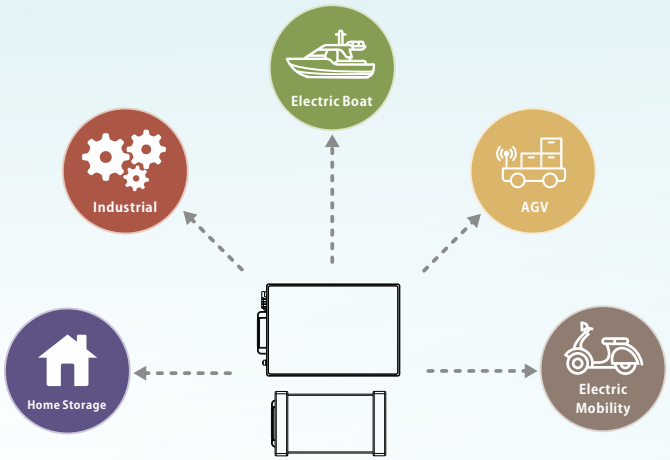
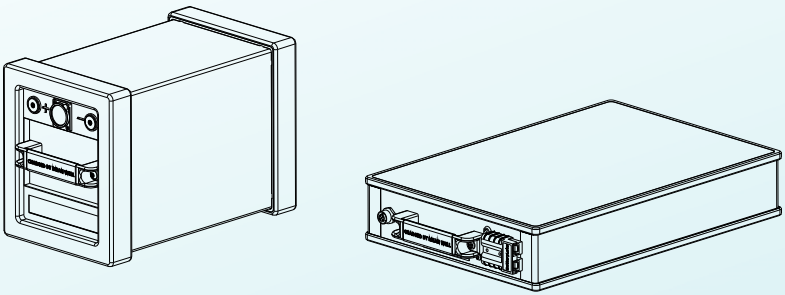
CAN Communication MEAN WELL EUROPE

Charged by



Intelligent Lithium Battery Pack

- *Compatible with multiple MEAN WELL smart chargers*



The intelligent battery pack of QHB and FMB series from MEAN WELL EUROPE are designed for various battery configurations and uses:

The QHB supports 7S-13S (24V-48V) Li-ion and 4S (12V) LiFePO4 batteries. The durable design, consisting of fiber reinforced plastics, makes this battery suitable for operating in harsh environments.

The FMB series is designed for multipurpose use within i-ion 7S (24V), 14S (48V), and 17S (60V) battery setups. This battery is suitable for parallel operation. Due to the modular concept, it is possible to suit the battery with different types of connectors and with or w/o a digital indicator, CAN or Bluetooth connectivity and an IoT database connection.

These batteries are suited for multipurpose use in various environments and applications, providing robust and flexible solutions for battery management and connectivity.

Contents

1) Introduction

This document describes the CAN communication interface. This interface is suitable for both normally-on state BMS types (power on the battery terminals by default) as normally-off type BMS types. In any case of a different approach between the two, this will be mentioned.

The battery pack configuration can consist of a single battery or multiple batteries combined. In case of multiple batteries, one will be 'master' and the others will be 'slaves'. The master communicates as if it were a single 'virtual' battery taking all the slaves' data into account.
A single battery is a 'master' without 'slaves'.
The main process data objects (PDOs) are sent by the master battery.
Individual process data objects (PDOs) are sent by each individual battery. The service data objects (SDOs) are sent and retrieved per individual battery.
Global Battery Service messages may be sent and retrieved by any battery.

2) Battery state

Both the battery pack and all individual batteries have a battery status. The possible states are:

State value	State	Active/passive	Description
10	Standby	Passive	Normally-on BMS: This state is not possible. Normally-off BMS: Default state. Battery disconnected from load, but connectable.
20	Ready	Active	Normally-on BMS: Default state. Normally-off BMS: Battery connected to load but no charge or discharge current.
30	Disengaged	Passive	Battery disconnected from load, not connectable. Battery ran in a safety threshold and paused activation. Once the disengage cause is resolved and the calculated disengage timer expires the battery will: Normally-on BMS: return to ready state. Normally-off BMS: return to standby state.

State value	State	Active/passive	Description
40	Discharging	Active	Battery is discharging.
50	Charging	Active	Battery is charging.
70	Error	Passive	Battery detects unusual behavior and will cut off power. A battery with an Error state will cut off all other batteries for safety reasons, thus; the whole battery pack will enter Error state.

3) Battery start-up sequence (only applicable for normally -off BMS types)

By default, the output power of the battery is turned off and will be in "standby" state (normally off). To achieve output power on the battery terminals there are two stages that must be delt with:

1.Connect the key-pin of the battery to its own positive terminal - or any other voltage supply above 10V that shares the ground with the battery ground. This step will start CAN communication. This step is mandatory before step two will have any effect.

2.Set the 'permission-to-join' variable to true, this may be by PDO message or by waiting 4 seconds if a system has no active batteries while key-pins are connected to positive. For this instance, the battery with highest SOC will be set to true, if multiple batteries have the highest SOC, all of them will be set to true – in case no smart charger is detected. In case there is a smart charger detected the lowest SOC will be set to true.
Once the key-pin connection is disconnected, 'permission-to-join' will be set to false automatically. If no battery should set 'permission-to-join' to true (thus stay in off state) although a key-pin connection has been made, a PDO message can be sent every at least 4 seconds (but try to send it every second) to reset 'permission-to-join' timer. This may only be possible if there is an alternative power source available that powers the node sending the 'permission-to-join' timer reset message.

4) CAN baud rate and termination

Upon request the baud rate can be set to 125, 250, 500 or 1.000 kbps. The **default baud rate is 250kbps**. Baud rate may be altered via CAN PDO message. The CAN does not contain a termination node.

5) Master-Slave ranking

When multiple batteries exist on the same CAN bus, only one of them can be 'master'. The MEAN WELL EUROPE algorithm will address one battery as master. The other batteries will get a successive slave Id.
When the master battery disappears for 5 seconds, all battery node-IDs will be rearranged, and a new master will be appointed.
When a single battery (always 'master', because no others) is added to a system that already has a 'master', internal node-IDs will shuffle, and a new single master will be appointed for the whole system.

6) Messages overview

The MEAN WELL EUROPE CAN communication sends the following messages when the BSI (Battery Status Interface) is not
in start-up or off state. All data will be sent in '**little endian**' format with data type '**unsigned byte**' unless specified. The messages are based on the **CANopen** protocol.

In case of a single or 'master' battery, main process data objects (PDOs) are sent with specific COB-IDs or CAN frame identifiers, based on Node-ID: 15. For individual PDO's and SDO's, the single or 'master' battery will communicate under Node-ID: 15, and the 'slave' batteries will communicate under successive Node Ids: e.g. the first slave Node-ID+1, which is 16 and so on, if more 'slave' batteries are available.
The number of batteries available can be extracted from the PDO message [PACK DATA 1 - COB-ID 18F], by adding up the number of active and the number of passive batteries.

CAN Message Overview

COB-IDs	Communication Object	CAN Message Name	Contents
0x18F	Transmit PDO 1	PACK DATA1	Battery Pack Operational Values 1
0x28F	Transmit PDO 2	PACK DATA2	Battery Pack Operational Values 2
0x40F	Receive PDO 3	INDIVIDUAL DATA REQUEST	Individual Data Request [confidential]
0x38F	Transmit PDO 3	PACK DATA 3	Battery Pack Max Allowed Values
0x48F	Transmit PDO 4	INDIVIDUAL DATA 1	Individual Data 1
0x58F	Transmit SDO	BAT DATA UPLOAD	Individual Battery Data Upload Response
0x60F	Receive SDO	BAT DATA REQUEST	Individual Battery Data Upload Request

CAN Message Content Overview

CAN Message Name	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
PACK DATA 1	Pack SOC All batteries	Pack Voltage				Pack SOC Active batteries	# Active Batteries	# Passive Batteries
PACK DATA 2	Pack State	Pack Current		Smsrt charger connected	Max Pack SOC	Min Pack SOC	Max Pack Temp	Min Pack Temp
PACK DATA 3	Max charge Voltage		Max charge Current		Max discharge Current		Max discharge Voltage	
INDIVIDUAL DATA 1	Permission to join	Heating mode & state	Virtual Identifier (chem type)	Virtual Identifier (cells in series)	Individual SOC	Individual Battery State	Individual Current	Individual Temp
BAT DATA UPLOAD	SDO Overhead	SDO Overhead	SDO Overhead	SDO Overhead	data	data	data	data
BAT DATA REQUEST	SDO Overhead	SDO Overhead	SDO Overhead	SDO Overhead	empty			

7) Battery Pack Operational Values 1: PACK DATA 1

Name	PACK DATA 1
COB-ID	0x18F
Interval	1000 ms
Length	8

Byte	Bit	Data Type	Unit	Offset	Scale	Description
0	-	byte	%	-	-	State of Charge of all batteries (active+passive) [0-100%]
1	-	byte	V	-	1/1024	Voltage
2	-	byte				
3	-	byte				
4	-	byte				
5	-	byte	%	-	-	State of Charge of active batteries only [0-100%]
6	-	byte	#	-	-	Number of Active Batteries
7	-	byte	#	-	-	Number of Passive Batteries

Specification:
[Byte 6] The number of active batteries is batteries that are connected to the CAN bus and can be charged or discharged.

[Byte 7] The number of passive batteries is batteries that are connected to the CAN bus but not able to be charged or discharged. The SOC covers the total of active batteries. Furter information about active and passive batteries can be found in chapter 2 (Battery State).

8) Battery Pack Operational Values 2: PACK DATA 2

Name	PACK DATA 2
COB-ID	0x28F
Interval	1000 ms
Length	8

Byte	Bit	Data Type	Unit	Offset	Scale	Description
0	-	byte	%	-	-	Battery State (see specification)
1	-	byte	A	-	-	Current
2	-	byte				
3	-	boolean	Bin	%	-	Smart charger connected (0=no, 1=yes)
4	-	byte	-	%	-	Maximum Pack SOC
5	-	byte	-	-	-	Minimum Pack SOC
6	-	byte	°C	-55	-	Maximum Pack Temperature
7	-	byte	°C	-55	-	Minimum Pack Temperature

Specification:

Battery States: 10=Standby, 20=Ready, 30=Disengaged, 40=Discharging, 50=Charging, 70=Error

The pack maximum and minimum temperatures concern any pack configuration: from a single battery to any number of combined battery packs.

9) Battery Pack Maximum allowed Values: PACK DATA 3

These values represent the maximum allowed voltage and current in different battery states. These values are real-time calculated by the active algorithm that ensures maximum performance without running into battery safety thresholds. The values are distributed by the virtual master node and will cover the whole battery pack.

Name	Maximum allowed pack values
COB-ID	0x38F
Interval	Approx. 1000 ms
Length	8

Byte	Bit	Data Type	Unit	Offset	Scale	Description
0	-	byte	V	-	*10	Max charge Voltage
1	-	byte				
2	-	byte	A	-	*10	Max charge Current
3	-	byte				
4	-	byte	A	-	*10	Max discharge Current
5	-	byte				
6	-	byte	V	-	*10	Max discharge Voltage
7	-	byte				

10.Individual Battery Data: INDIVIDUAL DATA 1

Name	INDIVIDUAL DATA 1
COB-ID	0x48 + Node ID
Interval	Approx. 1000 ms
Length	8

Byte	Bit	Data Type	Unit	Offset	Scale	Description
0	-	Boolean	Bin	-	-	Only applicable for normally-off BMS: Permission to join. 1 = yes, 2 = no. Permission to join is set automatically by the MEAN WELL EUROPE protocol but may be overruled with the corresponding SDO message.
1	-	Split byte	Bin	-	-	0x00 – 0x0F Heating mode, 0x10 Heating active
2	-	byte	#	-	-	Virtual internal identifier (chem type; 1=li-ion NMC, 2= LiFePO4, 3=Lead acid)
3	-	byte	#	-	-	Virtual internal identifier (cells in series)
4	-	byte	%	-	-	Individual State of Charge [0-100%]
5	-	byte	#	-	-	Individual Battery State (see specification)
6	-	byte	A	-	-	Individual Current
7	-	byte	°C	-55	-	Individual Temperature

Specification:

Battery States: 10=Standby, 20=Ready, 30=Disengaged, 40=Discharging, 50=Charging, 70=Error

11) Global Battery Service Messages

Global service messages will give instructions to all batteries in the system. MEAN WELL EUROPE uses COB-id 0x7F[X] for its service messages. Please reserve all COB-id's in range 0x7F0 up to 0x7FF for MEAN WELL EUROPE Global Battery Service Messages.

Name	Permission-delay-reset (only applicable for normally-off BMS)
COB-ID	0x7FA
Interval	1.000ms (3.000ms margin)
Length	1
Description	Normal operation of the battery pack tries to have the highest SOC batteries active while discharging and the lowest SOC batteries while charging (with a smart charger – regenerative breaking and such is not taken in to account for this matter). The Permission-delay-reset message will give more control to the user. [0x7FA 0]: batteries will **not** turn on/off automatically. [0x7FA 1]: batteries will turn on/off automatically but will **not** switch to a battery with a higher SOC if this is added to the pack while discharging, nor will the pack switch to a battery with a lower SOC if a charger is activated. Note that it is advised to send this message every second. By using [0x7FA 0] in combination with the 'Permission to join pack' SDO message it is possible to take more control of the system.

Byte	Bit	Data Type	Unit	Offset	Scale	Description
0	-	Boolean	#	-	-	0: reset delay-to-join-timer + reset delay-to-jump-timer. 1: reset delay-to-jump-timer.

12) Individual Battery Service Values: BATTERY DATA REQUEST

Individual battery service responds with answers displayed in data field 0-3, little endian.

Name	BAT DATA REQUEST
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x40	CS	SDO Overhead
1	*Specification	Index 0	SDO Overhead
2	*Specification	Index 1	SDO Overhead
3	*Specification	Sub-index	SDO Overhead
4	0	Data 0	Empty
5	0	Data 1	
6	0	Data 2	
7	0	Data 3	

*Specification (values in DEC):

Data Specification	Explanation	Battery serial	Battery capacity*	Battery SOH	VendorID (CiA)	Product code (CiA)	Revision number (CiA)	Serial number (CiA)
Index 0	Index low byte (Unsigned16, LSB)	30	10	30	24	24	24	24
Index 1	Index high byte (Unsigned16, MSB)	60	61	62	16	16	16	16
Sub-index	Sub-index (Unsigned8)	0	0	0	1	2	3	4

* Datafield 0-1, little endian: full capacity (Ah), datafield 2-3, little endian: remaining Capacity (Ah)

13) Individual Battery Smart Charger Integration and Additional Protocols

Several types of smart charger protocols can be activated. On default, all protocols are activated.

Name	Smart charger protocols
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	80(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	Protocol type
5	*Specification	Data 1	On/off
6	0	Data 2	0
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	Protocol type	1 - 5	1: Victron 2: MeanWell 3: DeltaQ 4: ChineseJ1939 5: Zivan
Data 1	Protocol on/off	0 - 1	0: off 1: on

14) Individual Battery LEDs: LEDs flash while charging

Name	BAT LED flash while charging
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	77(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	Charge LED option
5	0	Data 1	0
6	0	Data 2	0
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	Charge LED option	0 - 4	0: No LEDs while charging 1: LEDs rolling while charging 2: LEDs rolling while charging + smart charger 3: LEDs blinking while charging 4: LEDs blinking while charging + smart charger

The battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO. The LED charge option will be stored in the EEPROM.

15) Individual Battery LEDs: Battery LED sequence activation

For specific purposes the LEDs of the batteries can be activated in different sequences.

Name	BAT LED SEQUENCE ACTIVATION
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	45(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	LED sequence choice
5	*Specification	Data 1	LED interval speed
6	*Specification	Data 2	LED sequence duration
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	LED sequence choice	1 - 4	1: All 5LEDS on 2: All 5 LEDs blinking 3: Outside to inside blinking 4: 'Knight rider'
Data 1	LED interval speed	0 - 255	[10 ms] example: value 15 -> interval speed 150 milliseconds
Data 2	LED sequence duration	0 - 255	[1 sec] example: value 20 -> sequence duration20 seconds Remark: 255(0xFF) will trigger an infinite timer, only to be expired after the key pin is cut off (battery removed from connecter base).

The battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO.

16) Individual Battery Permission to Join Pack (Only applicable for normally-off BMS)

While the automatic permission to join function aims to have the highest SOC batteries activated so when draining those subsequential batteries will join when reaching those SOC levels, it is possible to take control by sending the periodic "permission-to-join-delay-reset" in a 1 second frequency while using this individual battery permission to join pack message to appoint batteries that can join your active battery pack.

Name	Permission to join pack
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	55(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	Permission to join
5	0	Data 1	0
6	0	Data 2	0
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	Permission to join	0 - 1	0: false 1: true

The battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO.

17) Individual Battery Set Baud rate

It is possible to change the baud rate of the battery. After adjusting the baud rate the communication driver will restart, this will also cause the battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO.

Name	Battery CAN Baudrate
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	75(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	CAN Baudrate
5	0	Data 1	0
6	0	Data 2	0
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	CAN Baud rate	1 - 4	1: 125kbps 2: 250kbps 3: 500kbps 4: 1000kbps

The battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO. Switching the Baud rate will cause an automatic restart of the battery.

18) Individual Battery Heating Activation

Battery heating Mode 3 is activated by default. Any change of mode will be stored in the eeprom of the battery and can only be changed by a CAN bus command with just one exception; When operating in Mode 4 and an SOC of <2% is reached, the Mode will switch to Mode 0 automatically.

Name	BAT HEATING ACTIVATION
COB-ID	0x600 + Node ID
Interval	Not applicable
Length	8

Byte	Data Value	CANopen Specification	Description
0	0x23	CS	SDO Overhead
1	10(dec)	Index 0	SDO Overhead
2	35(dec)	Index 1	SDO Overhead
3	0	Sub-index	SDO Overhead
4	*Specification	Data 0	Heating mode options
5	0	Data 1	0
6	0	Data 2	0
7	0	Data 3	0

*Specification (values in DECIMALS):

Data Specification	Description	Data Value Range	Info + examples
Data 0	Heating mode option	0 - 4	The explanation of the modes can be found in the schematic below.

The battery will respond to the received SDO with a 0x580 + Node ID message with a CS: 0x60 and all other values corresponding to the values of the received SDO.

The base condition for starting heating is the measured battery temperature ≤2 °C. Additional conditions can be found in this schematic:

Additional conditions	Heating will start with or without any measured current	Heating will start at any measured charge current	Heating will start at any discharge current	Battery cells will be cut-off at any charge current
Mode 0	NO	NO	NO	NO
Mode 1	NO	NO	NO	YES
Mode 2	NO	YES	NO	YES
Mode 3	NO	YES	YES	YES
Mode 4	YES	NO	NO	NO

Heating will stop after one of the following actions:

- Battery temperature reaches 16°C.
- Heating time calculated by algorithm expires.

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