Innovation in energy storage

Version 2.28 – 09-09-2024

MG Master HV

- Communication guide -

MG Master HV 800300 / 800500

MG Energy Systems B.V.

TABLE OF CONTENTS

1 GENERAL

This communication guide will give insight on the data that is transmitted by the Master HV according to the selected protocol. Required Master HV firmware version is 1.28 or higher.

1.1 Document history

Table 1 - Document history

Rev	Date	Revision author
1.28	2024-09-09	W. Portinga
	Modifications: • Updated Combined control State register description, see 3.4.2	
1.26	2024-02-07	W. Portinga
	Modifications: • Changed MG REGS Periodically/on change settings, see 3.4.2	
1.25	2023-07-14	W. Portinga
	Modifications: • Added bit 29 to System Status external 1, see 3.5.2 • Added bit 27 to System warning external 1, see 3.5.2 • Added bit 6 to System warning external 2, see 3.5.2 • Added bit 20 and 21 to System failure external 1, see 3.5.2	
2.24	2023-06-14	W. Portinga
	Modifications: • Typo fix, kelvin data type from “int16” to “uint16”, see 3.3.3 • Added warning flag to System warning external 2 bit 5, see 3.5.2 • Relocated “Output voltage” from MGREG 3.5 to VREG 3.4	
2.22	2023-01-10	W. Portinga
	Modifications: • Updated status flags VREG 0x2100, see 3.4.2 “Status flags”. • Updated BMS error values VREG 0x2101, see 3.4.2 “BMS error”. • Added PGN information, see 3.3.1 and 3.3.2.	
2.11	2022-06-03	W. Portinga
	Modifications: • Added status bit 10, bit 14 and bit 15 to PGN status 4.3.2 • Added warning bit 24, bit 25 and bit 26 to PGN warning 4.3.3. • Added failure bit 43 to PGN Failure 4.3.4. • Added system voltage, status, warning and failure MG registers to 3.5.2	
2.10	2021-09-09	W. Portinga
	Modifications: • Added MG Registers for combined status and to 3.5.2	
2.9	2020-10-02	W. Portinga
	Modifications: • Added battery humidity high to PGN System warning, see 4.3.3, bit 23. • Added NMEA2000 protocol, see 3.	
2.8	2020-05-12	W. Portinga
	Modifications: • Added temperature alerts to PGN System status, see 4.3.2, bit 24 - 28	

	• Added input state to PGN System status, see 4.3.2, bit 7 - 9. • Added input warning state to PGN System warning, only when configured, see 4.3.3, bit 20 – 22. • Added coolant flued leakage and E-Stop functionality failure detect to PGN system warning, 4.3.3, bit 37 and 38. • Added current sensor failure to PGN Failure, see 4.3.4, bit 42. • Updated names of PGN Failure, see 4.3.4, bit 32 – 33. • Added S.O.H. to PGN 4.3.5, byte 5. • Added T.T.G. to PGN 4.3.5, byte 6 – 7. • Added new PGN Battery average measurements, see 4.3.8. • Updated names of PGN commands flags, see 4.4.1, byte 0.

2 COMMUNICATION WITH THE MG MASTER HV

Communication with the MG Master HV can be established via CAN-Bus.
There are 3 main protocols implemented which can be selected:

- MG NMEA2000 PROTOCOL;
- Master HV J1939 protocol (Visedo) – Not recommended for new system designs;
- None (no communication);

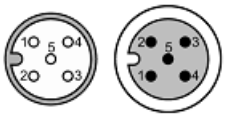
The NMEA2000 and none protocol can only be used in combination with the general purpose input option set at start/stop/restart function.

There are 3 NMEA2000 protocol options. The MG-NMEA2000 protocol is using a NMEA2000 manufacturer code assigned for “MG energy systems”, recommended for new designs. The VE-NMEA2000 protocols are using a NMEA2000 manufacturer code assigned for “Victron Energy”.

CAN interface

Pin definition

Type: 5-pin A-coded

Pin	Description	CANOpen, NMEA2000 connector
1	Shield	M12 plug/socket, 5-pin, A-coded  Male Female
2	V+	
3	GND	
4	CAN-H	
5	CAN-L	

2.1.1 M12 Connector details

The connectors used for connecting the CAN-bus are all of the same type, namely a circular M12 connector with 5 positions and A-coded keying.

Table 2 – Circular M12 connector with 5 positions A-coded details

Pin	Description	Connector view
1	Shield	
2	V+	
3	GND	
4	CAN-H	
5	CAN-L	

Cables to be used for the battery system are typically referred to as NMEA 2000 or DeviceNet compatible cables. The minimum requirements for cables are:

- Twisted pair connected to pins 4 and 5 for communication with a minimum wire cross sectional area of 0.2 mm^2 (24 AWG).
- Pair of conductors connected to pin 2 and 3 for power and HVIL with a minimum wire cross sectional area of 0.34 mm^2 (22 AWG).
- Cable with braided shielding connected to pin 1.

NOTICE:
Do not use sensor/actor cables. They often don't have any twisted pairs and are therefore not suitable for this application.

3 MG NMEA2000 PROTOCOL

There are 3 NMEA2000 protocol options. The MG-NMEA2000 protocol is using a NMEA2000 manufacturer code assigned for “MG energy systems”, recommended for new designs. The VE-NMEA2000 protocols are using a NMEA2000 manufacturer code assigned for “Victron Energy”.

NOTICE:
When Micropower chargers are enabled in the settings, 11-bit CAN messages with ID 0x600 will be added on the NMEA2000 bus. These messages are not explained in this document.

3.1 Interface definition

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

3.2 Message definition

NMEA2000 Identifier definition.

<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

Table 3 - PGN list

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
	ISO Address Claim	060928	0xEE00		
	Product information	126996	0x1F014		
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
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
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

Notes:

- Battery instance 0 and DC Instance 0 are the same;
- One or more MG Lithium-Ion batteries together in one system are a Battery pack;
- The DC detailed status is a NMEA2000 fast packet;
- The default source address of the MG Master HV is 0x50;
- PGN name BATTERY_BANK is also named BATTERY_STATUS.

The Data instance from PGN: 127508 BATTERY_BANK or PGN: 127506 DC_DETAILED can be changed by steps of 32 -> 0, 32, 64, 96, 128. If data instance from BATTERY_BANK is changed, also data instance of DC_DETAILED will change, vice versa. Data instance from BATTERY_BANK_MIN, BATTERY_BANK_MAX are increased with the data instance from BATTERY_BANK.

Table 4 - Data instance from PGN's

BATTERY_BANK DC_DETAILED	BATTERY_BANK_MIN	BATTERY_BANK_MAX
0	1	2
32	33	34
64	65	66
...	...	...
224	225	226

- Data instance is stored, if during boot data instance is invalid, it will be restored to 0.
- DeviceInstance can be changed and is stored.
- DeviceFunctionInstance can be changed and is stored.
- Device Class Instance can be changed and is stored.

3.3.1 PGN: ISO Address Claim, 060928 (0xEE00)

NMEA2000 manufacturer code for MG Energy Systems B.V. is 1160

Unique Number (ISO Identity Number): unique number subtracted from serial number.
Manufacturer Code (industry marine + manufacturer code): 0x9C88
Device Instance Lower (ISO ECU Instance): 0
Device Instance Upper (ISO Function Instance): 0
Device Function (ISO Function): 170
Device Class: 35
System Instance (ISO Device Class Instance): 0 ->(ISO Function Instance)
Industry Group: 4 (Marine)
NMEA Reserved (ISO Self Configurable): 1

3.3.2 PGN: Product information, 126996 (0x1F014)

NMEA Network Message Database Version: 1301
NMEA Manufacturer's Product Code: 0xFFFF
Manufacturer's Model ID: String containing device name, example MG BMS 48-900V/300A
Manufacturer's Software Version Code: String containing software version
Manufacturer's Model Version: String containing hardware version
Manufacturer's Model Serial Code: MGE(SerialNumber)
NMEA 2000 Certification Level: 1
Load Equivalency: 1

3.3.3 PGN: Battery Status, 127508 (0x1F214)

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

3.3.3.1 Battery Instance "0"

0x1F214 - Battery Status			
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

3.3.3.2 Battery Instance "1"

0x1F214 - Battery Status Lowest Value's			
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:	16 bit, int16 Voltage, DC

		Resolution: Range:	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

3.3.3.3 Battery Instance "2"

0x1F214 - Battery Status Highest Value's			
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, int16 - - -
4	Byte 5 Byte 6	Highest 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:	8 bit, uint8 Sequence ID, short

		Resolution: Range:	1 bit 0 to 252

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

0x1F212 -DC Detailed Status			
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.	
		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 … 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 0-252% 1 % 0 to 252 %
5	Byte 4	State-Of-Health	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic Absolute Percentage 0-252% 1 % 0 to 252 %
6	Byte 5 Byte 6	Time remaining	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Time 1 minute 0 to 65532 minutes

7	Byte 7 Byte 8	Ripple voltage (not implemented)	
		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.

Table 5 - DC detailed fast packet

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	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

3.4 Victron VREGS

3.4.1 Message definition

CAN-ID : 1CEF <target address><source address>
Example : 1CEF5030 means source address 0x30 end target address 0x50

0xFF as target address means broadcast message. Every node will receive this message.

All fields are sent in Little Endian order. Message data of a VREG looks like the following:

Table 6 - VREG message data

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x66	0x99	regId.L	regId.H	Data	Data	Data	Data

3.4.2 VREG ID List

If “periodically” is “Yes” the VREG is broadcasted with an interval of 5 seconds. If “on change” is “yes” the VREG will be broadcasted directly if the value has been changed. The “on change” condition can have a maximum delay of 1 second.

Description	VREG ID	Period-ically/on Change	Comments
Device			
Product ID	0x0100	No/No	Lynx Ion BMS General = 0xA390 MG BMS 48-900V/300A = 0xB0D9 MG BMS 48-900V/500A = 0xB0DA
Firmware version	0x0102	No/No	un8 = Identifier : un24 = Firmware Version, 0xFFFFFF = no firmware present, Firmware version: 0x123456=v12.34.56
Serial number	0x010A	No/No	stringZeroEnded[32] = Serial : un8 = padding, 0 =zeropadding (not implemented)
Model name	0x010B	No/No	stringZeroEnded[64] = Model : un8 = padding, 0 = zeropadding (not implemented)
BMS Status values			
Voltage	0xED8D	Yes/No	sn16 = DC Channel 1 Voltage [0.01V], 0x7FFF = Not Available
Current	0xED8F	Yes/No	sn16 = DC Channel 1 Current [0.1A], 0x7FFF = Not Available
Cell Volt. max/min	0x0385	Yes/No	un16 = Minimum voltage [0.01V] : un16 = Maximumvoltage [0.01V]
Cell Temperature max/min	0x0386	Yes/No	un16 = Minimum temperature [0.01K] : un16 =Maximum temperature [0.01K]
State-of-Charge	0x0FFF	Yes/Yes	un16 = SOC [0.01%]
Time-to-go	0x0FFE	No/No	un16 = Time to go [1minutes], 0xFFFF = not available
Consumed Ah	0xEEFF	No/No	sn32 = Consumed Ah [0.1Ah]
Last error 1-4	0x2110	No/Yes	un8 = Error 1, Last error : un8 = Error 2 : un8 = Error 3 : un8 = Error 4, Oldest error
Last error 1 time	0x2111	No/Yes	un32 = BMS: UTC time of last error 1

Description	VREG ID	Period-ically/on Change	Comments
Last error 2 time	0x2112	No/Yes	un32 = BMS: UTC time of last error 2
Last error 3 time	0x2113	No/Yes	un32 = BMS: UTC time of last error 3
Last error 4 time	0x2114	No/Yes	un32 = BMS: UTC time of last error 4
Status flags	0x2100	No/Yes	un32 = BMS page BMV flags (bit flags) bit 0 = Charged bit 1 = Almost charged bit 2 = Discharged bit 3 = Almost discharged bit 4 = Charging bit 5 = Discharging bit 6 = Balancing in progress bit 7 = Main safety contactor closed bit 8 = Main safety contactor closed bit 9 = Alarm over voltage bit 10 = Warning over voltage bit 11 = Alarm under voltage bit 12 = Warning under voltage bit 13 = Warning high charge current bit 14 = Warning high discharge current bit 15 = Alarm over temperature bit 16 = Warning over temperature bit 17 = Warning under temperature charge bit 18 = Alarm under temperature charge bit 19 = Warning under temperature discharge bit 20 = Alarm under temperature discharge bit 21 = Low SOC (< 20%) bit 22 = Alarm under temperature bit 23 = Alarm short circuit (not implemented) bit 24 = Alarm hardware failure bit 25 = Allowed to charge bit 26 = Allowed to discharge bit 27 = Pre-alarm (not implemented) bit 28 = Warning bad contactor (not implemented) bit 29 = Alarm high current bit 30 = Warning cell imbalance bit 31 = Warning service requested
BMS State	0x0371	No/Yes	un8 =BMS state (Value) 0-8= Initializing 9 = Running 10= Error 12 = Shutting down 13 = Updating battery firmware 14 = Standby

Description	VREG ID	Period-ically/on Change	Comments
			15 = Going to running state 16 = Pre-charging
BMS Error	0x2101	No/Yes	un8 = BMS error (Value) 0 = No error, system OK 2 = No batteries found 4 = Batteries connected are not the same type 5 = Number of batteries connected incorrect 7 = Measure error 11 = Hardware failure 12 = Watchdog error 13 = Over voltage detected 14 = Under voltage detected 15 = Over temperature detected 16 = Under temperature detected 18 = Battery protection automatic shutdown 23 = BMS slave failure 25 = Pre-charge failure 26 = Contactor failure 27 = Over current 28 = Slave update failure 29 = Slave update unavailable 35 = Pre-charge timeout 37 = Interlock 38 = Emergency stop 39 = Communication timeout 41 = Terminal over temperature
Programmable relay state	0x034E	No/Yes	un8 = programmable relay state, 0 = open, 1 = closed.
System configuration			
Battery installed capacity	0x1000	No/Yes	un16 = Battery capacity [Ah]
Battery installed configuration	0x0380	No/Yes	un8 = Number of batteries : un8 = Cells per battery : un8= Number of batteries in parallel : un8 =Number of batteries in series
History values			
Deepest discharge	0x0300	No/No	sn32 = Deepest discharge [0.1Ah]
Total Ah drawn	0x0305	No/No	sn32 = Cumulative Ah drawn from the battery [0.1Ah]
Minimum voltage	0x0306	No/No	sn32 = Minimum battery voltage [0.01V]

Description	VREG ID	Period-ically/on Change	Comments
Maximum voltage	0x0307	No/No	sn32 = Maximum battery voltage [0.01V]
Automatic syncs	0x0309	No/No	sn32 = Number of automatic synchronizations
Discharged energy	0x0310	No/No	un32 = The amount of energy drawn from the source [0.01kWh]
Charged energy	0x0311	No/No	un32 = The amount of energy put into the source [0.01kWh]
Maximum temperature	0x0312	No/No	un16 = The maximum temperature [0.01K]
Minimum temperature	0x0313	No/No	un16 = The minimum temperature [0.01K]
Min/Max cell voltage	0x0384	No/No	un16 = Minimum voltage [0.01V] : un16 = Maximum voltage [0.01V]
BMS Limits			
Battery charge voltage	0x0390	Yes/Yes	un32 = Charge voltage [0.01V], 0xFFFFFFFF = Not Available
DC charge current limitation	0x0391	Yes/Yes	un32 = Charge current [0.1A], 0xFFFFFFFF = Not Available
DC discharge voltage	0x0392	Yes/Yes	un32 = Discharge voltage [0.01V] , 0xFFFFFFFF = Not Available
Battery discharge current limitation	0x0393	Yes/Yes	un32 = Discharge current [0.1A] , 0xFFFFFFFF = Not Available
Charger link percentage	0x2014	Yes/Yes	un8 = Percentage [1%], 0xFF = Not Available, valid range 0 till 100
Charger link current limit	0x2015	Yes/Yes	un16 = Link Charge Current Limit [0.1A], 0xFFFF =Not Available
Settings	This VREG's can be read and written.		
Synchronize group number	0x0374	No / Yes	Un8 = group, 0 = Disabled, 1-3 = Enabled. Used to synchronize multiple BMSS in parallel that are set to this group number.
Battery strategy	0x0376	No / Yes	Un8 = Battery strategy, 0 = Default, 1 = Performance.
Combined BMS	0x0377	No / Yes	Un8 = Combined BMS, 0 = Disabled, 1 = Enabled.
Re-start request	0x0379	No / Yes	Un8 = Restart request, 0 = Disabled, 1 = Enabled, BMS will shut down and startup again.
Number of batteries in parallel	0x0387	No / Yes	Un8 = batteries parallel, 0 = automatically detected, 1-96 = Number of batteries connected to BMS in parallel.
Number of batteries in series	0x0388	No / Yes	Un8 = batteries series, 0 = automatically detected, 1-96 = Number of batteries connected to BMS in series.

Description	VREG ID	Period-ically/on Change	Comments
	Read 0xFF = Not available (System is in error state)		
Control	This VREG's can be read and written.		

Combined control State	0x0378	No / Yes	Un8 = Combined BMS state/commands : Un8 = address:
			
			// Combined BMS state:
			WAITING_FOR_USER = 0x00
			PRECHARGING = 0x01
			OPERATING = 0x02
			RECEIVED_SWITCH_START_COMMAND = 0x10
			RECEIVED_CANBUS_START_COMMAND = 0x11
			
			When master BMS is transmitting a received start command, other master will go into interrupted state and for 5 seconds they will not accept any command.
			
			// Commands send by system integrator:
			HEARTBEAT_COMMAND = 0x20, send each 1 second.
			START_COMMAND = 0x21
			STOP_COMMAND = 0x22
			
			// Address:
			Network address of the desired Master BMS where a start or stop command is transmitted to. Heartbeat is broadcasted 0xFF.
			
			Example:
			System integrator NAD: 0x**20**
			
			Heartbeat command, each 1 second:
			HEARTBEAT_COMMAND = 0x20,
			ID=0x1CEFFF**20**,Length=8,Data=0x6699-7803-20-FF-FFFF
			
			Master BMS is not sending anything as long it's in standby.
			Message is send once on Master BMS start-up.
			WAITING_FOR_USER = 0x00
			ID=0x1CEFFF50,Length=8,Data=0x6699-7803-00-00-0000
			
			Start command to Master BMS with NAD *0x50*:
			START_COMMAND = 0x21
			ID=0x1CEFFF**20**,Length=8,Data=0x6699-7803-21-*50*-0000
			
			Reply from Master BMS when received start command:
			RECEIVED_CANBUS_START_COMMAND = 0x11
			ID=0x1CEFFF50,Length=8,Data=0x6699-7803-11-00-0000
			
			Master BMS will start pre-charging:
			PRECHARGING = 0x01

Description	VREG ID	Period-ically/on Change	Comments
			ID=0x1CEFFF50,Length=8,Data=0x6699-7803-01-00-0000 When Master BMS is pre-charged it will go to operating: OPERATING = 0x02 ID=0x1CEFFF50,Length=8,Data=0x6699-7803-02-00-0000 From this moment, other Master BMS's will monitor the system and close the contactor when the system voltage is equal. **Single Master:** Disable the setting "Combined BMSs", the "OPERATING" state will not be transmitted. Use "BMS State – ID: 0x0371" to see in what state the Master is. **Note:** Multiple master will dynamically assign a new NAD starting at 0x50 and increasing.
Output Voltage	0x037A	Yes/No	Un32 = Voltage [0.01V], 0xFFFFFFFF = Output not active.

3.4.3 Examples

Request (0x0001) for Firmware Version (0x0102) of node at address 0x50 from address 0x20:

CAN-ID	Data
0x1CEF5020	0x66 0x99 0x01 0x00 0x02 0x01 0xFF 0xFF

Reply (is always broadcast) firmware version 1.04:

CAN-ID	Data
0x1CEFFF50	0x66 0x99 0x02 0x01 0x00 0x00 0x04 0x01

If the request was not supported for this register, the reply will be an ACK (0x0002) with code 0x8000, invalid request:

CAN-ID	Data
0x1CEF2050	0x66 0x99 0x02 0x00 0x02 0x01 0x00 0x80

3.5 MG energy systems REGS

3.5.1 Message definition

CAN-ID : 1CEF <target address><source address>
Example : 1CEF5030 means source address 0x30 end target address 0x50

0xFF as target address means broadcast message. Every node will receive this message.

All fields are sent in Little Endian order. Message data of a MGREG looks like the following:

Table 7 - MGREG message data

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x88	0x9C	regId.L	regId.H	Data	Data	Data	Data

3.5.2 MGREG ID List

Description	MGREG ID	Period-ically/on Change	Comments
System Voltage	0x48EE	250ms/No	Sn32 = Voltage [0.001V], 0x80000000 = Not Available.
System Status external 1	0x2140	250ms/Yes	un32 = Status 1 flags (bit flags) Bit 0 = Initializing, Bit 1 = Operational (ready to active DC-bus connection), Bit 2 = DC-bus connected, Bit 3 = Warning, Bit 4 = Failure, Bit 5 = Updating batteries, Bit 6 = Requested for system reset, Bit 7 = Input 1 state, Bit 8 = Input 2 state, Bit 9 = Input 3 state, Bit 10 = Programmable relay active, ... Bit 14 = Contactor close request by user, Bit 15 = Contactor is going to be opened, Bit 16 = DC-Bus Pre-Charging, Bit 17 = Charged, Bit 18 = Discharged, Bit 19 = Cell balancing, Bit 20 = Almost charged, Bit 21 = Almost discharged, Bit 22 = Charging allowed, Bit 23 = Discharging allowed , Bit 24 = Charging over temperature alert, Bit 25 = Discharging over temperature alert, Bit 26 = Charging under temperature alert, Bit 27 = Discharging under temperature alert, Bit 28 = battery power terminal over temperature alert, Bit 29 = battery contactor over temperature alert

Description	MGREG ID	Period-ically/on Change	Comments
System Status external 2	0x2141	250ms/Yes	un32 = Status 2 flags (bit flags) Bit 0 = Combined standby, Bit 1 = Combined monitoring for equal battery-to-system voltage, Bit 2 = Service mode
System warning external 1	0x2142	5 sec./Yes	un32 = Warning 1 flags (bit flags) Bit 0 = Battery cell voltage too high, Bit 1 = Redundancy Unit battery voltage too high, Bit 2 = Battery cell voltage too low, Bit 3 = Redundancy Unit battery voltage too low, Bit 4 = Battery cell temperature too high for charging, Bit 5 = Battery cell temperature too high for discharging, Bit 6 = Redundancy Unit battery temperature too high, Bit 7 = Battery cell temperature too low for charging, Bit 8 = Battery cell temperature too low for discharging, Bit 9 = Redundancy Unit battery temperature too low, Bit 10 = Private CAN-bus communication timeout, Bit 11 = Public CAN-bus communication timeout, Bit 12 = Internal 12V power supply stability problem, Bit 13 = External 24V power supply stability problem, Bit 14 = Hardware failure, Bit 15 = Service request, Bit 16 = Battery terminal temperature too high, Bit 17 = Redundancy Unit minus terminal temperature too high, Bit 18 = Redundancy Unit plus terminal temperature too high, Bit 19 = Master internal temperature too high, Bit 20[a] = Input 1, Bit 21[a] = Input 2, Bit 22[a] = Input 3, Bit 23 = Battery humidity high, Bit 24 = Private CAN-bus protocol violated, Bit 25 = Pre-charge fuse broken, Bit 26 = Fuse broken, Bit 27 = Battery contactor temperature too high. [a]) Only present when configured.
System warning external 2	0x2143	5 sec./Yes	un32 = Warning 2 flags (bit flags) Bit 0 = Battery cell voltages deviation detected, Bit 1 = Battery cell temperatures deviation detected, … Bit 3 = Charge current too high, Bit 4 = Discharge current too high, Bit 5 = Battery leakage detected, Bit 6 = Master current overload.

Description	MGREG ID	Period-ically/on Change	Comments
System failure external 1	0x2144	5 sec./Yes	un32 = Failure 1 flags (bit flags) Bit 0 = Battery cell voltage too high, Bit 1 = Redundancy Unit battery voltage too high, Bit 2 = Battery cell voltage too low, Bit 3 = Second stage protection battery voltage too low, Bit 4 = Battery cell temperature too high for charging, Bit 5 = Battery cell temperature too high for discharging, Bit 6 = Second stage protection battery temperature too high, Bit 7 = Battery cell temperature too low for charging, Bit 8 = Battery cell temperature too low for discharging, Bit 9 = Redundancy Unit battery temperature too low, Bit 10 = Private CAN-bus communication timeout, Bit 11 = Public CAN-bus communication timeout, Bit 12 = Internal 12V power supply stability problem, Bit 13 = External 24V power supply stability problem, Bit 14 = Hardware failure, … Bit 16 = Battery terminal temperature too high, Bit 17 = Redundancy Unit minus terminal temperature too high, Bit 18 = Redundancy Unit plus terminal temperature too high, Bit 19 = Battery redundancy unit interrupted the interlock, Bit 20 = Battery over current, Bit 21 = Battery contactor temperature too high.
System failure external 2	0x2145	5 sec./Yes	un32 = Failure 2 flags (bit flags) Bit 0 = Pre-Charging critical overload detected, Bit 1 = Pre-Charging took too long, Bit 2 = Contactor minus welding, Bit 3 = Contactor plus welding, Bit 4 = Contactor minus failure detected, Bit 5 = Contactor plus failure detected, Bit 6 = High voltage interlock circuits, Bit 7 = E-Stop shutdown, Bit 8 = Battery initializing, Bit 9 = Battery updating, Bit 10 = Current sensor failure, Bit 11 = Initialization.

4 Master HV J1939 protocol (not recommended for new system design)

4.1 Interface definition

Speed : 250 kbps

ID : 29-bit CAN 2.0B

4.2 Message definition

J1939 Identifier definition.

<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.

4.3 PGN list

Data	PGN Name	PGN hex	Field	Remarks
Charge voltage limit	Charge Discharge Limits	0x1FF40	0	uint16 [0.1V]
Charge current limit	Charge Discharge Limits	0x1FF40	2	uint16 [0.1A]
Discharge voltage limit	Charge Discharge Limits	0x1FF40	4	uint16 [0.1V]
Discharge current limit	Charge Discharge Limits	0x1FF40	6	uint16 [0.1A]
Status information	System status	0x1FF41	0	Uint32 [1 bits]
Warning information	System warning	0x1FF42	0	Uint64 [1 bits]
Failure information	System failure	0x1FF43	0	Uint64 [1 bits]
Voltage	System measurements	0x1FF44	0	uint16 [0.1V]
Current	System measurements	0x1FF44	2	int16 [0.1A]
State-Of-Charge (SOC)	System measurements	0x1FF44	4	uint8 [1%]
State-Of-Health (SOH)	System measurements	0x1FF44	5	uint8 [1%]
Time-To-Go (TTG)	System measurements	0x1FF44	6	uint16 [1 minutes]
Highest cell voltage	Battery measurements scale	0x1FF45	0	uint16 [0.01V]
Lowest cell voltage	Battery measurements scale	0x1FF45	2	uint16 [0.01V]
Highest cell temperature	Battery measurements scale	0x1FF45	4	uint16 [0.01K]
Lowest cell temperature	Battery measurements scale	0x1FF45	6	uint16 [0.01K]
Highest cell voltage	Battery measurements	0x1FF46	0	uint16 [0.001V]
Lowest cell voltage	Battery measurements	0x1FF46	2	uint16 [0.001V]
Highest cell temperature	Battery measurements	0x1FF46	4	uint16 [1K]
Lowest cell temperature	Battery measurements	0x1FF46	6	uint16 [1K]
Average cell voltage	Battery average measurements	0x1FF47	0	uint16 [0.001V]
Average cell temperature	Battery average measurements	0x1FF47	2	uint16 [1K]
Software version	Device Information	0x1FF4F	0	uint16 [0x0102->V1.2]
Hardware Type	Device Information	0x1FF4F	2	uint16 [0x3E82->16002]
Hardware Configuration	Device Information	0x1FF4F	4	uint16 [-]
Hardware Version	Device Information	0x1FF4F	6	uint16 [0x0102->V1.2]

Notes:

- The default source address of the MG Master HV is 0x50.
- TTG and SOH is supported from master firmware version 1.13 and higher.

4.3.1 PGN: Charge Discharge Limits, 0x1FF40

0x1FF40 -Charge Discharge Limits			
Periodicity: Priority Default: Format:		250milliseconds 0 Little Endian/Intel convention	
1	Byte 0 Byte 1	Maximum allowed charge voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.1 V 0 to 6553.4 V (invalid: 0xFFFF)
2	Byte 2 Byte 3	Maximum allowed charge current.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Current, Electric 0.1 A 0 to 6553.4 A (invalid: 0xFFFF)
3	Byte 4 Byte 5	Maximum allowed discharge voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.1 V 0 to 6553.4 V (invalid: 0xFFFF)
4	Byte 6 Byte 7	Maximum allowed discharge current.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Current, Electric 0.1 A 0 to 6553.4 A (invalid: 0xFFFF)

4.3.2 PGN: System status, 0x1FF41

<table>
<tr><td colspan="4">0x1FF41 - Status flags, discharge current and charge current</td></tr>
<tr><td colspan="2">Periodicity:
Priority Default:
Format:</td><td colspan="2">250 milliseconds
3
Little Endian/Intel convention</td></tr>
<tr><td rowspan="5">1</td><td rowspan="5">Byte 0
Byte 1
Byte 2
Byte 3</td><td colspan="2">Status flags</td></tr>
<tr><td>Data Length:
Unit:
Resolution:
Range:</td><td>32 bit
-
1 bit
Variable</td></tr>
<tr><td colspan="2">Bit 0 = Initializing,
Bit 1 = Operational (ready to active DC-bus connection),
Bit 2 = DC-bus connected,
Bit 3 = Warning,
Bit 4 = Failure,
Bit 5 = Updating batteries,
Bit 6 = Requested for system reset,
Bit 7 = Input 1 state,
Bit 8 = Input 2 state,
Bit 9 = Input 3 state,
Bit 10 = Programmable relay active,
...
Bit 14 = Contactor close request by user,
Bit 15 = Contactor is going to be opened,
Bit 16 = DC-Bus Pre-Charging,
Bit 17 = Charged,
Bit 18 = Discharged,
Bit 19 = Cell balancing,
Bit 20 = Almost charged,
Bit 21 = Almost discharged,
Bit 22 = Charging allowed,
Bit 23 = Discharging allowed ,
Bit 24 = Charging over temperature alert,
Bit 25 = Discharging over temperature alert,
Bit 26 = Charging under temperature alert,
Bit 27 = Discharging under temperature alert,
Bit 28 = battery power terminal over temperature alert.</td></tr>
</table>

4.3.3 PGN: Warning, 0x1FF42

0x1FF42 -Warning flags.			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0	Status flags	
	Byte 1 Byte 2 Byte 3 Byte 4	Data Length: Unit: Resolution: Range:	64 bit - 1 bit Variable
	Byte 5 Byte 6 Byte 7	Bit 0 = Battery cell voltage too high, Bit 1 = Redundancy Unit battery voltage too high, Bit 2 = Battery cell voltage too low, Bit 3 = Redundancy Unit battery voltage too low, Bit 4 = Battery cell temperature too high for charging, Bit 5 = Battery cell temperature too high for discharging, Bit 6 = Redundancy Unit battery temperature too high, Bit 7 = Battery cell temperature too low for charging, Bit 8 = Battery cell temperature too low for discharging, Bit 9 = Redundancy Unit battery temperature too low, Bit 10 = Private CAN-bus communication timeout, Bit 11 = Public CAN-bus communication timeout, Bit 12 = Internal 12V power supply stability problem, Bit 13 = External 24V power supply stability problem, Bit 14 = Hardware failure, Bit 15 = Service request, Bit 16 = Battery terminal temperature too high, Bit 17 = Redundancy Unit minus terminal temperature too high, Bit 18 = Redundancy Unit plus terminal temperature too high, Bit 19 = Master internal temperature too high, Bit 20[a] = Input 1, Bit 21[a] = Input 2, Bit 22[a] = Input 3, Bit 23 = Battery humidity high, Bit 24 = Private CAN-bus protocol violated, Bit 25 = Pre-charge fuse broken, Bit 26 = Fuse broken, ... Bit 32 = Battery cell voltages deviation detected, Bit 33 = Battery cell temperatures deviation detected, … Bit 35 = Charge current too high, Bit 36 = Discharge current too high, Bit 37 = Coolant flued leakage detected, Bit 38 = E-Stop functionality failure detected	

[a]) Only present when configured.

4.3.4 PGN: Failure, 0x1FF43

0x1FF43 -Failure flags.			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0	Status flags	
	Byte 1 Byte 2 Byte 3 Byte 4	Data Length: Unit: Resolution: Range:	64 bit - 1 bit Variable
	Byte 5 Byte 6 Byte 7	Bit 0 = Battery cell voltage too high, Bit 1 = Redundancy Unit battery voltage too high, Bit 2 = Battery cell voltage too low, Bit 3 = Second stage protection battery voltage too low, Bit 4 = Battery cell temperature too high for charging, Bit 5 = Battery cell temperature too high for discharging, Bit 6 = Second stage protection battery temperature too high, Bit 7 = Battery cell temperature too low for charging, Bit 8 = Battery cell temperature too low for discharging, Bit 9 = Redundancy Unit battery temperature too low, Bit 10 = Private CAN-bus communication timeout, Bit 11 = Public CAN-bus communication timeout, Bit 12 = Internal 12V power supply stability problem, Bit 13 = External 24V power supply stability problem, Bit 14 = Hardware failure, … Bit 16 = Battery terminal temperature too high, Bit 17 = Redundancy Unit minus terminal temperature too high, Bit 18 = Redundancy Unit plus terminal temperature too high, Bit 19 = Battery redundancy unit interrupted the interlock, ... Bit 32 = Pre-Charging critical overload detected, Bit 33 = Pre-Charging took too long, Bit 34 = Contactor minus welding, Bit 35 = Contactor plus welding, Bit 36 = Contactor minus failure detected, Bit 37 = Contactor plus failure detected, Bit 38 = High voltage interlock circuits, Bit 39 = E-Stop shutdown, Bit 40 = Battery initializing, Bit 41 = Battery updating, Bit 42 = Current sensor failure, Bit 43 = Initialization.	

4.3.5 PGN: System measurements, 0x1FF44

0x1FF44 -System measurements			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0 Byte 1	Voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.1 V 0 to 6553.4 V (invalid: 0xFFFF)
2	Byte 2 Byte 3	Current.	
		Data Length: Unit: Resolution: Range:	16 bit, int16 Current, Electric 0.1 A -3276.8 A (discharging) to 3276.6 A (charging) (invalid: 0x7FFF)
3	Byte 4	State-Of-Charge (SOC).	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic Absolute Percentage 0-100% 1 % 0 to 100 % (invalid: 0xFF)
4	Byte 5	State-Of-Health (SOH).	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 Generic Absolute Percentage 0-100% 1 % 0 to 100 % (invalid: 0xFF)
5	Byte 6 Byte 7	Time-To-Go (TTG).	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Time, minutes. 1 minutes 0 to 65534 minutes (invalid: 0xFFFF)

Notes:

- TTG and SOH is supported from master firmware version 1.13 and higher.

4.3.6 PGN: Battery measurements on scale, 0x1FF45

0x1FF45 -Battery measurements on scale			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0 Byte 1	Highest cell voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.01 V 0 to 655.34 V (invalid: 0xFFFF)
2	Byte 2 Byte 3	Lowest cell voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.01 V 0 to 655.34 V (invalid: 0xFFFF)
3	Byte 4 Byte 5	Highest cell temperature.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 0.01 K 0 to 655.32 deg K
4	Byte 6 Byte 7	Lowest cell temperature.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 0.01 K 0 to 655.32 deg K

4.3.7 PGN: Battery measurements, 0x1FF46

0x1FF46 -Battery measurements			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0 Byte 1	Highest cell voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.001 V 0 to 65.534 V (invalid: 0xFFFF)
2	Byte 2 Byte 3	Lowest cell voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.001 V 0 to 65.534 V (invalid: 0xFFFF)
3	Byte 4 Byte 5	Highest cell temperature.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 1 K 0 to 65534 deg K (invalid: 0xFFFF)
4	Byte 6 Byte 7	Lowest cell temperature.	
		Data Length: Unit:	16 bit, uint16 Generic Temperature, Kelvin

		Resolution: Range:	1 K 0 to 65534 deg K (invalid: 0xFFFF)

4.3.8 PGN: Battery average measurements, 0x1FF47

0x1FF47 -Battery measurements			
Periodicity: Priority Default: Format:		250 milliseconds 3 Little Endian/Intel convention	
1	Byte 0 Byte 1	Average cell voltage.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.001 V 0 to 65.534 V (invalid: 0xFFFF)
2	Byte 2 Byte 3	Average cell temperature.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Generic Temperature, Kelvin 1 K 0 to 65534 deg K (invalid: 0xFFFF)

4.3.9 PGN: Battery SOC Synchronization broadcast, 0x1FF4E

0x1FF4E -Battery SOC synchronization broadcast. (source address 0xFF)			
Periodicity: Priority Default: Format:		On SOC synchronization 3 Little Endian/Intel convention	
1	Byte 0	Group number	
		Data Length:	8 bit, uint8
2	Byte 1	Source address	
		Data Length:	8 bit, uint8

4.3.10 PGN: Device Information, 0x1FF4F

0x1FF4F -Device Information			
Periodicity: Priority Default: Format:		250 milliseconds 7 Little Endian/Intel convention	
1	Byte 0 Byte 1	Software version.	
		Data Length: Unit:	16 bit, uint16 0x0102->V1.2
2	Byte 2 Byte 3	Hardware Type.	
		Data Length: Unit:	16 bit, uint16 0x3E82->16002
3	Byte 4 Byte 5	Hardware Configuration.	
		Data Length: Unit:	16 bit, uint16 -
4	Byte 6 Byte 7	Hardware Version.	
		Data Length: Unit:	16 bit, uint16 0x0102->V1.2

4.4 Received data

4.4.1 PGN: Commands and Main DC Voltage, 0x0FFB1

The received command messages needs to have a length of 8 bytes.

0x0FFB1 -commands and Main DC voltage			
Periodicity: Priority Default: Format:		250 milliseconds - Little Endian/Intel convention	
1	Byte 0	Status flags	
		Data Length: Unit: Resolution: Range:	8 bit, uint8 - 1 bit Variable
		0x00 = DC-Bus disconnect (Master active), 0x01 = DC-bus connect (High voltage output will be activated), 0x02 = Restart (Used to restart from failure mode)	
2	Byte 1 Byte 2	Main DC voltage, reserved, not implemented.	
		Data Length: Unit: Resolution: Range:	16 bit, uint16 Voltage, DC 0.05V 0 to 3212.75 V
3	Byte 3	Destination network address device	
		Data Length: Unit: Range:	8 bit, uint8 Network address device 0 to 0xFB (default: 0x50)
4	Byte 4 Byte 5 Byte 6 Byte 7	dummy.	
		Data Length:	32 bit

4.4.2 PGN: Change network address device, 0x0FEAD

The received command messages needs to have a length of 8 bytes. Once a new network address is received, it will be stored automatically. The new network address is used instantaneously, no re/boot is required.

0x0FEAD -Change network address device			
Periodicity: Priority Default: Format:		- - Little Endian/Intel convention	
1	Byte 0	Destination master HV network address	
		Data Length: Unit: Range:	8 bit, uint8 Network address device 0 to 0xFB (default: 0x50)
2	Byte1	New device network address	
		Data Length: Unit: Range:	8 bit, uint8 Network address device 0 to 0xFB
3	Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7	dummy.	
		Data Length:	48 bit