EMUS BMS – NMEA2000 gateway

Version 1.1 [2025/05/27]

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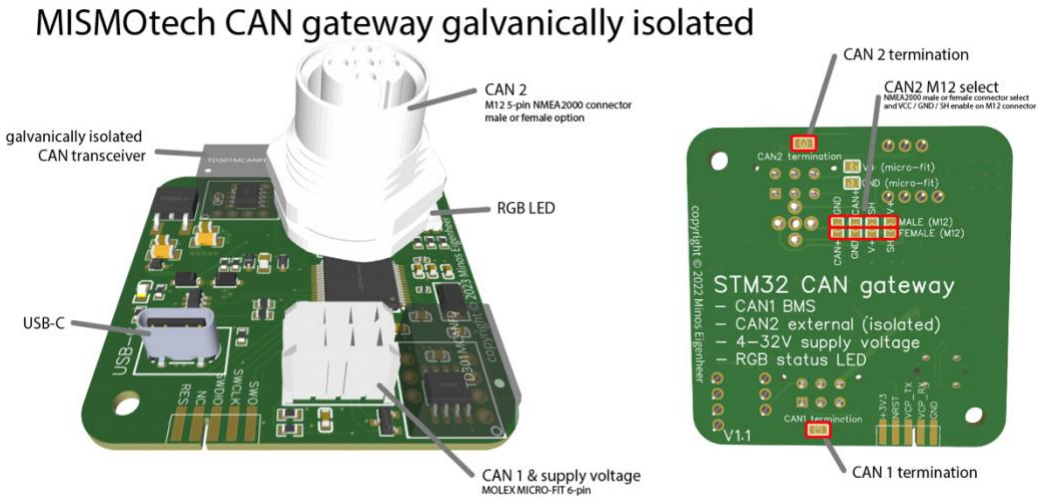
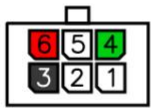
1 Hardware overview

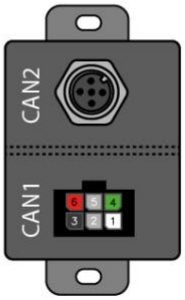


2 Pinout

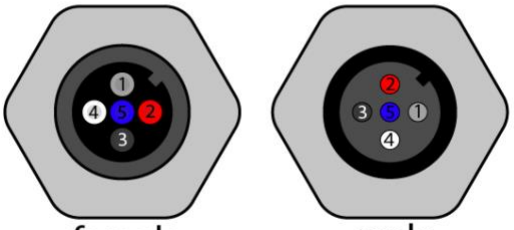
CAN 1
micro-fit 6p.



1 CAN Low
2 Analog input 1
3 GND
4 CAN High
5 Analog input 2
6 Voltage supply 12V

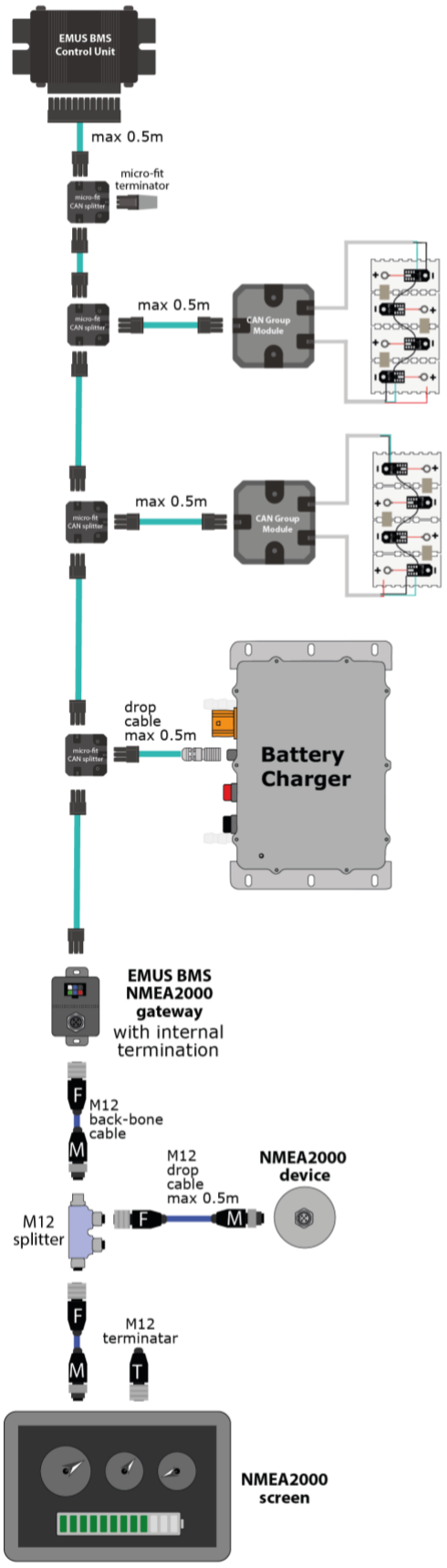


CAN 2 galvanically isolated
NMEA2000 M12 5p. connector



1 Shield (optional SJ) not isolated!
2 PWR (optional SJ) not isolated!
3 GND (optional SJ) not isolated!
4 CAN H isolated
5 CAN L isolated

Connection diagram



CAN1 - BMS
6P micro-fit

CAN2 - NMEA2000
5P M12

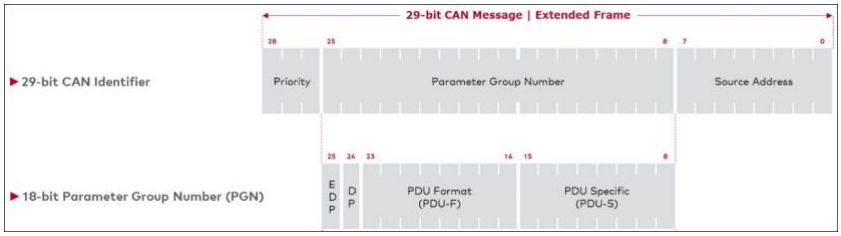
3 NMEA2000 battery messages

3.1 Interface definition

Speed : 250 kbps
ID : 29-bit CAN 2.0B

3.2 Message definition

NMEA2000 Identifier definition.



	DEC	HEX	BIN	note
PR (Priority)	6	6	110	1...8
PGN (Parameter group number)	127506	1F212	011111001000010010	DC Detailed Status
EDP (extended datapage)	0	0	0	Reserved
DP (Datapage)	1	1	1	parameter group of this ID
PDU Format (0...239 adressable, 240...255 broadcast)	242	F2	11110010	PDU2 (broadcast)
PDU Specific / destination address	18	12	00010010	PDU Specific
SA (Source address)	80	50	01010000	Broadcast Address (BCA)

	DEC	HEX	BIN
CAN ID	435294800	19F21250	11001111100100001001001010000

<3-bits priority><1-bit reserved><1-bit datapage>< 16-bits PGN >< 8-bit source address >

As described in the list below a PGN consists of datapage + PGN.
For example 0x1F214 means:
Datapage = 1
PGN = 0XF214

3.3 PGN list

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery pack voltage	Battery Status	127508	0x1F214	2	Battery instance 0
Battery pack current	Battery Status	127508	0x1F214	3	Battery instance 0
Battery pack highest temperature	Battery Status	127508	0x1F214	4	Battery instance 0
Lowest cell voltage in pack	Battery Status	127508	0x1F214	2	Battery instance 1
Lowest cell temperature in pack	Battery Status	127508	0x1F214	4	Battery instance 1
Highest cell voltage in pack	Battery Status	127508	0x1F214	2	Battery instance 2
Highest cell temperature in pack	Battery Status	127508	0x1F214	4	Battery instance 2
State-Of-Charge (SOC)	DC detailed status	127506	0x1F212	4	DC instance 0
Time-To-Go (TTG)	DC detailed status	127506	0x1F212	6	DC instance 0
Amp hours	DC detailed status	127506	0x1F212	8	DC instance 0

Notes:

- Battery instance 0 and DC Instance 0 are the same.
- The DC detailed status is a NMEA2000 fast packet message.
- The default source address of the BMS is 0x50.

3.4 PGN: Battery Status, 127508 (0x1F214)

There are three battery status messages that are separated by the "Battery Instance".

3.4.1 Battery Instance "0"

0x1F214 - Battery Status			CAN ID 0x19F21450
Periodicity: Priority Default: Format: Single Frame:		1500 milliseconds 6 Little Endian/Intel convention Yes	
1	Byte 0	**Battery Instance = 0**	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic numeric ID, short 1 bit 0 to 252
2	Byte 1 Byte 2	Battery Voltage DC	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Voltage, DC 0.01 V +/- 327.64 V
3	Byte 3 Byte 4	Battery Current, + = battery is charged, - = battery is discharged	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Current, Electric 0.1 A +/- 3276.4 A
4	Byte 5 Byte 6	Highest Battery Temperature	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 0.01 K 0 to 655.32 deg K
5	Byte 7	Sequence ID, an upward counting number used to tie related information together between different PGNs.	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Sequence ID, short 1 bit 0 to 252

3.4.2 Battery Instance "1"

0x1F214 - Battery Status Lowest Value's			CAN ID 0x19F21450
Periodicity: Priority Default: Format: Single Frame:		1500 milliseconds 6 Little Endian/Intel convention Yes	
1	Byte 0	**Battery Instance = 1**	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic numeric ID, short 1 bit 0 to 252
2	Byte 1 Byte 2	Lowest cell voltage in pack	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Voltage, DC 0.01 V +/- 327.64 V
3	Byte 3 Byte 4	not implemented (0x7FFF)	
		Data Length: Unit: Resolution: Range:	16 bit, int16 - - -
4	Byte 5 Byte 6	Lowest cell temperature in pack	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 0.01 K 0 to 655.32 deg K
5	Byte 7	Sequence ID, an upward counting number used to tie related information together between different PGNs.	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Sequence ID, short 1 bit 0 to 252

3.4.3 Battery Instance "2"

0x1F214 - Battery Status Highest Value's			CAN ID 0x19F21450
Periodicity: Priority Default: Format: Single Frame:		1500 milliseconds 6 Little Endian/Intel convention Yes	
1	Byte 0	**Battery Instance = 2**	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic numeric ID, short 1 bit 0 to 252
2	Byte 1 Byte 2	Highest cell voltage in pack	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Voltage, DC 0.01 V +/- 327.64 V
3	Byte 3 Byte 4	not implemented (0x7FFF)	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 - - -
4	Byte 5 Byte 6	Highest cell temperature in pack	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Generic Temperature, Kelvin 0.01 K 0 to 655.32 deg K
5	Byte 7	Sequence ID, an upward counting number used to tie related information together between different PGNs.	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Sequence ID, short 1 bit 0 to 252

3.4.4 PGN: DC Detailed Status, 127506 (0x1F212)

0x1F212 -DC Detailed Status			CAN ID 0x19F21250
Periodicity: Priority Default: Format: Single Frame:		1500 milliseconds 6 Little Endian/Intel convention No (fast packet)	
1	Byte 0	Sequence ID, an upward counting number used to tie related information together between different PGNs.	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Sequence ID, short 1 bit 0 to 252
2	Byte 1	DC Instance. = 0	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic numeric ID, short 1 bit 0 to 252
3	Byte 2	DC Type	
		Data Length: Unit: Resolution: Range:	8 bit, int8 - 1 bit Variable
		0x00 = Battery, 0x01 = Alternator, 0x02 = Convertor, 0x03 = Solar Cell, 0x04 = Wind Generator, 0x05 = Reserved, thru 0xFD = Reserved 0xFE = Error 0xFF = Data Not Available	
4	Byte 3	State-Of-Charge	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic Absolute Percentage 1 % 0 to 100 %
5	Byte 4	State-Of-Health	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic Absolute Percentage 1 % 0 to 100 %

6	Byte 5 Byte 6	Time remaining	energy left / averaged power
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Time 1 minute 0 to 65532 minutes
7	Byte 7 Byte 8	Ripple voltage (not implemented 0xFF)	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 AC ripple voltage 1 mV 0 to 65532 mV
8	Byte 9 Byte 10	Amp hours	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Battery capacity 1 Ah 0 to 65532 Ah

The DC detailed status is actually two messages that are combined as one.

NOTE: The DC detailed message is a NMEA2000 fast packet. This means that it has a little protocol overhead.

The message consists out of 2 messages.

Message	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
1	b0 to b4 = 00000 b4 to b7 = 3-bit Sequence counter	Total number of data bytes. For this PGN it is 0x0B.	SID	DC Instance	DC type	SOC	SOH (=0xFF)	Time remaining byte 0
2	b0 to b4 = frame counter b4 to b7 = 3-bit Sequence counter	Time remaining byte 1	0XFF	0XFF	Amp hours byte 0	Amp hours byte 1	0XFF	0XFF

= DC Detailed Status PGN

3.5 New PGN's to be implemented

As soon as NMEA2000 library supports the new electric storage system PGN's we will implement them.

127508	Battery Status	**1 Battery instance** **2 Battery Voltage** **3 Battery Current** **4 Battery Temperature**	Old battery status PGN
127506	DC Detailed Status	**1 DC instance** **2 DC type** **3 State of Charge** **4 State of Health** 5 Time remaining 6 Ripple voltage **7 Amp hours**	Old DC system PGN 2: DC type = 0 = Battery
127491	Electric Energy Storage Status (Dynamic)	1 Energy Storage Identifier **2 State of Charge** **3 Time Remaining** **4 Highest Cell Temperature** **5 Lowest Cell Temperature** **6 Average Cell Temperature** **7 Max. Discharge Current** **8 Max. Charge Current** 9 Cooling System Status 10 Heating System Status	Not implemented
128003	Electric Energy Storage Status (Rapid Update)	1 Energy Storage Identifier **2 Battery Status** 3 Isolation Status **4 Battery Error** **5 Battery Voltage** **6 Battery Current** 7 NMEA Reserved	Not implemented
127495	Electric Energy Storage Information	1 Energy Storage Identifier 2 Energy Storage Mode 3 NMEA Reserved 4 Storage Chemistry/Conversion 5 Maximum Temperature Derating 6 Maximum Temperature Shut Off 7 Minimum Temperature Derating 8 Minimum Temperature Shut Off **9 Usable Battery Energy** **10 State of Health** **11 Battery Cycle Counter** 12 Battery Full Status 13 Battery Empty Status 14 NMEA Reserved **15 Maximum Charge (SOC)** **16 Minimum Discharge (SOC)**	Not implemented

4 CAN bus notes

>> Use twisted and shielded cable for the CAN bus.

>> Don’t use drop cables longer than 0.5m.

>> Make sure you have <u>two</u> 120-ohm termination resistors connected on each CAN bus!

The gateway has on-board termination resistors (split terminator type) which can be enabled with a solder jumper on the back of the PCB.

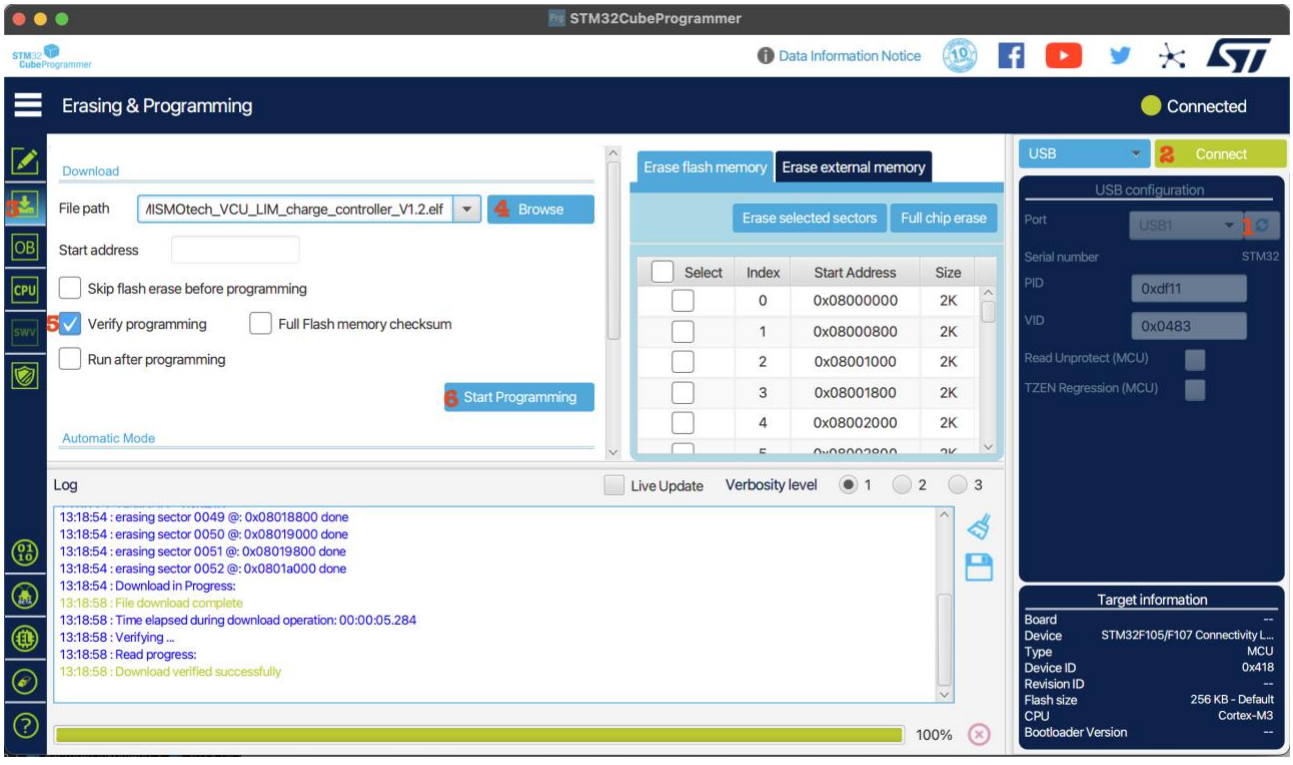
5 RGB status LED

Yellow dimmed	No connection
Green dimmed	Not ready (contactors open)
Green breath	Ready
Blue breath	Charging
Blue dimmed	Charging finished
Orange breath	BMS warning
Red flashing	BMS Fault (protection)
Off	No Power supply
Dark blue	SW update mode

6 CAN gateway software update process

The controller software can be updated with a USB-C data cable. **Make sure the cable has actually data wires and not only power!** The device is also powered by the USB during the software update.

1. Download and install STM32CubeProgrammer for your operating system.
   https://www.st.com/en/development-tools/stm32cubeprog.html
2. Disconnect the CAN cables from the gateway to turn it off.
   Remove the case with the two screws at the bottom.
3. Connect a USB-C cable from your computer to the device.
   The status LED should be blue.
4. Select USB as the communication method in STM32CubeProgrammer.
   It sometimes takes a few seconds before the device is recognized in DFU mode, just press the refresh button a couple of times until you see USB1 device.
   >> Try a different USB cable if it does not work.
5. Press “Connect” to establish a connection to the device.
6. Move to the Erasing & Programming tab on the left and press “Browse” to select the *.elf image with the new software.
7. Select “Verify programming”.
8. Make sure “Run after programming” is **not** selected.
9. Press “Start Programming” and wait until the process finishes.
   Do not disconnect the device during the download process!
10. You should get a few pop-ups with the “File download complete” and “Download Verified successfully” messages and your VCU should be updated at this point.
    You can press “Disconnect” and remove the USB-C cable.
11. Put controller back in the case and reconnect the CAN cables.



7 Revision history

Revised on	Version	Description	Approved by
01-06-2023	0.1	Initial document creation	ME
14-11-2024	1.0	Publish document	ME
	1.1	Updated Software update manual Updated pinout	