority:**			6								
Transfer Rate:		500ms	**Extended Data Page / Data Page:**			0 / 0								
Data Length:		8	**PDU Format:**			255 (FFh)								
Source Address:		Battery ECU Address	**PDU Specific:**			220 (DCh)								
							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Upper SOC Cell 1	Percent	0.5 % / bit	-10	-10	115	1	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 2	Percent	0.5 % / bit	-10	-10	115	2	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 3	Percent	0.5 % / bit	-10	-10	115	3	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 4	Percent	0.5 % / bit	-10	-10	115	4	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 5	Percent	0.5 % / bit	-10	-10	115	5	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 6	Percent	0.5 % / bit	-10	-10	115	6	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 7	Percent	0.5 % / bit	-10	-10	115	7	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 8	Percent	0.5 % / bit	-10	-10	115	8	D7	D6	D5	D4	D3	D2	D1	D0

6.21   Battery Cell Lower SOC 1

Description:	Provides cell-level Lower State of Charge (SOC) information.														
Transmitter:	Battery Pack Monitor #1-4		**Parameter Group Name:**			PropB_DD									
Receiver:	Any		**Parameter Group Number:**			65501 (FFDDh)									
Protocol:	Global		**Priority:**			6									
Transfer Rate:	500ms		**Extended Data Page / Data Page:**			0 / 0									
Data Length:	8		**PDU Format:**			255 (FFh)									
Source Address:	Battery ECU Address		**PDU Specific:**			221 (DDh)									
							msb			bit #					lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Lower SOC Cell 1	Percent	0.5 % / bit	-10	-10	115	1	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 2	Percent	0.5 % / bit	-10	-10	115	2	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 3	Percent	0.5 % / bit	-10	-10	115	3	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 4	Percent	0.5 % / bit	-10	-10	115	4	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 5	Percent	0.5 % / bit	-10	-10	115	5	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 6	Percent	0.5 % / bit	-10	-10	115	6	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 7	Percent	0.5 % / bit	-10	-10	115	7	D7	D6	D5	D4	D3	D2	D1	D0	
Lower SOC Cell 8	Percent	0.5 % / bit	-10	-10	115	8	D7	D6	D5	D4	D3	D2	D1	D0	

6.22 Battery State of Charge

Description:	Provides the overall State-of-Charge for the entire battery.			
Transmitter:	Battery Pack Monitor #1-4	Parameter Group Name:	PropB_DE	
Receiver:	Any	Parameter Group Number:	65502 (FFDEh)	
Protocol:	Global	Priority:	6	
Transfer Rate:	500ms	Extended Data Page / Data Page:	0 / 0	
Data Length:	8	PDU Format:	255 (FFh)	
Source Address:	Battery ECU Address	PDU Specific:	222 (DEh)	

							msb			bit #				lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Lower Battery SOC	Percent	0.1 % / bit	-10	-10	115	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
Upper Battery SOC	Percent	0.1 % / bit	-10	-10	115	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Reserved	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Reserved	-	-	-	-	-	6	-	-	-	-	-	-	-	-
Reserved	-	-	-	-	-	7	-	-	-	-	-	-	-	-
Reserved	-	-	-	-	-	8	-	-	-	-	-	-	-	-

6.23   Battery Cell Status 3

Description:		Provides cell voltage data for a specific battery, indicated by the source address field.											
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_E1							
Receiver:		Any	**Parameter Group Number:**			65505 (FFE1h)							
Protocol:		Global	**Priority:**			6							
Transfer Rate:		250ms	**Extended Data Page / Data Page:**			0 / 0							
Data Length:		8	**PDU Format:**			255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**			225 (E1h)							
							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Cell Voltage 9	Voltage	0.0001 V / bit	0	0	6.4255	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 10	Voltage	0.0001 V / bit	0	0	6.4255	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 11	Voltage	0.0001 V / bit	0	0	6.4255	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
Cell Voltage 12	Voltage	0.0001 V / bit	0	0	6.4255	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

6.24 Battery Cell Status 4

Description:				Provides cell voltage data for a specific battery, indicated by the source address field.											
Transmitter:		Battery Pack Monitor #1-4		**Parameter Group Name:**			PropB_E2								
Receiver:		Any		**Parameter Group Number:**			65506 (FFE2h)								
Protocol:		Global		**Priority:**			6								
Transfer Rate:		250ms		**Extended Data Page / Data Page:**			0 / 0								
Data Length:		8		**PDU Format:**			255 (FFh)								
Source Address:		Battery ECU Address		**PDU Specific:**			226 (E2h)								
								msb			bit #				lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0	
Cell Voltage 13	Voltage	0.0001 V / bit	0	0	6.4255	1	D7	D6	D5	D4	D3	D2	D1	D0	
						2	D15	D14	D13	D12	D11	D10	D9	D8	
Cell Voltage 14	Voltage	0.0001 V / bit	0	0	6.4255	3	D7	D6	D5	D4	D3	D2	D1	D0	
						4	D15	D14	D13	D12	D11	D10	D9	D8	
Cell Voltage 15	Voltage	0.0001 V / bit	0	0	6.4255	5	D7	D6	D5	D4	D3	D2	D1	D0	
						6	D15	D14	D13	D12	D11	D10	D9	D8	
Cell Voltage 16	Voltage	0.0001 V / bit	0	0	6.4255	7	D7	D6	D5	D4	D3	D2	D1	D0	
						8	D15	D14	D13	D12	D11	D10	D9	D8	

6.25 Battery Cell Upper SOC 2

Description:		Provides the estimated state of charge of the specified cell.											
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_E3							
Receiver:		Any	**Parameter Group Number:**			65507 (FFE3h)							
Protocol:		Global	**Priority:**			6							
Transfer Rate:		500ms	**Extended Data Page / Data Page:**			0 / 0							
Data Length:		8	**PDU Format:**			255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**			227 (E3h)							

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Upper SOC Cell 9	Percent	0.5 % / bit	-10	-10	115	1	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 10	Percent	0.5 % / bit	-10	-10	115	2	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 11	Percent	0.5 % / bit	-10	-10	115	3	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 12	Percent	0.5 % / bit	-10	-10	115	4	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 13	Percent	0.5 % / bit	-10	-10	115	5	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 14	Percent	0.5 % / bit	-10	-10	115	6	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 15	Percent	0.5 % / bit	-10	-10	115	7	D7	D6	D5	D4	D3	D2	D1	D0
Upper SOC Cell 16	Percent	0.5 % / bit	-10	-10	115	8	D7	D6	D5	D4	D3	D2	D1	D0

6.26 Battery Cell Lower SOC 2

Description:		Provides cell-level Lower State of Charge (SOC) information.												
Transmitter:		Battery Pack Monitor #1-4	**Parameter Group Name:**				PropB_DD							
Receiver:		Any	**Parameter Group Number:**				65508 (FFE4h)							
Protocol:		Global	**Priority:**				6							
Transfer Rate:		500ms	**Extended Data Page / Data Page:**				0 / 0							
Data Length:		8	**PDU Format:**				255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**				228 (E4h)							
							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Lower SOC Cell 9	Percent	0.5 % / bit	-10	-10	115	1	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 10	Percent	0.5 % / bit	-10	-10	115	2	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 11	Percent	0.5 % / bit	-10	-10	115	3	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 12	Percent	0.5 % / bit	-10	-10	115	4	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 13	Percent	0.5 % / bit	-10	-10	115	5	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 14	Percent	0.5 % / bit	-10	-10	115	6	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 15	Percent	0.5 % / bit	-10	-10	115	7	D7	D6	D5	D4	D3	D2	D1	D0
Lower SOC Cell 16	Percent	0.5 % / bit	-10	-10	115	8	D7	D6	D5	D4	D3	D2	D1	D0

6.27 Battery Regulation Information 1

Description:		Communicates the maximum charge current and estimated open-circuit voltage.											
Transmitter:		Battery Pack Monitor	**Parameter Group Name:**			PropB_03							
Receiver:		Any	**Parameter Group Number:**			65283 (FF03h)							
Default Transfer Rate:		250ms	**Priority:**			Any							
Configurable Transfer Rate:		Yes	**Extended Data Page / Data Page:**			0 / 0							
Data Length:		8	**PDU Format:**			255 (FFh)							
Source Address:		Battery ECU Address	**PDU Specific:**			223 (03h)							

							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Battery Terminal Voltage	Volts	0.05V / bit	0	0	3,212.75	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
Open Circuit Voltage	Volts	0.05V / bit	0	0	3,212.75	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Battery Current	Amps	0.05A / bit	-1600	-1600.00	1,612.75	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
Maximum Charge Current	Amps	0.05A / bit	0	0	3,212.75	7	D7	D6	D5	D4	D3	D2	D1	D0
						8	D15	D14	D13	D12	D11	D10	D9	D8

6.28 Battery Regulation Information 2

Description:	Communicates the optimal charge voltage and charging capabilities.			
Transmitter:	Battery Pack Monitor	Parameter Group Name:	PropB_04	
Receiver:	Any	Parameter Group Number:	65284 (FF04h)	
Default Transfer Rate:	250ms	Priority:	Any	
Configurable Transfer Rate:	Yes	Extended Data Page / Data Page:	0 / 0	
Data Length:	4	PDU Format:	255 (FFh)	
Source Address:	Battery ECU Address	PDU Specific:	224 (04h)	

							msb			bit #				lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Contactor(s) State	Status	4 states / 2 bits	0	0	3	1							D1	D0
Charge Capability State	Status	4 states / 2 bits	0	0	3	1					D1	D0		
Reserved	-	-	-	-	-	1	1	1	1	1				
Bus Voltage Request	Volts	0.05V / bit	0	0	3,212.75	2	D7	D6	D5	D4	D3	D2	D1	D0
						3	D15	D14	D13	D12	D11	D10	D9	D8
Transportability SOC	Percent	0.5% / bit	0	0	100	4	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	5	1	1	1	1	1	1	1	1
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

Data	State	Value
Contactor(s) State	Contactor(s) is open	0
	Contactor(s) is closed	1
	Error	2
	N/A	3
Charge Capability State	Battery is unable to accept charge	0
	Battery is able to accept charge	1
	Error	2
	N/A	3

6.29   Fault Logs

Description:	Provides the Fault log information from the Battery's ECU.												
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**			PropB_E7								
Receiver:	Any	**Parameter Group Number:**			65511 (FFE7h)								
Protocol:	Global	**Priority:**			6								
Transfer Rate:	On Request	**Extended Data Page / Data Page:**			0 / 0								
Data Length:	8	**PDU Format:**			255 (FFh)								
Source Address:	Battery ECU Address	**PDU Specific:**			231 (E7h)								

						Byte #	msb 7	6	5	bit # 4	3	2	1	lsb 0
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**									
Spare	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Log #	Value	1 / bit	0	0	255	2	D7	D6	D5	D4	D3	D2	D1	D0
# Times Occurred	Value	1 / bit	0	0	65536	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Last Value	Measurement	Type Specific	0	-2,147,483,648	2,147,483,647	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
						7	D23	D22	D21	D20	D19	D18	D17	D16
						8	D31	D30	D29	D28	D27	D26	D25	D24

Fault Log	#	Fault Log	#	Fault Log	#
Cell Voltage High	0	Voltage Reference (PBIT)	14	FET Stuck Open (CBIT)	28
Critical Cell Voltage High	1	Internal EEPROM (PBIT)	15	Temperature Shorted High (CBIT)	29
Cell Voltage Low	2	Battery Calibrated (IBIT)	16	Temperature Shorted Low (CBIT)	30
Critical Cell Voltage Low	3	Voltage Reference (IBIT)	17	Under Voltage Lockout (CBIT)	31
Cell Temperature High	4	Internal EEPROM (IBIT)	18	AFE Voltage (SBIT)	32
Critical Cell Temperature High	5	Voltage Reference (CBIT)	19	AFE Temperature (SBIT)	33
Critical Board Temperature High	6	ROP (CBIT)	20	AFE Broken Wire (SBIT)	34
MCU Temperature High	7	Delta State of Charge (CBIT)	21	AFE Shutdown (SBIT)	35
Hardware Overload	8	Delta Temperature (CBIT)	22	AFE MUXFAIL (SBIT)	36
Fast Software Overload	9	Heater (CBIT)	23	RAM (SBIT)	37
Software Overload	10	FET Short (CBIT)	24	Flash (SBIT)	38
Battery Voltage Low	11	Analog Front End VRef (CBIT)	25	ROP (SBIT)	39
BIT Fault (Overall Fault Status)	12	AFE Comm Loss (CBIT)	26		
Battery Calibrated (PBIT)	13	Power Supply (CBIT)	27		

Table 6-14: Fault Log #s

6.30 Table Data

Description:	Message used to send table data to a controller												
Transmitter:	Battery Pack Monitor #1-4	**Parameter Group Name:**				PropB_E9							
Receiver:	Any	**Parameter Group Number:**				65513 (FFE9h)							
Destination:	Global or Specific	**Priority:**				6							
Transfer Rate:	On Request	**Extended Data Page / Data Page:**				0 / 0							
Data Length:	8	**PDU Format:**				255 (FFh)							
Source Address:	Any	**PDU Specific:**				233 (E9h)							

Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7 msb	6	5	4	3	2	1	0 lsb
Table ID	ID	1 / bit	0	0	250	1	D7	D6	D5	D4	D3	D2	D1	D0
Data Type/Resolution	ID	1 / bit	0	0	250	2	D7	D6	D5	D4	D3	D2	D1	D0
Row Number	Value	1 / bit	0	0	250	3	D7	D6	D5	D4	D3	D2	D1	D0
Column Number	Value	1 / bit	0	0	250	4	D7	D6	D5	D4	D3	D2	D1	D0
Data[1]	Value	1 / bit	0	0	4,211,081,215	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
						7	D23	D22	D21	D20	D19	D18	D17	D16
						8	D31	D30	D29	D28	D27	D26	D25	D24

[1] When both Row Number and Column Number are 0, the Data field consists of two unsigned 16-bit integers: the first for the number of rows, and the second for the number of columns. When only Row Number is 0, the Data field consists of the "label" for the Column value. When only Column Number is 0, the Data field consists of the "label" for the Row value. Here, "label" means the value represented by the column or row. For example, for Table ID 0, when Row is 1 and Column is 0, a Data value of 100 would mean that the values in Row 1 correspond to values at 10.0% Battery SOC.

Data	State	Value	Row Units	Column Units	Table Units		Data	State	Value
Table ID	State of Health Calendar Data	0	Battery SOC	Avg. Cell Temp.	Time at Temp/SOC		**Data Type / Resolution**	2 16-bit Unsigned Ints	0
	State of Health Depth-of-Discharge Cycle Data	1	Battery DOD	N/A	Number of Cycles to DOD			32-bit Unsigned Int	1
	Spare	3 – 250	-	-	-			0.1%	2
	Reserved	251 – 253	-	-	-			1°C	3
	Error	254	-	-	-			0.1 Hours	4
	N/A	255	-	-	-			0.01%	5
								Spare	5 – 250
								Reserved	251 – 253
								Error	254
								N/A	255

Table 6-15: Table Data Values

7 RX FRAME SPECIFICATION

7.1 NAME Management Message

Description:	Message used to change the NAME of the battery.		
Transmitter:	Any	Parameter Group Name:	NM
Receiver:	Battery Pack Monitor	Parameter Group Number:	37632 (09300h)
Protocol:	Global / Specific	Priority:	6
Transfer Rate:	On request	Extended Data Page / Data Page:	0 / 0
Data Length:	8	PDU Format:	147
Source Address:	Any	PDU Specific:	Battery ECU Address or 255

Data[*]	Units	Resolution	Offset	Low Range	High Range	Byte #	7 (msb)	6	5	4	3	2	1	0 (lsb)
NAME Checksum / Error Code [0, 4]	Status	256 states / 8 bits	0	0	255	1	D7	D6	D5	D4	D3	D2	D1	D0
Manufacturer Code qualifier flag [0, 8]	Status	1 bit	0	0	1	2								D0
ECU Instance qualifier flag [0, 8]	Status	1 bit	0	0	1	2							D0	
Function Instance qualifier flag [0, 8]	Status	1 bit	0	0	1	2						D0		
Function qualifier flag [0, 8]	Status	1 bit	0	0	1	2					D0			
Vehicle System qualifier flag [0, 8]	Status	1 bit	0	0	1	2				D0				
Vehicle System Instance qualifier flag [0, 8]	Status	1 bit	0	0	1	2			D0					
Industry Group qualifier flag [0, 8]	Status	1 bit	0	0	1	2		D0						
Arbitrary Address Capable qualifier flag [0, 8]	Status	1 bit	0	0	1	2	D0							
NM Control Mode indicator ALL MODES	Status	16 states / 4 bits	0	0	15	3					D3	D2	D1	D0
Reserved	-	-	-	-	-	3				1				
Commanded Manufacturer Code[+ 0, 1, 2, 3, 8]	Status	1 Code / bit	0	0	2047	3	D2	D1	D0					
						4	D10	D9	D8	D7	D6	D5	D4	D3
Commanded ECU Instance[+ 0, 1, 2, 3, 8]	Status	1 Instance / bit	1	1	8	5						D2	D1	D0
Commanded Function Instance[+ 0, 1, 2, 3, 8]	Status	1 Instance / bit	1	1	32	5	D4	D3	D2	D1	D0			
Commanded Function[+ 0, 1, 2, 3, 8]	Status	254 states / 8 bits	0	0	254	6	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	7								1
Commanded Vehicle System[+ 0, 1, 2, 3, 8]	Status	127 states / 7 bits	0	0	127	7	D6	D5	D4	D3	D2	D1	D0	

[*] The Mode that each of the parameters is used in will be tagged as superscript on each parameter.

[+] These fields shall be populated when their corresponding qualifier flag is set to 0. When their qualifier flag is set to 1, the field shall be set to all 1s.

Name														
Commanded Vehicle System Instance[+ 0, 1, 2, 3, 8]	Status	1 Instance / bit	1	1	16	8					D3	D2	D1	D0
Commanded Industry Group[+ 0, 1, 2, 3, 8]	Status	1 Group / bit	0	0	7	8		D2	D1	D0				
Commanded Arbitrary Address Capable[+ 0, 1, 2, 3, 8]	Status	2 states / 1 bit	0	0	1	8	D0							

Data	State	Value
NAME Error Code	Security not satisfied. Different SA for Adopt Pending than Set Pending	0
	Item(s) not allowed to change. Qualifier flags of disallowed items are set to one.	1
	Item conflict. Cannot perform Function assigned, cannot perform as Arbitrary Address capable, etc. Qualifier flags of disallowed items are set to one.	2
	Checksum does not match	3
	Pending NAME not set	4
	Other	5
	Reserved	6 – 254
	Not Available	255
NM Control Mode indicator	Set Pending NAME	0
	Pending NAME	1
	Current NAME	2
	NAME ACK	3
	NAME NACK	4
	Request Pending NAME	5
	Request Current NAME	6
	Adopt Pending NAME	7
	Request NAME Address Claim	8
	Reserved	9 – 15

Table 7-1: NAME Management Values

7.2 Request

Description:		Message used to request a specific message (PGN) from a Battery Pack Monitor.									
Transmitter:		Any	Parameter Group Name:			RQST					
Receiver:		Battery Pack Monitor #1-4	Parameter Group Number:			59904 (EA00h)					
Destination:		Global or Specific	Priority:			Any					
Transfer Rate:		As Needed	Extended Data Page / Data Page:			0 / 0					
Data Length:		3	PDU Format:			234 (EAh)					
Source Address:		216 (D8h), 217 (D9h), 250 (FAh), or 255 (FFh)	PDU Specific:			Battery ECU Address or 255					

							msb			bit #				lsb
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Parameter Group Number (of message requested)	ID	1 / bit	0	000000h	03FFFFh	1	D7	D6	D5	D4	D3	D2	D1	D0
						2	D15	D14	D13	D12	D11	D10	D9	D8
						3	D23	D22	D21	D20	D19	D18	D17	D16

PGN	Description
DM3 - 65228 (FECCh)	Erases all diagnostic information pertaining to the previously active DTCs. Active DTCs are unaffected. DM3 must be issued via a Request (PGN 59904) with DM3 as the requested PGN. Battery Pack monitor will send an Acknowledgment (PGN 65392) to indicate a successfully completed DM3.
All Others:	All from Table 4-1: J1939 PGN List with TX direction. (Except: Acknowledge [ACK], and Transport Protocol Messages)

7.3   Battery Command

Description:	Message used to issue specific commands to the Battery Pack Monitor														
Transmitter:	Any		**Parameter Group Name:**			PropA									
Receiver:	Battery Pack Monitor #1-4		**Parameter Group Number:**			61184 (EF00h)									
Destination:	Specific		**Priority:**			Any (6)									
Transfer Rate:	As Needed		**Extended Data Page / Data Page:**			0 / 0									
Data Length:	8		**PDU Format:**			239 (EFh)									
Source Address:	Any		**PDU Specific:**			Battery ECU Address									
						msb				bit #					lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	01h	FAh	1	D7	D6	D5	D4	D3	D2	D1	D0
Command Specific	-	-	-	-	-	2 – 8	-	-	-	-	-	-	-	-

Command Extension	Value	Description
Reserved	00h – 01h	-
Transportability Command	02h	Sets the "Transportability SOC" field of the Battery Regulation Information 2 to the commanded value for 15 seconds.
Reserved	03h – 04h	-
Do IBIT	05h	Commands the Battery ECU to perform Initiated Built-In-Test. Results will be available in PGN FFD3 (BIT Status)
Set Reserve Protect Limit	06h	Sets the Reserve Protect Limit .
Reserved	07h	
Battle Override Command	08h	Turns battle override on or off. Automatically turns off again after 10 minutes without receiving another command.
Set Arctic Heating Temperature[1]	09h	Sets the temperature that the battery cell temperature will activate arctic heating. The value will be capped at 25 degrees. Automatically turns off after 10 minutes.
Set Battery Storage Delay	0Ah	Sets the amount of time the battery delays entering Storage mode once the Battery Disable pin is asserted. Disabled by default, remains enabled until the battery enters Storage mode.
Set Generator Control	0Bh	Turns the Generator Control on or off, and sets the maximum generator current the battery will request. Automatically turns off after 10 seconds without receiving another command message.
Set Telemetry States	0Ch	Allows the OBDT to control which CAN telemetry is sent from the battery.
Reset Battery Address	0Dh	Commands the battery to revert to the address set by the address lines (will attempt to reclaim)
Set Mode Storage	0Eh	Commands the battery to storage mode.
Read Fault Logs	0Fh	Commands the battery to read the fault logs .
Set Real Time Clock	10h	Commands the battery to set the Real Time Clock to the provided values.
Reserved	11h	-
Send Table Data	12h	Commands the battery to send a series of Table Data messages based on given ID.
Reserved	13h-79h	-
Reserved	80h - FAh	-

Table 7-2: Command Extension Values

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[1] Disabled in LEV

Transportability Command

Command: Transportability Command														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1 / bit	0	02h	02h	1	0	0	0	0	0	0	1	0
Reserved	-	-	-	-	-	2	1	1	1	1	1	1	1	1
						3	1	1	1	1	1	1	1	1
Transportability Command	%	0.5% / bit	0	0	100	4	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-		-	-	-	5	1	1	1	1	1	1	1	1
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

Table 7-3: Transportability Command

Data	State	Value
Transportability Command	0 – 100%	00h – C8h
	Reserved	CAh - FAh
	Disable Transportability Command	FBh
	Reserved	FCh-FEh
	N/A	FFh

Table 7-4: Transportability Command Values

Do IBIT

Command: Do IBIT														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	05h	05h	1	0	0	0	0	0	1	0	1
Reserved	-	-	-	-	-	2 − 8	-	-	-	-	-	-	-	-

Table 7-5: Do IBIT Command

Set Reserve Protect Limit

Command: Set Reserve Protect Limit														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	06h	6h	1	0	0	0	0	0	1	1	0
RP Enable	Bool	True/False	0	0	1	2	D7	D6	D5	D4	D3	D2	D1	D0
RP Limit	% x 10	1/bit	0	0	1000	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Reserved	-	-	-	-	-	5 − 8	-	-	-	-	-	-	-	-

Table 7-6: Set Reserve Protect Limit Command

Battle Override Command

Command: Battle Override Command														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	08h	8h	1	0	0	0	0	1	0	0	0
BO Enable	Bool	True/False	0	0	1	2	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	3 − 8	-	-	-	-	-	-	-	-

Table 7-7: Battle Override Command

Set Arctic Heating Temperature[1]

Command:	Set Arctic Heating Temperature													
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Command Extension	ID	1/bit	0	09h	09h	1	0	0	0	0	1	0	0	1
AH Enable	Bool	True/False	0	0	1	2	D7	D6	D5	D4	D3	D2	D1	D0
AH Temp Cap	C	1/bit	-50	-50	25	3	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	4 – 8	-	-	-	-	-	-	-	-

Table 7-8: Set Arctic Heating Temperature Command

Set Battery Storage Delay

Command:	Set Battery Storage Delay													
Data	Units	Resolution	Offset	Low Range	High Range	Byte #	7	6	5	4	3	2	1	0
Command Extension	ID	1/bit	0	0Ah	0Ah	1	0	0	0	0	1	0	1	0
Storage Delay Enable	Bool	True/False	0	0	1	2	D7	D6	D5	D4	D3	D2	D1	D0
Delay Time	Seconds	1/bit	0	0	65535	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Reserved	-	-	-	-	-	5 – 8	-	-	-	-	-	-	-	-

Table 7-9: Set Battery Storage Delay Command

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[1] Disabled in LEV

Set Generator Control Command

Command: Set Generator Control Command														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	0Bh	0Bh	1	0	0	0	0	1	0	1	1
Generator Control Enable	Bool	0 = Disabled 1 = Enabled	0	0	1	2	-	-	-	-	-	-	-	D0
Generator Current Setpoint	Amps	0.1A/bit	0	0	6553.5	3	D7	D6	D5	D4	D3	D2	D1	D0
						4	D15	D14	D13	D12	D11	D10	D9	D8
Maximum Generator Voltage	Volts	0.01V/bit	0	26.00V	32.00V	5	D7	D6	D5	D4	D3	D2	D1	D0
						6	D15	D14	D13	D12	D11	D10	D9	D8
Generator Response Time	mS	250mS/bit	0	250mS	1000mS	7					D3	D2	D1	D0
Generator Control Trim Threshold	%	See Table 7-11	0	0	7	7	D2	D1	D0	-				
Reserved	-	-	-	-	-	8	-	-	-	-	-	-	-	-

Table 7-10: Set Generator Control Command

Generator Control Trim Threshold	
+/-20% of Max Continuous Charge Current	0
+/-12.5 % of Max Continuous Charge Current	1
+/-10% of Max Continuous Charge Current	2
+/-8.3% of Max Continuous Charge Current	3
+/-5% of Max Continuous Charge Current	4
+/-2.5% of Max Continuous Charge Current	5
+/-1% of Max Continuous Charge Current	6
+/-10% of Max Continuous Charge Current **(default)**	7

Table 7-11: Generator Control Trim Threshold Specification

Battery Type	Generator Control Setpoint									
	Temp	-25C	-20C	-15C	-10C	-5C	0C	5C	10C	15C	>20C
X6T	Current	9A	13A	17A	21A	40A	65A	96A	137A	189A	253A
X6T – Energy	Current	5A	8A	10A	12A	23A	38A	56A	80A	110A	147A
LEV	Current	0A	0A	0A	0A	0A	0A	50A	50A	50A	50A

Table 7-12: Generator Control Set Point Specification

Set Telemetry States

Command: Set Telemetry States														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	0Ch	0Ch	1	0	0	0	0	1	0	1	1
Time/Date Telemetry	State	4 states / 2 bits	0	0	3	2							D1	D0
Generator Control Telemetry	State	4 states / 2 bits	0	0	3	2					D1	D0		
Fault States Telemetry	State	4 states / 2 bits	0	0	3	2			D1	D0				
ECU Status Telemetry	State	4 states / 2 bits	0	0	3	2	D1	D0						
BIT Status Telemetry	State	4 states / 2 bits	0	0	3	3							D1	D0
Cell Status Telemetry	State	4 states / 2 bits	0	0	3	3					D1	D0		
Battery Performance Telemetry	State	4 states / 2 bits	0	0	3	3			D1	D0				
Temperatures Telemetry	State	4 states / 2 bits	0	0	3	3	D1	D0						
Balancing Telemetry	State	4 states / 2 bits	0	0	3	4							D1	D0
State of Health Telemetry	State	4 states / 2 bits	0	0	3	4					D1	D0		
Battery Voltage Telemetry	State	4 states / 2 bits	0	0	3	4			D1	D0				
Cell SOC Telemetry	State	4 states / 2 bits	0	0	3	4	D1	D0						
Battery SOC Telemetry	State	4 states / 2 bits	0	0	3	5							D1	D0
Battery Regulation Info Telemetry	State	4 states / 2 bits	0	0	3	5					D1	D0		
Spare	-	-	-	-	-	5	1	1	1	1				
						6	1	1	1	1	1	1	1	1
						7	1	1	1	1	1	1	1	1
						8	1	1	1	1	1	1	1	1

Table 7-13: Set Telemetry States

Telemetry Control States	
Disable	0
Enabled	1
Reserved	2
Do Not Change	3

Table 7-14: Telemetry States

Reset Battery Address

Command: Reset Battery Address														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	0Dh	0Dh	1	0	0	0	0	1	1	0	1
Reserved	-	-	-	-	-	2 − 8	-	-	-	-	-	-	-	-

Table 7-15: Reset Battery Address

Set Mode Storage

Command: Set Mode Storage														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	0Eh	0Eh	1	0	0	0	0	1	1	1	0
Reserved	-	-	-	-	-	2 − 8	-	-	-	-	-	-	-	-

Table 7-16: Set Mode Storage

Read Fault Logs

Command: Read Fault Logs														
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	0Fh	0Fh	1	0	0	0	0	1	1	1	1
Reserved	-	-	-	-	-	2 − 8	-	-	-	-	-	-	-	-

Table 7-17: Read Fault Logs

Set Real Time Clock

Command:	Set Real Time Clock													
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	10h	10h	1	0	0	0	1	0	0	0	0
Reserved	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Second	Seconds	1/bit	0	0	59	3	D7	D6	D5	D4	D3	D2	D1	D0
Minute	Minutes	1/bit	0	0	59	4	D7	D6	D5	D4	D3	D2	D1	D0
Hour	Hours	1/bit	0	0	23	5	D7	D6	D5	D4	D3	D2	D1	D0
Day	Days	1/bit	0	1	30	6	D7	D6	D5	D4	D3	D2	D1	D0
Month	Months	1/bit	0	1	11	7	D7	D6	D5	D4	D3	D2	D1	D0
Year	Years	1/bit	2000	2000	2255	8	D7	D6	D5	D4	D3	D2	D1	D0

Table 7-18: Set Real Time Clock

Send Table Data

Command:	Send Table Data													
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Command Extension	ID	1/bit	0	12h	12h	1	0	0	0	1	0	0	1	0
Table ID	ID	1 / bit	0	0	250	2	D7	D6	D5	D4	D3	D2	D1	D0
Reserved	-	-	-	-	-	2 – 8	-	-	-	-	-	-	-	-

Table 7-19: Send Table Data

Data	**State**	**Value**	**Row Units**	**Column Units**	**Table Units**
Table ID	State of Health Calendar Data	0	Battery SOC	Avg. Cell Temp.	Time at Temp/SOC
	State of Health Depth-of-Discharge Cycle Data	1	Battery DOD	N/A	Number of Cycles to DOD
	Spare	3 – 250	-	-	-
	Reserved	251 – 253	-	-	-
	Error	254	-	-	-
	N/A	255	-	-	-

Table 7-20: Table Data IDs

7.4 Battery Global Command

Description:	Message used to inform all Battery Pack Monitor(s) about various vehicle states.													
Transmitter:	Vehicle	**Parameter Group Name:**		PropB_F3										
Receiver:	Battery Pack Monitor #1-4	**Parameter Group Number:**		65523 (FFF3h)										
Destination:	Global	**Priority:**		Any										
Transfer Rate:	As Needed	**Extended Data Page / Data Page:**		0 / 0										
Data Length:	8	**PDU Format:**		255 (FFh)										
Source Address:	Any	**PDU Specific:**		243 (F3h)										
							msb			bit #				lsb
Data	**Units**	**Resolution**	**Offset**	**Low Range**	**High Range**	**Byte #**	7	6	5	4	3	2	1	0
Identical to data in Battery Command (**Error! Reference source not found.**)														

8 APPENDIX

8.1 Definitions, Acronyms, and Abbreviations

A	Ampere
Balancing	The process of equalizing cell voltages among more than one cell in series.
BATT	Battery
Battery	Group of cells, containing electronics, high-voltage components.
BIT	Built-In-Test
C	Celsius degrees
CBIT	Continuous Built-In-Test
Cmd	Command
C-Stop	Charge Stop
DOC	Depth of Charge (State of Charge based on highest cell voltage)
DOD	Depth of Discharge (Inverted State of Charge based on lowest cell voltage)
dV	Delta Voltage
FET	Field-effect transistor
LEV	Light Electric Vehicle
LSB	Least Significant Byte (The lower byte (xxxxxxxx**XXXXXXXX**) in an integer value)
Module	Group of cells, containing electronics, high-voltage components; Lowest Replaceable Unit (LRU). Each module contains one CANProbe® board.
ms	Millisecond (1/1000 of a second)
MSB	Most Significant Byte (The higher byte (**XXXXXXXX**xxxxxxxx) in an integer value)
mV	Millivolt
NVRAM	Non-volatile random-access memory
PBIT	Power-up Built-in-test
Protection	Prevention of over-charge, over-current, and over/under-temperature; to ensure safety and extend life of the LiON® cells.
Sec	Second
SOC	State of Charge (based on avg cell voltage)
usec	Microsecond
V	Voltage or Volts