energy storage solutions

U-CHARGE® XP POWER SYSTEM

XP U-BMS
Battery Management System

U-BMS Rev 2 CANbus Specification

(including Multi BMS Systems)

V 0.6

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REVISION HISTORY

Date	Revision	Description	Engineer
14/04/10	V0.1	Creation of the document	
03/09/10	V0.2	Change of layout to Brusa Charging Protocol	
1/24/12	V0.3	Update for rev2 changes	
5/31/12	V0.4	Update for BMS 9b0e and C&M 3.2.1 releases	Patrick Sullivan
9/17/12	V0.5	Update to fix issues found in the document	Patrick Sullivan
2/20/13	V0.6	Per review comments. Fix to be inconsistencies, inaccuracies, and provide clear definitions.	Patrick Sullivan

Introduction

This document defines the CAN messages exchanged between the Valence U-Charge Revision 2 battery management system (U-BMS), the vehicle management unit or host controller (VMU) and PC monitoring software application. The document also includes changes to the protocol to cater for a parallel arrangement of up to 4 strings of 55 modules, with each string controlled by a dedicated U-BMS. A Valence Master Battery Server (MBS) controls the operation of the whole system by communicating with each U-BMS therefore offering a system redundancy.

The protocol for controlling and communicating with up to 4 U-BMS's is derived from offsetting the Valence CANbus message Ids of 440, 0C0, 0C1, 0C2 and 0C4. This is laid out in the first table.

Single U-BMS systems should always be set up as U-BMS #1 and the CANbus Ids mentioned above used as required.

CAN Specification

CAN 2.0B compliant with 125, 250 500 Kbit/s (adjustable by software), standard frames used (11-bit identifier).
Remote frames are not used. Only data frames are used.

U-BMS CANbus Separation (up to 4 U-BMS's)

Valence CAN ID (Hex)	DLC	Function	U-BMS #	ID range U-BMS to MBS Communication (Hex)
440	4	VMU_U-BMS_INFO	1	440
			2	442
			3	444
			4	446
0C0	8	U-BMS_VMU_STATUS	1	0C0
			2	0C6
			3	0CC
			4	0D2
0C1	8	U-BMS_VMU_INFO	1	0C1
			2	0C7
			3	0CD
			4	0D3
0C2	8	U-BMS_VMU_CHARGE	1	0C2
			2	0C8
			3	0CE
			4	0D4
0C4	8	U-BMS_VMU_TRACE	1	0C4
			2	0CA
			3	0D0
			4	0D6

CAN Frames of System Information

Messages from VMU to U-BMS

VMU → U-BMS	**VMU_U-BMS_INFO**	U-BMS#1 Id: 440 U-BMS#2 Id: 442 U-BMS#3 Id: 444 U-BMS#4 Id: 446	Rate: 600 ms

	bit 7	bit 6	Bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Spare			
byte 1							0	0	U-BMS mode request	0 0	N/A	0 0 : standby mode request A standby mode request causes the battery contactor opening and puts the battery in standby mode
							0	1		0 1	N/A	0 1 : charge mode request
							1	0		1 0	N/A	1 0 : drive mode request
							1	1		1 1	N/A	1 1 : not significant
						1/0			Reserved	0 → 1	N/A	Reserved
					1/0				Reserved	0 → 1	N/A	Reserved
				1/0					Reserved	0 → 1	N/A	Reserved
			1/0						Insulation measurement request	0 → 1	N/A	transition 0 → 1 : insulation measurement request
		1/0							Reserved	0 → 1	N/A	Reserved
	x								Spare			
byte 2									Spare			
byte 3									Spare			

Messages from U-BMS to VMU

U-BMS → VMU	**U-BMS_VMU_STATUS**	U-BMS#1 Id: 0C0 U-BMS#2 Id: 0C6 U-BMS#3 Id: 0CC U-BMS#4 Id: 0D2	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									battery State Of Charge	0 → 100 %	1%	SOC" Decimal range 1 to 100
byte 1							0	0	U-BMS mode	0 0	N/A	0 0 : standby mode
							0	1		0 1	N/A	0 1 : charge mode
							1	0		1 0	N/A	1 0 : drive mode
							1	1		1 1	N/A	1 1 : not significant
					x	x			Charge Stage	x x		Only significant in charge mode
					0	0				0 0	N/A	00: Main charge
					0	1				0 1	N/A	01: Equalizing charge
					1	0				1 0	N/A	10: Floating charge
					1	1				1 1	N/A	11 : not significant
				1/0					Inter-module balancing	0 → 1	N/A	Only significant in charge mode 1 : Enabled 0: Disabled
			x						Low Temperature Warning	0 → 1	N/A	
		x							Low Temperature Alarm	0 → 1	N/A	
	x								Low Temperature Shutdown	0 → 1	N/A	

U-BMS → VMU	**U-BMS_VMU_STATUS**	U-BMS#1 Id: 0C0 U-BMS#2 Id: 0C6 U-BMS#3 Id: 0CC U-BMS#4 Id: 0D2	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 2	x	x	x	x	x	x	x	x	Battery faults	N/A	N/A	Each battery fault is coded by 1 bit (0: no fault; 1: detected fault).
byte 2	x	x	x	x	x	x	x	1/0	Module Lost	0 → 1	N/A	U-BMS is unable to communicate with at least one battery module at the moment
byte 2	x	x	x	x	x	x	1/0	x	Over Temperature Warning	0 → 1	N/A	The max battery temp exceeds 55°C or the max PCB temp exceeds 80°C.
byte 2	x	x	x	x	x	1/0	x	x	Over Temperature Alarm	0 → 1	N/A	The max battery temp exceeds 65°C or the max PCB temp exceeds 85°C.
byte 2	x	x	x	x	1/0	x	x	x	Low Capacity	0 → 1	N/A	System State Of Charge is less than 20%.
byte 2	x	x	x	1/0	x	x	x	x	Critically Discharged Alarm	0 → 1	N/A	Min cell voltage reaches 2.3V. This will result in opening the contactor.
byte 2	x	x	1/0	x	x	x	x	x	Over Volt Alarm	0 → 1	N/A	Max cell voltage reaches 4.0V. This will result in opening the contactor.
byte 2	x	1/0	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 2	1/0	x	x	x	x	x	x	x	Over Temp ShutDown	0 → 1	N/A	BMS Shut down system without VMU's permission.
byte 3	x	x	x	x	x	x	x	1/0	Reserved	0 → 1	N/A	Reserved
byte 3	x	x	x	x	x	x	1/0	x	Too Many Modules	0 → 1	N/A	Too many modules connected to the BMS.
byte 3	x	x	x	x	x	1/0	x	x	Temp Sensor Failure	0 → 1	N/A	Temp sensor of any battery module detects current temp is great than 250°C or less than -100°C
byte 3	x	x	x	x	1/0	x	x	x	Volt Sensor Failure	0 → 1	N/A	Volt sensor of any battery module detects a fault voltage due to bad connection of the sensor leads.
byte 3	x	x	x	1/0	x	x	x	x	Current Sensor Failure	0 → 1	N/A	Max current or min current reported by battery module deviates more than 5A from the average value.
byte 3	x	x	1/0	x	x	x	x	x	SOC (State Of Charge) Mismatch	0 → 1	N/A	SOC reported by each battery module deviates more than 30% from each other.
byte 3	x	1/0	x	x	x	x	x	x	Critically Discharged Warning	0 → 1	N/A	Min cell voltage reaches 2.5V.
byte 3	1/0	x	x	x	x	x	x	x	Over Volt Warning	0 → 1	N/A	Max cell voltage reaches 3.8V.
byte 4	x	x	x	x	x	x	x	1/0	Over Current Warning	0 → 1	N/A	Over Current Warning

U-BMS → VMU	**U-BMS_VMU_STATUS**	U-BMS#1 Id: 0C0 U-BMS#2 Id: 0C6 U-BMS#3 Id: 0CC U-BMS#4 Id: 0D2	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 4	x	x	x	x	x	x	1/0	x	Over Current Alarm	0 → 1	N/A	Over Current Alarm
byte 4	x	x	x	x	x	1/0	x	x	Over Current Shut down	0 → 1	N/A	Over Current Shut down
byte 4	x	x	x	x	1/0	x	x	x	PCBA Over Temp Warning	0 → 1	N/A	PCBA Over Temperature Warning
byte 4	x	x	x	1/0	x	x	x	x	PCBA Over Temp Alarm	0 → 1	N/A	PCBA Over Temperature Alarm
byte 4	x	x	1/0	x	x	x	x	x	PCBA Over Temp Shutdown	0 → 1	N/A	PCBA Over Temperature Shutdown
byte 4	x	x							reserved			
byte 5									Current_Module_NUM	0 → 104	1	Number of modules U-BMS is communicating with at the moment
byte 6									Inter_Balance_NUM	0 → 104	1	Number of modules enabling their inter-bal circuits
byte 7	x	x	x	x	x	x	x	1/0	Reserved	0 → 1	N/A	Reserved
byte 7	x	x	x	x	x	x	1/0	x	Reserved	0 → 1	N/A	Reserved
byte 7	x	x	x	x	x	1/0	x	x	OVSD	0 → 1	N/A	Over Voltage Shut Down
byte 7	x	x	x	x	1/0	x	x	x	CDSD	0 → 1	N/A	Critically Discharged Shut Down
byte 7	x	x	x	1/0	x	x	x	x	VMU Time Out	0 → 1	N/A	VMU Time Out
byte 7	x	x	1/0	x	x	x	x	x	Discharge Pre-charge Failure	0 → 1	N/A	Discharge Pre-charge Failure
byte 7	x	1/0	x	x	x	x	x	x	Sanity Error	0 → 1	N/A	RS485 Communication problem Max cell & Min cell voltage and module current Data reported by any module remains unchanged for 60s
byte 7	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved

U-BMS → VMU	**U-BMS_VMU_INFO**	U-BMS#1 Id: 0C1 U-BMS#2 Id: 0C7 U-BMS#3 Id: 0CD U-BMS#4 Id: 0D3	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Battery voltage	0 → 510 V (0→ 765V**)	1-4 V (**)	Voltage measured before battery contactor Decimal Value. ** The scaling can be configured using the BMS Firmware Update and Configuration Screen (specially used with Higher Voltage systems), to have the units be greater than 1V per unit value. The maximum voltage that can be set is 765V.
byte 1									Battery current (LSB)	-32768 A / 32767 A	1 A	> 0 : regenerative current < 0 : discharge current 0 → -32768 A 65535 → 32767 A
byte 2									Battery current (MSB)			
byte 3									Max discharge current (LSB)	0 / 65535 A	1 A	Only significant in drive mode. Maximum discharge current authorised by the battery taking account the battery state of charge and temperature. These values are continuous real time values for the value per each message cycle.
byte 4									Max discharge current (MSB)			
byte 5									**Max regenerative current (LSB)**	0 / 65535 A	1 A	Only significant in drive mode. Maximum regenerative current authorized by the battery taking account the battery state of charge and temperature. These values are continuous real time values for the value per each message cycle.
byte 6								1/0	Battery contactor opening request	0 → 1	N/A	0 : no request 1 : request
							1/0		Battery discharge contactor state	0 → 1	N/A	0 : opened 1 : closed
					0	0			Insulation measurement state	0 0	N/A	0 0 : correct
					0	1				0 1	N/A	0 1 : in progress
					1	0				1 0	N/A	1 0 : fault measurement
					1	1				1 1	N/A	1 1 : invalid measurement
				1/0					Battery charge contactor state	0 → 1	N/A	0 : opened 1 : closed

U-BMS → VMU	**U-BMS_VMU_INFO**	U-BMS#1 Id: 0C1 U-BMS#2 Id: 0C7 U-BMS#3 Id: 0CD U-BMS#4 Id: 0D3	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
			1/0						Charge Pre-charge Failure	0 → 1	N/A	Charge Pre-charge Failure
		1/0							Reserved	0 → 1	N/A	Reserved
	x								Spare			
byte 7									**Max regenerative current (MSB)**	0 / 65535 A	1 A	Only significant in drive mode. Maximum regenerative current authorised by the battery taking account the battery state of charge and temperature. These values are continuous real time values for the value per each message cycle.

U-BMS → VMU	**U-BMS_VMU_CHARGE**	U-BMS#1 Id: 0C2 U-BMS#2 Id: 0C8 U-BMS#3 Id: 0CE U-BMS#4 Id: 0D4	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Charge current set-point	0 → 255 A	1 A	Only significant in charge mode Current set-point of charger output
byte 1									Charge voltage set-point (LSB)	0 V → 65535 V	1 V	Only significant in charge mode Voltage set-point of charger output
byte 2									Charge voltage set-point (MSB)			
byte 3								1/0	Reserved	0 → 1	N/A	Reserved
							1/0		Reserved	0 → 1	N/A	Reserved
						1/0			End of charge	0	N/A	Only significant in charge mode 0 : charge in progress 1 : charge completed The U-BMS indicates the end of charge only when the charge balancing is completed. This condition is not latched, it will change if the charger is turned off, and state of charge decreases (any cell block drops below 3.400v).
					1/0				Reserved	0 → 1	N/A	Reserved
				1/0					Reserved	0 → 1	N/A	Reserved
			1/0						Reserved	0 → 1	N/A	Reserved
		x							Spare			
	x								Spare			
byte 4									Inter balance request number	0 → 104	1	Only significant in charge mode for debug purpose only Number of modules qualified for performing inter balance, this value should be the same as Inter_Balance_NUM

U-BMS → VMU	**U-BMS_VMU_TRACE**	U-BMS1 Id: 0C4 U-BMS2 Id: 0CA U-BMS3 Id: 0D0 U-BMS4 Id: 0D6	Rate: 600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Battery max temperature	-40 → 215 °C	1 °C	0 → -40 °C 255 → 215 °C
byte 1									Battery min temperature	-40 → 215 °C	1 °C	0 → -40 °C 255 → 215 °C
byte 2									Reserved	NA	NA	Reserved
byte 3									Battery PCBA max temperature	-40 → 215 °C	1 °C	0 → -40 °C 255 → 215 °C
byte 4									Cell max voltage LSB	In mV units per cell specification	1 mV	max (cells voltage)
byte 5									Cell max voltage MSB			
byte 6									Cell min voltage LSB	In mV units per cell specification	1 mV	min (cells voltage)
byte 7									Cell min voltage MSB			

CAN frames of hardware and firmware revision number

U-BMS → VMU	**Hardware & firmware revision**	U-BMS1 Id: 180 U-BMS2 Id: 181 U-BMS3 Id: 182 U-BMS4 Id: 183	Rate: see note 2

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Main Code Rev	NA	NA	(e.g. 43 is V4.3)
byte 1									Customer Related Rev	NA	NA	(e.g. 43 is V4.3)
byte 2									Boot loader Rev	NA	NA	(e.g. 43 is V4.3)
byte 3									HV / LV	NA	NA	0 = LV, 1= HV, 3 = SHV
byte 4									Hardware Rev to run the software	NA	NA	(43 is V4.3)
byte 5									Customer Code	NA	NA	(1st letter)
byte 6									Customer Code	NA	NA	(2nd letter)
byte 7									Customer Code	NA	NA	(3rd letter)

Notes:

1. Customer Code is 3 letters, each letter represented by standard ASCII code.
2. This message is transmitted approximately every 3 secondswhen CAN interface is initiated, after 12V ignition is applied to BMS

CAN frames of module cell voltages

U-BMS → VMU	**Module cell voltages**	**Id : 0350**	Rate: see note

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									U-BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1									0 – cell block 1-3, 1 – cell block 7-9			
byte 2									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 1,7
byte 3									Cell voltage LSB			
byte 4									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 2,8
byte 5									Cell voltage LSB			
byte 6									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 3,9
byte 7									Cell voltage LSB			

U-BMS → VMU	**Module cell voltages**	**Id : 0351**	Rate: see note

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									U-BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1									0 – cell block 4-6, 1 – cell block 10-12			
byte 2									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 4,10
byte 3									Cell voltage LSB			
byte 4									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 5,10
byte 5									Cell voltage LSB			
byte 6									Cell voltage MSB	0 → 65535 mV	1 mV	Module 1, Cell Block 6,12
byte 7									Cell voltage LSB			

Notes:

1. The CAN ID increments by 2 for each module in the system, to a limit of 55 modules for an Id range of 350h through 3BDh (i.e. Module 2 voltages are in ID352 + ID353, etc.).
2. CAN message rate is determined by the number of modules in the system, for each group of 3 modules, the message rate increases by 600ms.

(i.e. for 3 modules the message rate is 600ms, for 9 modules each module will have data reported every 1800ms)

3. The U1_12XP, U24_12XP, and U27_12XP modules use 4 cell blocks (1-4). The UEV_18XP module uses 6 cell blocks (1-6). The P42_24EP module uses all 8 cell blocks (1-8). The U27_36XP uses 12 cell blocks (all 8 cell blocks from this 26Ah message, plus cell block bits 9-12 from the 274h message.

CAN frames of module current

U-BMS → VMU	**Module current**	**Id : 046A**	Rate: 3600ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									U-BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1									0 (standard format), 1 (Enhanced Format)			
byte 2									Current MSB	0 → 65535	0.01A	Module 1, (signed)
byte 3									Current LSB			
byte 4									Current MSB	0 → 65535	0.01A	Module 2, (signed)
byte 5									Current LSB			
byte 6									Current MSB	0 → 65535	0.01A	Module 3, (signed)
byte 7									Current LSB			

Note:

1. CAN id increments by 1 for every 3 modules, to a limit of 55 modules for an Id rage of 46Ah through 47Bh (i.e. Modules 4, 5 and 6 currents are in ID 046B, etc.).

2. Enhanced format current bytes are packed as follows –
   Sign 0 for +positive and 1 for -negative.

- 0 (bit) for .01A resolution - currents lower than 100Amps.
- 1 (bit) for .1A resolution (for higher currents -- can accommodate up to -- 1638Amps.)

Sign	Resolution	14 bits of current

CAN frames of module exists flag

U-BMS → VMU	**Module exists flags**	**Id : 056A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1	x	x	x	x	x	x	x	1/0	Module 1 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	x	x	x	x	x	1/0	x	Module 2 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	x	x	x	x	1/0	x	x	Module 3 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	x	x	x	1/0	x	x	x	Module 4 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	x	x	1/0	x	x	x	x	Module 5 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	x	1/0	x	x	x	x	x	Module 6 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	x	1/0	x	x	x	x	x	x	Module 7 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 1	1/0	x	x	x	x	x	x	x	Module 8 flag	0 → 1	N/A	0: Absent, 1: Exists
bytes 2-6	…	…	…	…	…	…	…	…	. . .	. . .	. . .	. . .
byte 7	x	x	x	x	x	x	x	1/0	Module 49 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	x	x	x	x	x	1/0	x	Module 50 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	x	x	x	x	1/0	x	x	Module 51 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	x	x	x	1/0	x	x	x	Module 52 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	x	x	1/0	x	x	x	x	Module 53 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	x	1/0	x	x	x	x	x	Module 54 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	x	1/0	x	x	x	x	x	x	Module 55 flag	0 → 1	N/A	0: Absent, 1: Exists
byte 7	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved

Notes:

1. Exist status of Modules(1~55) are presented in CAN id 056A

CAN frames of insulation resistance

U-BMS → VMU	**Insulation resistance**	U-BMS#1 Id: 66A U-BMS#2 Id: 66C U-BMS#3 Id: 66E U-BMS#4 Id: 670	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									Value of insulation resistance (MSB 2)	32 bit	Kohm	(MSB2 MSB1 LSB2 LSB1) (signed)
byte 1									Value of insulation resistance (MSB 1)			
byte 2									Value of insulation resistance (LSB 2)			
byte 3									Value of insulation resistance (LSB1)			

U-BMS → VMU	**Insulation Voltage**	U-BMS#1 Id: 66B U-BMS#2 Id: 66D U-BMS#3 Id: 66F U-BMS#4 Id: 671	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									(MSB)	0 → 65535	V	V_Chassis_NegStack_First
byte 1									(LSB)			
byte 2									(MSB)	0 → 65535	V	V_PosStack_Chassis_First
byte 3									(LSB)			
byte 4									(MSB)	0 → 65535	V	V_Chassis_NegStack_Next
byte 5									(LSB)			
byte 6									(MSB)	0 → 65535	V	V_PosStack_Chassis_Next
byte 7									(LSB)			

CAN frames of module temperature

U-BMS → VMU	**Module temperature**	**Id : 076A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1												
byte 2									Temperature (MSB)	0 → 65535	0.01°C	Module 1 (signed)
byte 3									Temperature (LSB)			
byte 4									Temperature (MSB)	0 → 65535	0.01°C	Module 2 (signed)
byte 5									Temperature (LSB)			
byte 6									Temperature (MSB)	0 → 65535	0.01°C	Module 3 (signed)
byte 7									Temperature (LSB)			

Notes:

1. Maximum temperature of Module temperature sensors
2. CAN id increments by 1 for every 3 modules in the system, to a limit of 55 Modules for an Id range of 76Ah through 77Bh (i.e. Modules 4, 5 and 6 temperatures are in ID 076B, etc.).

CAN frames of module SOC

U-BMS → VMU	**Module SOC**	**Id : 06A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1									Module 1 SOC	0 → 255	1%	0~255 = 0%~100%
byte 2									Module 2 SOC	0 → 255	1%	0~255 = 0%~100%
byte 3									Module 3 SOC	0 → 255	1%	0~255 = 0%~100%
byte 4									Module 4 SOC	0 → 255	1%	0~255 = 0%~100%
byte 5									Module 5 SOC	0 → 255	1%	0~255 = 0%~100%
byte 6									Module 6 SOC	0 → 255	1%	0~255 = 0%~100%
byte 7									Module 7 SOC	0 → 255	1%	0~255 = 0%~100%

Notes:

1. CAN id increments by 1 for every 7 modules in the system, to a limit of 55 Modules for an Id range of 06Ah through071h(i.e. Module SOC, for modules 8 to 14 are in ID 06B, etc.).

CAN frames of module inter balance

U-BMS → VMU	**Module inter balance flags**	**Id : 016A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1	x	x	x	x	x	x	x	1/0	Module 1 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	x	x	x	x	x	1/0	x	Module 2 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	x	x	x	x	1/0	x	x	Module 3 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	x	x	x	1/0	x	x	x	Module 4 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	x	x	1/0	x	x	x	x	Module 5 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	x	1/0	x	x	x	x	x	Module 6 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	x	1/0	x	x	x	x	x	x	Module 7 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 1	1/0	x	x	x	x	x	x	x	Module 8 flag	0 → 1	N/A	0: Inactive, 1: Active
bytes 2-6	…	…	…	…	…	…	…	…	. . .	. . .	. . .	. . .
byte 7	x	x	x	x	x	x	x	1/0	Module 49 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	x	x	x	x	x	1/0	x	Module 50 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	x	x	x	x	1/0	x	x	Module 51 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	x	x	x	1/0	x	x	x	Module 52 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	x	x	1/0	x	x	x	x	Module 53 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	x	1/0	x	x	x	x	x	Module 54 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	x	1/0	x	x	x	x	x	x	Module 55 flag	0 → 1	N/A	0: Inactive, 1: Active
byte 7	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved

Notes:

1. Balance status of Modules(1~55) are presented in CAN id 016A. Modules 9-55 in bytes 2 through 8 of the message.

CAN frames of module Sanity errors

U-BMS → VMU	**Module Sanity Error flags**	**Id : 016C**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1	x	x	x	x	x	x	x	1/0	Module 1 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	x	x	x	x	x	1/0	x	Module 2 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	x	x	x	x	1/0	x	x	Module 3 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	x	x	x	1/0	x	x	x	Module 4 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	x	x	1/0	x	x	x	x	Module 5 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	x	1/0	x	x	x	x	x	Module 6 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	x	1/0	x	x	x	x	x	x	Module 7 flag	0 → 1	N/A	0: No error, 1: Error
byte 1	1/0	x	x	x	x	x	x	x	Module 8 flag	0 → 1	N/A	0: No error, 1: Error
bytes 2-6	…	…	…	…	…	…	…	…	. . .	. . .	. . .	. . .
byte 7	x	x	x	x	x	x	x	1/0	Module 49 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	x	x	x	x	x	1/0	x	Module 50 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	x	x	x	x	1/0	x	x	Module 51 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	x	x	x	1/0	x	x	x	Module 52 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	x	x	1/0	x	x	x	x	Module 53 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	x	1/0	x	x	x	x	x	Module 54 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	x	1/0	x	x	x	x	x	x	Module 55 flag	0 → 1	N/A	0: No error, 1: Error
byte 7	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved

Notes:

1. Sanity error flags for Modules(1~55) are presented in CAN id 016C

The Sanity error flags are not individually visible with Valence XP Monitoring Kit

CAN frames of module intra-balance

U-BMS → VMU	**Module Intra-balance flags**	**Id : 026A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1	x	x	x	x	x	x	x	1/0	Module 1, cell block 1, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	x	x	1/0	x	Module 1, cell block 2, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	x	1/0	x	x	Module 1, cell block 3, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	1/0	x	x	x	Module 1, cell block 4, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	1/0	x	x	x	x	Module 1, cell block 5, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	1/0	x	x	x	x	x	Module 1, cell block 6, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	1/0	x	x	x	x	x	x	Module 1, cell block 7, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	1/0	x	x	x	x	x	x	x	Module 1, cell block 8, flag	0 → 1	N/A	0: Active, 1: Inactive
bytes 2-6	…	…	…	…	…	…	…	…	. . .	. . .	. . .	. . .
byte 7	x	x	x	x	x	x	x	1/0	Module 7, cell block 1, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	x	x	1/0	x	Module 7, cell block 2, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	x	1/0	x	x	Module 7, cell block 3, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	1/0	x	x	x	Module 7, cell block 4, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	1/0	x	x	x	x	Module 7, cell block 5, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	1/0	x	x	x	x	x	Module 7, cell block 6, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	1/0	x	x	x	x	x	x	Module 7, cell block 7, flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	1/0	x	x	x	x	x	x	x	Module 7, cell block 8, flag	0 → 1	N/A	0: Active, 1: Inactive

Notes:

1. CAN id increments by 1 for every 7 modules in the system, up to a limit of 55 Modules. Uses ID 26Ah through 271h.

2. The U1_12XP, U24_12XP, and U27_12XP modules use 4 cell blocks (1-4). The UEV_18XP module uses 6 cell blocks (1-6). The P42_24EP module uses all 8 cell blocks (1-8). The U27_36XP uses 12 cell blocks (all 8 cell blocks from this 26Ah message, plus cell block bits 9-12 from the 274h message.

CAN frames of module inter balance

U-BMS → VMU	**Module inter balance flags**	**Id : 0274**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1	x	x	x	x	x	x	x	1/0	Module 1, cell block - 9 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	x	x	1/0	x	Module 1, cell block - 10 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	x	1/0	x	x	Module 1, cell block - 11 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	x	1/0	x	x	x	Module 1, cell block - 12 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 1	x	x	x	1/0	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 1	x	x	1/0	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 1	x	1/0	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 1	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
bytes 2-6	…	…	…	…	…	…	…	…	. . .	. . .	. . .	. . .
byte 7	x	x	x	x	x	x	x	1/0	Module 7, cell block - 9 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	x	x	1/0	x	Module 7, cell block - 10 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	x	1/0	x	x	Module 7, cell block - 11 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	x	1/0	x	x	x	Module 7, cell block - 12 flag	0 → 1	N/A	0: Active, 1: Inactive
byte 7	x	x	x	1/0	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 7	x	x	1/0	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 7	x	1/0	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved
byte 7	1/0	x	x	x	x	x	x	x	Reserved	0 → 1	N/A	Reserved

Notes:

1. CAN id increments by 1 for every 7 modules in the system, up to a limit of 55 Modules. Uses ID 274h through 27Bh
2. This message is currently only used for the U27_26XP module type (since it is the only module type with more than 8 cell blocks)

CAN frames of module PCBA temperature

U-BMS → VMU	**Module PCBA temperature**	**Id : 067A**	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS #	1 → 4	N/A	Byte 0 = U-BMS # 1-4
byte 1												
byte 2									Temperature (MSB)	0 → 65535	0.01°C	Module 1 (signed)
byte 3									Temperature (LSB)			
byte 4									Temperature (MSB)	0 → 65535	0.01°C	Module 2 (signed)
byte 5									Temperature (LSB)			
byte 6									Temperature (MSB)	0 → 65535	0.01°C	Module 3 (signed)
byte 7									Temperature (LSB)			

Note:
CAN id increments by 1 for every 3 modules in the system, to a limit of 55 Modules (for an Id range of 67Ah through 68Bh)

CAN frames of BMS, Module TLA (Top Level Assembly) #, Firmware Revision Information

U-BMS → VMU	**BMS, Module TLA# and Firmware Revision**	U-BMS#1 Id: 184 U-BMS#2 Id: 185 U-BMS#3 Id: 186 U-BMS#4 Id: 187	Rate: 3600 ms

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Data	Range	Unit	Note
byte 0									BMS or Module Data	N/A	N/A	• Packet from Whom Designator -- If BMS information it is set to 0xFF. If for Module, it is set to module # (1 - 55) • Packet # (1 - 3). Since the information cannot fit in 6 bytes.
byte 1									Packet #			
byte 2									(MSB)	N/A	N/A	See note: for data packing format.
byte 3									(LSB)			
byte 4									(MSB)	N/A	N/A	
byte 5									(LSB)			
byte 6									(MSB)	N/A	N/A	
byte 7									(LSB)			

Note:

1. BMS Data is packed as follows -- 13 bytes of TLA (Top Level Assembly) serial # for BMS, followed by 4 bytes of BMS part # (i.e. a total of 17 bytes)
2. Module data is packed as follows - 7 bytes of Firmware part #, followed by 3 bytes of Firmware revision + 2 bytes of model info + 4 bytes of serial #
   - Let's look at an example of how the packed CAN data is displayed for a module, within the"S/N #" and "Firmware #" fields on the BMS CAN Monitoring screen Let's say the C&M "BMS CAN Monitoring" screen will show the fields as :

Module ID	S/N #	Firmware #
1	R2-C-12-36-1234	1004895A0612

a) The "S/N" Field is made up of the 4 bytes of serial # (the last 4 of 16 bytes of the message) and is build as follows:

- The “R2” stands for Revision 2, and it a string determined by module type.
- The “C” is the battery type (per Table 5.1 in document 1004717 A14).
- The next two characters “12” is the year of manufacture, followed by the next two characters “36” for the week of manufacture, followed by the last four characters of serial #; For our example, the year, week and serial # are stored within the 4 serial # bytes of the CAN message as follows:

Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Fields	Reserved				Year (base year 2000)						Week						Serial Number															
Binary	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	0
ASCII Field	0				12						36						1234															
Hex	0x03								0x24								0x04								0xD2							
32Bit Value	0x032404D2																															

b) The “Firmware #” Field (1004895A0612) is made up of the 12 bytes as follows:

Byte Offset	1	2	3	4	5	6	7	8	9	10	11	12
Field	Part#							Revision			Model Info	
Hex	0x31	0x30	0x30	0x34	0x38	0x39	0x35	0x41	0x30	0x36	0x31	0x32
ASCII	1	0	0	4	8	9	5	A	0	6	1	2
Ascii String	"1004895A0612"											

Charger CANbus Ids (Brusa Protocol)

CANbus IDs transmitted by BMS to Charger	U-BMS #1	U-BMS #2	U-BMS #3	U-BMS #4
BMS to Charger #1	618	608	5F8	5E8
BMS to Charger #2	5D8	5C8	5B8	5A8
BMS to Charger #2	598	588	578	568
BMS to Charger #4	558	548	538	528

CANbus Message IDs received by BMS from Charger	U-BMS #1	U-BMS #2	U-BMS #3	U-BMS #4
Charger #1 to U-BMS	**610**	**600**	**5F0**	**5E0**
	611	601	5F1	5E1
	612	602	5F2	5E2
	613	603	5F3	5E3
	614	604	5F4	5E4
Charger #2 to U-BMS	**5D0**	**5C0**	**5B0**	**5A0**
	5D1	5C1	5B1	5A1
	5D2	5C2	5B2	5A2
	5D3	5C3	5B3	5A3
	5D4	5C4	5B4	5A4
Charger #3 to U-BMS	**590**	**580**	**570**	**560**
	591	581	571	561
	592	582	572	562
	593	583	573	563
	594	584	574	564
Charger #4 to U-BMS	**550**	**540**	**530**	**520**
	551	541	531	521
	552	542	532	522
	553	543	533	523
	554	544	534	524

Note:

1. Only message IDs **XXX** are acted on by the U-BMS. The U-BMS will ignore the other messages.
2. Please refer to "http://www.metricmind.com/data/can_201_nlg5xx.pdf" for details on the Brusa NLG CAN message formats.

Typical Multi U-BMS System Architecture

The typical system architecture is shown below. The MBS, U-BMS's and chargers all communicate on the Battery CAN. The MBS interprets all the data from each U-BMS, carries out some data calculations, combinations and fault handling routines and passes data to the VMU using Ids 0C0, 0C1, 0C2 and 0C4. Using this technique, as far a the VMU is concerned it appears that there is only 1 U-BMS fitted on the vehilce. A display device can be fitted if required and the MBS can be programmed to display data on screen accordingly. For CANbus controlled charging the U-BMS's and chargers must communicate using Brusa protocol