TH!NK A306

Remote Lithium Energy Controller (RLEC)

CAN Programmers Guide

TH!NK North America

May, 2013

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1 Introduction

1.1 Purpose

This document defines the CAN interface to a Remote Lithium Energy Controller (RLEC). The RLEC is the controller for a Think A306 battery module. It provides guidelines for programming the CAN interface to perform real-time control and monitoring of the battery module. It also provides information on interpretation of battery module faults reported by the RLEC to aid in battery module troubleshooting and diagnostics.

1.2 Scope

This document is applicable to RLECs used in the EnerDel Li-Ion battery pack modules for the Think city A306 electric vehicle (Model PE700-393 Vigor+ Battery Pack).

1.3 Reference Documents

The following documents are incorporated into this document by reference:

Document	*Doc. #*	*Rev.*	*Date*	*Issued By*
PE700-393 Vigor+ Battery Pack Data Sheet	N/A	N/A	2012	EnerDel
Think A306 Battery Pack Application Manual	N/A	N/A	May, 2013	Think North America

1.4 Acronyms and Terms

1.4.1 Acronyms

Acronym	**Definition**
Ah	Ampere-hour
A/D	Analog-to-Digital
BOL	Beginning Of Life
BMS	Battery Management System
C	Celsius
C/3	C/3 Charge or Discharge Rate
CAN	Controller Area Network
EEPROM	Electronically Erasable Programmable Read Only Memory
ID	Identification
kWh	Kilowatt-Hours
LSB	Least Significant Bit
MLEC	Master Lithium Energy Controller
MSB	Most Significant Bit
MSBit	Most Significant Bit

MSByte	Most Significant Byte
msec	Milliseconds
mV	Millivolts
NMC	Nickel Metal Cobalt Oxide
N/A	Not Applicable
P	Parallel
RLEC	Remote Lithium Energy Controller
Rx	Receive
S	Series
SOC	State of Charge
TBD	To Be Determined
Tx	Transmit
V	Volt

1.4.2 Terms

1.4.2.1 Master Lithium Energy Controller (MLEC)

The Think A306 battery management system (BMS) consists of a Master Lithium Energy Controller (MLEC) and 16 RLECs, one for each battery module. The MLEC is responsible for overall control of the battery pack and communicates with the RLECs via an internal CAN bus. See the *Think A306 Battery Pack Application Manual* for a detailed description of the MLEC.

1.4.2.2 Active Fault

An active fault is defined as a fault which is currently detected by the BMS. Although the RLEC can detect certain kinds of faults directly, additional filtering is often performed by the MLEC. See the *Think A306 Battery Pack Application Manual* for a detailed description of MLEC fault detection algorithms.

2 RLEC Overview

2.1 Description

The RLEC is a controller for an individual battery module. The RLEC monitors 12 cell voltages and temperatures for a 12S2P battery module, i.e. a battery module configured as 12 cells in series x 2 cells in parallel. The RLEC continuously performs cell voltage balancing based on upper and lower cell voltage balancing limits sent by the MLEC. The RLEC also monitors battery module voltage, RLEC board temperature and RLEC operational status. The RLEC communicates with the MLEC via a CAN bus interface where the MLEC acts as a “master node” sending commands and requests to the RLECs which act as “slave nodes” responding to the commands and data requests from the MLEC. The MLEC transmits broadcast messages which are received by all RLECs and RLEC-specific messages addressed to individual RLECs. Note that the RLEC ID for each RLEC is programmed in RLEC EEPROM. Valid RLEC IDs are 0 – 15 and each RLEC ID in a battery pack must be unique, i.e. the MLEC can address a maximum of

16 RLECs in a battery pack. There is not necessarily any correlation between the RLEC ID and the physical location of the RLEC in a pack. An RLEC context diagram is shown in Figure 1.

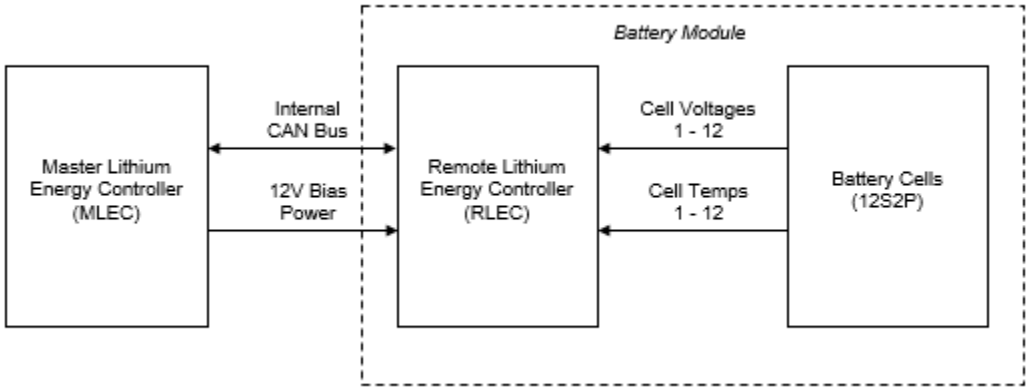

Figure 1 – RLEC Context Diagram

2.2 Theory of Operation

The RLEC receives 12V bias power from the MLEC. The RLEC automatically powers up when 12V power is applied. During power up, the RLEC performs hardware and software initialization and reads its pre-programmed RLEC ID from EEPROM. (Note that the RLEC DIP switch settings that were previously used for setting the RLEC ID are now ignored by the RLEC software.) The RLEC then enters its normal operating mode regardless of whether the MLEC has established CAN communications with the RLEC.

During operation, the RLEC continuously reads cell voltages and temperatures from the battery module in a round-robin sequence where all cell voltages and temperatures are read every 100 msec. The RLEC reads the battery module voltage as the voltage across cell voltages 1 – 12. Within a battery module, cells are numbered sequentially where the low side of cell 1 is the negative terminal of the battery module, cell 2 is adjacent to cell 1, cell 3 is adjacent to cell 2, etc. and the high side of cell 12 is the positive terminal of the battery module. Likewise, cell temperatures are numbered sequentially where cell temperature *n* is associated with cell voltage *n*. In addition to reporting individual cell temperatures, the RLEC also reports the current maximum and minimum cell temperature as a convenience.

The RLEC includes 12 balance resistors of 37.5 ohms each (actually two 75 ohm resistors in parallel) that can be switched across the positive and negative terminals of individual cell pairs to discharge the cell as needed for cell balancing. The MLEC sends upper and lower cell voltage balancing limits to the RLEC. If the cell voltage for a given cell is above the upper cell voltage balancing limit, the RLEC switches in (enables) the cell balance resistor for that cell. If the cell voltage for a given cell is below the lower cell voltage balancing limit, the RLEC switches out (disables) the cell balance resistor for that cell. When the RLEC is operating without an MLEC (i.e. the RLEC is not receiving any CAN messages from the MLEC), the RLEC uses default upper and lower cell voltage balancing limits of 4.15 V and 4.1 V respectively. Note that the RLEC automatically disables cell balance resistors during cell voltage measurements including the cell balance resistors on either side of the cell voltage currently being measured.

During operation, the RLEC performs low-level diagnostics and reports operational status to the MLEC via the CAN interface. Specifically, the RLEC checks for A/D faults on all analog signals including cell voltages 1 – 12 read via the main cell voltage measurement circuit, cell temperatures, RLEC board temperature and the redundant cell 1 voltage measurement circuit. In addition, the RLEC verifies cell voltage measurements by comparing the primary cell 1 voltage measurement to the redundant cell 1 voltage measurement circuits and will set a fault if the readings differ by more than 50 mV. (Note that cell 1 is the first/lowest cell in the battery module.) The RLEC also periodically checks for high impedance cell voltage connections which would cause incorrect cell voltage measurements.

When 12V bias power is removed from the RLEC, the RLEC software stops execution without any specific shutdown sequence.

2.3 CAN Communications Overview

The MLEC communicates with the RLECs via a CAN bus interface internal to the battery pack. (Note that the MLEC communicates with the external system controller via a separate external CAN bus interface.) The MLEC acts as a master on the CAN bus sending broadcast commands and individual data requests to the RLECs. The RLEC sends cell voltages, temperatures and additional status to the MLEC in response to data requests from the MLEC.

The MLEC is programmed to request a full set of cell data from all RLECs in a round-robin fashion every 100 msec. At the start of each data collection cycle, the MLEC sends 6 broadcast CAN messages to all RLECs which contain cell voltage balancing commands. The MLEC then sends a set of 4 RLEC-specific data request CAN messages to individual RLECs every 6.25 msec (i.e. 6.25 msec/RLEC x 16 RLECs = 100 msec). Data requests are performed in sequence starting with RLEC 0, then RLEC 1, RLEC 2, etc. to RLEC 15 after which the MLEC cycles back to requesting data from RLEC 0. When the RLEC receives all 6 broadcast messages and all 4 data request messages addressed to its CAN address, it responds by sending a set of 13 data response CAN messages to the MLEC. The data response messages include various filtered and unfiltered versions of cell voltages, cell temperatures, module voltage, RLEC temperature and RLEC fault status. At the end of the data collection cycle, the MLEC uses the lowest cell voltage reported by the RLECs as a basis for the cell voltage balancing limits for the next data collection cycle.

2.4 Technical Specifications

The technical specifications for the A306 RLEC and associated battery module are given in Table 1.

Specification	***Value***	***Notes***
Module Configuration	12S2P	
Cell Voltages/Module	12	1 voltage measurement/cell pair
Cell Temps/Module	12	1 temperature sensor/cell pair
Cell Type	Li-Ion	

Cell Chemistry	NMC	
Cell Capacity	17.5 Ah	C/3 discharge rating
Cell Voltage Range	30.0 V – 49.2 V	0 – 100% SOC
Cell Nominal Voltage	3.6 V	50% SOC
Module Voltage Range	2.5 V – 4.1 V	0 – 100% SOC
Module Nominal Voltage	43.2 V	50% SOC
Module Capacity	35 Ah	2 cells in parallel
Module Energy	1.5 kWh	Min. guaranteed C/3 discharge rating at Beginning of Life (BOL)
Balance Resistor	37.5 ohms	2 x 75 ohms in parallel
Nominal Bias Voltage	12V	Supplied by MLEC
Battery Thermal Management	Passive convection cooling	

Table 1 – A306 RLEC and Battery Module Technical Specifications

3 CAN Interface

3.1 Electrical Interface and Communications Protocol

The MLEC communicates with the RLECs via an internal CAN bus. The internal CAN bus electrical specifications and communication bus protocol specifications are given below:

Signal Type:	Serial Communications Bus
Reference Standard:	ISO 11898 2.0B
Data Transfer Rate:	500K Baud
Message ID Length:	11 Bits
Max. Data Bytes:	8
Multi-Byte Data Format:	Motorola format, i.e. Most Significant Byte (MSByte) first
Bit Format:	Most Significant Bit (MSBit) first
Tx Mode:	Broadcast messages and RLEC-specific messages
Terminating Node:	No

3.2 CAN Message Format

The internal CAN message format is shown in Figure 2. Bit and byte numbering are also defined in Figure 2 for reference purposes. Data bytes are numbered beginning with byte 0. Within a data byte, the least significant bit (LSB) is bit 0 which is the rightmost bit and the most significant bit (MSB) is bit 7 which is the leftmost bit. For multi-byte data such as 16-bit integers, the leftmost byte is the most significant byte (Motorola format). Note that there are a maximum of 8 data bytes per message.

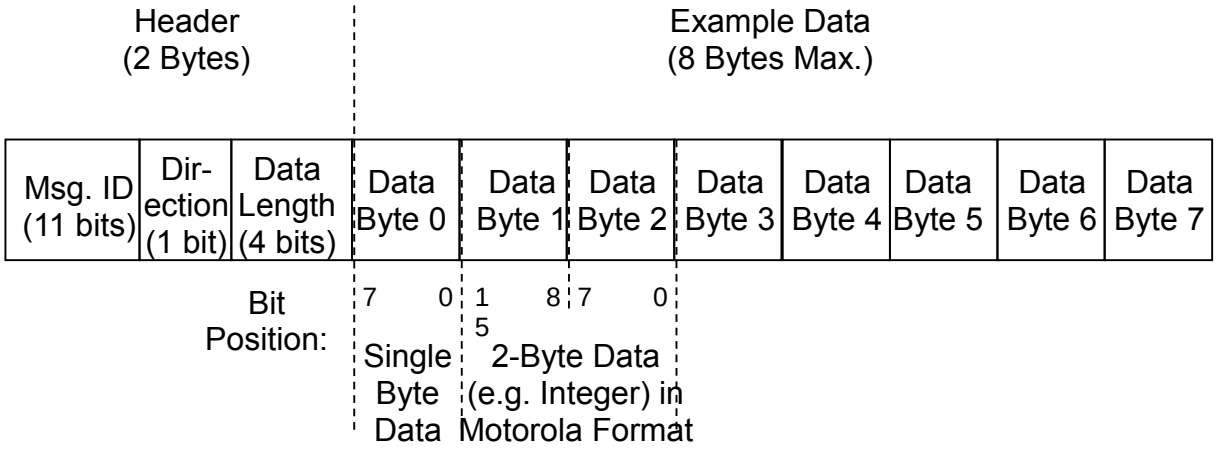

Figure 2 – RLEC CAN Message Format

3.3 CAN Message Definitions

A summary of the RLEC CAN messages is shown in Table 2. Detailed message data definitions are given in the following paragraphs. CAN messages are grouped into "Rx" and "Tx" categories referenced from the RLEC perspective. Note that Table 2 does not include CAN messages used solely for reprogramming and certain diagnostic functions as these are considered EnerDel proprietary.

Msg ID	***Msg Name***	***Rx/Tx***	***Period (msec.)***	***Notes***
0x7E1	Broadcast Message 1	Rx	100	Broadcast message to all RLECs with RLEC configuration data
0x7E2	Broadcast Message 2	Rx	100	Broadcast message to all RLECs with balancing limits & charge state info
0x7E3	Broadcast Message 3	Rx	100	Broadcast message to all RLECs with cell balancing control values
0x7E4	Broadcast Message 4	Rx	100	Broadcast message to all RLECs with cell balancing control values
0x7E5	Broadcast Message 5	Rx	100	Broadcast message to all RLECs with cell balancing control values
0x7E6	Broadcast Message 6	Rx	100	Broadcast message to all RLECs with max. and min. cell temp data
0x406, 0x40A – 0x40C	RLEC 0 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 0 data request
0x426, 0x42A – 0x42C	RLEC 1 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 1 data request

0x446, 0x44A – 0x44C	RLEC 2 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 2 data request
0x466, 0x46A – 0x46C	RLEC 3 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 3 data request
0x486, 0x48A – 0x48C	RLEC 4 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 4 data request
0x4A6, 0x4AA – 0x4AC	RLEC 5 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 5 data request
0x4C6, 0x4CA – 0x4CC	RLEC 6 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 6 data request
0x4E6, 0x4EA – 0x4EC	RLEC 7 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 7 data request
0x506, 0x50A – 0x50C	RLEC 8 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 8 data request
0x526, 0x52A – 0x52C	RLEC 9 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 9 data request
0x546, 0x54A – 0x54C	RLEC 10 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 10 data request
0x566, 0x56A – 0x56C	RLEC 11 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 11 data request
0x586, 0x58A – 0x58C	RLEC 12 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 12 data request
0x5A6, 0x5AA – 0x5AC	RLEC 13 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 13 data request
0x5C6, 0x5CA – 0x5CC	RLEC 14 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 14 data request
0x5E6, 0x5EA –	RLEC 15 Data Request Messages 6, 10 – 12	Rx	100	4-part RLEC 15 data request

0x5EC				
0x001 – 0x00D	RLEC 0 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 0 data response
0x021 – 0x02D	RLEC 1 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 1 data response
0x041 – 0x04D	RLEC 2 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 2 data response
0x061 – 0x06D	RLEC 3 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 3 data response
0x081 – 0x08D	RLEC 4 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 4 data response
0x0A1 – 0x0AD	RLEC 5 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 5 data response
0x0C1 – 0x0CD	RLEC 6 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 6 data response
0x0E1 – 0x0ED	RLEC 7 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 7 data response
0x101 – 0x10D	RLEC 8 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 8 data response
0x121 – 0x12D	RLEC 9 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 9 data response
0x141 – 0x14D	RLEC 10 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 10 data response
0x161 – 0x16D	RLEC 11 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 11 data response
0x181 – 0x18D	RLEC 12 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 12 data response
0x1A1 – 0x1AD	RLEC 13 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 13 data response
0x1C1 – 0x1CD	RLEC 14 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 14 data response
0x1E1 – 0x1ED	RLEC 15 Data Response Messages 1 – 13	Tx	N/A	13-part RLEC 15 data response

Table 2 – External CAN Message Summary

3.3.1 Rx Messages (MLEC → RLEC)

3.3.1.1 CAN ID 0x7E1: Broadcast Message 1

The Broadcast Message 1 data format is shown in Figure 3. The MLEC transmits Broadcast Message 1 at the start of each 100 msec. data collection cycle but the RLEC software only requires that Broadcast Message 1 be received once during initial establishment of communications between the MLEC and the

RLEC. Thus in theory, the MLEC could transmit Broadcast Message 1 once at power-up and thereafter only when the data in Broadcast Message 1 changes (which should normally never happen).

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	8

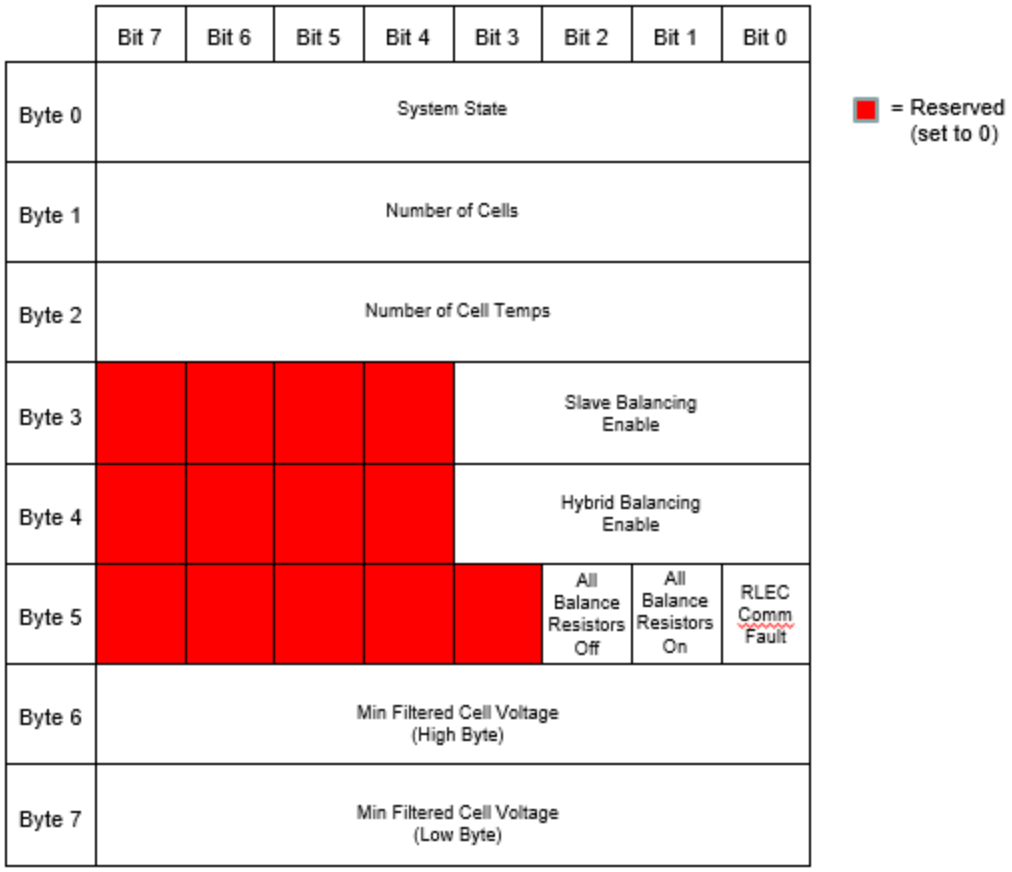

Figure 3 – CAN ID 0x7E1: Broadcast Message 1 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x7E1	0x01	0x0C	0x0C	0x01	0x01	0x00	0x05	0xBD

Example:

Interpretation:

System State = 1 (Normal Operation)
Number of Cells = 12
Number of Cell Temperatures = 12
Slave Balancing Enable = True
Hybrid Balancing Enable = True

All Balance Resistors Off = False
All Balance Resistors On = False
RLEC Communications Fault = False
Min. Filtered Cell Voltage = 3.584 V

3.3.1.1.1 *System State*

Description:	MLEC operating state
Position:	Byte 0
Format:	Encoded
States:	0 = Off(?)
	1 = Normal Operation
	2 – 255 = Reserved
Default Value:	1
RLEC Processing:	Unknown
Prog. Guidelines:	For predictable RLEC operation, always set System State = 1.

3.3.1.1.2 *Number of Cells*

Description:	Number of cell pairs per battery module
Position:	Byte 1
Format:	Constant integer
Value:	12
RLEC Processing:	Battery module cell configuration information for RLEC software.
Prog. Guidelines:	Always set to 12 for the A306 battery module hardware configuration.

3.3.1.1.3 *Number of Cell Temperatures*

Description:	Number of cell temperature sensors per battery module
Position:	Byte 2
Format:	Constant integer
Value:	12
RLEC Processing:	Battery module cell temperature sensor configuration information for RLEC software.
Prog. Guidelines:	Always set to 12 for the A306 battery module hardware configuration.

3.3.1.1.4 *Slave Balancing Enable*

Description:	Master enable for normal cell balancing control in RLEC

Position:	Byte 3, Bits 0 – 3
Format:	Boolean
States:	0 = Cell balancing controlled by RLEC(?) 1 = Cell balancing controlled by MLEC (normal operation)
Default Value:	1
RLEC Processing:	If Slave Balancing Enable = 1, the RLEC will perform cell balancing based on cell balance limits sent by the MLEC in CAN message ID 0x7E3. It is believed that if Slave Balancing Enable = 0, the RLEC will set balance resistor outputs based on the Mode 4 Balance Resistor Override Masks/Outputs in RLEC Data Request Message 6 however this has not been verified.
Prog. Guidelines:	For predictable RLEC operation, always set Slave Balancing Enable = 1.

3.3.1.1.5 Hybrid Balancing Enable

Description:	Master enable for hybrid cell balancing control in RLEC
Position:	Byte 4, Bits 0 – 3
Format:	Boolean
States:	0 = Hybrid cell balancing disabled 1 = Hybrid cell balancing enabled
Default Value:	1
RLEC Processing:	The effect of the Hybrid Balancing Enable signal on RLEC cell balancing operation is unknown.
Prog. Guidelines:	It is believed that setting Hybrid Balancing Enable = 1 has no negative effect on RLEC cell balancing operation and thus this is the recommended default value.

3.3.1.1.6 All Balance Resistors Off

Description:	A battery pack status flag set by the MLEC indicating that all balance resistors in all battery modules are currently reported as disabled (i.e. switched off) by the associated RLECs.
Position:	Byte 5, Bit 2
Format:	Boolean
States:	0 = All balance resistors not disabled 1 = All balance resistors disabled
Default Value:	0
RLEC Processing:	None
Prog. Guidelines:	This bit is for informational purposes only and has no effect on the RLEC.

3.3.1.1.7 All Balance Resistors On

Description:	A battery pack status flag set by the MLEC indicating that all balance resistors in all battery modules are currently reported as enabled (i.e. switched on) by the associated RLECs.
Position:	Byte 5, Bit 1
Format:	Boolean
States:	0 = All balance resistors not enabled 1 = All balance resistors enabled
Default Value:	0
RLEC Processing:	None
Prog. Guidelines:	This bit is for informational purposes only and has no effect on the RLEC.

3.3.1.1.8 RLEC Communications Fault

Description:	A flag that indicates the MLEC has lost communications with one or more RLECs
Position:	Byte 5, Bit 0
Format:	Boolean
States:	0 = MLEC communications with all RLECs OK 1 = MLEC has lost communication with one or more RLECs
Default Value:	0
RLEC Processing:	None
Prog. Guidelines:	This bit is for informational purposes only and has no effect on the RLEC.

3.3.1.1.9 Minimum Filtered Cell Voltage

Description:	Lowest filtered cell voltage currently reported by all RLECs in the battery pack
Position:	Bytes 6 – 7
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
RLEC Processing:	None
Prog. Guidelines:	This parameter is for informational purposes only and has no effect on the RLEC.

3.3.1.2 CAN ID 0x7E2: Broadcast Message 2

The Broadcast Message 2 data format is shown in Figure 4. The MLEC transmits Broadcast Message 2 at the start of each 100 msec. data collection cycle however none of the data is used by the RLEC during normal operation. It is currently unknown whether the RLEC actually requires that this message be received during normal operation but this may easily be determined via system testing.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	8

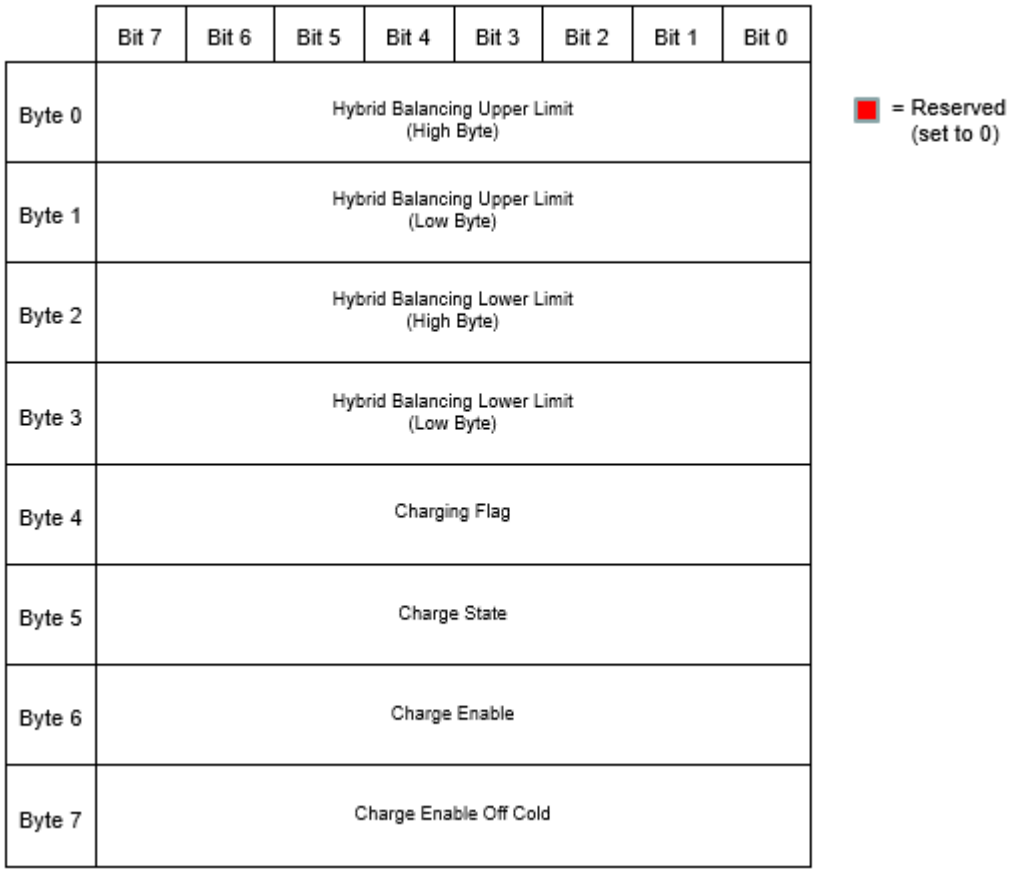

Figure 4 – CAN ID 0x7E2: Broadcast Message 2 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x7E2	0x00	0x0A	0x00	0x0A	0x00	0x00	0x01	0x00

Example:

Interpretation: Hybrid Balancing Upper Limit = TBD (10 x unknown resolution)
Hybrid Balancing Lower Limit = TBD (10 x unknown resolution)
Charging Flag = False
Charge State = 0 (TBD)
Charge Enable = True
Charge Enable Off Cold = False

3.3.1.2.1 Hybrid Balancing Upper Limit

Description:	Upper cell voltage limit for hybrid cell balancing
Position:	Bytes 0 – 1
Format:	Unsigned integer
Range:	TBD
Resolution:	TBD
Default Value:	10
RLEC Processing:	TBD
Prog. Guidelines:	It is believed that setting Hybrid Balancing Upper Limit = 10 has no negative effect on RLEC cell balancing operation and thus this is the recommended default value.

3.3.1.2.2 Hybrid Balancing Lower Limit

Description:	Lower cell voltage limit for hybrid cell balancing
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	TBD
Resolution:	TBD
Default Value:	10
RLEC Processing:	TBD
Prog. Guidelines:	It is believed that setting Hybrid Balancing Lower Limit = 10 has no negative effect on RLEC cell balancing operation and thus this is the recommended default value.

3.3.1.2.3 Charging Flag

Description:	Charging in progress flag(?)
Position:	Byte 4
Format:	Boolean
States:	0 = Charging not in progress(?) 1 = Charging in progress(?)
Default Value:	0
RLEC Processing:	Unknown
Prog. Guidelines:	It is currently assumed that Charging Flag has no effect on RLEC operation however for predictable RLEC operation, always set Charging Flag = 0.

3.3.1.2.4 Charge State

Description:	External charger state(?)
Position:	Byte 5

Format: Encoded(?)
States: TBD
Default Value: 0
RLEC Processing: Unknown
Prog. Guidelines: It is currently assumed that Charge State has no effect on RLEC operation however for predictable RLEC operation, always set Charge State = 0.

3.3.1.2.5 *Charge Enable*

Description: Master charge enable flag(?)
Position: Byte 6
Format: Boolean
States: 0 = Charging disabled(?)
1 = Charging enabled(?)
Default Value: 1
RLEC Processing: Unknown
Prog. Guidelines: It is believed that setting Charge Enable = 1 has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.2.6 *Charge Enable Off Cold*

Description: Master charge disable at cold temperatures flag(?)
Position: Byte 7
Format: Boolean
States: 0 = Charging not disabled at cold temperatures(?)
1 = Charging disabled at cold temperatures(?)
Default Value: 0
RLEC Processing: Unknown
Prog. Guidelines: It is currently assumed that Charge Enable Off Cold has no effect on RLEC operation however for predictable RLEC operation, always set Charge Enable Off Cold = 0.

3.3.1.3 CAN ID 0x7E3: Broadcast Message 3

The Broadcast Message 3 data format is shown in Figure 5. The MLEC transmits Broadcast Message 3 at the start of each 100 msec. data collection cycle.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	8

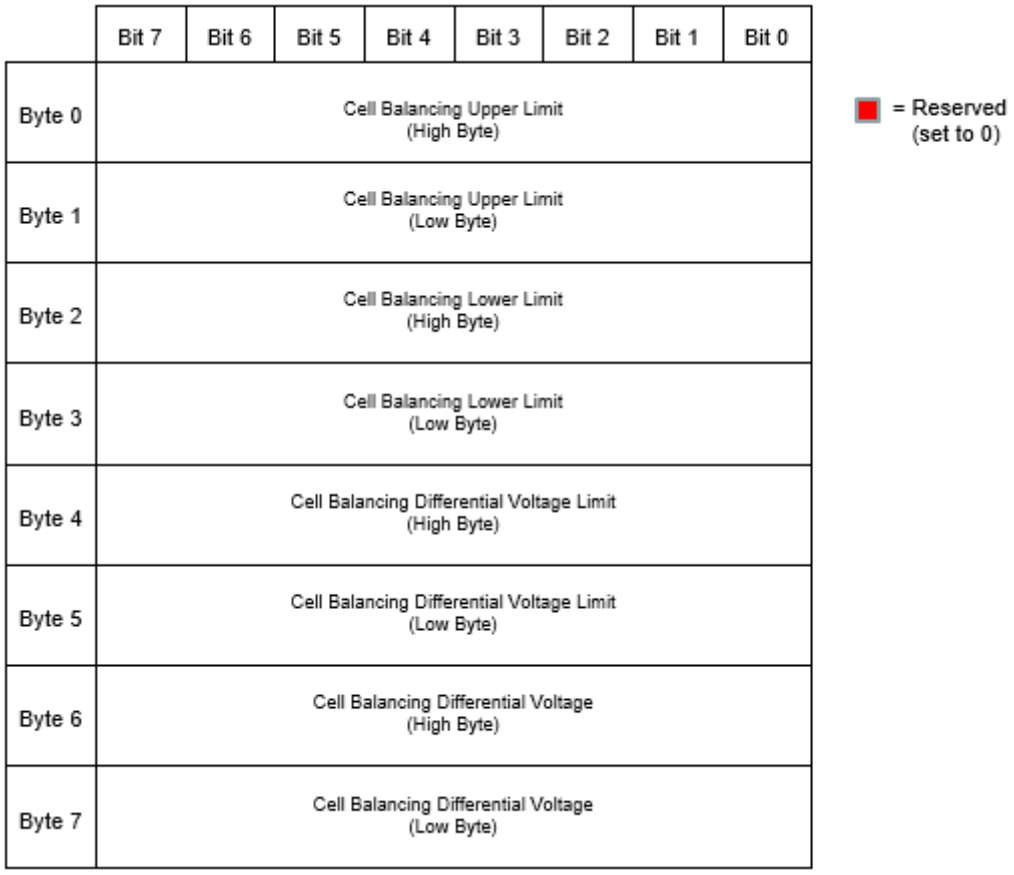

Figure 5 – CAN ID 0x7E3: Broadcast Message 3 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x7E3	0x04	0x00	0x04	0x00	0x00	0x09	0x00	0x03

Example:

Interpretation: Cell Balancing Upper Limit = 2.5 V
Cell Balancing Lower Limit = 2.5 V
Cell Balancing Differential Voltage Limit = 0.022 V
Cell Balancing Differential Voltage = 0.0073 V

3.3.1.3.1 Cell Balancing Upper Limit

Description: Upper cell voltage limit for normal cell balancing
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V

RLEC Processing: The RLEC will enable the cell balancing resistor for any cell voltage which is above the Cell Balancing Upper Limit.

Prog. Guidelines: It is recommended to set Cell Balancing Upper Limit = lowest cell voltage in the battery pack + 25 mV.

3.3.1.3.2 Cell Balancing Lower Limit

Description: Lower cell voltage limit for normal cell balancing

Position: Bytes 2 – 3

Format: Unsigned integer

Range: 0 – 5 V

Resolution: 0.00244 V

RLEC Processing: The RLEC will disable the cell balancing resistor for any cell voltage which is below the Cell Balancing Lower Limit.

Prog. Guidelines: It is recommended to set Cell Balancing Lower Limit = lowest cell voltage in the battery pack + 25 mV (i.e. = Cell Balancing Upper Limit).

3.3.1.3.3 Cell Balancing Voltage Differential Limit

Description: Min. voltage differential between cell balancing upper and lower limits(?)

Position: Bytes 4 – 5

Format: Unsigned integer

Range: 0 – 5 V

Resolution: 0.00244 V

RLEC Processing: It is believed that Cell Balancing Voltage Differential Limit is a legacy parameter which no longer has any effect on RLEC operation.

Prog. Guidelines: As a precaution, it is recommended to set Cell Balancing Voltage Differential Limit to a constant value of 0.022 V.

3.3.1.3.4 Cell Balancing Differential Voltage

Description: Min. cell voltage hysteresis required to change state of balancing resistors (i.e. to switch from enabled to disabled)(?)

Position: Bytes 6 – 7

Format: Unsigned integer

Range: 0 – 5 V

Resolution: 0.00244 V

RLEC Processing: It is unknown whether Cell Balancing Differential Voltage Differential has any effect on RLEC operation.

Prog. Guidelines: It is believed that setting Cell Balancing Differential Voltage to a constant value of 0.0073 V has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4 CAN ID 0x7E4: Broadcast Message 4

The Broadcast Message 4 data format is shown in Figure 6. The MLEC transmits Broadcast Message 4 at the start of each 100 msec. data collection cycle however none of the data is used by the RLEC during normal operation. It is currently unknown whether the RLEC actually requires that this message be received during normal operation but this may easily be determined via system testing.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	8

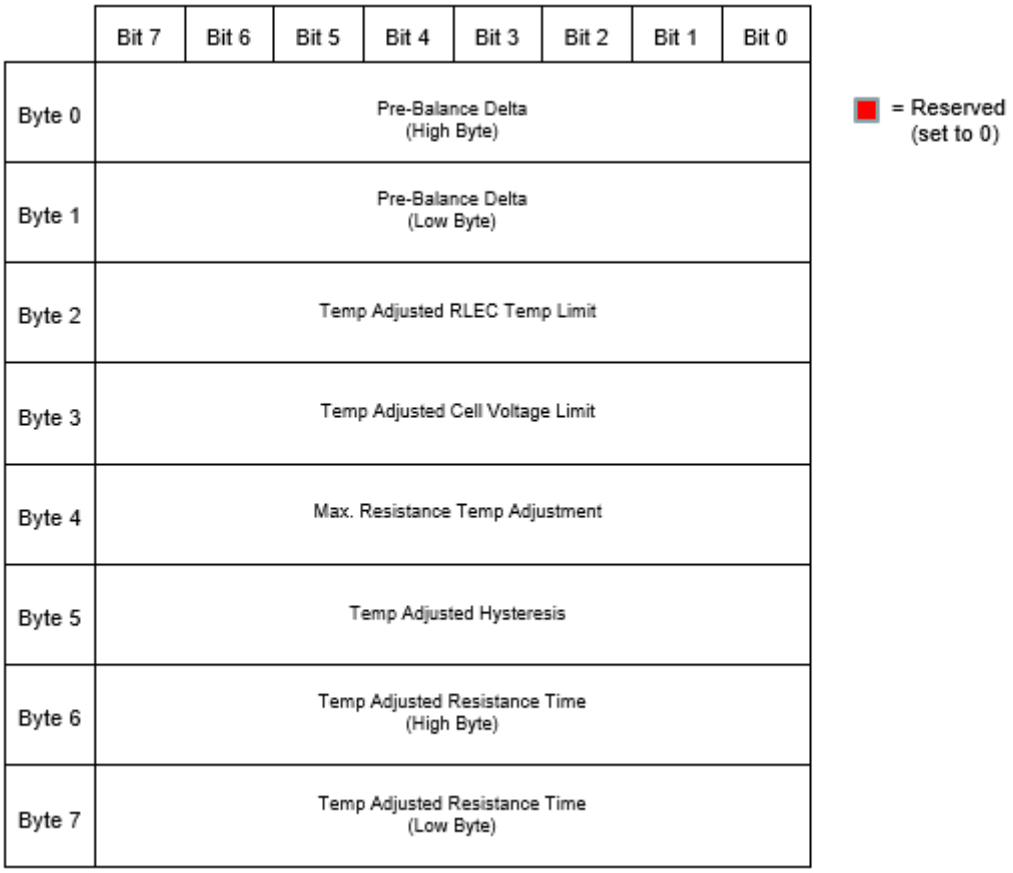

Figure 6 – CAN ID 0x7E4: Broadcast Message 4 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x7E4	0x00	0x09	0x46	0x2D	0x0A	0x02	0x00	0x4B

Example:

Interpretation: Pre-Balance Delta = 0.022 V(?)

Temp Adjusted RLEC Temp Limit(?) = TBD

Temp Adjusted Cell Voltage Limit(?) = TBD
Max. Resistance Temp Adjustment(?) = TBD
Temp Adjusted Hysteresis(?) = TBD
Temp Adjusted Resistance Time(?) = TBD

3.3.1.4.1 *Pre-Balance Delta*

Description:	Unknown
Position:	Bytes 0 – 1
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V(?)
RLEC Processing:	It is believed that Pre-Balance Delta is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines:	It is believed that setting Pre-Balance Delta to a constant value of 0.022 V(?) has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4.2 *Temp Adjusted RLEC Temperature Limit*

Description:	Unknown
Position:	Byte 2
Format:	Unknown
Range:	Unknown
Resolution:	Unknown
RLEC Processing:	It is believed that Temp Adjusted RLEC Temperature Limit is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines:	It is believed that setting Temp Adjusted RLEC Temperature Limit to a constant value of 0x46 has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4.3 *Temp Adjusted Cell Voltage Limit*

Description:	Unknown
Position:	Byte 3
Format:	Unknown
Range:	Unknown
Resolution:	Unknown
RLEC Processing:	It is believed that Temp Adjusted Cell Voltage Limit is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.

Prog. Guidelines: It is believed that setting Temp Adjusted Cell Voltage Limit to a constant value of 0x2D has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4.4 Max. Resistance Temp Adjustment

Description: Unknown
Position: Byte 4
Format: Unknown
Range: Unknown
Resolution: Unknown
RLEC Processing: It is believed that Max. Resistance Temp Adjustment is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines: It is believed that setting Max. Resistance Temp Adjustment to a constant value of 0x0A has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4.5 Temp Adjusted Hysteresis

Description: Unknown
Position: Byte 5
Format: Unknown
Range: Unknown
Resolution: Unknown
RLEC Processing: It is believed that Temp Adjusted Hysteresis is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines: It is believed that setting Temp Adjusted Hysteresis to a constant value of 0x02 has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.4.6 Temp Adjusted Resistance Time

Description: Unknown
Position: Bytes 6 – 7
Format: Unknown
Range: Unknown
Resolution: Unknown
RLEC Processing: It is believed that Temp Adjusted Resistance Time is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.

Prog. Guidelines: It is believed that setting Temp Adjusted Resistance Time to a constant value of 0x004B has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.5 CAN ID 0x7E5: Broadcast Message 5

The Broadcast Message 5 data format is shown in Figure 7. The MLEC transmits Broadcast Message 5 at the start of each 100 msec. data collection cycle however none of the data is used by the RLEC during normal operation. It is currently unknown whether the RLEC actually requires that this message be received during normal operation but this may easily be determined via system testing.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	8

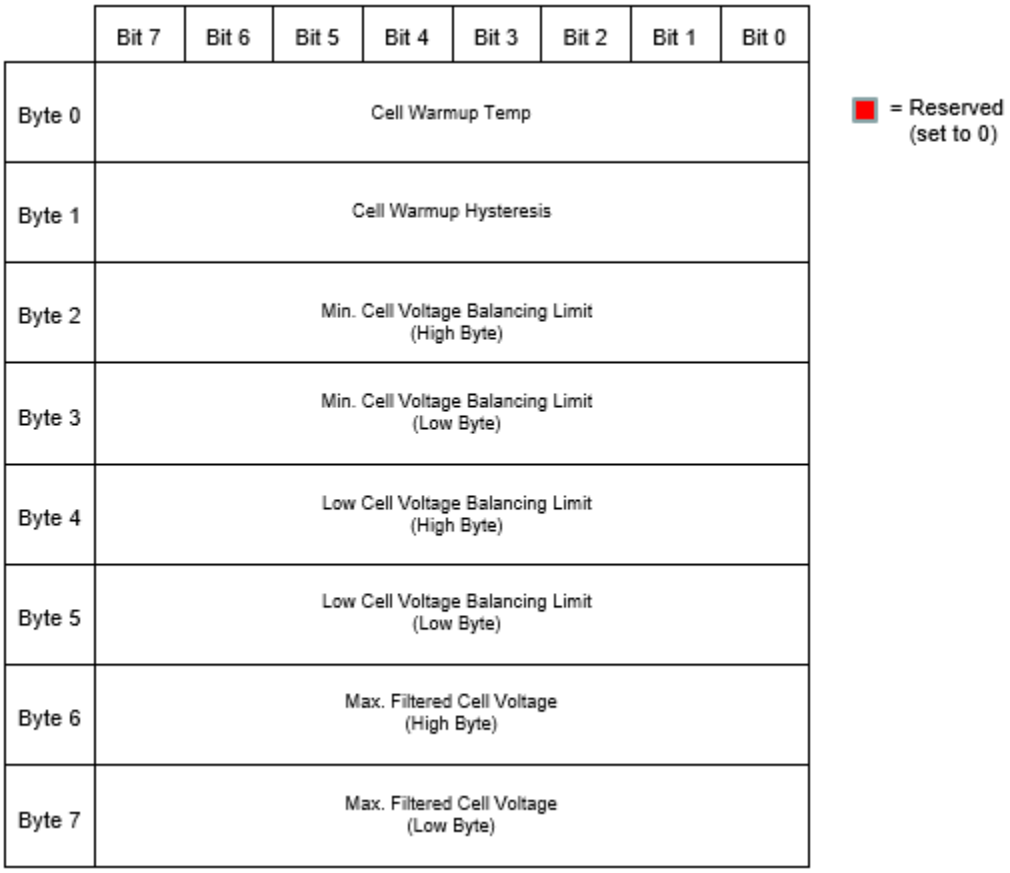

Figure 7 – CAN ID 0x7E5: Broadcast Message 5 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x7E5	0x05	0x02	0x03	0x51	0x03	0xAE	0x05	0xCA

Example:

Interpretation: Cell Warmup Temperature = 5°C(?)
Cell Warmup Hysteresis = 2°C(?)

Min. Cell Voltage Balancing Limit = 2.0 V
Low Cell Voltage Balancing Limit = 2.3 V
Max. Filtered Cell Voltage = 3.62 V

3.3.1.5.1 *Cell Warmup Temperature*

Description:	Min. cell temperature for cell balancing(?)
Position:	Byte 0
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
RLEC Processing:	It is believed that Cell Warmup Temperature is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines:	It is believed that setting Cell Warmup Temperature to a constant value of 5°C has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.5.2 *Cell Warmup Hysteresis*

Description:	Required cell temperature hysteresis for enabling cell balancing at low temperatures(?)
Position:	Byte 1
Format:	Signed short integer(?)
Range:	-128°C to 127°C
Resolution:	1°C
RLEC Processing:	It is believed that Cell Warmup Hysteresis is a parameter intended for non-A306 applications and has no effect on A306 RLEC operation.
Prog. Guidelines:	It is believed that setting Cell Warmup Hysteresis to a constant value of 2°C has no negative effect on RLEC operation and thus this is the recommended default value.

3.3.1.5.3 *Min. Cell Voltage Balancing Limit*

Description:	The absolute cell voltage limit below which cell balancing will not be enabled.
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V

RLEC Processing: It is believed that the RLEC will not enable the balance resistor of any cell with a cell voltage below Min. Cell Voltage Balancing Limit (however this should be verified via testing).

Prog. Guidelines: It is recommended that Min. Cell Voltage Balancing Limit be set to a constant value of 2.0 V to prevent the RLEC from further draining cells with extremely low cell voltages.

3.3.1.5.4 Low Cell Voltage Balancing Limit

Description: The cell voltage limit below which the RLEC will limit the cell balancing resistor duty cycle(?).

Position: Bytes 4 – 5

Format: Unsigned integer

Range: 0 – 5 V

Resolution: 0.00244 V

RLEC Processing: It is hypothesized that the RLEC will limit the duty cycle of the balance resistor "on-time" of any cell with a cell voltage below Low Cell Voltage Balancing Limit (however this should be verified via testing).

Prog. Guidelines: It is recommended that Low Cell Voltage Balancing Limit be set to a constant value of 2.3 V to prevent the RLEC from quickly draining cells with low cell voltages.

3.3.1.5.5 Max. Filtered Cell Voltage

Description: Highest filtered cell voltage currently reported by all RLECs in the battery pack

Position: Bytes 6 – 7

Format: Unsigned integer

Range: 0 – 5 V

Resolution: 0.00244 V

RLEC Processing: None

Prog. Guidelines: This parameter is for informational purposes only and has no effect on the RLEC.

3.3.1.6 CAN ID 0x7E6: Broadcast Message 6

The Broadcast Message 6 data format is shown in Figure 8. The MLEC transmits Broadcast Message 6 at the start of each 100 msec. data collection cycle however the message is intended for a specific pack cycler only and none of the data is used by the RLEC during normal operation. It is assumed that the RLEC does NOT require that this message be received during normal operation but this should be verified via system testing.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	All RLECs	Periodic	100 msec.	2

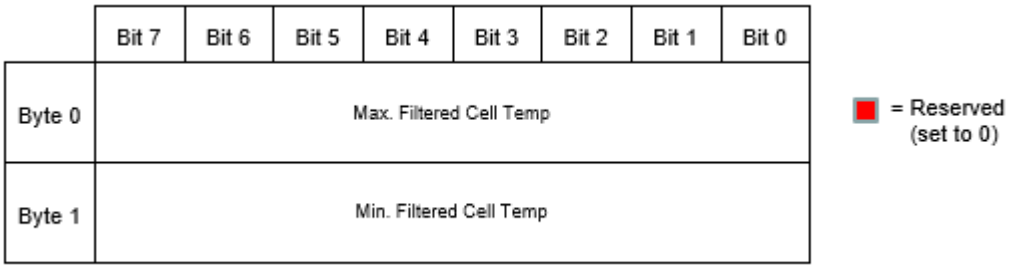

Figure 8 – CAN ID 0x7E6: Broadcast Message 6 Data Format

Msg ID	Byte 0	Byte 1
0x7E6	0x23	0x1E

Example:

Interpretation: Max. Filtered Cell Temperature = 35°C
Min. Filtered Cell Temperature = 30°C

3.3.1.6.1 Max. Filtered Cell Temperature

Description: Highest filtered cell temperature currently reported by all RLECs in the battery pack
Position: Byte 0
Format: Signed short integer
Range: -128°C to 127°C
Resolution: 1°C
RLEC Processing: None
Prog. Guidelines: This parameter is intended for a specific pack cycler only and has no effect on the RLEC.

3.3.1.6.2 *Min. Filtered Cell Temperature*

Description:	Lowest filtered cell temperature currently reported by all RLECs in the battery pack
Position:	Byte 1
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
RLEC Processing:	None
Prog. Guidelines:	This parameter is intended for a specific pack cycler only and has no effect on the RLEC.

3.3.1.7 RLEC 0 – 15 Data Request Message 6

The RLEC n (where n = 0 – 15) Data Request Message 6 data format is shown in Figure 9. The MLEC transmits Data Request Message 6 as part of a set of 4 Data Request Messages sent to each RLEC every 100 msec. data collection cycle. When an RLEC receives a complete set of 4 Data Request Messages, it responds by sending a set of 13 Data Response Messages to the MLEC.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	RLEC n	Periodic	100 msec.	8

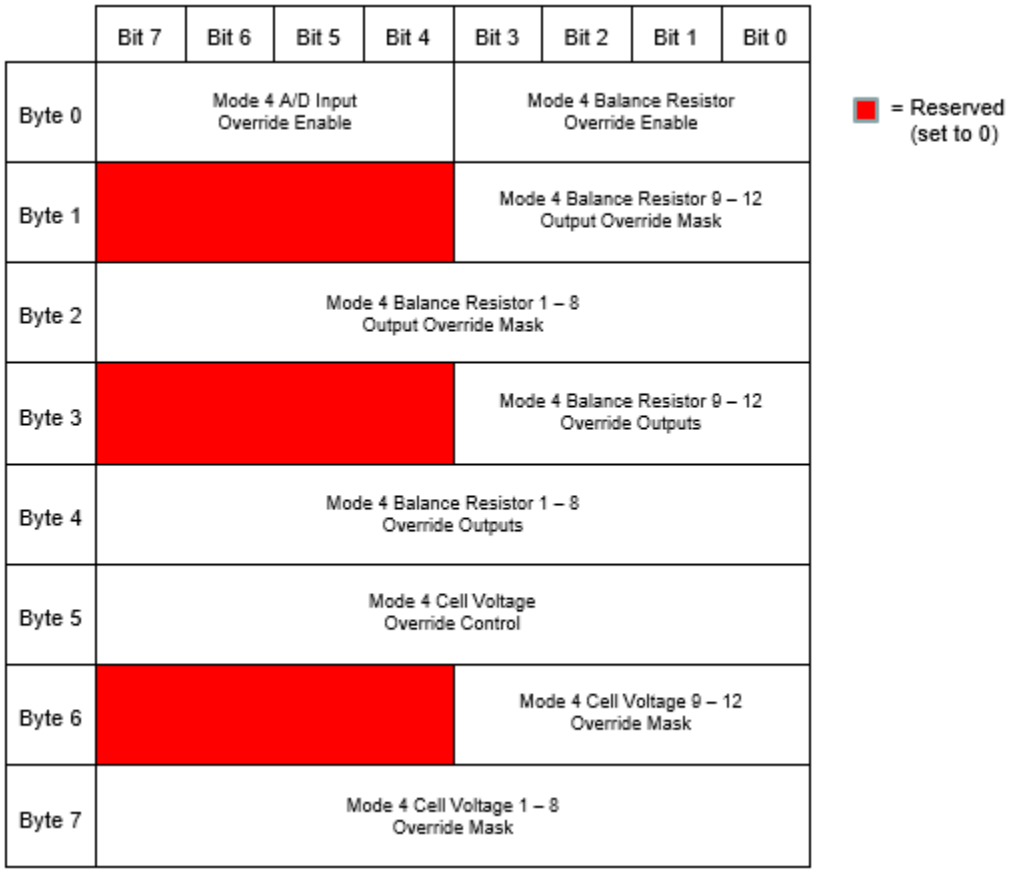

Figure 9 – RLEC 0 – 15 Data Request Message 6 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x406	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Example:

Interpretation: Mode 4 A/D Input Override Enable = False
Mode 4 Balance Resistor Override Enable = False

Mode 4 Balance Resistor 9 – 12 Output Override Mask = False
Mode 4 Balance Resistor 1 – 8 Output Override Mask = False
Mode 4 Balance Resistor 9 – 12 Override Outputs = False
Mode 4 Balance Resistor 1 – 8 Override Outputs = False
Mode 4 Cell Voltage Override Enable = False
Mode 4 Cell Voltage 9 – 12 Override Mask = False
Mode 4 Cell Voltage 1 – 8 Override Mask = False

3.3.1.7.1 *Mode 4 Balance Resistor Override Enable*

Description:	Diagnostic control parameter to override RLEC balance resistor outputs
Position:	Byte 0, bits 0 – 3
Format:	Boolean
States:	0 = Normal operation 1 = Enable “Mode 4” diagnostic override for RLEC balance resistor outputs
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Balance Resistor Override Enable = 0.

3.3.1.7.2 *Mode 4 A/D Input Override Enable*

Description:	Diagnostic control parameter to override RLEC A/D inputs
Position:	Byte 0, bits 4 – 7
Format:	Boolean
States:	0 = Normal operation 1 = Enable “Mode 4” diagnostic override for RLEC A/D inputs
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 A/D Input Override Enable = 0.

3.3.1.7.3 *Mode 4 Balance Resistor 1 – 12 Output Override Mask*

Description:	Mode 4 diagnostic balance resistor output override mask
Position:	Byte 1, bits 0 – 7 and Byte 2, bits 0 – 3
Format:	Bit mask
States:	0 = Ignore Mode 4 Balance Resistor x Override Output when Mode 4 Balance Resistor Override Enable = True 1 = Don’t ignore Mode 4 Balance Resistor x Override Output when Mode 4 Balance Resistor Override Enable = True
Default Value:	0

RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Balance Resistor Output Override Mask = 0.

3.3.1.7.4 Mode 4 Balance Resistor 1 – 12 Override Outputs

Description: Mode 4 diagnostic balance resistor output override mask
Position: Byte 3, bits 0 – 7 and Byte 4, bits 0 – 3
Format: Boolean
States: 0 = Disable Balance Resistor x when Mode 4 Balance Resistor Override Enable = True and Mode 4 Balance Resistor x Output Override Mask = True
1 = Enable Balance Resistor x when Mode 4 Balance Resistor Override Enable = True and Mode 4 Balance Resistor x Output Override Mask = True
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Balance Resistor Override Outputs = 0.

3.3.1.7.5 Mode 4 Cell Voltage Override Enable

Description: Diagnostic control parameter to override RLEC cell voltage inputs
Position: Byte 5
Format: Boolean
States: 0 = Normal operation
1 = Enable “Mode 4” diagnostic override for RLEC cell voltage inputs
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Cell Voltage Override Enable = 0.

3.3.1.7.6 Mode 4 Cell Voltage 1 – 12 Override Mask

Description: Mode 4 diagnostic cell voltage input override mask
Position: Byte 6, bits 0 – 7 and Byte 7, bits 0 – 3
Format: Bit mask
States: 0 = Ignore Mode 4 Cell Voltage x Override Input when Mode 4 Cell Voltage Override Enable = True
1 = Don’t ignore Mode 4 Cell Voltage x Override Input when Mode 4 Cell Voltage Override Enable = True
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Cell Voltage Override Mask = 0.

3.3.1.8 RLEC 0 – 15 Data Request Message 10

The RLEC n (where n = 0 – 15) Data Request Message 10 data format is shown in Figure 10. The MLEC transmits Data Request Message 10 as part of a set of 4 Data Request Messages sent to each RLEC every 100 msec. data collection cycle. When an RLEC receives a complete set of 4 Data Request Messages, it responds by sending a set of 13 Data Response Messages to the MLEC.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	RLEC n	Periodic	100 msec.	8

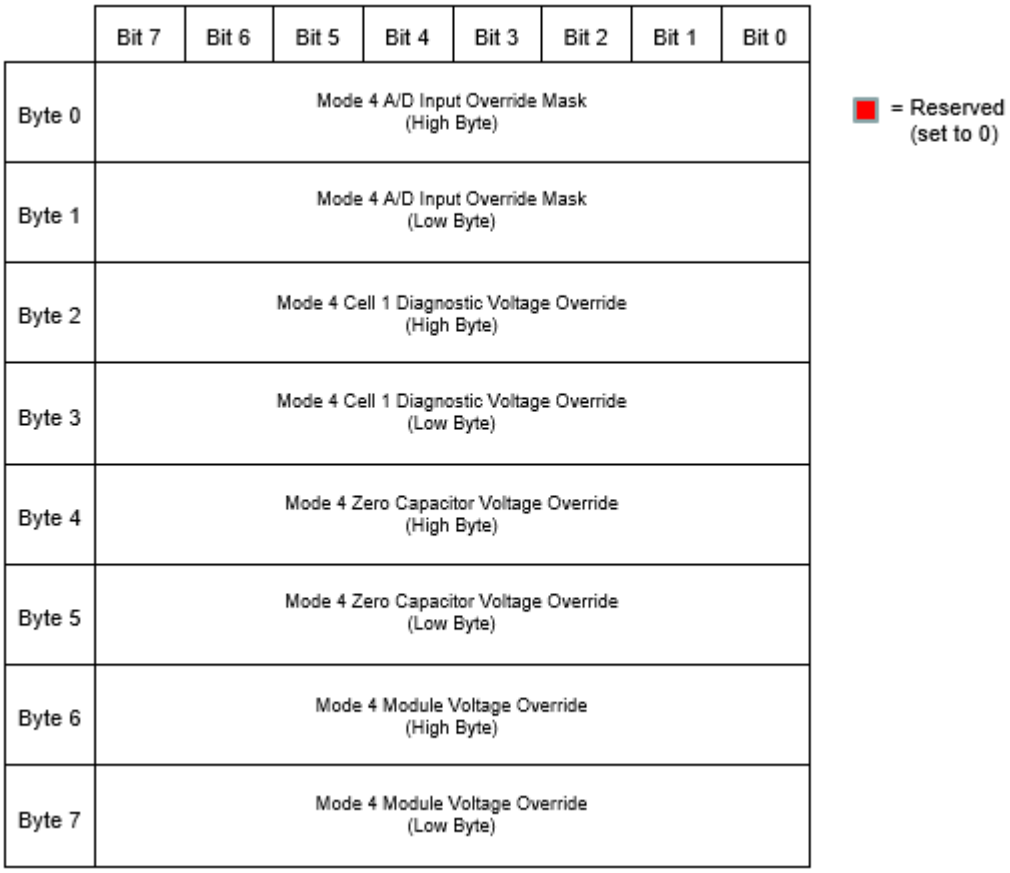

Figure 10 – RLEC 0 – 15 Data Request Message 10 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x40A	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Example:

Interpretation: Mode 4 A/D Input Override Mask = False
Mode 4 Cell 1 Diagnostic Voltage Override = 0 V

Mode 4 Zero Capacitor Voltage Override = 0 V
Mode 4 Module Voltage Override = 0 V

3.3.1.8.1 *Mode 4 A/D Input Override Mask*

Description:	Mode 4 A/D input override mask
Position:	Bytes 0 – 1
Format:	Bit mask (specific format unknown)
States:	0 = Ignore corresponding Mode 4 A/D Input Override Input when Mode 4 A/D Input Override Enable = True 1 = Don't ignore corresponding Mode 4 A/D Input Override Input when Mode 4 A/D Input Override Enable = True
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 A/D Input Override Mask = 0.

3.3.1.8.2 *Mode 4 Cell 1 Diagnostic Voltage Override*

Description:	Mode 4 cell 1 diagnostic voltage override
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell 1 Diagnostic Voltage Override = 0.

3.3.1.8.3 *Mode 4 Zero Capacitor Voltage Override*

Description:	Mode 4 zero capacitor voltage override
Position:	Bytes 4 – 5
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Zero Capacitor Voltage Override = 0.

3.3.1.8.4 *Mode 4 Module Voltage Override*

Description:	Mode 4 module voltage override
Position:	Bytes 6 – 7
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Module Voltage Override = 0.

3.3.1.9 RLEC 0 – 15 Data Request Message 11

The RLEC n (where n = 0 – 15) Data Request Message 11 data format is shown in Figure 11. The MLEC transmits Data Request Message 11 as part of a set of 4 Data Request Messages sent to each RLEC every 100 msec. data collection cycle. When an RLEC receives a complete set of 4 Data Request Messages, it responds by sending a set of 13 Data Response Messages to the MLEC.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	RLEC n	Periodic	100 msec.	8

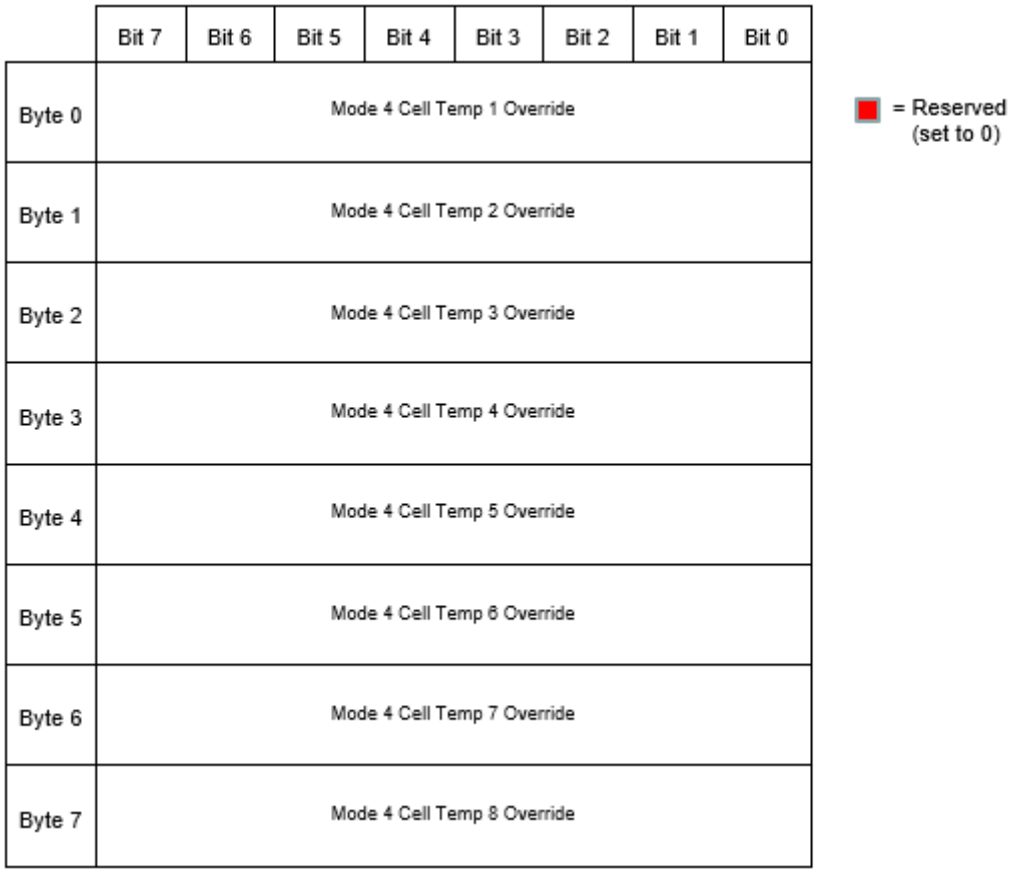

Figure 11 – RLEC 0 – 15 Data Request Message 11 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x40B	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Example:

Interpretation: Mode 4 Cell Temperature 1 Override = 0°C
Mode 4 Cell Temperature 2 Override = 0°C
Mode 4 Cell Temperature 3 Override = 0°C

Mode 4 Cell Temperature 4 Override = 0°C
Mode 4 Cell Temperature 5 Override = 0°C
Mode 4 Cell Temperature 6 Override = 0°C
Mode 4 Cell Temperature 7 Override = 0°C
Mode 4 Cell Temperature 8 Override = 0°C

3.3.1.9.1 *Mode 4 Cell Temperature 1 Override*

Description:	Mode 4 cell temperature 1 override
Position:	Byte 0
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 1 Override = 0.

3.3.1.9.2 *Mode 4 Cell Temperature 2 Override*

Description:	Mode 4 cell temperature 2 override
Position:	Byte 1
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 2 Override = 0.

3.3.1.9.3 *Mode 4 Cell Temperature 3 Override*

Description:	Mode 4 cell temperature 3 override
Position:	Byte 2
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 3 Override = 0.

3.3.1.9.4 *Mode 4 Cell Temperature 4 Override*

Description: Mode 4 cell temperature 4 override
Position: Byte 3
Format: Signed short integer
Range: -128°C to 127°C
Resolution: 1°C
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Cell Temperature 4 Override = 0.

3.3.1.9.5 *Mode 4 Cell Temperature 5 Override*

Description: Mode 4 cell temperature 5 override
Position: Byte 4
Format: Signed short integer
Range: -128°C to 127°C
Resolution: 1°C
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Cell Temperature 5 Override = 0.

3.3.1.9.6 *Mode 4 Cell Temperature 6 Override*

Description: Mode 4 cell temperature 6 override
Position: Byte 5
Format: Signed short integer
Range: -128°C to 127°C
Resolution: 1°C
Default Value: 0
RLEC Processing: Special RLEC diagnostics mode.
Prog. Guidelines: Always set Mode 4 Cell Temperature 6 Override = 0.

3.3.1.9.7 *Mode 4 Cell Temperature 7 Override*

Description: Mode 4 cell temperature 7 override
Position: Byte 6
Format: Signed short integer
Range: -128°C to 127°C
Resolution: 1°C

Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 7 Override = 0.

3.3.1.9.8 Mode 4 Cell Temperature 8 Override

Description:	Mode 4 cell temperature 8 override
Position:	Byte 7
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 8 Override = 0.

3.3.1.10 RLEC 0 – 15 Data Request Message 12

The RLEC n (where n = 0 – 15) Data Request Message 12 data format is shown in Figure 12. The MLEC transmits Data Request Message 12 as part of a set of 4 Data Request Messages sent to each RLEC every 100 msec. data collection cycle. When an RLEC receives a complete set of 4 Data Request Messages, it responds by sending a set of 13 Data Response Messages to the MLEC.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
MLEC	RLEC n	Periodic	100 msec.	8

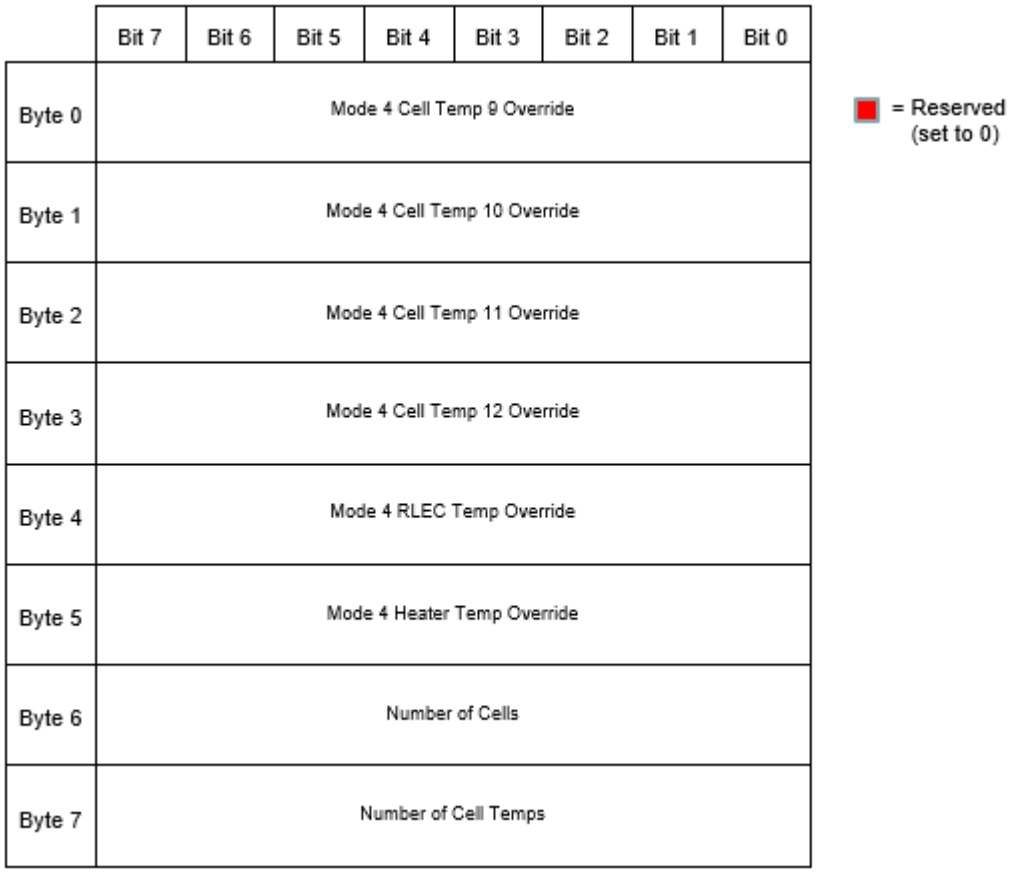

Figure 12 – RLEC 0 – 15 Data Request Message 12 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x40C	0x00	0x00	0x00	0x00	0x00	0x00	0x0C	0x0C

Example:

Interpretation: Mode 4 Cell Temperature 9 Override = 0°C
Mode 4 Cell Temperature 10 Override = 0°C

Mode 4 Cell Temperature 11 Override = 0°C
Mode 4 Cell Temperature 12 Override = 0°C
Mode 4 RLEC Temperature Override = 0°C
Mode 4 Heater Temperature Override = 0°C
Number of Cells = 12
Number of Cell Temperatures = 12

3.3.1.10.1 *Mode 4 Cell Temperature 9 Override*

Description:	Mode 4 cell temperature 9 override
Position:	Byte 0
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 9 Override = 0.

3.3.1.10.2 *Mode 4 Cell Temperature 10 Override*

Description:	Mode 4 cell temperature 10 override
Position:	Byte 1
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 10 Override = 0.

3.3.1.10.3 *Mode 4 Cell Temperature 11 Override*

Description:	Mode 4 cell temperature 11 override
Position:	Byte 2
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 11 Override = 0.

3.3.1.10.4 *Mode 4 Cell Temperature 12 Override*

Description:	Mode 4 cell temperature 12 override
Position:	Byte 3
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Cell Temperature 12 Override = 0.

3.3.1.10.5 *Mode 4 RLEC Temperature Override*

Description:	Mode 4 RLEC board temperature override
Position:	Byte 4
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Board Temperature Override = 0.

3.3.1.10.6 *Mode 4 Heater Temperature Override*

Description:	Mode 4 heater temperature override
Position:	Byte 5
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
Default Value:	0
RLEC Processing:	Special RLEC diagnostics mode.
Prog. Guidelines:	Always set Mode 4 Heater Temperature Override = 0.
Note:	The RLEC heater temperature input is related to a previous RLEC hardware design. The current RLEC hardware design does not include an actual heater temperature input.

3.3.1.10.7 *Number of Cells*

Description:	Number of cell pairs for this specific battery module (i.e. RLEC-specific)
Position:	Byte 6

Format:	Constant integer
Value:	12
RLEC Processing:	RLEC-specific battery module cell configuration information for RLEC software. It is believed that a non-zero value will override the “Number of Cells” parameter in Broadcast Message 1 however this has not been verified.
Prog. Guidelines:	Always set to 12 for the A306 battery module hardware configuration.

3.3.1.10.8 Number of Cell Temperatures

Description:	Number of cell temperature sensors for this specific battery module (i.e. RLEC-specific)
Position:	Byte 7
Format:	Constant integer
Value:	12
RLEC Processing:	Battery module cell temperature sensor configuration information for RLEC software. It is believed that a non-zero value will override the “Number of Cell Temps” parameter in Broadcast Message 1 however this has not been verified.
Prog. Guidelines:	Always set to 12 for the A306 battery module hardware configuration.

3.3.2 Tx Messages

3.3.2.1 RLEC 0 – 15 Data Response Message 1

The RLEC n (where n = 0 – 15) Data Response Message 1 data format is shown in Figure 13. The RLEC transmits Data Response Message 1 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

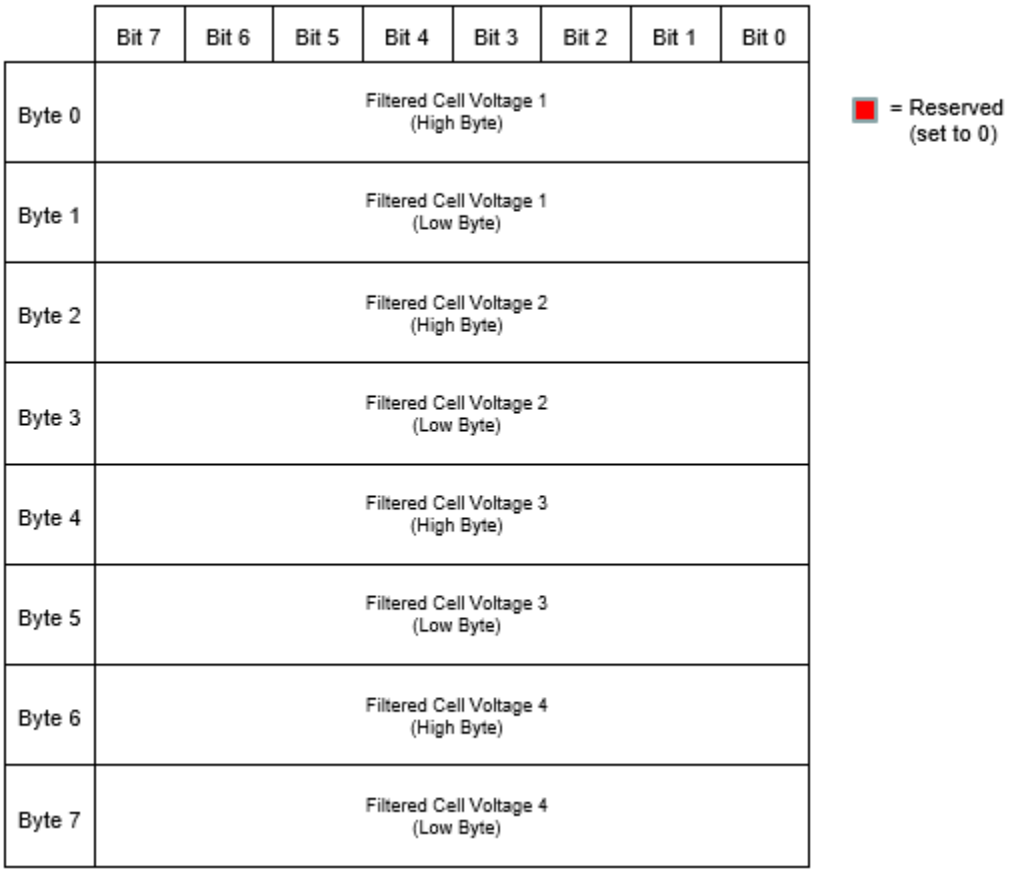

Figure 13 – RLEC 0 – 15 Data Response Message 1 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x001	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Filtered Cell Voltage 1 = 3.599 V
Filtered Cell Voltage 2 = 3.611 V
Filtered Cell Voltage 3 = 3.584 V
Filtered Cell Voltage 4 = 3.616 V

3.3.2.1.1 *Filtered Cell Voltage 1*

Description: Filtered cell voltage 1
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.1.2 *Filtered Cell Voltage 2*

Description: Filtered cell voltage 2
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.1.3 *Filtered Cell Voltage 3*

Description: Filtered cell voltage 3
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.1.4 *Filtered Cell Voltage 4*

Description:	Filtered cell voltage 4
Position:	Bytes 6 – 7
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.2 RLEC 0 – 15 Data Response Message 2

The RLEC n (where n = 0 – 15) Data Response Message 2 data format is shown in Figure 14. The RLEC transmits Data Response Message 2 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

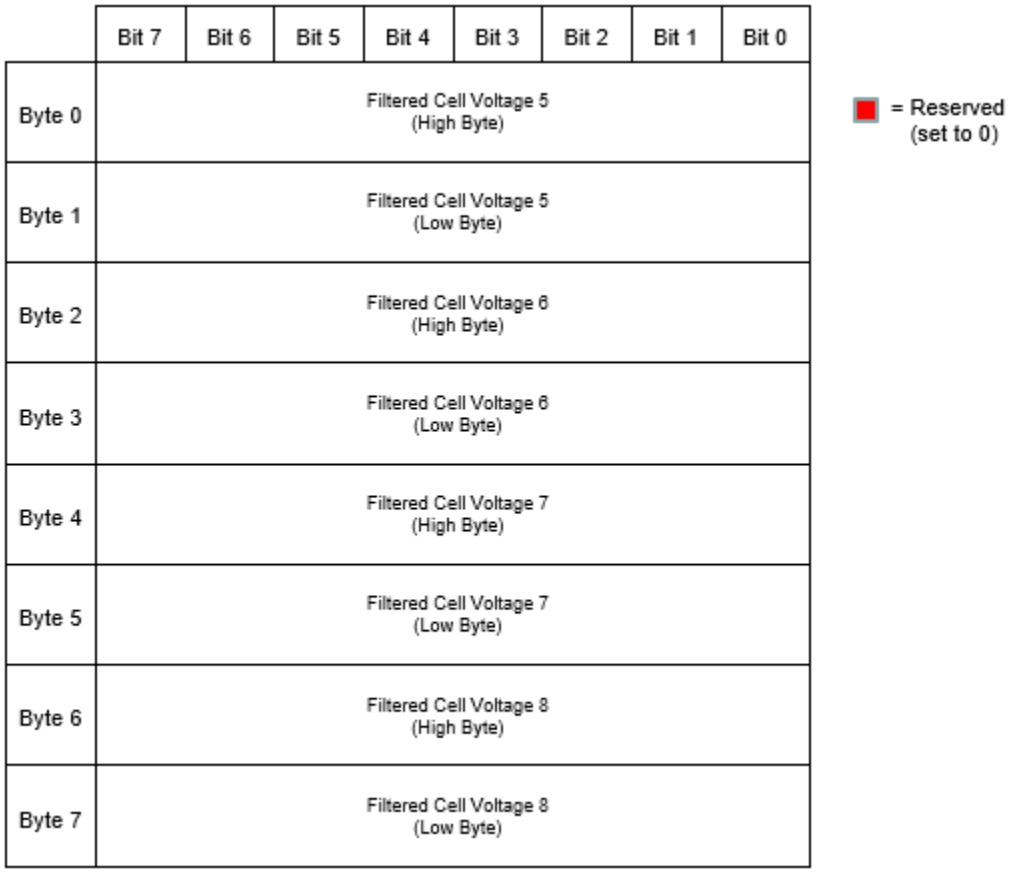

Figure 14 – RLEC 0 – 15 Data Response Message 2 Data Format

Example:

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x002	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Interpretation: Filtered Cell Voltage 5 = 3.599 V
Filtered Cell Voltage 6 = 3.611 V
Filtered Cell Voltage 7 = 3.584 V
Filtered Cell Voltage 8 = 3.616 V

3.3.2.2.1 *Filtered Cell Voltage 5*

Description: Filtered cell voltage 5
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.2.2 *Filtered Cell Voltage 6*

Description: Filtered cell voltage 6
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.2.3 *Filtered Cell Voltage 7*

Description: Filtered cell voltage 7
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.2.4 *Filtered Cell Voltage 8*

Description: Filtered cell voltage 8
Position: Bytes 6 – 7

Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.3 RLEC 0 – 15 Data Response Message 3

The RLEC n (where n = 0 – 15) Data Response Message 3 data format is shown in Figure 15. The RLEC transmits Data Response Message 3 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

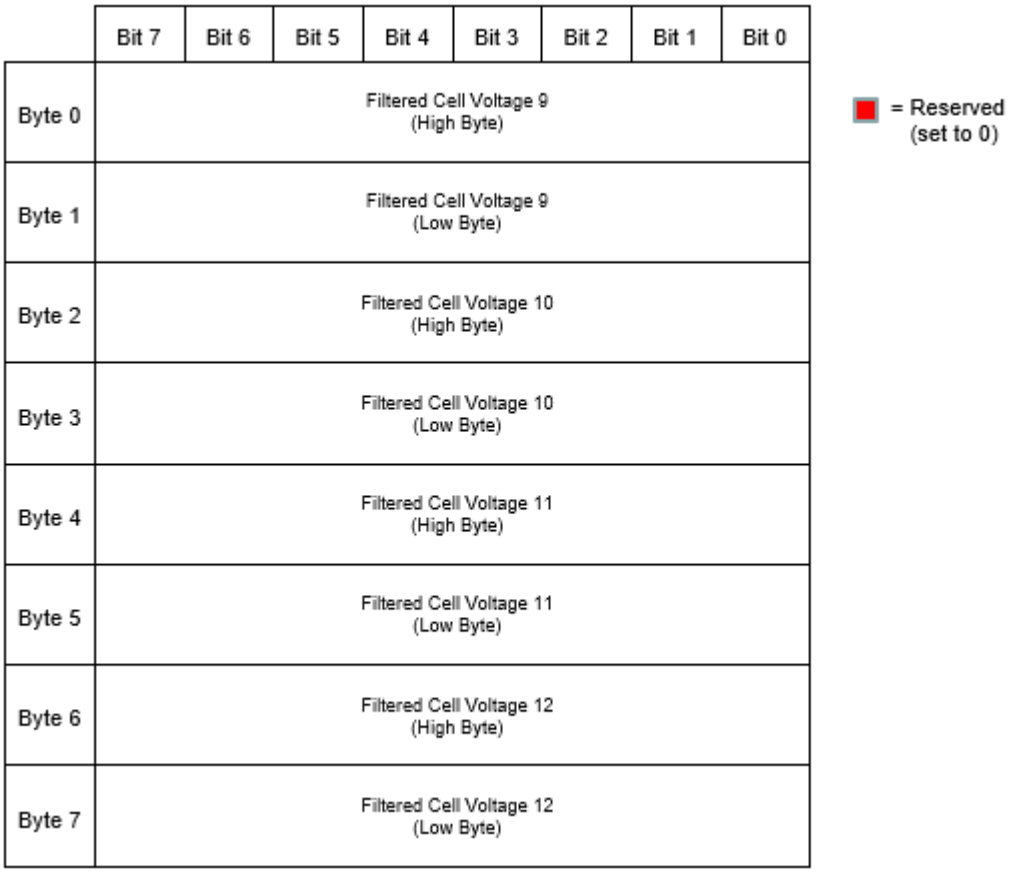

Figure 15 – RLEC 0 – 15 Data Response Message 3 Data Format

Example:

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x003	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Interpretation: Filtered Cell Voltage 9 = 3.599 V
Filtered Cell Voltage 10 = 3.611 V
Filtered Cell Voltage 11 = 3.584 V
Filtered Cell Voltage 12 = 3.616 V

3.3.2.3.1 *Filtered Cell Voltage 9*

Description: Filtered cell voltage 9
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.3.2 *Filtered Cell Voltage 10*

Description: Filtered cell voltage 10
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.3.3 *Filtered Cell Voltage 11*

Description: Filtered cell voltage 11
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.3.4 *Filtered Cell Voltage 12*

Description: Filtered cell voltage 12
Position: Bytes 6 – 7

Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	The MLEC uses filtered cell voltages for all cell voltage processing, e.g. SOC calculations, current limiting, fault detection, etc.

3.3.2.4 RLEC 0 – 15 Data Response Message 4

The RLEC n (where n = 0 – 15) Data Response Message 4 data format is shown in Figure 16. The RLEC transmits Data Response Message 4 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Max. Filtered Cell Voltage (High Byte)							
Byte 1	Max. Filtered Cell Voltage (Low Byte)							
Byte 2	Min. Filtered Cell Voltage (High Byte)							
Byte 3	Min. Filtered Cell Voltage (Low Byte)							
Byte 4	Filtered RLEC Temp							
Byte 5					Cell 12 Balance Resistor Output	Cell 11 Balance Resistor Output	Cell 10 Balance Resistor Output	Cell 9 Balance Resistor Output
Byte 6	Cell 8 Balance Resistor Output	Cell 7 Balance Resistor Output	Cell 6 Balance Resistor Output	Cell 5 Balance Resistor Output	Cell 4 Balance Resistor Output	Cell 3 Balance Resistor Output	Cell 2 Balance Resistor Output	Cell 1 Balance Resistor Output
Byte 7	Cell 1 Voltage Fault	Zero Cap Voltage Fault	Module Voltage A/D Fault	Cell Voltage A/D Fault	CV Conn-ection Fault	RLEC Temp A/D Fault	Cell Temp A/D Fault	Cell 1 A/D Fault

= Reserved (set to 0)

Figure 16 – RLEC 0 – 15 Data Response Message 4 Data Format

Example:

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x004	0x05	0xCA	0x05	0xBD	0x23	0x05	0x55	0x00

Interpretation:	Max. Filtered Cell Voltage = 3.616 V Min. Filtered Cell Voltage = 3.584 V Filtered RLEC Temp = 35°C Cell Balance Resistors 1, 3, 5, 7, 9, 11 = ON Cell Balance Resistors 2, 4, 6, 8, 10, 12 = OFF All RLEC Faults = False

3.3.2.4.1 Max. Filtered Cell Voltage

Description:	Highest filtered cell voltage for this RLEC
Position:	Bytes 0 – 1
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Same as for filtered cell voltages 1 – 12.
Note:	In addition to providing filtered cell voltages 1 – 12, the RLEC provides the max. filtered cell voltage as a convenience.

3.3.2.4.2 Min. Filtered Cell Voltage

Description:	Lowest filtered cell voltage for this RLEC
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Same as for filtered cell voltages 1 – 12.
Note:	In addition to providing filtered cell voltages 1 – 12, the RLEC provides the min. filtered cell voltage as a convenience.

3.3.2.4.3 Filtered RLEC Temperature

Description:	Filtered RLEC board temperature
Position:	Byte 4
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC uses the filtered RLEC temperature to check for RLEC overtemperature faults.

3.3.2.4.4 *Cell Balance Resistor Outputs 1 – 12*

Description:	Current status of cell balance resistor outputs 1 – 12, i.e. enabled (on) vs. disabled (off)
Position:	Bytes 5 – 6
Format:	Boolean
States:	0 = Cell balance resistor disabled (off) 1 = Cell balance resistor enabled (on)
MLEC Processing:	None
Note:	The cell balance resistor output status is provided for informational purposes.

3.3.2.4.5 *Cell 1 A/D Fault*

Description:	Cell 1 redundant voltage measurement circuit A/D fault flag
Position:	Byte 7, Bit 0
Format:	Boolean
States:	0 = No fault 1 = Cell 1 A/D fault
MLEC Processing:	This fault indicates to the MLEC that the RLEC cell voltage measurements may be invalid. This is considered a critical fault and the MLEC responds by opening the main contactors.
Note:	Cell 1 if the first/lowest cell in the battery module.

3.3.2.4.6 *Cell Temp A/D Fault*

Description:	Cell temperature measurement circuit A/D fault flag
Position:	Byte 7, Bit 1
Format:	Boolean
States:	0 = No fault 1 = Cell temperature A/D fault
MLEC Processing:	This fault indicates to the MLEC that the RLEC cell temperature measurements are invalid. This is not considered a critical fault, however and the MLEC does not open the main contactors in response.

3.3.2.4.7 *RLEC Temp A/D Fault*

Description:	RLEC board temperature measurement circuit A/D fault flag
Position:	Byte 7, Bit 2
Format:	Boolean
States:	0 = No fault

1 = RLEC board temperature A/D fault

MLEC Processing: This fault indicates to the MLEC that the RLEC board temperature measurements is invalid. This is not considered a critical fault, however and the MLEC does not open the main contactors in response.

3.3.2.4.8 Cell Voltage Connection Fault

Description: High impedance cell voltage connection fault flag
Position: Byte 7, Bit 3
Format: Boolean
States: 0 = No fault
1 = Cell voltage connection fault
MLEC Processing: This fault indicates to the MLEC that high impedance connections have been detected in the RLEC cell voltage measurement circuit and as a result, the RLEC cell voltage measurements may be invalid. This is considered a critical fault and the MLEC responds by opening the main contactors.

3.3.2.4.9 Cell Voltage A/D Fault

Description: Cell primary voltage measurement circuit A/D fault flag
Position: Byte 7, Bit 4
Format: Boolean
States: 0 = No fault
1 = Cell voltage A/D fault
MLEC Processing: This fault indicates to the MLEC that the RLEC cell voltage measurements are invalid. This is considered a critical fault and the MLEC responds by opening the main contactors.

3.3.2.4.10 Module Voltage A/D Fault

Description: Module voltage measurement circuit A/D fault flag
Position: Byte 7, Bit 5
Format: Boolean
States: 0 = No fault
1 = Module voltage A/D fault
MLEC Processing: This fault indicates to the MLEC that the RLEC module voltage measurement is invalid. While this is not considered a critical fault from the RLEC perspective, the MLEC uses module voltage to validate cell voltage measurements. When the module voltage measurement is invalid, the cell voltage measurement

validation checks fail and the MLEC ultimately responds by opening the main contactors.

3.3.2.4.11 Zero Capacitor Voltage Fault

Description:	Zero capacitor voltage fault flag
Position:	Byte 7, Bit 6
Format:	Boolean
States:	0 = No fault 1 = Zero capacitor voltage fault
MLEC Processing:	This fault flag is a legacy from an earlier RLEC hardware design and is no longer valid. This fault should never be set and there is no MLEC response to this fault.

3.3.2.4.12 Cell 1 Voltage Fault

Description:	This fault indicates that the primary cell 1 voltage measurement differs from the redundant cell 1 voltage measurement by at least 50 mV
Position:	Byte 7, Bit 7
Format:	Boolean
States:	0 = No fault 1 = Cell 1 voltage fault
MLEC Processing:	This fault indicates to the MLEC that the RLEC cell voltage measurements may be invalid. This is considered a critical fault and the MLEC responds by opening the main contactors.
Note:	Cell 1 if the first/lowest cell in the battery module.

3.3.2.5 RLEC 0 – 15 Data Response Message 5

The RLEC n (where n = 0 – 15) Data Response Message 5 data format is shown in Figure 17. The RLEC transmits Data Response Message 5 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

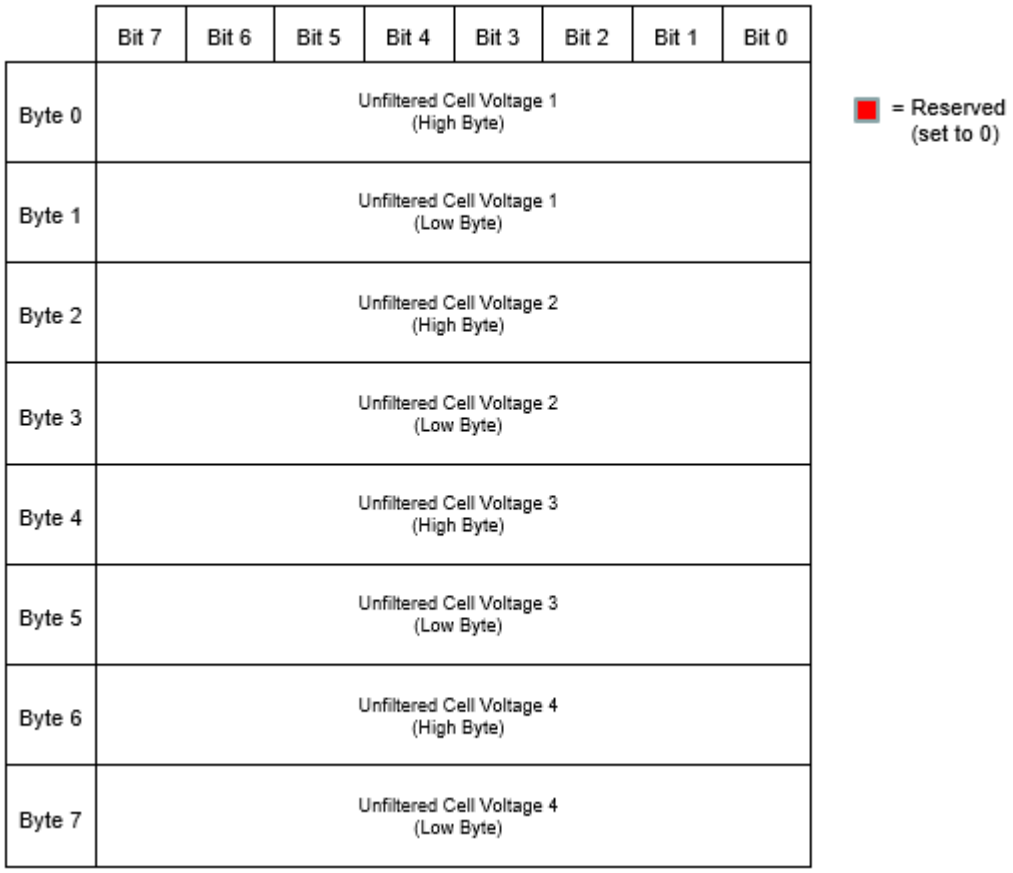

Figure 17 – RLEC 0 – 15 Data Response Message 5 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x005	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Unfiltered Cell Voltage 1 = 3.599 V

Unfiltered Cell Voltage 2 = 3.611 V
Unfiltered Cell Voltage 3 = 3.584 V
Unfiltered Cell Voltage 4 = 3.616 V

3.3.2.5.1 *Unfiltered Cell Voltage 1*

Description: Unfiltered cell voltage 1
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.5.2 *Unfiltered Cell Voltage 2*

Description: Unfiltered cell voltage 2
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.5.3 *Unfiltered Cell Voltage 3*

Description: Unfiltered cell voltage 3
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.5.4 *Unfiltered Cell Voltage 4*

Description: Unfiltered cell voltage 4
Position: Bytes 6 – 7
Format: Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.6 RLEC 0 – 15 Data Response Message 6

The RLEC n (where n = 0 – 15) Data Response Message 6 data format is shown in Figure 18. The RLEC transmits Data Response Message 6 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

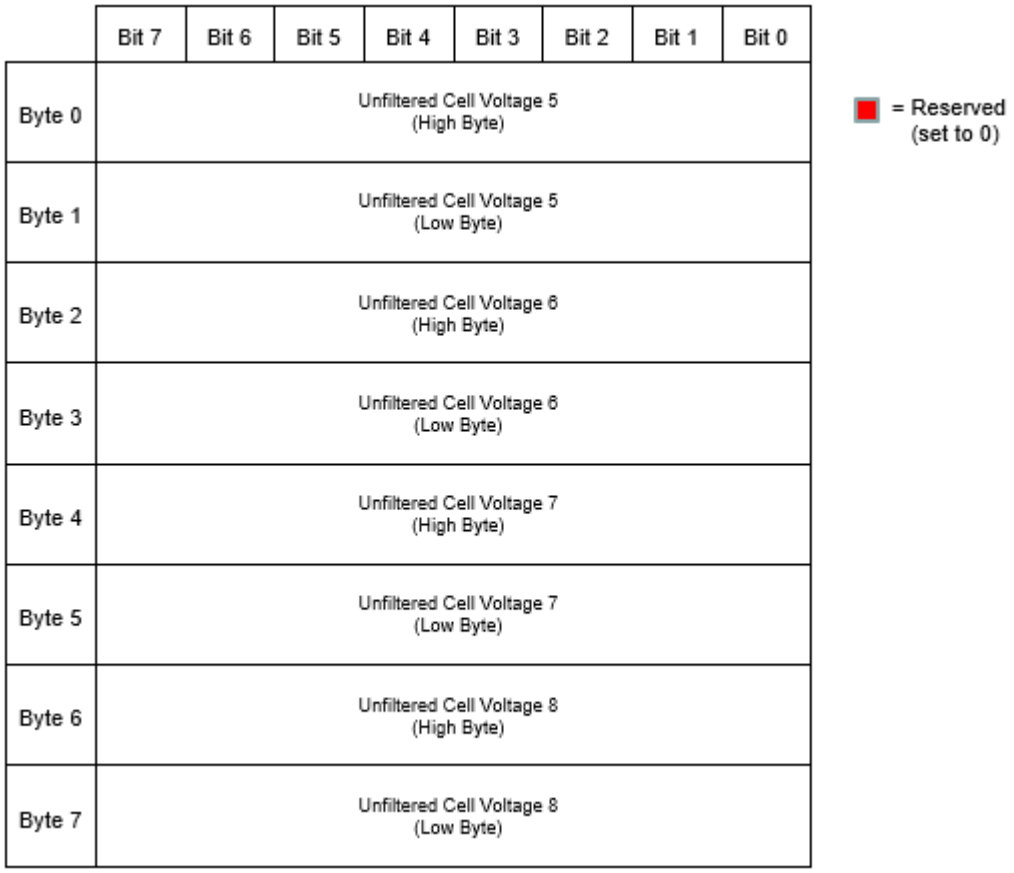

Figure 18 – RLEC 0 – 15 Data Response Message 6 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x006	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Unfiltered Cell Voltage 5 = 3.599 V

Unfiltered Cell Voltage 6 = 3.611 V
Unfiltered Cell Voltage 7 = 3.584 V
Unfiltered Cell Voltage 8 = 3.616 V

3.3.2.6.1 *Unfiltered Cell Voltage 5*

Description: Unfiltered cell voltage 5
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.6.2 *Unfiltered Cell Voltage 6*

Description: Unfiltered cell voltage 6
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.6.3 *Unfiltered Cell Voltage 7*

Description: Unfiltered cell voltage 7
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.6.4 *Unfiltered Cell Voltage 8*

Description: Unfiltered cell voltage 8
Position: Bytes 6 – 7
Format: Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.7 RLEC 0 – 15 Data Response Message 7

The RLEC n (where n = 0 – 15) Data Response Message 7 data format is shown in Figure 19. The RLEC transmits Data Response Message 7 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

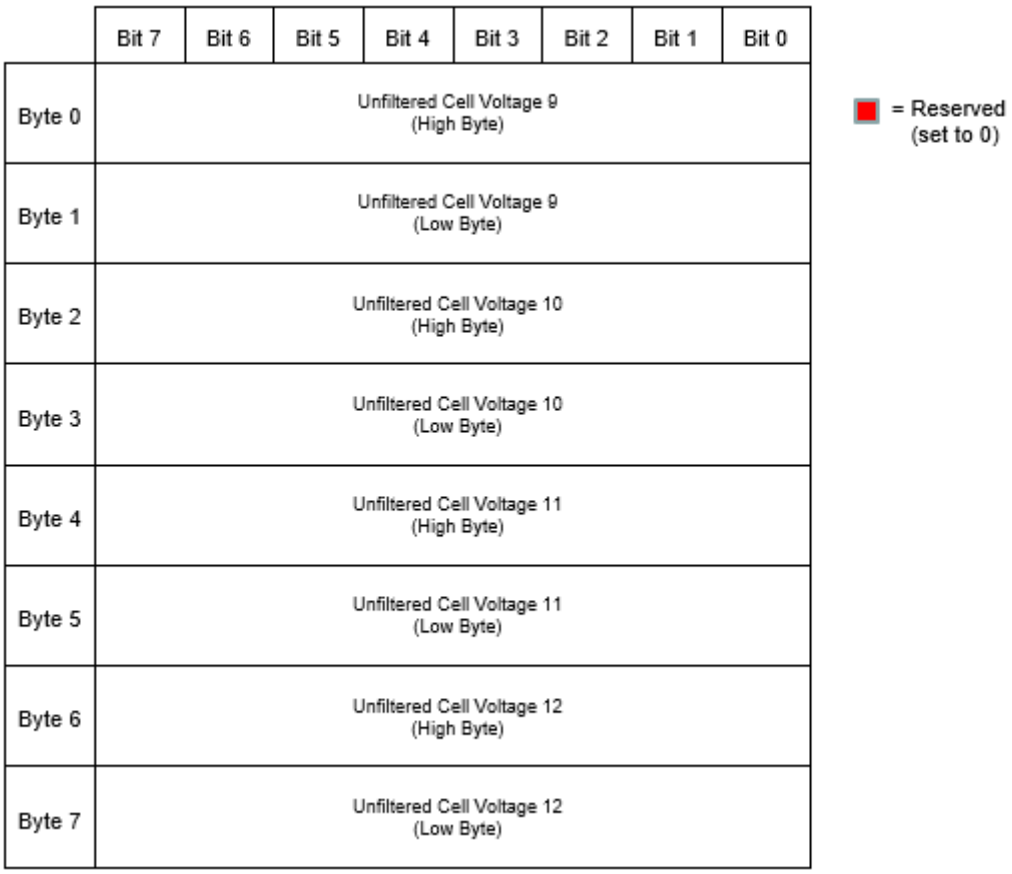

Figure 19 – RLEC 0 – 15 Data Response Message 7 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x007	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Unfiltered Cell Voltage 9 = 3.599 V

Unfiltered Cell Voltage 10 = 3.611 V
Unfiltered Cell Voltage 11 = 3.584 V
Unfiltered Cell Voltage 12 = 3.616 V

3.3.2.7.1 *Unfiltered Cell Voltage 9*

Description:	Unfiltered cell voltage 9
Position:	Bytes 0 – 1
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.7.2 *Unfiltered Cell Voltage 10*

Description:	Unfiltered cell voltage 10
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.7.3 *Unfiltered Cell Voltage 11*

Description:	Unfiltered cell voltage 11
Position:	Bytes 4 – 5
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.7.4 *Unfiltered Cell Voltage 12*

Description:	Unfiltered cell voltage 12
Position:	Bytes 6 – 7
Format:	Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Unfiltered cell voltages are ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.8 RLEC 0 – 15 Data Response Message 8

The RLEC n (where n = 0 – 15) Data Response Message 8 data format is shown in Figure 20. The RLEC transmits Data Response Message 8 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

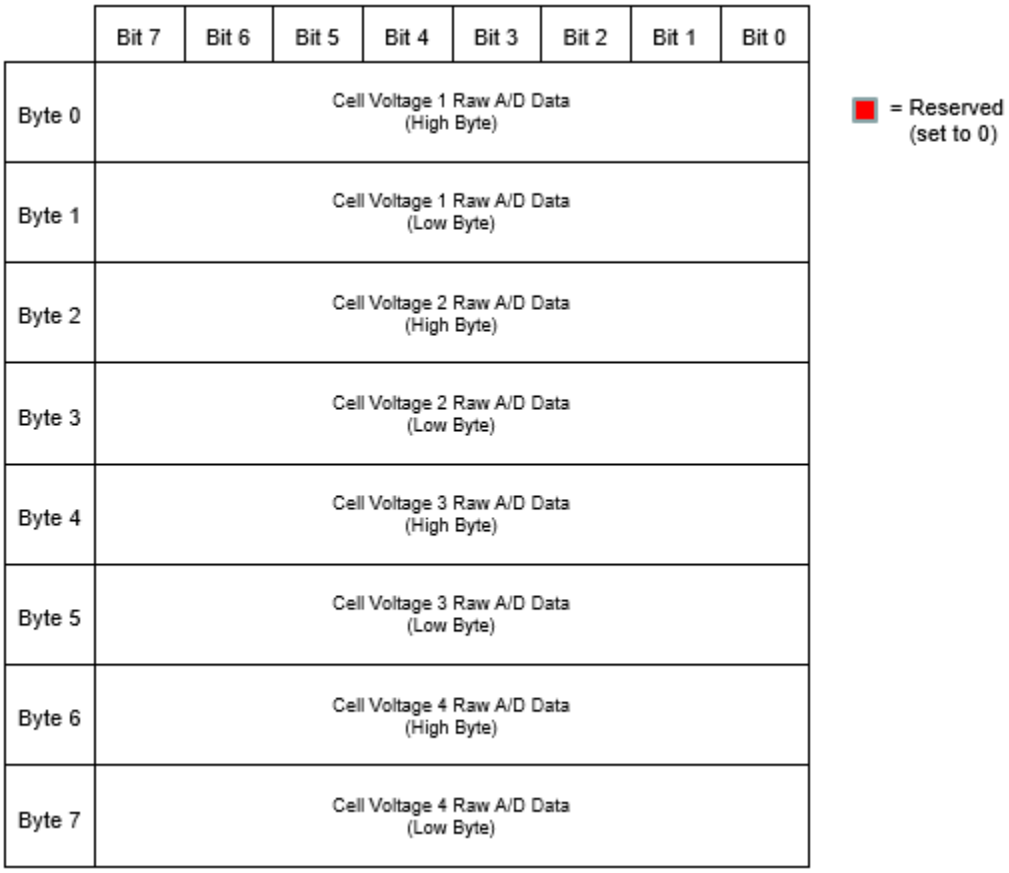

Figure 20 – RLEC 0 – 15 Data Response Message 8 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x008	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Cell Voltage 1 Raw A/D Data = 3.599 V

Cell Voltage 2 Raw A/D Data = 3.611 V
Cell Voltage 3 Raw A/D Data = 3.584 V
Cell Voltage 4 Raw A/D Data = 3.616 V

3.3.2.8.1 *Cell Voltage 1 Raw A/D Data*

Description: Cell voltage 1 raw A/D data
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.8.2 *Cell Voltage 2 Raw A/D Data*

Description: Cell voltage 2 raw A/D data
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.8.3 *Cell Voltage 3 Raw A/D Data*

Description: Cell voltage 3 raw A/D data
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.8.4 *Cell Voltage 4 Raw A/D Data*

Description: Cell voltage 4 raw A/D data
Position: Bytes 6 – 7
Format: Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.9 RLEC 0 – 15 Data Response Message 9

The RLEC n (where n = 0 – 15) Data Response Message 9 data format is shown in Figure 21. The RLEC transmits Data Response Message 9 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

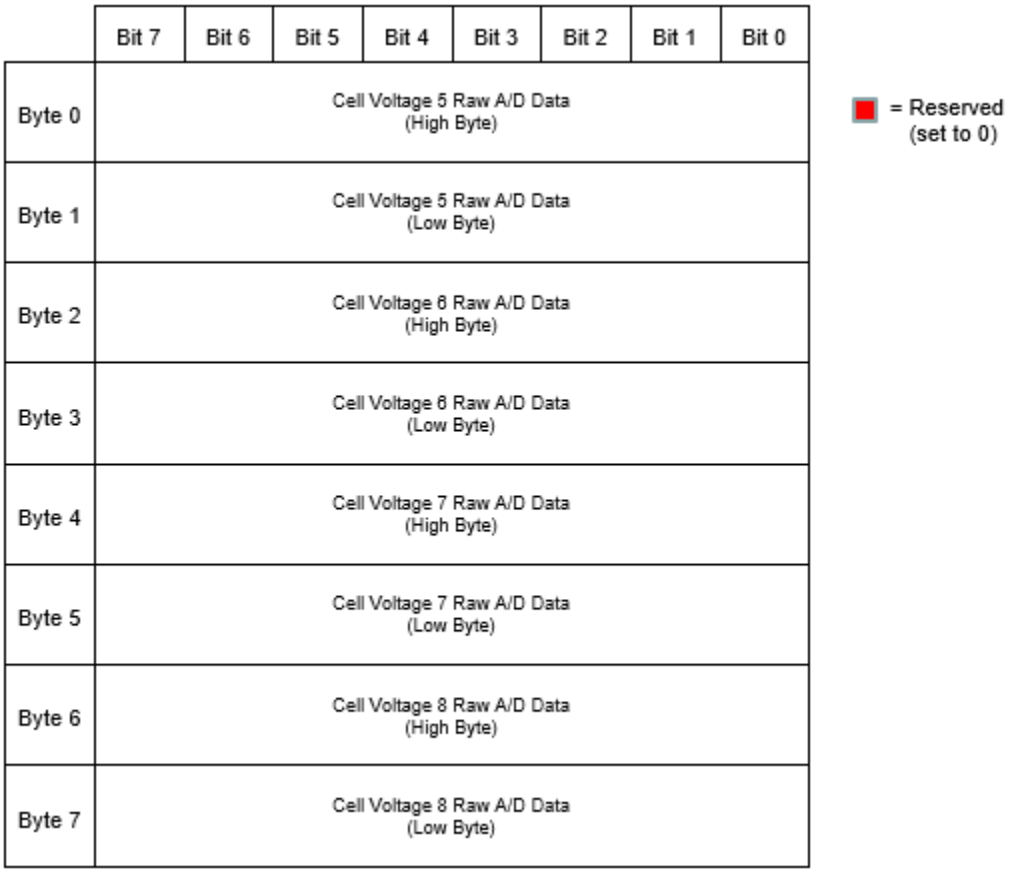

Figure 21 – RLEC 0 – 15 Data Response Message 9 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x009	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Cell Voltage 5 Raw A/D Data = 3.599 V

Cell Voltage 6 Raw A/D Data = 3.611 V
Cell Voltage 7 Raw A/D Data = 3.584 V
Cell Voltage 8 Raw A/D Data = 3.616 V

3.3.2.9.1 *Cell Voltage 5 Raw A/D Data*

Description: Cell voltage 5 raw A/D data
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.9.2 *Cell Voltage 6 Raw A/D Data*

Description: Cell voltage 6 raw A/D data
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.9.3 *Cell Voltage 7 Raw A/D Data*

Description: Cell voltage 7 raw A/D data
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.9.4 *Cell Voltage 8 Raw A/D Data*

Description: Cell voltage 8 raw A/D data
Position: Bytes 6 – 7
Format: Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.10 RLEC 0 – 15 Data Response Message 10

The RLEC n (where n = 0 – 15) Data Response Message 10 data format is shown in Figure 22. The RLEC transmits Data Response Message 10 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

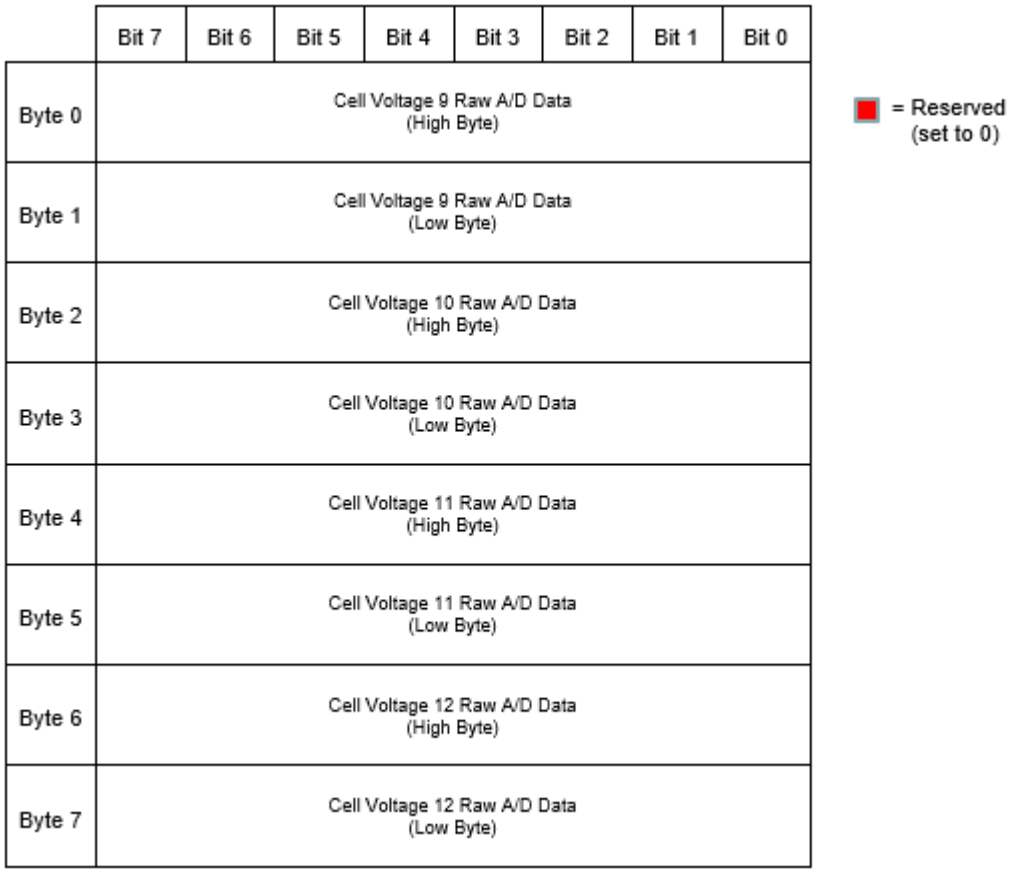

Figure 22 – RLEC 0 – 15 Data Response Message 10 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x00A	0x05	0xC3	0x05	0xC8	0x05	0xBD	0x05	0xCA

Example:

Interpretation: Cell Voltage 9 Raw A/D Data = 3.599 V

Cell Voltage 10 Raw A/D Data = 3.611 V
Cell Voltage 11 Raw A/D Data = 3.584 V
Cell Voltage 12 Raw A/D Data = 3.616 V

3.3.2.10.1 *Cell Voltage 9 Raw A/D Data*

Description: Cell voltage 9 raw A/D data
Position: Bytes 0 – 1
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.10.2 *Cell Voltage 10 Raw A/D Data*

Description: Cell voltage 10 raw A/D data
Position: Bytes 2 – 3
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.10.3 *Cell Voltage 11 Raw A/D Data*

Description: Cell voltage 11 raw A/D data
Position: Bytes 4 – 5
Format: Unsigned integer
Range: 0 – 5 V
Resolution: 0.00244 V
MLEC Processing: Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.10.4 *Cell Voltage 12 Raw A/D Data*

Description: Cell voltage 12 raw A/D data
Position: Bytes 6 – 7
Format: Unsigned integer

Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Raw cell voltage A/D data is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)

3.3.2.11 RLEC 0 – 15 Data Response Message 11

The RLEC n (where n = 0 – 15) Data Response Message 11 data format is shown in Figure 23. The RLEC transmits Data Response Message 11 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

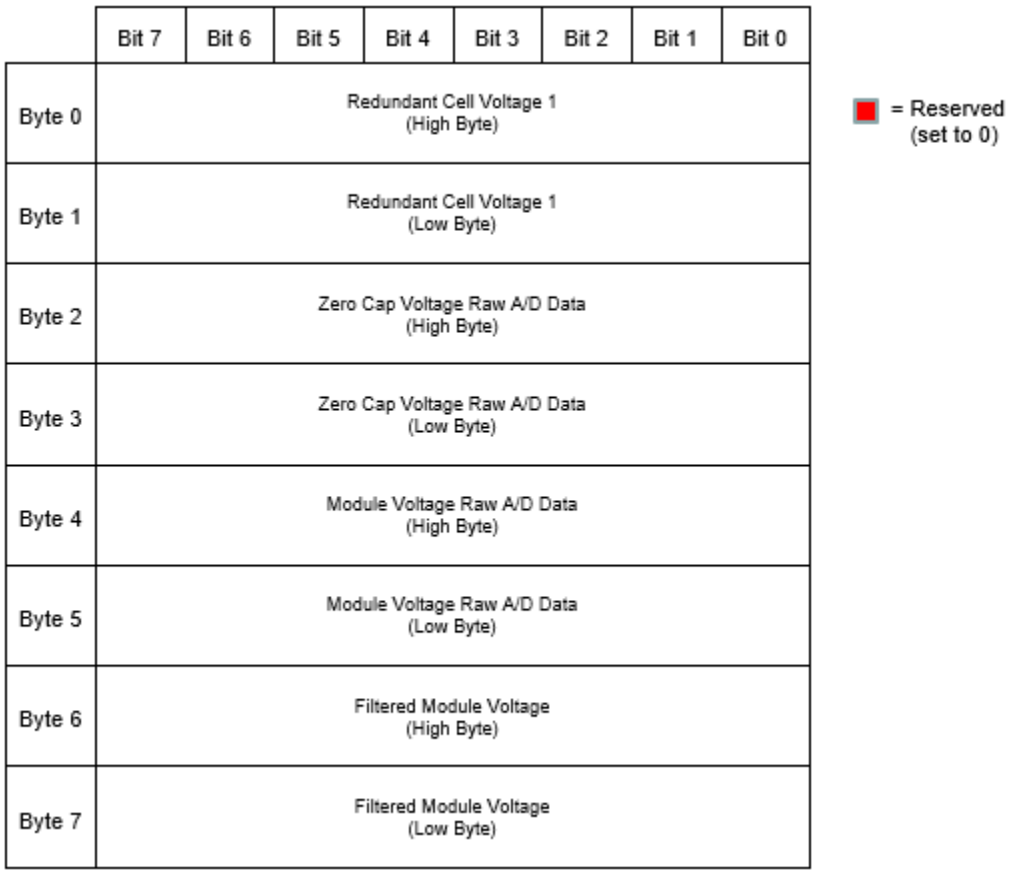

Figure 23 – RLEC 0 – 15 Data Response Message 11 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x00B	0x05	0xC8	0x00	0x12	0x0D	0xDE	0x0D	0xD7

Example:

Interpretation: Redundant Cell Voltage 1 = 3.611 V

Zero Capacitor Voltage Raw A/D Data = 0.044 V
Module Voltage Raw A/D Data = 43.31 V
Filtered Module Voltage = 43.23 V

3.3.2.11.1 *Redundant Cell Voltage 1*

Description:	Filtered redundant cell voltage 1 measurement from secondary cell voltage 1 measurement circuit
Position:	Bytes 0 – 1
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	Redundant cell voltage 1 is ignored by the MLEC. (The MLEC uses filtered cell voltages for all cell voltage processing.)
Note:	The RLEC compares the redundant cell voltage 1 value to the unfiltered cell voltage 1 value and if the two values differ by more than 50 mV, the RLEC sets cell 1 voltage fault in RLEC Data Response Message 4.

3.3.2.11.2 *Zero Capacitor Voltage Raw A/D Data*

Description:	Zero capacitor voltage raw A/D data
Position:	Bytes 2 – 3
Format:	Unsigned integer
Range:	0 – 5 V
Resolution:	0.00244 V
MLEC Processing:	The zero capacitor voltage A/D data is a legacy from an earlier RLEC hardware design and is ignored by the MLEC. (This value should generally be close to 0 V.)

3.3.2.11.3 *Module Voltage Raw A/D Data*

Description:	Module voltage raw A/D data
Position:	Bytes 4 – 5
Format:	Unsigned integer
Range:	0 – 60 V
Resolution:	0.0122 V
MLEC Processing:	Raw module voltage A/D data is ignored by the MLEC. (The MLEC uses the filtered module voltage for all module voltage processing.)

3.3.2.11.4 Filtered Module Voltage

Description:	Filtered module voltage
Position:	Bytes 6 – 7
Format:	Unsigned integer
Range:	0 – 60 V
Resolution:	0.0122 V
MLEC Processing:	The MLEC uses the filtered module voltage to detect cell voltage measurement faults by comparing the filtered module voltage to the sum of the filtered cell voltages for the associated battery module. The MLEC also uses the filtered module voltage to detect faults of other filtered module voltages by comparing each filtered module voltage to the average filtered module voltage for all battery modules.
Note:	The filtered module voltage is invalid if a module voltage A/D fault is present in RLEC Data Response Message 4.

3.3.2.12 RLEC 0 – 15 Data Response Message 12

The RLEC n (where n = 0 – 15) Data Response Message 12 data format is shown in Figure 24. The RLEC transmits Data Response Message 12 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

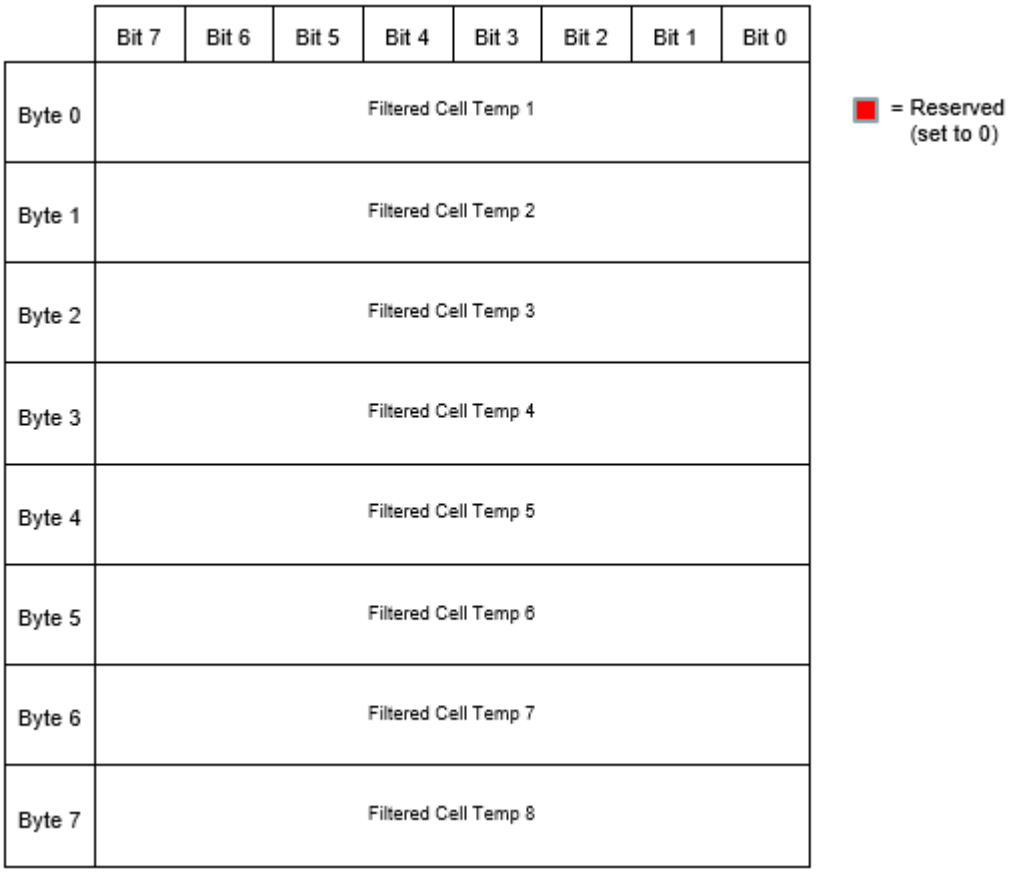

Figure 24 – RLEC 0 – 15 Data Response Message 12 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x00C	0x1D	0x1E	0x1E	0x1D	0x1D	0x20	0x1F	0x1E

Example:

Interpretation: Filtered Cell Temp 1 = 29°C

Filtered Cell Temp 2 = 30°C
Filtered Cell Temp 3 = 30°C
Filtered Cell Temp 4 = 29°C
Filtered Cell Temp 5 = 29°C
Filtered Cell Temp 6 = 32°C
Filtered Cell Temp 7 = 31°C
Filtered Cell Temp 8 = 30°C

3.3.2.12.1 Filtered Cell Temperature 1

Description:	Filtered cell temperature 1
Position:	Byte 0
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.2 Filtered Cell Temperature 2

Description:	Filtered cell temperature 2
Position:	Byte 1
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.3 Filtered Cell Temperature 3

Description:	Filtered cell temperature 3
Position:	Byte 2
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.4 *Filtered Cell Temperature 4*

Description:	Filtered cell temperature 4
Position:	Byte 3
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.5 *Filtered Cell Temperature 5*

Description:	Filtered cell temperature 5
Position:	Byte 4
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.6 *Filtered Cell Temperature 6*

Description:	Filtered cell temperature 6
Position:	Byte 5
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.7 *Filtered Cell Temperature 7*

Description:	Filtered cell temperature 7
Position:	Byte 6
Format:	Signed short integer

Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.12.8 Filtered Cell Temperature 8

Description:	Filtered cell temperature 8
Position:	Byte 7
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.13 RLEC 0 – 15 Data Response Message 13

The RLEC n (where n = 0 – 15) Data Response Message 13 data format is shown in Figure 25. The RLEC transmits Data Response Message 13 as part of a set of 13 Data Response Messages sent to the MLEC. The RLEC transmits a set of 13 Data Response Messages to the MLEC after receiving a complete set of 4 Data Request Messages sent by the MLEC every 100 msec. data collection cycle. Note that the MLEC's 100 msec. data collection cycle is not synchronized with the RLEC's 100 msec. data collection cycle and the data in the 13 RLEC Data Response Messages is a snapshot of the current RLEC data.

Source	*Destination(s)*	*Tx Mode*	*Tx Rate*	*Data Bytes*
RLEC n	MLEC	Trigger Event	N/A	8

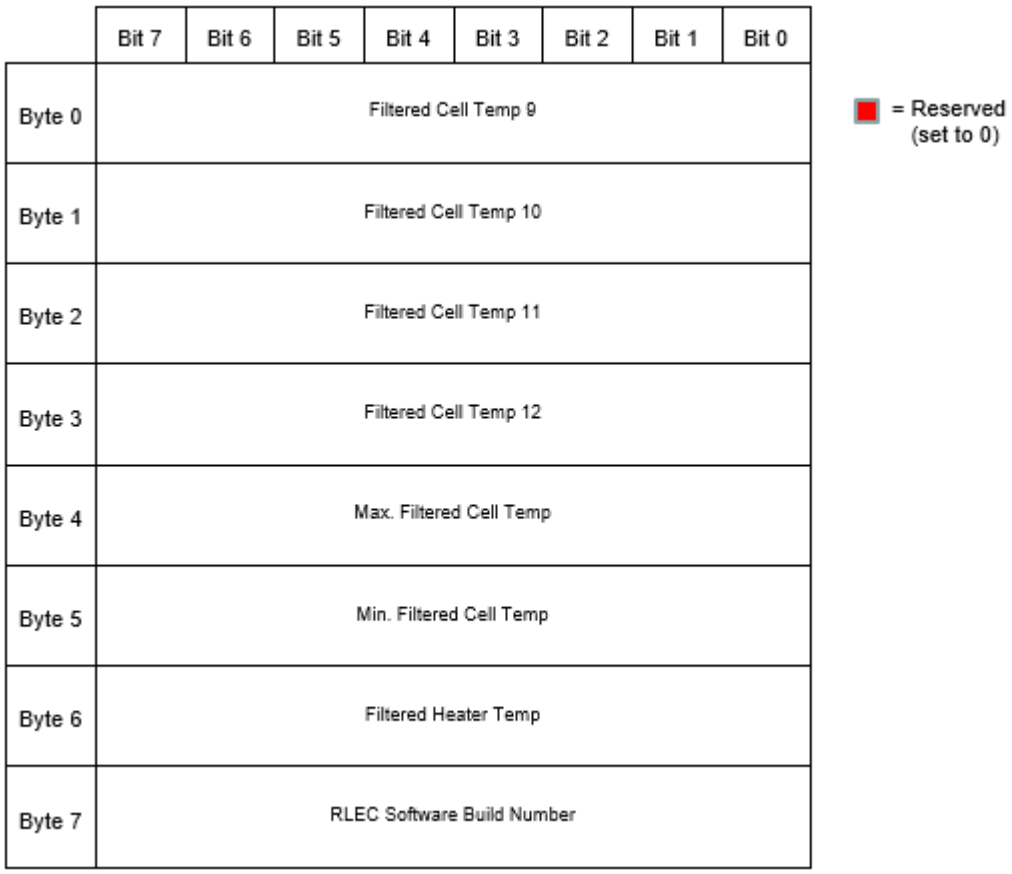

Figure 25 – RLEC 0 – 15 Data Response Message 13 Data Format

Msg ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x00D	0x1F	0x1D	0x1E	0x1E	0x20	0x1D	0x00	0x0C

Example:

Interpretation: Filtered Cell Temp 9 = 29°C

Filtered Cell Temp 10 = 30°C
Filtered Cell Temp 11 = 30°C
Filtered Cell Temp 12 = 29°C
Max. Filtered Cell Temp = 32°C
Min. Filtered Cell Temp = 29°C
Filtered Heater Temp = 0°C
RLEC Software Build Number = 12

3.3.2.13.1 *Filtered Cell Temperature 9*

Description:	Filtered cell temperature 9
Position:	Byte 0
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.13.2 *Filtered Cell Temperature 10*

Description:	Filtered cell temperature 10
Position:	Byte 1
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.13.3 *Filtered Cell Temperature 11*

Description:	Filtered cell temperature 11
Position:	Byte 2
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.13.4 *Filtered Cell Temperature 12*

Description:	Filtered cell temperature 12
Position:	Byte 3
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults. In addition, the MLEC limits the maximum and minimum discharge current based on the average filtered cell temperature.

3.3.2.13.5 *Max. Filtered Cell Temperature*

Description:	Highest filtered cell temperature for this battery module
Position:	Byte 4
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults.
Note:	Max. filtered cell temperature is provided as a convenience.

3.3.2.13.6 *Min. Filtered Cell Temperature*

Description:	Lowest filtered cell temperature for this battery module
Position:	Byte 5
Format:	Signed short integer
Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The MLEC monitors filtered cell temperatures to check for cell overtemperature and cell undertemperature faults.
Note:	Min. filtered cell temperature is provided as a convenience.

3.3.2.13.7 *Filtered Heater Temperature*

Description:	Filtered heater temperature
Position:	Byte 6
Format:	Signed short integer

Range:	-128°C to 127°C
Resolution:	1°C
MLEC Processing:	The filtered heater temperature is a legacy from an earlier RLEC hardware design and is ignored by the MLEC. (This value should normally be 0.)

3.3.2.13.8 RLEC Software Build Number

Description:	RLEC application software ID number
Position:	Byte 7
Format:	Char
Expected Value(s):	0x0C (Constant)
MLEC Processing:	It is believed that the MLEC ignores the RLEC software build number and assumes that it is compatible with the RLEC software interface.
Note:	The RLEC software build number is provided for software identification purposes and is primarily intended for debugging. However it is believed that there are multiple versions of RLEC software in the field and that the RLEC software build number could potentially be used for software compatibility checking if necessary.