



# MG Master LV Battery Management Controller Installation Guide

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Innovation in energy storage  
Version 2.0 – 20-04-2023 MG Master LV  
Battery management controller – Manual –  
MG Master LV 12V (all models)  
MG Master LV 24-48V (all models)  
MG Master LV 72-96V (all models)  
MG Energy Systems B.V.

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## Master LV Battery Management Controller



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## GENERAL

Before continuing read the instructions in this chapter carefully and be sure the instructions are fully understood. If there are questions after reading the instructions please consult MG Energy Systems.

### 1.1 Document history

Table 1 – Document history

Revision	Changes	Revision author
20-04-2023	Layout changes – Added new pictures – Added new information and clarifications F:F	M. Scholten

### 1.2 Terms, definitions, and abbreviations

Table 2 – List of terms, definitions, and abbreviations

Battery cell	The smallest building block in a battery, a chemical unit with a positive and negative terminal.
Battery cell cassette	An assembly of a cassette with a battery cell.
Battery cell block	An assembly of multiple battery cassettes.
Battery module	An assembly of battery cell cassettes including BMS.
Battery pack	Consists of one or more battery modules in combination with a battery management controller (BMS).
Battery system	Consists of one or multiple battery packs connected to a common DC-bus.
Battery management controller	Controls, manages and protects one or multiple battery modules.
BMS	Battery Management System that is integrated in the battery pack.
Master BMS	Shorthand for a battery management controller in a MG energy systems battery system.
Slave BMS	The part of the BMS that is integrated in the battery module.
Redundancy BMS	The redundancy BMS that is integrated in the battery module.
Boundary limit	A boundary limit consists of two level values, a set and a clear value, combined with a time condition.
EMS	Energy Management System; The EMS controls all power sources and consumers in a system in which a battery system may be a component.

DC-bus	Is the main DC-bus of the application where all user equipment is connected too, like generators, propulsion systems and other chargers and loads.
CAN-bus	Controller Area Network bus; CAN-bus Is a standard serial data bus that provides data communication between two or more devices.
HVIL	High Voltage Interlock Loop; is a wire loop which is created for protection of disconnecting cables from the battery system while in operation. It isolates the electrical connections of the batteries from the system when loop is not closed.
ATC	Allow-to-charge – A digital output used to control chargers.
AID	Allow to discharge — A digital output used to control loads.
Warning	A warning is a condition of such level causing the BMS to report a warning not critical to system operation, however counter action is needed to avert triggering fail-safe state. According the rules of DNV-GL the definition of a condition of this level is a pre-warning.
Failsafe	A condition of adequate level that causes an Alarm causing the battery pack to go in to failsafe state.
SOC	State-of-Charge – reflects the level of charge of a battery pack or battery module relative to its capacity. The units of SOC are percentage points where 0% indicates fully discharged and 100% indicates fully charged.
SOH	State-of-Health – reflects the level of health of a battery pack or battery module relative to its initial capacity.

### 1.3 This revision

This revision replaces all previous revisions of this document. MG Energy Systems B.V. has made every effort to ensure that this document is complete and accurate at the time of writing. In accordance with our policy of continuous product improvement, all data in this document is subject to change or correction without prior notice.

### 1.4 Scope

This product manual contains technical description, installation, safety and commissioning instructions and other relevant information for the MG Master LV series.

#### 1.4.1 Document structure

This document is structured into three categories:

- System design: Guidelines and general recommendations for system integrators and designers.
- Installation, commissioning and maintenance: Procedures and instructions for installers and maintenance personnel.
- Operation: Instructions and procedures for general users.






### 1.5 Related documents

More related documents for the MG Master LV can found on our Download Center.

## SAFETY INSTRUCTIONS

### 2.1 Safety message level definition

Table 3 – Safety message levels overview

	<b>WARNING:</b> A hazardous situation which, if not avoided, could result in death or serious injury.
	<b>CAUTION:</b> A hazardous situation which, if not avoided, could result in minor or moderate injury.
	<b>LIMITATION:</b> A limitation to use which must be considered for safe use of the equipment.
	<b>ELECTRICAL HAZARD:</b> The possibility of electrical risks if instructions are not followed in a proper manner.
	<b>NOTICE:</b> A potential situation which, if not avoided, could result in an undesirable result or state. A practice not related to personal injury.

## 2.2 User health and safety

### 2.2.1 General precautions

This product is designed and tested in accordance with international standards. The equipment should be used according to the intended use only.



#### **WARNING:**

A battery is a permanent energy source which cannot be turned off.



#### **ELECTRICAL HAZARD:**

- Wear applicable personal protective equipment when working on a battery system.
- Use insulated tools when working on a battery system.
- Make sure the local health and safety regulations for working on battery systems are followed.
- There is a risk of electrocution and burns when working on higher voltage systems without proper protective gear and special training.

### 2.2.2 Qualifications and training

The personnel responsible for the assembly, operation, inspection, and maintenance of the battery system must be appropriately qualified. The user company must do the following tasks:

- Define the responsibilities and competency of all personnel working on the battery system.
- Provide instruction and training.
- Ensure that the contents of the operating and safety instructions have been fully understood by the personnel.
- Check the local safety rules and guidelines; they have higher preference over the manufacturer's specification in case of regulatory conflicts.
- Working on higher voltages requires specific training and certification. Instructions and training can be carried out by MG Energy Systems B.V. by order of the user company.

### 2.2.3 Non-compliance risks

Failure to comply with all safety precautions can result in the following conditions:

- Death or serious injury due to electrical, mechanical, and chemical influences.

- Environmental damage due to the leakage of dangerous materials.
- Product damage.
- Property damage.
- Loss of all claims for damages.

#### **2.2.4 Risk assessment**

For every integration of the battery system it is mandatory to perform a risk assessment.

Goal of the risk assessment is to identify the hazards and determine the corresponding risks for the particular application.

The following topics need to be addressed:

- Fire hazards (fire from the batteries, fire from external source etc.)
- Environmental hazards (moisture, water ingress, vibration, heat etc.)
- Electrical hazards (short-circuit, cable dimensioning, cable routing etc.)
- Installation and operational hazards (lifting, communication, power loss etc.)

#### **2.2.5 Unacceptable modes of operation**

The operational reliability of this product is only guaranteed when it is used as intended. The operating limits on the identification tag and in the data sheet may not be exceeded under any circumstances. If the identification tag is missing or worn, contact MG Energy Systems B.V. for specific instructions.

### **TRANSPORT, STORAGE, UNPACKING AND HANDLING**

The package and transport instructions provided by the manufacturer must be followed under all circumstances.



#### **NOTICE:**

No liability can be accepted for damage during transport if the equipment is not transported in its original packaging or if the original packaging is opened before the destination is reached.

#### **3.1 Storage**

The storage instructions provided by the manufacturer must be followed in all circumstances.

Notes on storage:

- Store in a dry and clean location.
- Store in the original packaging.
- Special instructions are in place to store a fully connected system.

##### **3.1.1 Storage of a connected system**

Special instructions need to be considered when storing a fully connected system.

In a fully connected system the Master LV will always draw a small current. This can drain the batteries and damage them. To prevent this, consider the following instructions for longer periods of storage.

Instructions for a fully connected system:

- Charge the batteries between 50% and 80% State-Of-Charge.
- Disconnect the batteries from the MG Master LV. For example remove the fuses from the battery side.

##### **3.1.1.1 Storage time of a connected system**

The storage time of a full connected system depends on the number of batteries connected and the standby power of the MG Master LV. This standby power is the consumption when the MG Master LV is in standby, meaning that the main safety contactor is open. Table ... shows the different power consumptions of the different MG Master LV types at different voltages.

**Table 4 – Standby consumption**

	<b>Master LV 12V @12V</b>	<b>Master LV 24V-48 V @24V</b>	<b>Master LV 24V-48 V @48V</b>	<b>Master LV 72V-96 V @72V</b>	<b>Master LV 72V-96 V @96V</b>
Current	0.63 mA	1.66 mA	1.83 mA	≤ 10 µA	≤ 10 µA
Power	8.06 mW	42.50 mW	93.70 mW	≤ 0.77 mW	≤ 1.02 mW

Example storage time calculation 1 (50% SOC):

A system with 1x MG Master LV 12V and 2x a MG LFP 12V battery module.

When the batteries are at 50% State-Of-Charge there will be  $210\text{Ah} \times 2 \times 50\% = 210\text{ Ah}$  available capacity. The standby current is 0.63 mA. This means the storage time until the battery is fully discharged will be  $210\text{ Ah} / 0.63\text{ mA} = 333333.33\text{ Hours} = 13889\text{ Days} = \text{approx. } 38\text{ years}$ .

Example storage time calculation 2 (2% SOC):

A system with 1x MG Master LV 12V and 2x a MG LFP 12V battery module.

When the batteries are at 50% State-Of-Charge there will be  $210\text{Ah} \times 2 \times 2\% = 8.4\text{ Ah}$  available capacity. The standby current is 0.63 mA. This means the storage time until the battery is fully discharged will be  $8.4\text{ Ah} / 0.63\text{ mA} = 1333\text{ Hours} = 56\text{ Days}$ .

### 3.2 Unpacking and handling

Follow these handling guidelines when handling the product to prevent damage during unpacking:

- Use care when handling the product.
- Leave protective caps and covers on the product until installation.



#### **CAUTION:**

Always take the local applicable standards and regulations regarding the prevention of accidents into account when handling the product.



#### **CAUTION:**

Be aware of the total mass of the product and do not lift heavy objects unassisted.

#### 3.2.1 Scope of delivery

The scope of delivery is as following:

- MG Master LV of any type as described in chapter 5.1
- 2x Connector Terminal Block Plug 1×6 5.08mm – MG5000230
- 1x RJ45 terminator (bag of 2) – MGRJ45000010
- 1x Quick installation guide – MG Master LV



#### **NOTICE:**

Not within the scope of delivery:

- Fuses.
- Power cables and connectors.
- Communication cables and connectors.

Detailed information about the MG Master LV can be found in our Download Center.

<p><b>MG Download Center</b></p> 	<p><b>Manual Master LV</b></p> 
<a href="https://downloads.mgenergysystems.eu/masterlv/documents">https://downloads.mgenergysystems.eu/masterlv/documents</a>	<a href="https://downloads.mgenergysystems.eu/masterlv/documents/manual-en">https://downloads.mgenergysystems.eu/masterlv/documents/manual-en</a>
<p><b>Instruction Videos</b></p> 	<p><b>MG LinkedIn</b></p> 
<a href="https://www.youtube.com/channel/UCLCwjlgJDIRBMZ3hgFEkJvQ">https://www.youtube.com/channel/UCLCwjlgJDIRBMZ3hgFEkJvQ</a>	<a href="https://www.linkedin.com/company/mg-energy-systems">https://www.linkedin.com/company/mg-energy-systems</a>

## GENERAL DESCRIPTION

The MG Master LV is the safety and control unit of the battery.

This battery management controller is exclusively for low voltage systems in the range of 12 Vdc up to 96 Vdc. It protects the connected battery modules against over-charging, over-discharging, and temperature extremes. Furthermore the MG Master LV controls the balancing on cell and module level. Protecting, monitoring and controlling a battery system is essential for creating a safe, reliable and easy-to-use system.

Besides the safety function, the Master LV monitors and tracks all relevant parameters to give insight in the battery status and energy consumption. It collects for instance information about the state of the battery system like State-Of-Health, State-Of-Charge and keeps track of all events.

### 4.1 Battery system components

An MG Energy Systems Lithium-Ion battery system consists of the following components:

- One or multiple MG Master LV;
- One or multiple battery modules of the same type (HE Series, LFP 24V Series, LFP 12V Series, RS Series);
- MG Energy Monitor (optional);
- MG SmartLink MX for parallel redundant control (optional);

### 4.2 All in one design



The MG Master LV guarantees a safe operation of your MG battery system. All essential components for a safe and reliable battery system are integrated in this compact designed device. It contains e.g. a safety contactor, fuse holders and DC distribution to ensure safe operation of your energy system with MG battery modules.

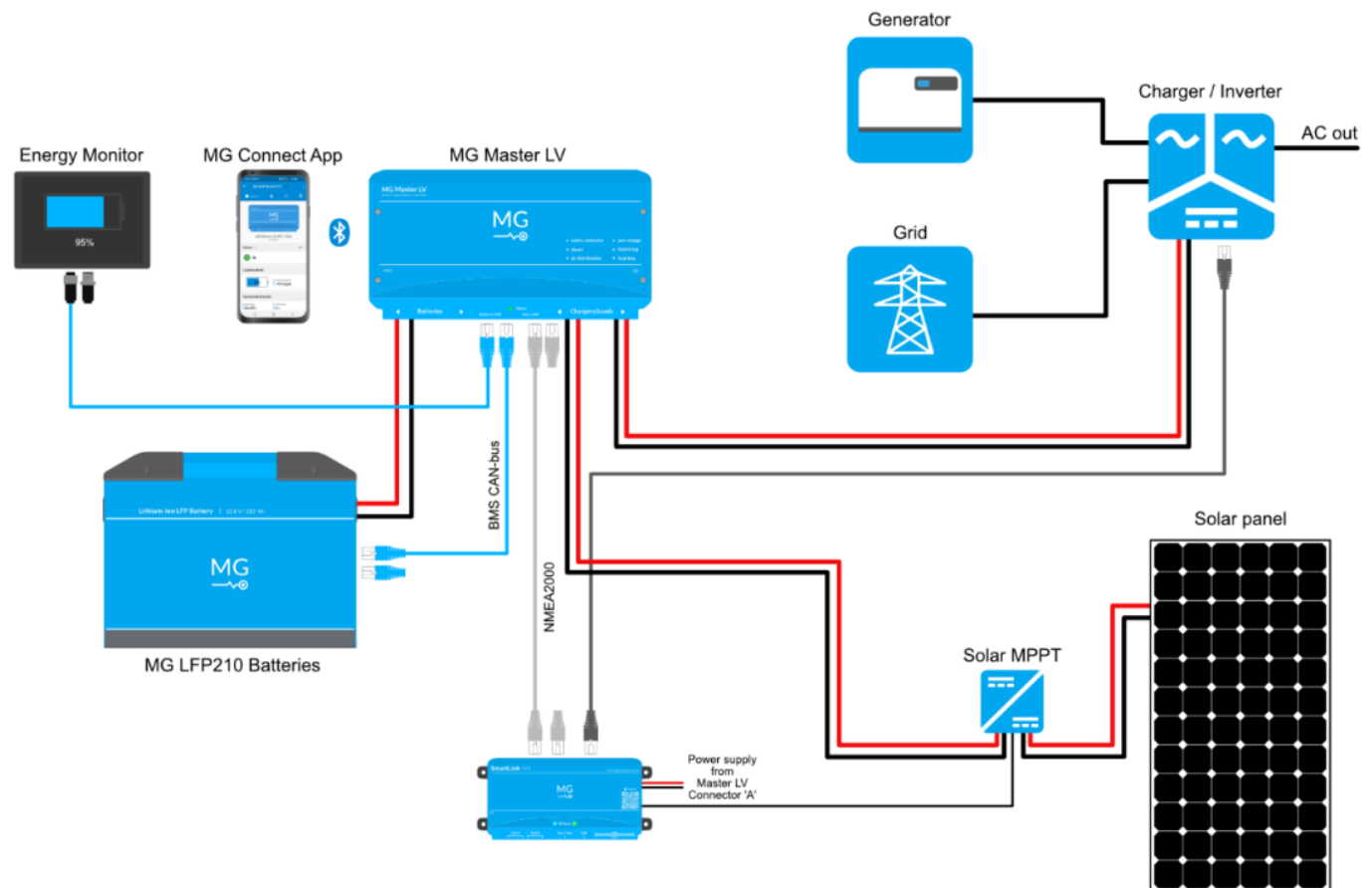
- Fuse box
- DC distribution
- Shunt
- Battery monitoring

The Master LV is easy to install in your MG battery system, thanks to the integrated safety components. Therefore it requires less cables and external equipment. This results in a quick Plug and Play installation. The integrated CAN-Bus automatically detects the configuration and updates the firmware of the batteries when a new version is available.

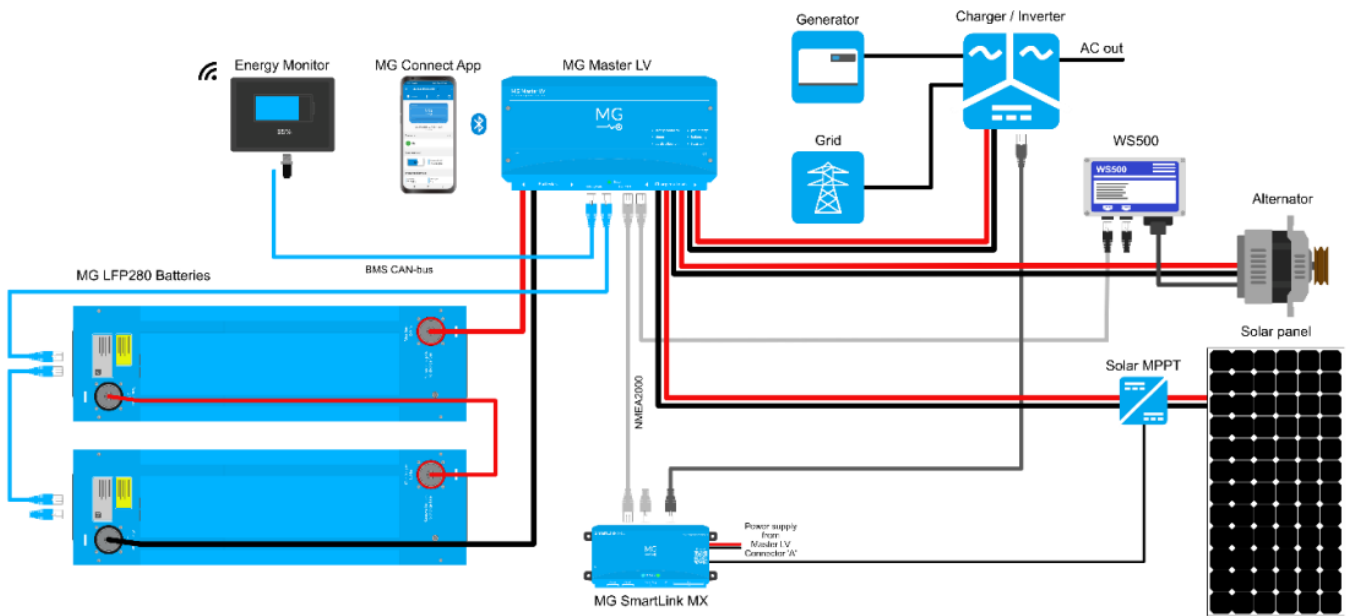
### 4.3 Example systems

The Master LV is a versatile battery management controller. Different system configurations can be made, from a small 12 V system up to a parallel redundant propulsion or ESS system. Contact MG Energy Systems B.V. for more information about possible configurations.

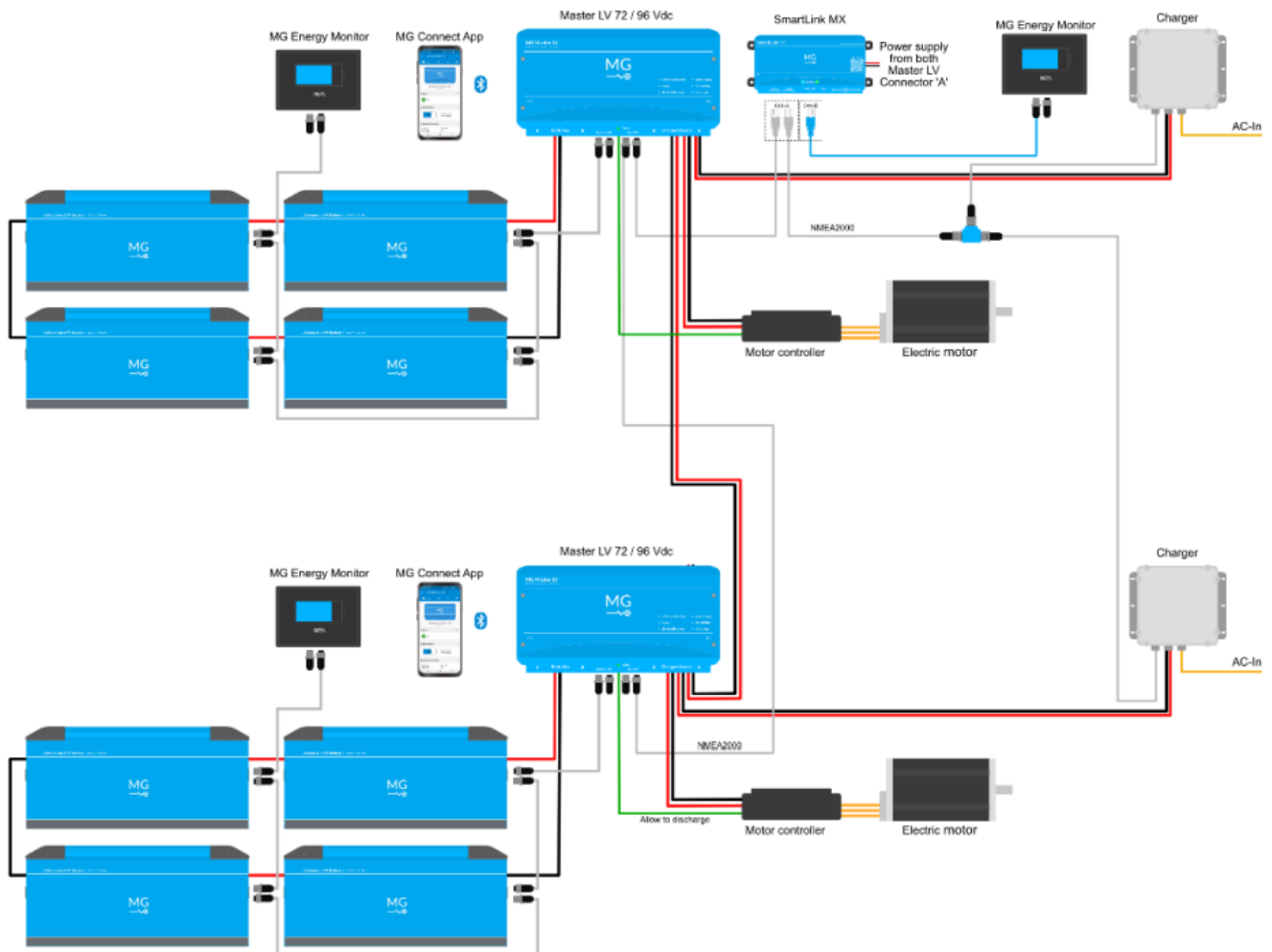
#### 4.3.1 Basic 12 V system



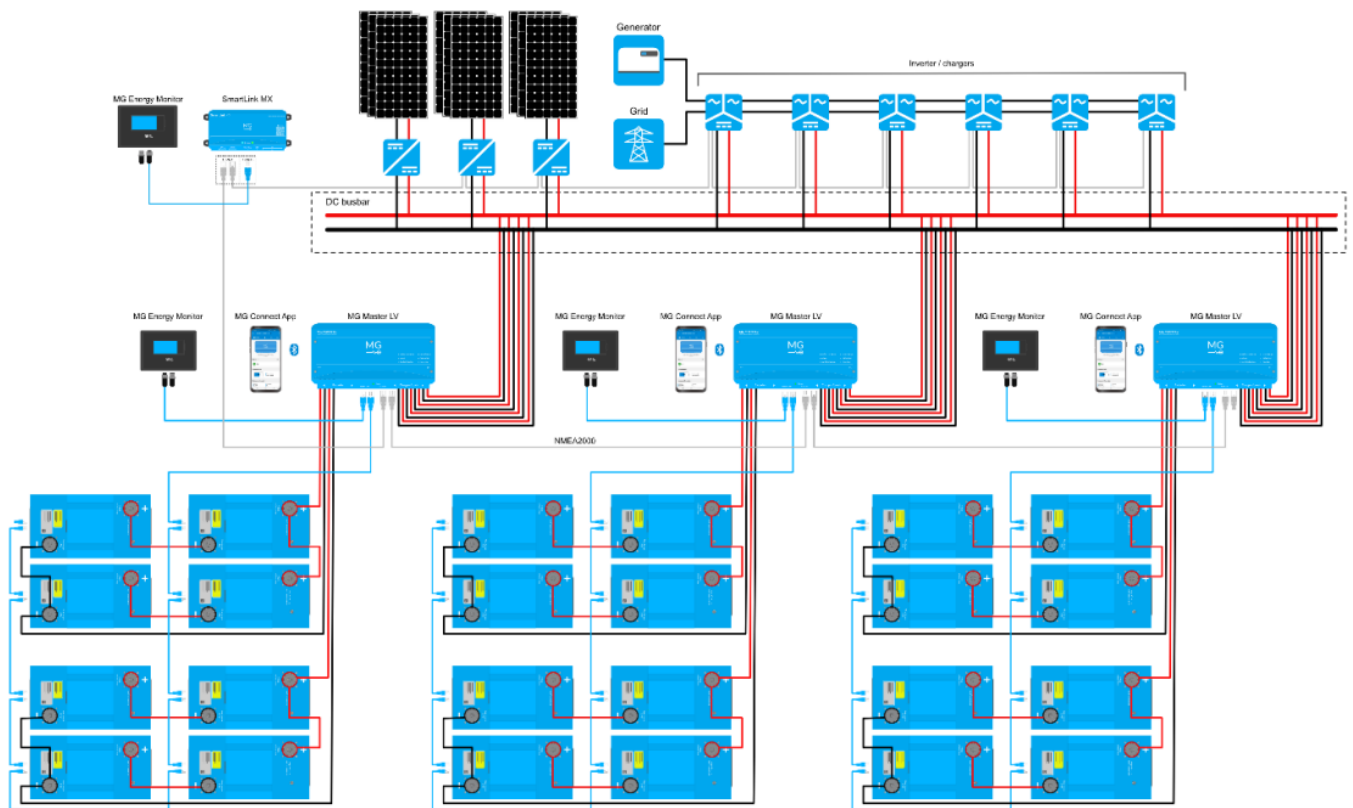
#### 4.3.2 Basic 48 V system



### 4.3.3 Basic 96 V propulsion system



### 4.3.4 Basic ESS system



## DEVICE MODELS

### 5.1 Models and configurations

The Master LV consists of a complete range of models used for different system voltages. On all models are RJ45 CAN-Bus connectors available. The models with “(M12)” indications shows that this product has additional M12 CAN-Bus connectors.

#### 5.1.1 Master LV for 12 V systems

Product	Article number
MG Master LV 12V/150A	MGMLV120150 (Discontinued)
MG Master LV 12V/400A	MGMLV120400
MG Master LV 12V/600A	MGMLV120600
MG Master LV 12V/1000A	MGMLV121000

#### 5.1.2 Master LV for 24 V and 48 V systems

Product	Article number
MG Master LV 24-48V/150A	MGMLV480150 (Discontinued)
MG Master LV 24-48V/400A	MGMLV480400 (Discontinued)
MG Master LV 24-48V/600A	MGMLV480600 (Discontinued)
MG Master LV 24-48V/1000A	MGMLV481000 (Discontinued)
MG Master LV 24-48V/150A (M12)	MGMLV481150 (Discontinued)
MG Master LV 24-48V/400A (M12)	MGMLV481400 (Discontinued)
MG Master LV 24-48V/600A (M12)	MGMLV481600 (Discontinued)
MG Master LV 24-48V/1000A (M12)	MGMLV481001 (Discontinued)
MG Master LV 24-48V/150A (M12)	MGMLV482150 (Discontinued)
MG Master LV 24-48V/400A (M12)	MGMLV482400
MG Master LV 24-48V/600A (M12)	MGMLV482600
MG Master LV 24-48V/1000A (M12)	MGMLV481002
MG Master LV 24-48V/1000A (M12) Pc+	MGMLV481003

### 5.1.3 Master LV for 72 V and 96 V systems

Product	Article number
MG Master LV 72-96V/500A	MGMLV960500 (Discontinued)
MG Master LV 72-96V/500A (M12)	MGMLV961500 (Discontinued)
MG Master LV 72-96V/500A (M12)	MGMLV962500

## 5.2 Identification label

The identification label of the MG Master LV is located at the left side of the device.

Example identification label:

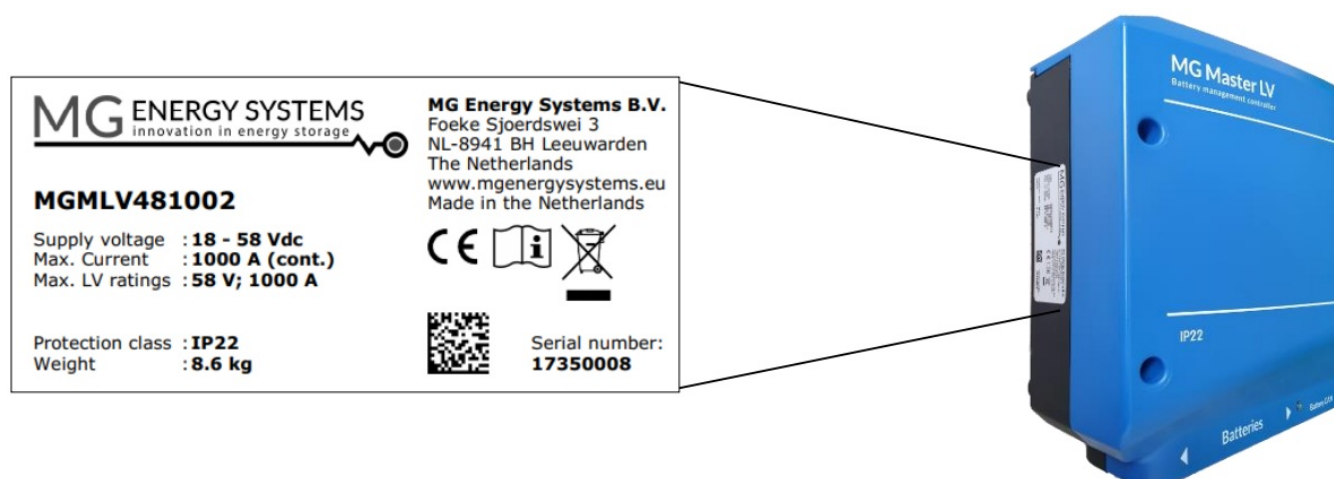






Figure 1 - Example identifications label

The identifications label shown in figure 1 contains written information about the product. The explanation of the symbols used on the identification label is stated in table 5.

**Table 5 – Identification label logo explanation**

	Declaration of conformity with health, safety, and environmental protection standards for products sold within the European Economic Area as per directive 2014/35/EU.
	Symbol indication the manual must be read before installation and use of the device.
	Device is treated according the Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU.
	GS1 data matrix type barcode containing detailed product information.

**5.2.1 Additional labels**

Figure 2 – Additional warning and informational labels shows the additional labels on the MG Master LV. This label can be found inside the product when the cover is removed.

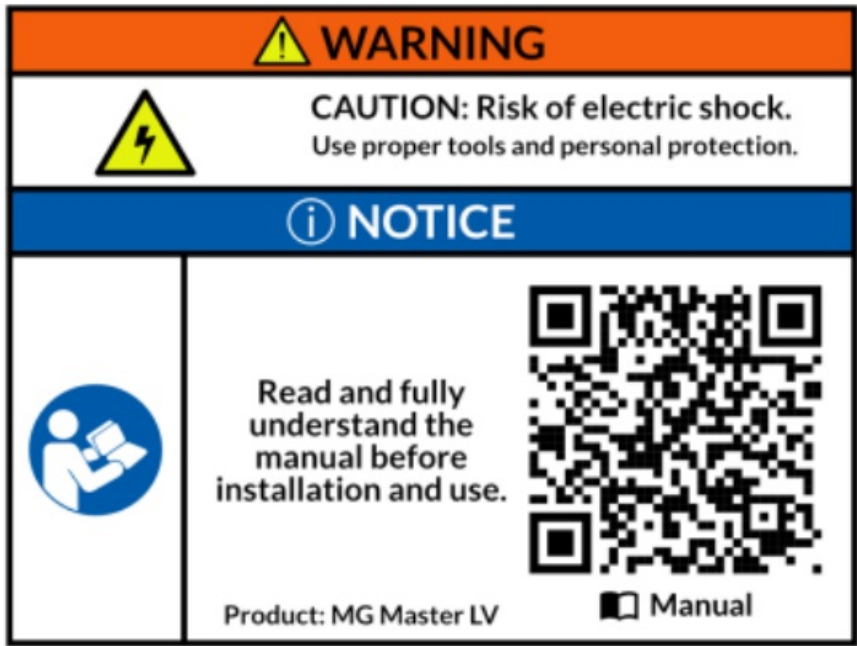


Figure 2 - Additional warning and informational labels

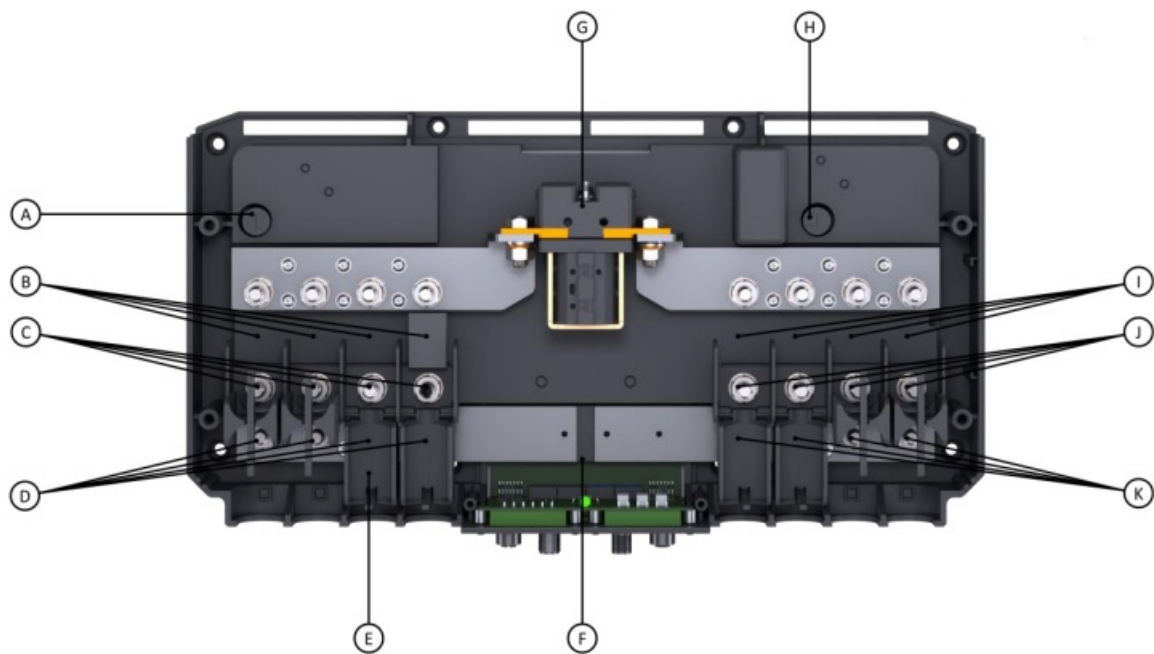
**5.3 Approvals and standards**

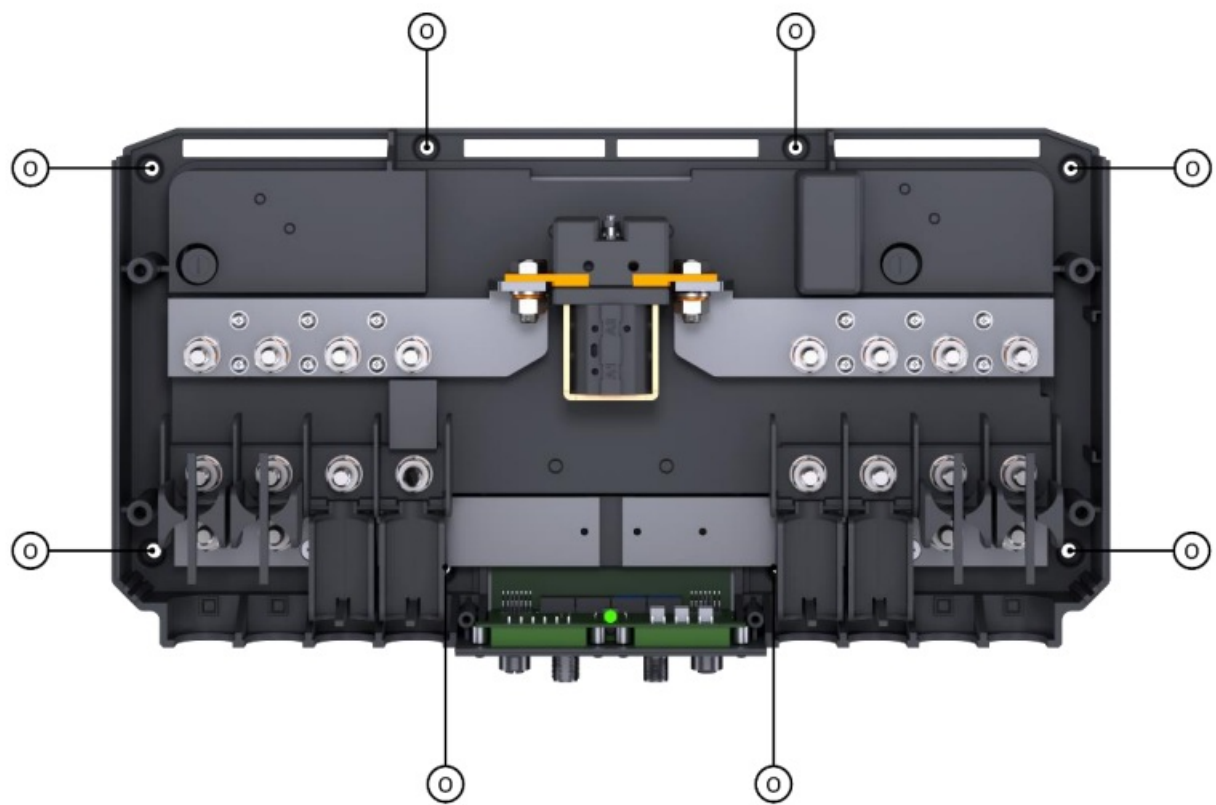
The MG Master LV certificates and tests can be found in the Download Center.

**OVERVIEW**

This chapter shows and overview of the MG Master LV.

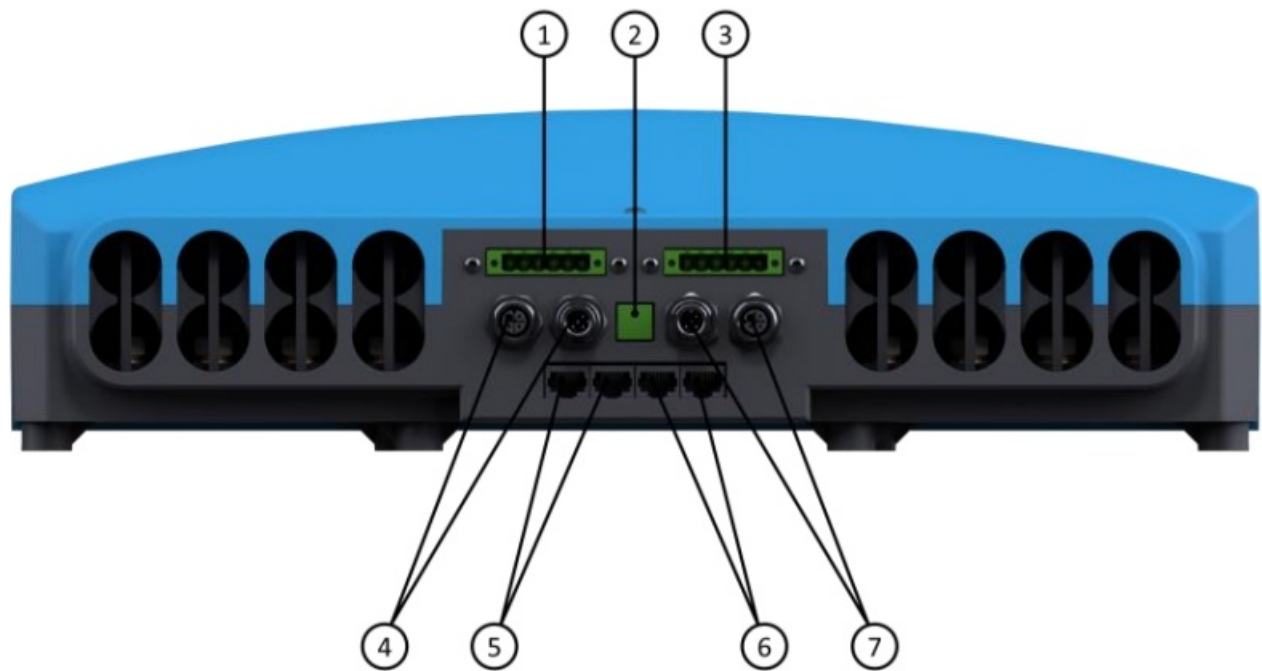
**6.1 General overview**





Part	Description
A	Main fuse for control electronics
B	Battery fuses (MEGA fuse size)
C	Positive power terminals for battery connections (M8 bolt connections)
D	Negative power terminals for battery connections (M8 bolt connections) (located under the insulation caps)
E	Insulation caps
F	Shunt
G	Main safety contactor
H	Pre-charge fuse
I	Loads/charger fuses (MEGA fuse size)
J	Positive power terminals for loads/charger connections (M8 bolt connections)
K	Negative power terminals for loads/chargers connections (M8 bolt connections) (located under the insulation caps)
L	Status LED
M	Enclosure cover
N	Mounting screws
O	Mounting points

## 6.2 Connector overview



Part	Description
1	I/O connector 'A'
2	Start/stop button
3	I/O connector 'B'
4	BMS CAN-Bus connectors M12
5	BMS CAN-Bus connectors R145
6	AUX. CAN-Bus connectors R145
7	AUX. CAN-Bus connectors M12

### 6.3 Connection details

This chapter will highlight the different connections for power, communication and IOs.

#### 6.3.1 I/O connectors

Figure 3 and Table 6 shows the pinout of the I/O connectors.





Figure 3 - Pinout of IO connectors

Table 6 – IO Connector specification

Connector pins and specifications					
Conn.	Pin	I/O	Voltage	Current	Purpose
A	1	Out	13,5 V	1 A	Aux. power output
	2	Out	13,5 V	1 A	Allow-to-Charge
	3	Out	13,5 V	1 A	Allow-to-Discharge
	4	In			External start button
	5	Out	13,5 V	140 mA	External status output
	6	–			GND
B	1	Out	Max. 60 VDC	0,8 A @ 60 VDC	Allow-to-charge
	2				
	3	Out	Max. 60 VDC	0,8 A @ 60 VDC	Allow-to-discharge
	4				
	5	Out	Max. 60 VDC	0,8 A @ 60 VDC	Programmable output
	6				

**NOTICE:**

The outputs of connector A are NOT isolated. Meaning the GND (pin 6) is connected to the battery GND. This is important when the battery system is potential wise a floating system and other equipment is power from connector A and connected to chassis GND.

**6.3.2 CAN-Bus connections**

The MG Master LV consists of several CAN-Bus connections. In basic there are two CAN-Bus ports with each M12 and RJ45 connection possibilities. Chapter 6.2 shows the different ports and connections.

On one side are the BMS CAN-Bus connections and on the other side are the AUX. CAN-Bus connections. Due to the different connection options, M12 or RJ45, there can be multiple ways to connect the CAN-Bus to the batteries or connect other equipment. The consequence is that correct termination of the CAN-Bus need to be taken into account. For example if the batteries are connected to the BMS CAN-Bus M12 connection of the Master LV, it can be terminated in the last battery with an M12 terminator and in the MG Master LV with a RJ45 terminator.

**NOTICE:**

The BMS CAN-Bus RJ45 and M12 connections are all internally connected in parallel except for the Male M12 port as shown in Figure 4. This is a return port only for specific functionality for example Emergency stop and Interlock loop monitoring.

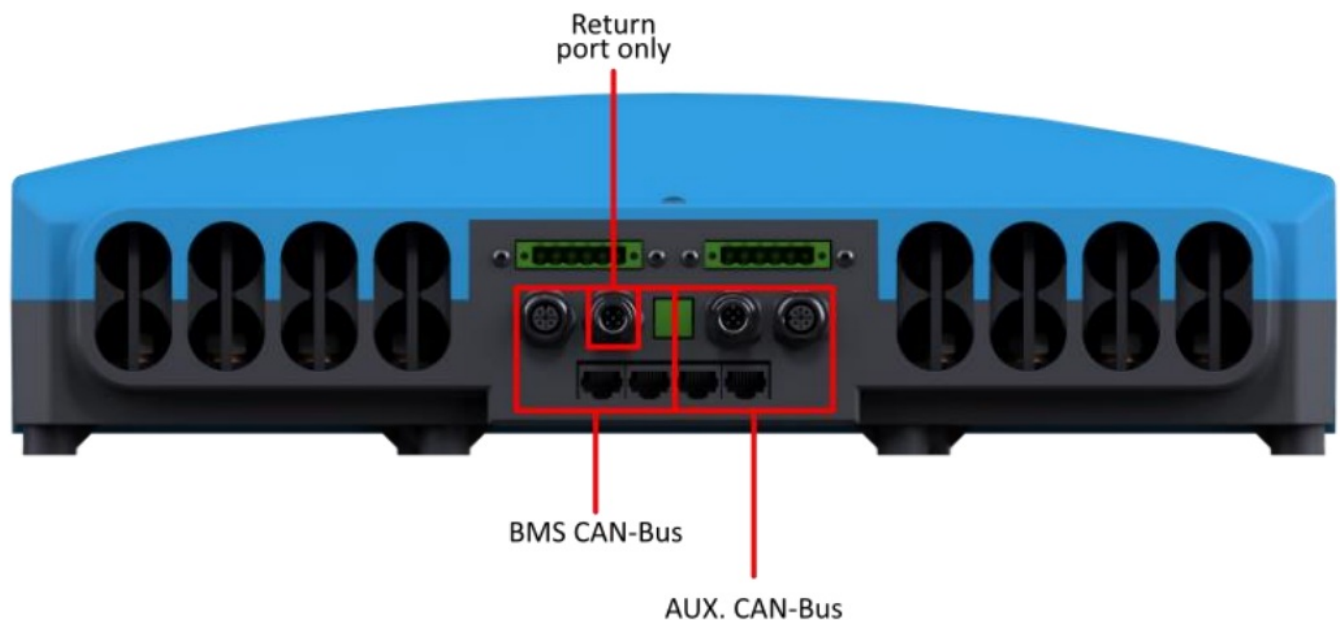


Figure 4 - CAN-Bus connections overview

**NOTICE:**

The AUX. CAN-Bus RJ45 and M12 connections are all internally connected in parallel.

**NOTICE:**

The AUX. CAN-Bus RJ45 and M12 connections are all internally connected in parallel.

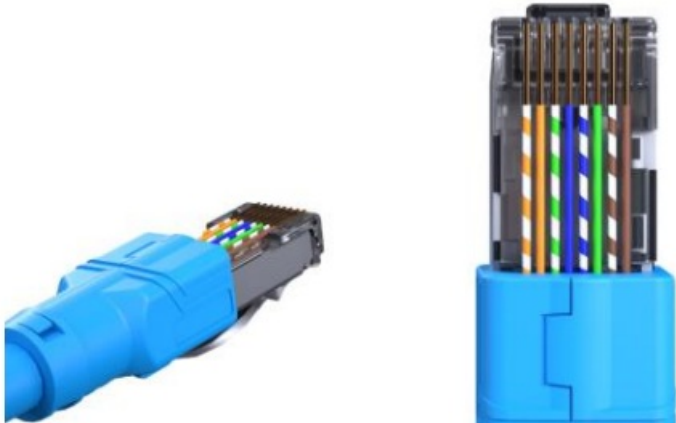
**NOTICE:**

The AUX. CAN-Bus is not supplying any power to the CAN-Bus.

**6.3.2.1 RJ45 Connector details**

Typical cables that are used for the RJ45 CAN-Bus connections are standard CAT 5 Ethernet network patch cables.

**Table 7 – RJ45 connector details**

Pin	Description	Connector view
1		<div> <div>T-568B</div> <div>12345678</div>  </div>
2		
3	GND	
4		
5		
6	V+	
7	CAN-H	
8	CAN-L	






#### NOTICE:

Always use standard prefabricated Ethernet network patch cables (straight).

#### 6.3.2.2 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 8 – Circular M12 connector with 5 positions A-coded details**

Pin	Description	Connector view
1	Shield	<div> <div>M12, 5-pin, A-coded</div>  </div>
2	V+	
3	GND	
4	CAN-H	
5	CAN-L	
		<div> <div>  <p>Male</p> </div> <div>  <p>Female</p> </div> </div>

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 (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<sup>2</sup> (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.

#### 6.3.3 Power connections

The power connections consist of M8 bolts. There is a positive bus bar and a negative bus bar to mount the cables to. Four sets of cable can be mounted to the left side of the Master LV and four sets of cables can be mounted to the right side of the Master LV.

The maximum diameter that can be connected is 95 mm<sup>2</sup>.



#### NOTICE:

It is possible to connect a 120 mm<sup>2</sup> cable, but this is depending on the dimensions of the cable lug and fuse if it fits.

#### 6.4 Fuses

Different type of fuses are used in the MG Master LV.

##### 6.4.1 Power fuses

The Master LV has the possibility to add fuses to each positive power connection. The location of these fuses is stated in chapter 6.1 items "B" and "I".

There are a limited number of fuses that fit. Table 9 shows a list of possible fuse types that fit inside the MG Master LV.

**Table 9 – Fuse types that fit inside the MG Master LV**

Fuse type	Voltage
MEGA Fuse 32V BF2 fuse (little fuse)	32V: Used for 24V systems
MEGA Fuse 58V BF2 fuse (little fuse)	58V: Used for 48V systems
FWA 150V (Bussmann)	150V: Used for systems up to 150V (the MG Master LV can handle voltages up to 60V max. For higher voltage contact the manufacturer.)



#### NOTICE:

- Some applications require to install fuses in the positive and negative power lines.
- Local rules and regulations may require other type of fusing. For example T class fuses.

##### 6.4.2 Pre-charge fuse type

The pre-charge fuse is to protect the built-in pre-charge circuit. A specific type of fuse is used as showed in the table below.

Fuse type	Description
Bel Fuse 5HT 10-R	5x20mm Time-Lag surge withstand, high breaking capacity, ceramic body cartridge Fuse. 10 A / 250 V

### 6.4.3 Main fuse type

The main fuse protects the control electronics of the BMS. When this fuse is broken then contact MG Energy Systems B.V..

Fuse type	Description
MULTICOMP PRO MC000850	5mm × 20mm Ceramic Fast Blow Fuses. 6.3 A / 250 V

### 6.5 Status indication

The status indicators are a two colour LED and a buzzer. These indicate the state of the Master LV.

For example it is in failsafe mode it will blink in a particular way and beeps in sync with this. The meaning of those blinks and beeps can be found in chapter 6.5.

### 6.6 Main safety contactor

The MG Master LV contains a main safety contactor. Chapter 6.1 show the location of the safety contactor inside the MG Master LV. This contactor is of a non-latching type which means that if it is not powered it will be open and the batteries are isolated from any charging or discharging equipment.

**Table 10 – List of contactors and maximum currents**

Product post-fix from different types	Maximum current
MG Master LV type xx /150A	150 A
MG Master LV type xx /400A	400 A
MG Master LV type xx /600A	600 A
MG Master LV type xx /1000A	1000 A
MG Master LV type xx /500A	500 A

Each contactor type has a different power consumption rating when closed. This is specified in chapter 0.

### 6.7 Pre-charge circuit

Each MG Master LVs contains an integrated pre-charge circuit. This is used to pre-charge capacitive loads before closing the main safety contactor. It prevents high inrush current from damaging the main safety contactor and capacitive loads.

The pre-charge circuit consist of a relay, a resistor and a fuse. The capability of the circuit inside the Master LV is different for each type. Table 11 shows a list of the different values.

**Table 11 – Pre-charge capability per MG Master LV type**

Product	Pre-charge capability
MG Master LV 12V	Maximum pre-charge capacity is 2 F
MG Master LV 24-48V	Maximum pre-charge capacity is 300 mF
MG Master LV 24-48V Pc+	Maximum pre-charge capacity is 2 F
MG Master LV 72-96V	Maximum pre-charge capacity is 50 mF

#### 6.7.1 DC consumers during pre-charging

In some cases the Master LV needs to pre-charge a DC-bus that is not only capacitive, but also DCloads are connected that will instantly use power when a voltage is applied. This can cause the Master LV to fail in pre-charging the DC-bus. It will go to failsafe and in some cases the pre-charge fuse will break.

To prevent the pre-charge from failing during the start of the system, a solution would be to switch DC-loads with a DC/DC converter or relay controlled by the allow-to-discharge contact. During the start of the system the allow-to-charge is inactive and the DC-loads should be off. When the main safety contactor is closed the allow-to-

discharge will be active and the DC-loads get power.

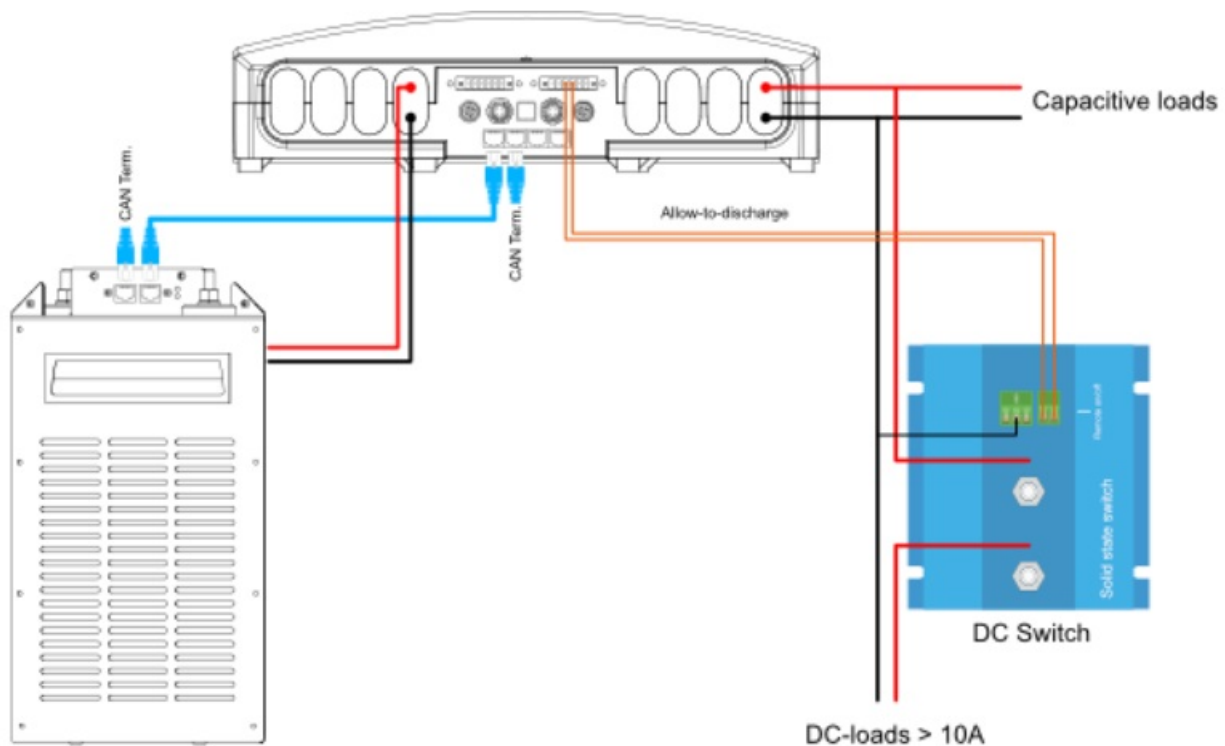


Figure 5 - Example schematic with a solid state switch for the DC consumers

## INTEGRATION REQUIREMENTS AND INSTRUCTIONS

This chapter describes the necessary requirements and instructions for integration of the battery module into the application.

### 7.1 Risk assessment

Performing a risk assessment for the integration of a battery system is mandatory. Depending on the application, specific rules might apply.

MG Energy Systems can supply the necessary basic documentation for risk assessment.



#### NOTICE:

Before integration design check the applicable rules for the application where the battery system will be integrated in.

### 7.2 Location

The location of the battery system needs special attention, since some regulatory body categorize Lithium-Ion battery systems as hazardous. Check for the local rules for the requirements of the battery system location in the used application.

The MG Master LV is a switching device and can produce sparks. Therefore some local rules and standards state NOT to install the MG Master LV in the battery space.

General recommendations and requirements for the battery space with respect to the battery module are as following:

- Make sure the battery space is in accordance with the applicable rules.
- Ensure the battery space complies with the operating conditions of the batteries.
- Do not place the batteries next to a heat source.
- Take into account the placement requirements of the particular battery type.

#### 7.2.1 Environment

The MG Master LV has an IP rating of IP22 and must be placed in a space that is moisture and dust free, non-condensing and protected against fluid (water, oil etc.) ingress from top and bottom.

### **WARNING:**

Moisture or water can damage the MG Master LV and its electronics. This might lead to dangerous situations.

#### **7.3 Placement**

The product must be installed in a dry and well-ventilated area, as close as possible to the batteries.

Mount vertically (recommended) or horizontally:

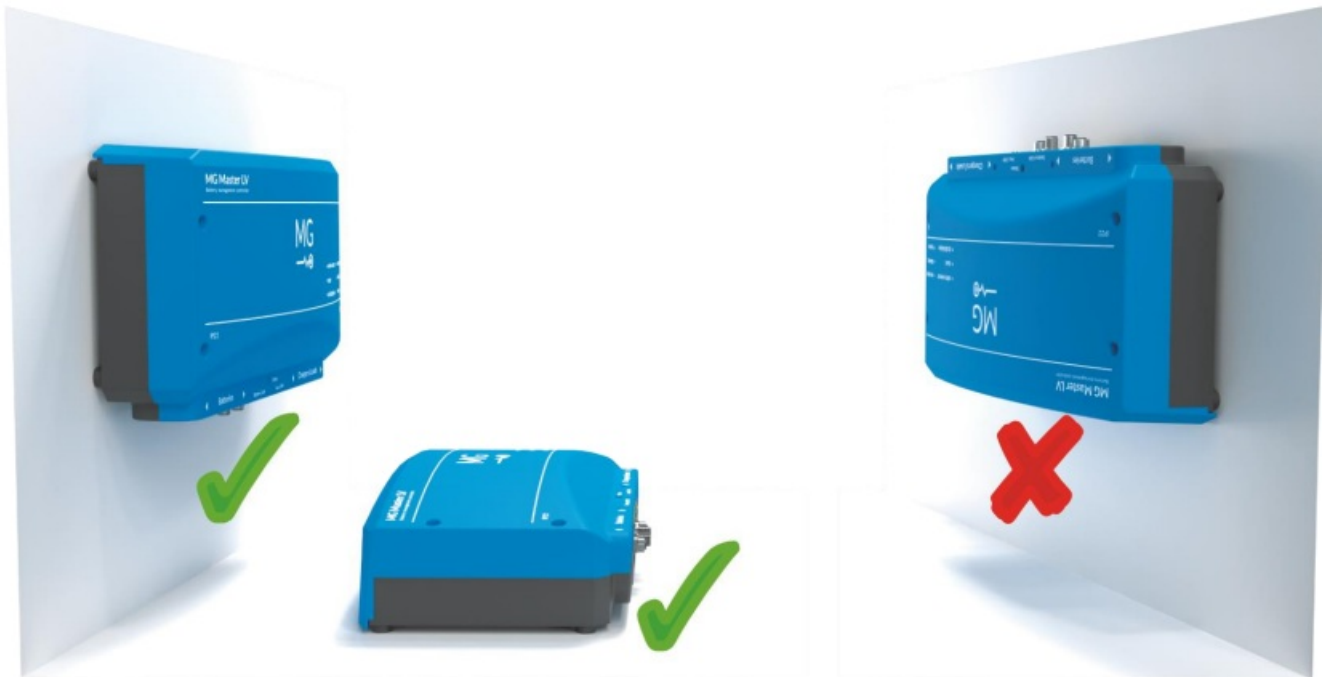


Figure 6 - Placement options

#### **7.4 Basic operation goals**

The basic goals of a system in operation are as following:

- The MG Master LV is in control of any charger and/or loads connected.
- The main safety contactor never opens during normal operation of the MG Master LV.
- The MG Master LV protects the Lithium-Ion battery bank in any case. In emergency cases it can open the main safety contactor to isolate the battery bank from any chargers and/or loads.

##### **7.4.1 Control of chargers**

The control of chargers by the MG Master LV can be achieved using CAN-Bus or IO-level control.

##### **7.4.2 Control of loads**

The control of loads by the MG Master LV can be achieved using CAN-Bus or IO-level control.

#### **7.5 Chargers**

Charge voltage is depending on the connected battery type. These values can be found in the battery's specific manual.

- RS Battery
- LFP 24V battery
- LFP 12V battery
- HE Battery

#### **7.6 Powering devices from the Master LV**

The MG Master LV has an Aux. power supply on connector 'A' as specified in chapter 6.3.1. 3 party equipment can be powered from this. The main advantage is that when the main safety contactor is opened in case of a failsafe

event, this power supply port will be powered for 10 minutes. rd One of the use cases is that the MG SmartLink MX is powered from this supply or even from multiple MG Master LVs in redundant systems.

- MG SmartLink MX

### 7.7 Communication protocol for 3rd party integration

The MG Master LV can communicate on the AUX. CAN-Bus port to 3 party equipment. The default protocol that is used is MG NMEA2000 at 250 kbit/s. For new system designs we recommend to use this protocol for integration. Refer to the communication guide for details about the communication protocols.

## INSTALLATION

Read the installation instructions in this chapter before commencing installation activities.  
Additional information for installation:

- Installation video's: MG Master LV
- Quick installation guide: MG Master LV
- Technical drawings
- Application Notes



### **WARNING:**

Before continuing make sure the following instructions are met:

- Ensure that the connection cables are provided with fuses and circuit breakers.
- Never replace a protective device by a component of a different type.  
Refer to the ordering information sections of this manual or contact manufacturer for a correct replacement.
- Before switching the device on, check whether the available DC bus voltage range conforms to the configuration of the product as described in the manual.
- Ensure that the equipment is used under the correct operating conditions.  
Never operate it in a wet or dusty environment.
- Ensure that there is always sufficient free space around the product.
- Install the product in an environment that can sustain some heat. Ensure therefore that there are no chemicals, plastic parts, curtains or other textiles, etc. in the immediate vicinity of the equipment.



### **ELECTRICAL HAZARD:**

- Wear applicable personal protective equipment when working on a battery system.
- Use insulated tools when working on a battery system.
- Make sure the locale health and safety regulations for working on battery systems are followed.

### 8.1 Tooling

The required tools during installation are the following:

- Phillips screwdriver PH1 and PH2 (insulated);
- Torque wrench M8 (13 mm) (insulated);



## 8.2 Installation procedure

Below the basic installation procedures:

1. Mounting the MG Master LV;
2. Connecting the power cables for the chargers and loads;
3. Connecting the power cables for the batteries;
4. Connecting CAN-Bus communication cables to the batteries;
5. Connecting CAN-Bus communication cables to an external CAN network;
6. Connection IO cables (optional);

## 8.3 Mounting procedure

Before mounting first remove the top cover of the device.

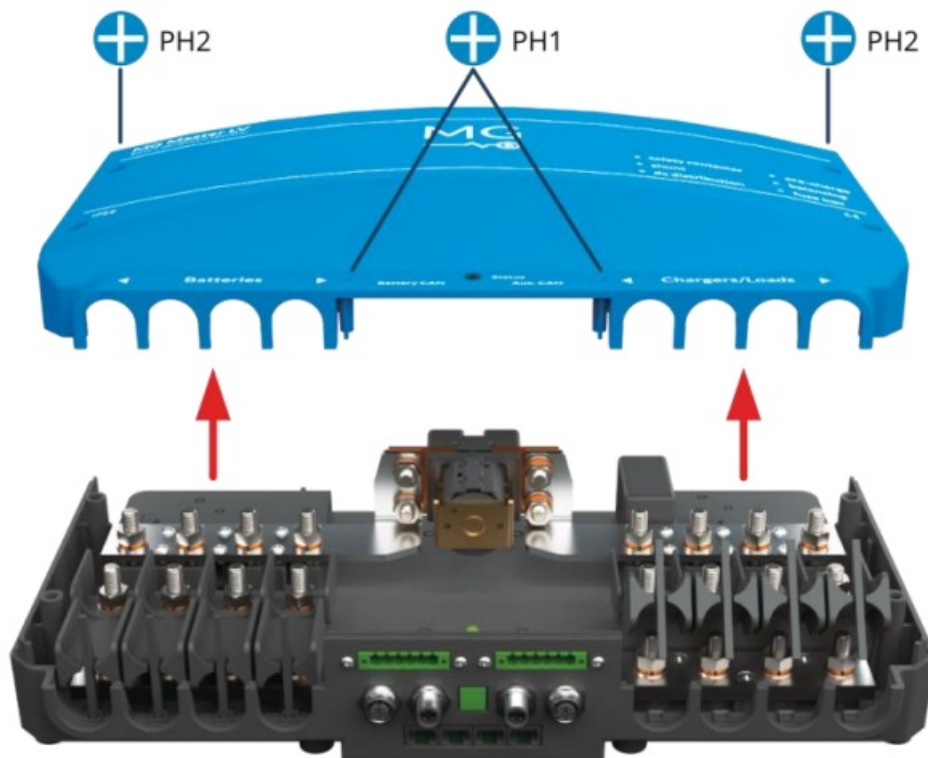
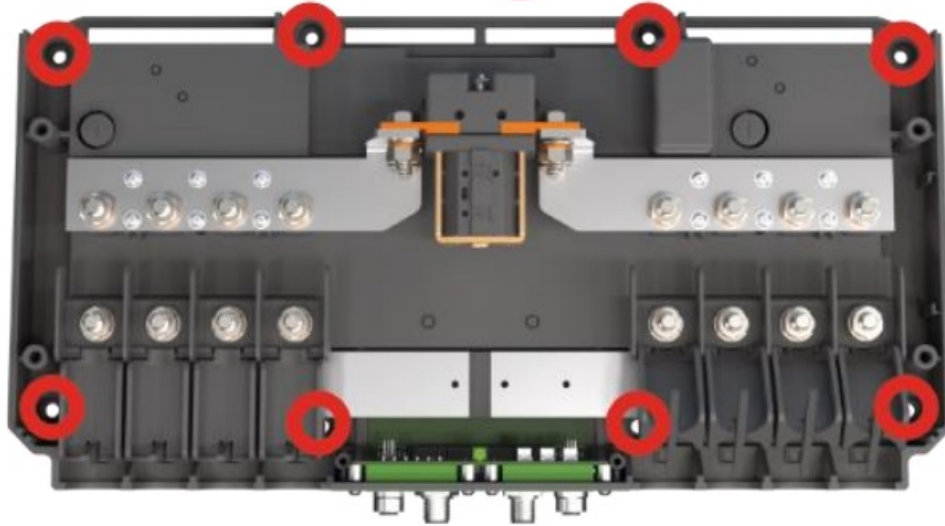


Figure 7 - Remove cover

Mount the MG Master LV using the mounting holes indicated in chapter 6.1 item "O".

# Mounting Holes



## 8.4 Connecting the power cables for the chargers and loads

The power cables to the chargers and loads should be connected first. These must be connected at the chargers and loads side of the Master LV (right side) as shown in Figure 8.

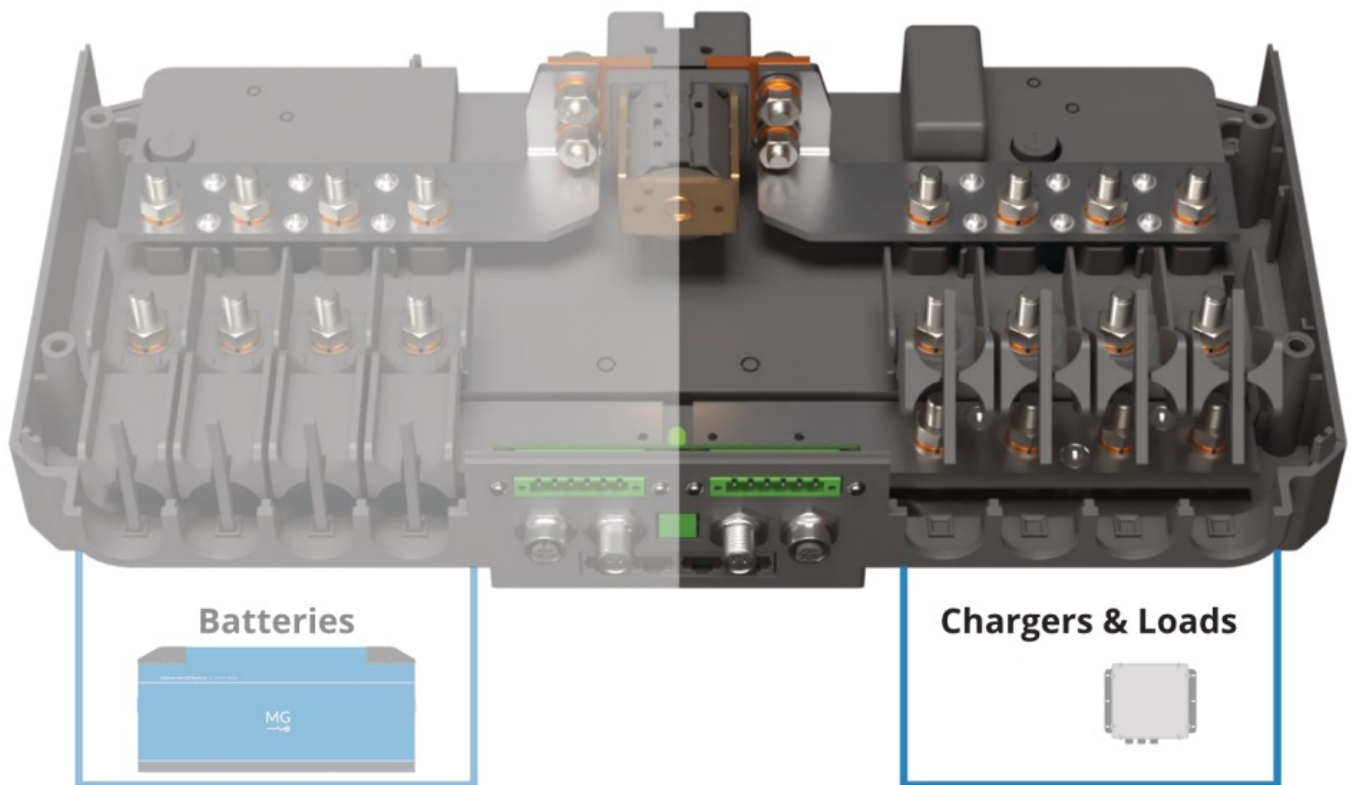
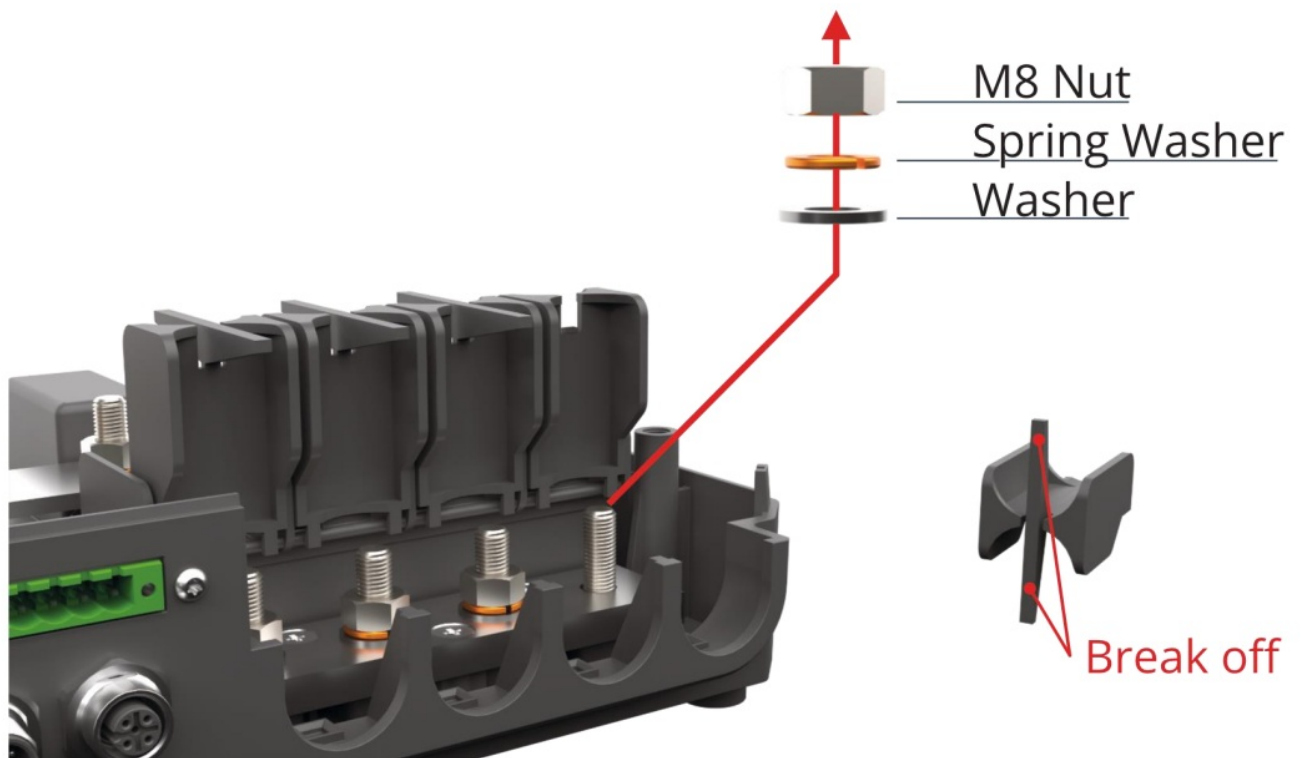
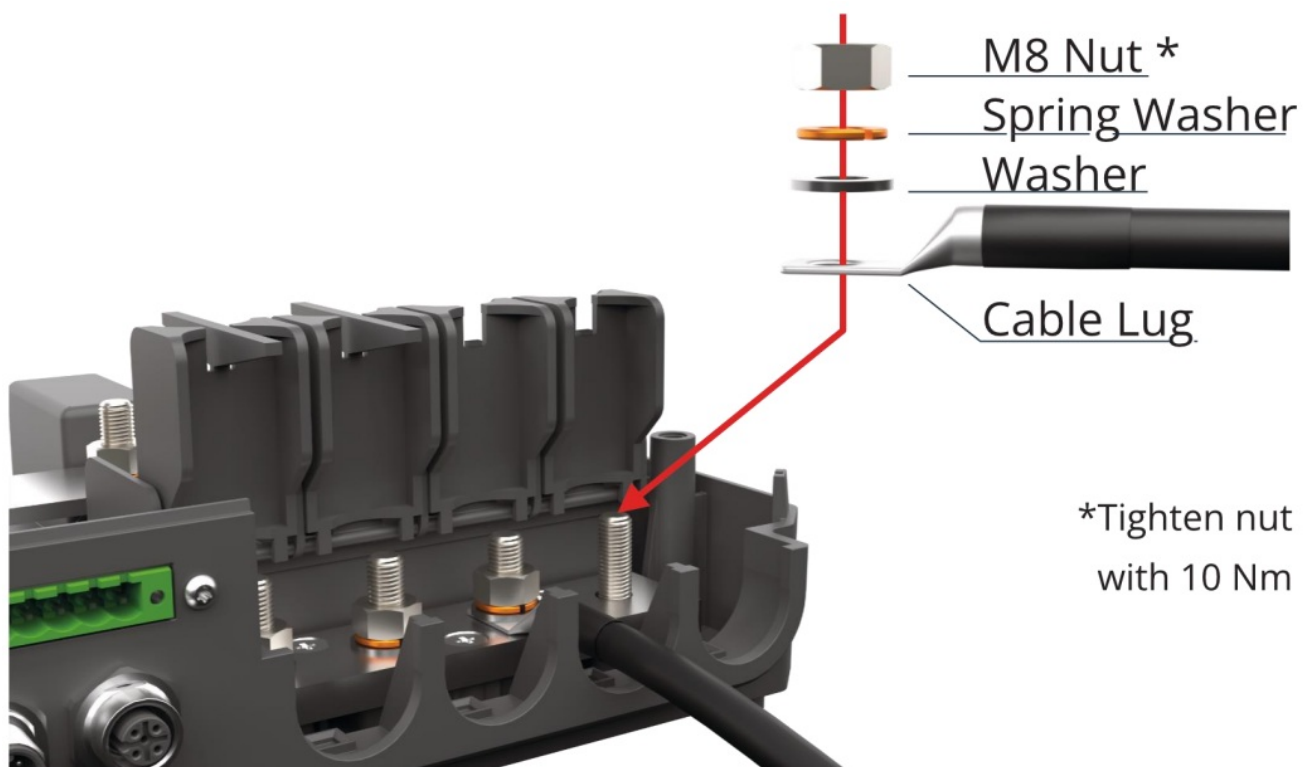


Figure 8 - Chargers and loads power connections

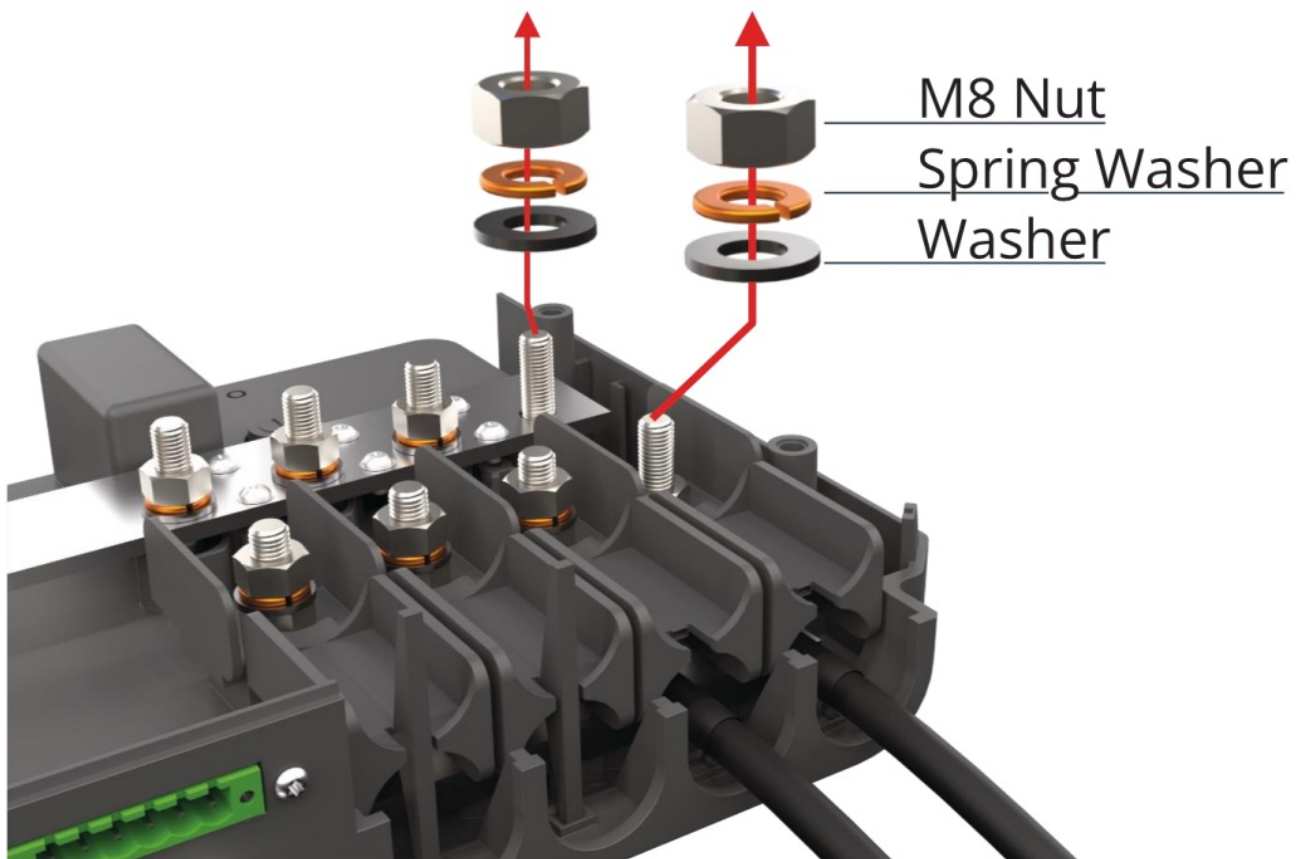
1. Remove the nut, spring washer and washer from the negative bolt connection.



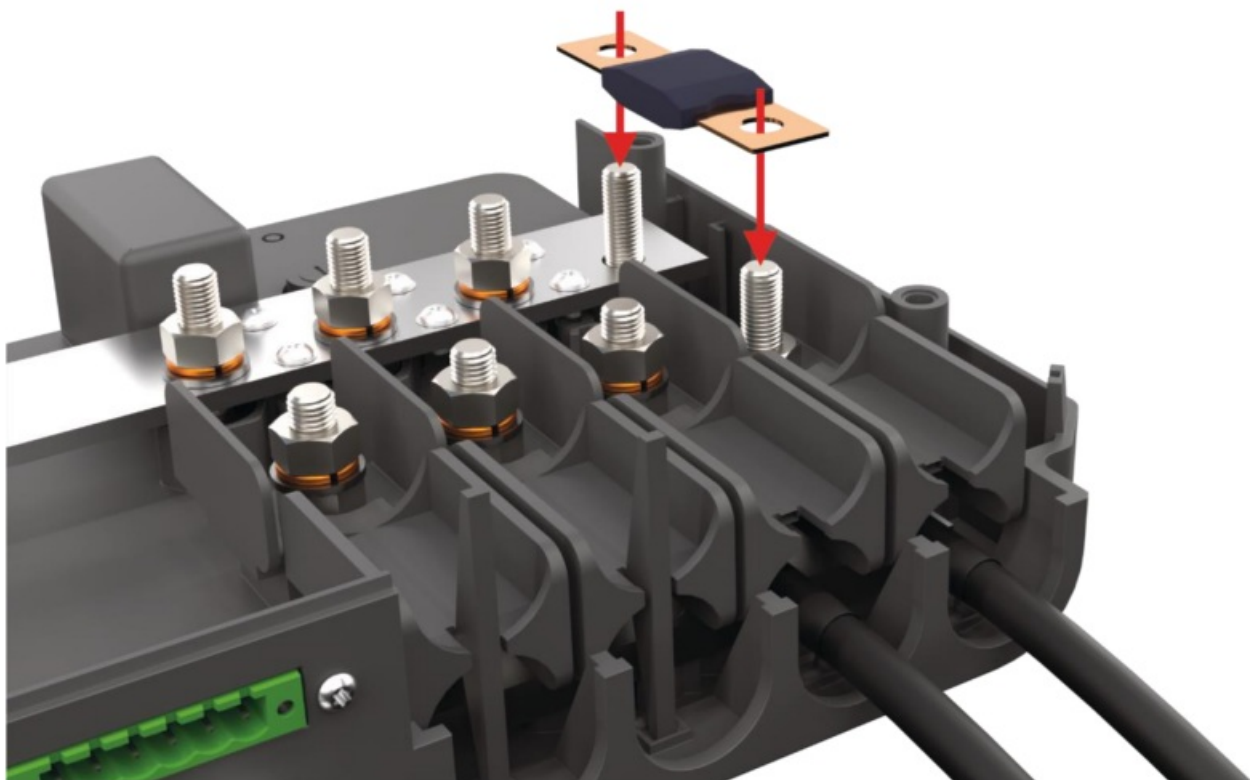
2. Place the negative power cable on the bolt and place washer, spring washer and nut back on the bolt. Tighten the nut with 10 Nm.



3. Remove the nut, spring washer and washer from the positive bolt connections.



4. Place the fuse on the positive connection bolts **first**.

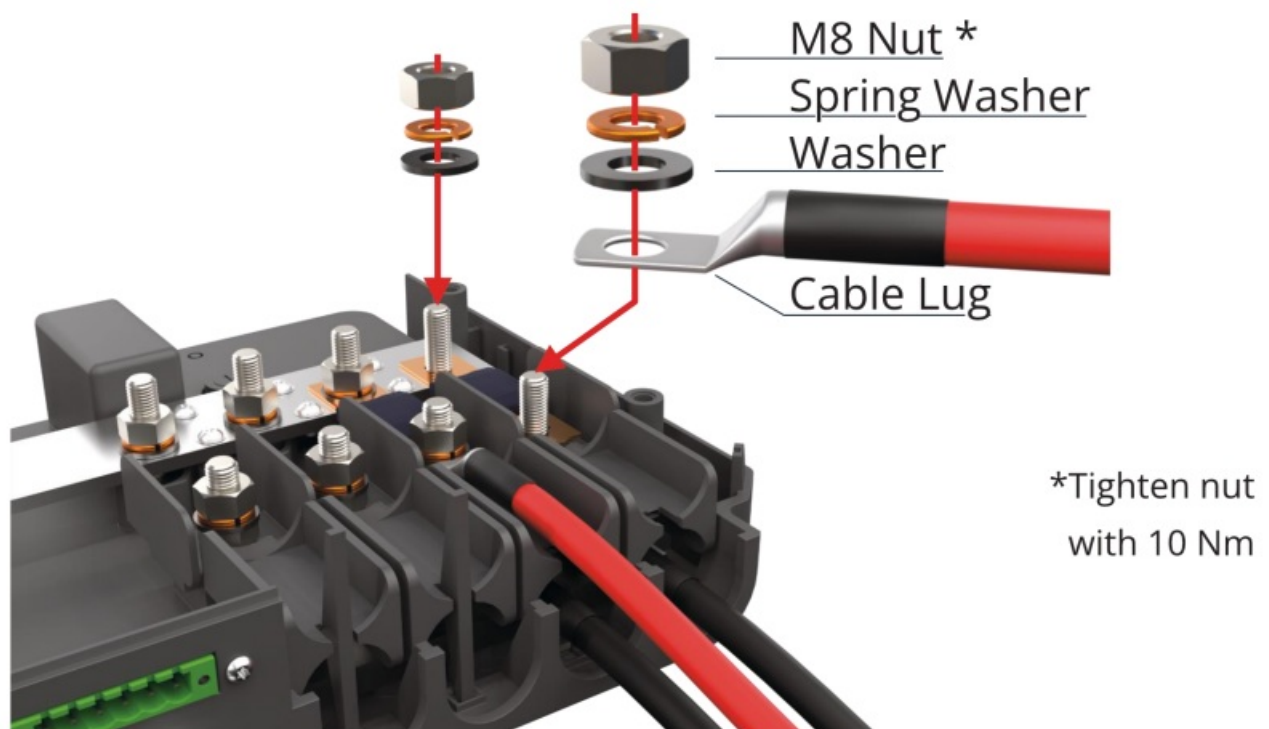


**⚠ WARNING:**

Use proper sized fusing. See chapter 6.4 for fuse options.

5. Place the positive power cable on the bolt and place washer, spring washer and nut back on both bolts. Tighten the nuts with 10 Nm.





### 8.5 Connecting the power cable for the batteries

The power cables to the batteries should be connected last. These must be connected at the Batteries side of the Master LV (left side) as shown in Figure 9.

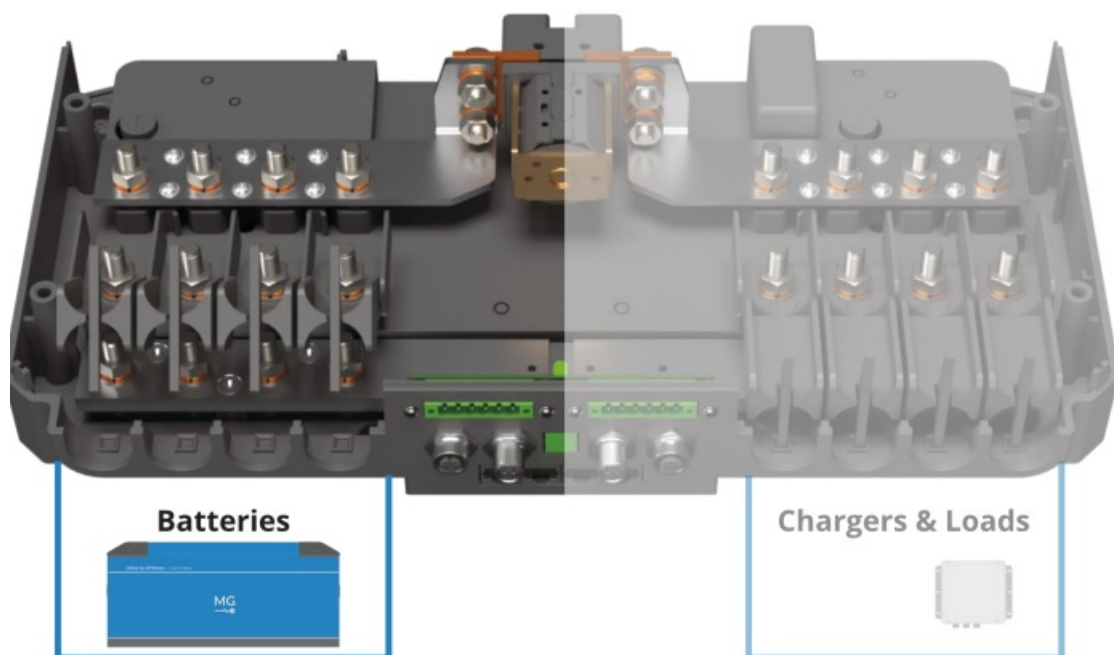


Figure 9 - Batteries power connection

Repeat step 1 to 5 from chapter 8.4 to connect the battery power cables to the Master LV.

### 8.6 Connecting CAN-Bus communication cables to the batteries

Communication cables can be connected with M12 or RJ45 cables to the Master LV depending on the type of battery module that is used.



Figure 10 - Basic BMS CAN-Bus connection overview

### 8.6.1 Connecting RJ45 cables

Connecting batteries with M12 requires battery modules with RJ45 connections.

1. Start connecting the batteries to one of the RJ45 connections of the BMS CAN-Bus port on the MG Master LV.
2. Connect the next RJ45 cable from the first battery module to the next. Repeat this until the last battery module is connected.
3. Place an RJ45 terminator at the last battery module.
4. Place an RJ45 terminator at the MG Master LV's BMS CAN-Bus.

### 8.6.2 Connecting using M12 cables

Connecting batteries with M12 requires battery modules with M12 connections.

5. Only one of the M12 connections can be used to connect batteries to. Start connecting the batteries to the most left (female) M12 CAN-Bus port.
6. Connect the next M12 cable from the first battery module to the next. Repeat this until the last battery module is connected.
7. Place an M12 terminator at the last battery module.
8. Place an RJ45 terminator at the MG Master LV's BMS CAN-Bus.

### **⚠ WARNING:**

- Do NOT connect the batteries to the M12 return CAN-Bus port.
  - Do NOT use a M12 terminator on the M12 return CAN-Bus port.
- Refer to chapter 6.3.2 for detailed information about the M12 return port.

### **i NOTICE:**

The M12 return CAN-Bus port is only used for an interlock return or emergency stop. In this case the terminator is integrated inside Master LV.

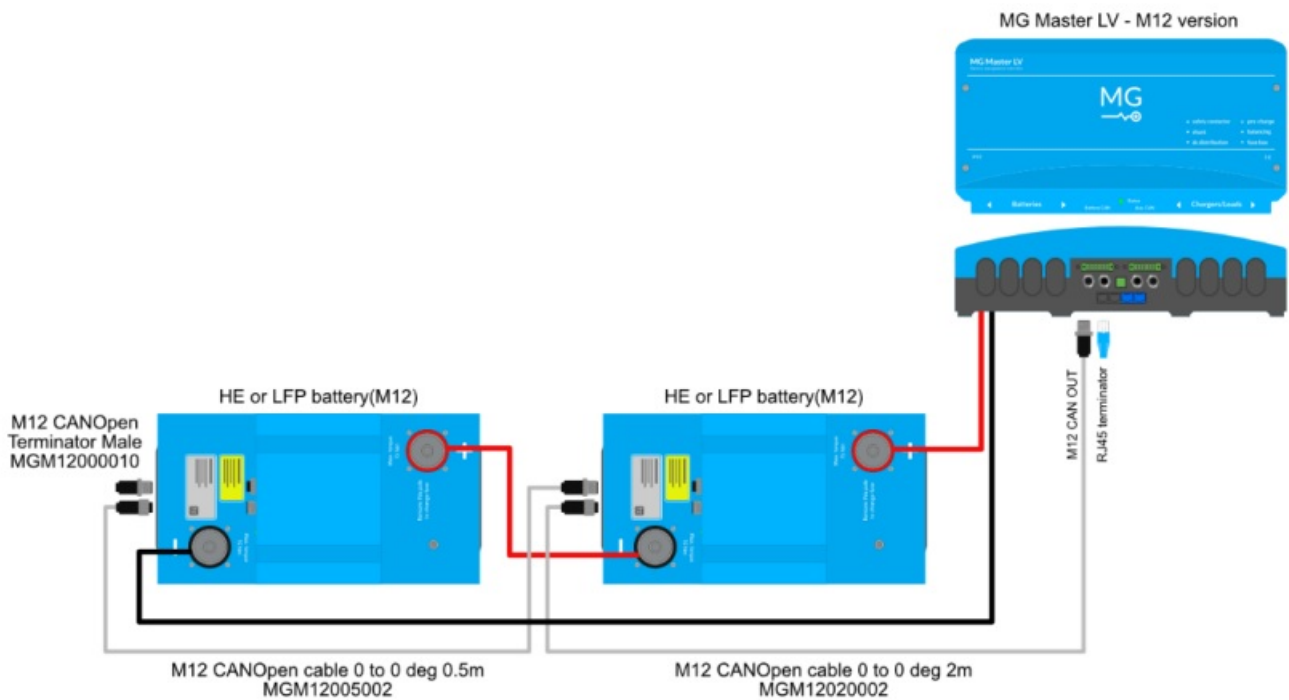


Figure 11 - Basic M12 CAN-Bus schematic

### 8.7 Connecting CAN-Bus communication cables to an external CAN network

The external CAN-Bus connection can either be with M12 connection as well as RJ45 connections. Refer to chapter 6.3.2 and 7.7 for detailed information.

The connection of the AUX. CAN-Bus is depending on the layout of the system and where it will be connected in the CAN-Bus system.



#### NOTICE:

Make sure of the proper CAN-Bus termination.

### 8.8 Connecting the allow-to-charge and allow-to-discharge

The Allow-to-charge and Allow-to-discharge IO contact can be used to control chargers and loads.

Refer to chapter 6.3.1 for details about the connections.

### 8.9 Connecting a remote Start/stop button

An external Start/Stop button with status indication can be installed using I/Os of connector A.

Figure 12 – External Start/stop button schematic overview shows the connection overview.

Requirements of the Start/Stop button are:

- Button must be of a momentary type.
- Status LED must be 12V type.

Article number	Description
MG5000287	Momentary LED Push Button Switch, IP66

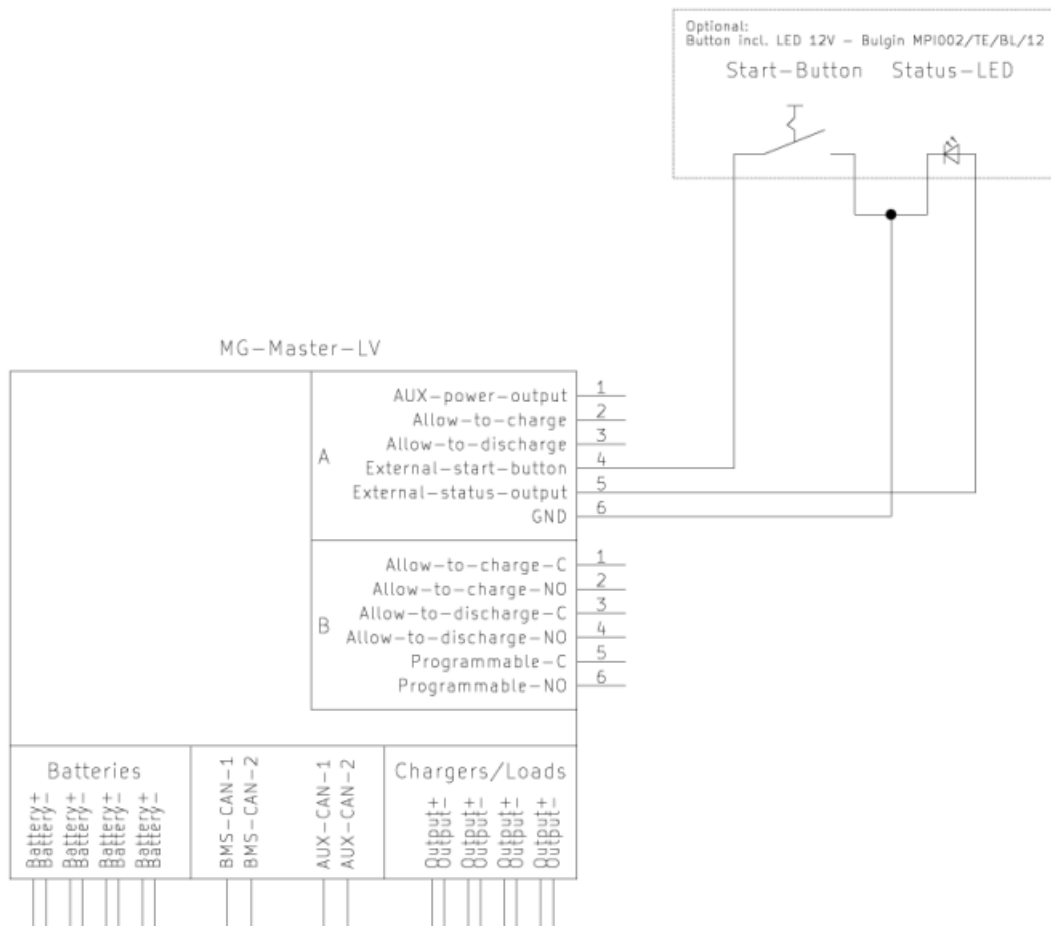


Figure 12 - External Start/stop button schematic overview

## CONFIGURATION

When the installation is complete and everything is connected the system can be started and configured. First time configuration must always be performed without main safety contactor opened. This can be achieved by pulling a BMS CAN-Bus cable going to the batteries from the Master LV. When starting then Master LV it will go to failsafe because the lack of battery communication.



### NOTICE:

The failsafe is only active for 10 minutes then the MG Master LV is going to Standby state. Configuration can be performed in three ways:

1. Using the MG Diagnostic Tool;
2. Using the MG Connect App;
3. Using the MG Energy Monitor;

### 9.1 Basic configuration and checks

Preferable the configuration is performed using the MG Diagnostic Tool. This has the advantage to save and restore configuration to and from a file. Import setting to check and set:

- Always set the `Number of batteries` in series and parallel as a fixed value.
- Check if the system is used to work in `Combined Battery mode` or `Standalone`.
- Check if the `Auto start-up on external charger` setting is required.
- Check the `External CAN-Bus protocol`. Default and recommended is to use the `MG NMEA2000` protocol.



## 9.2 MG Diagnostic Tool software

There is Diagnostic Tool software available to look into the detailed status, read out events, and perform settings.

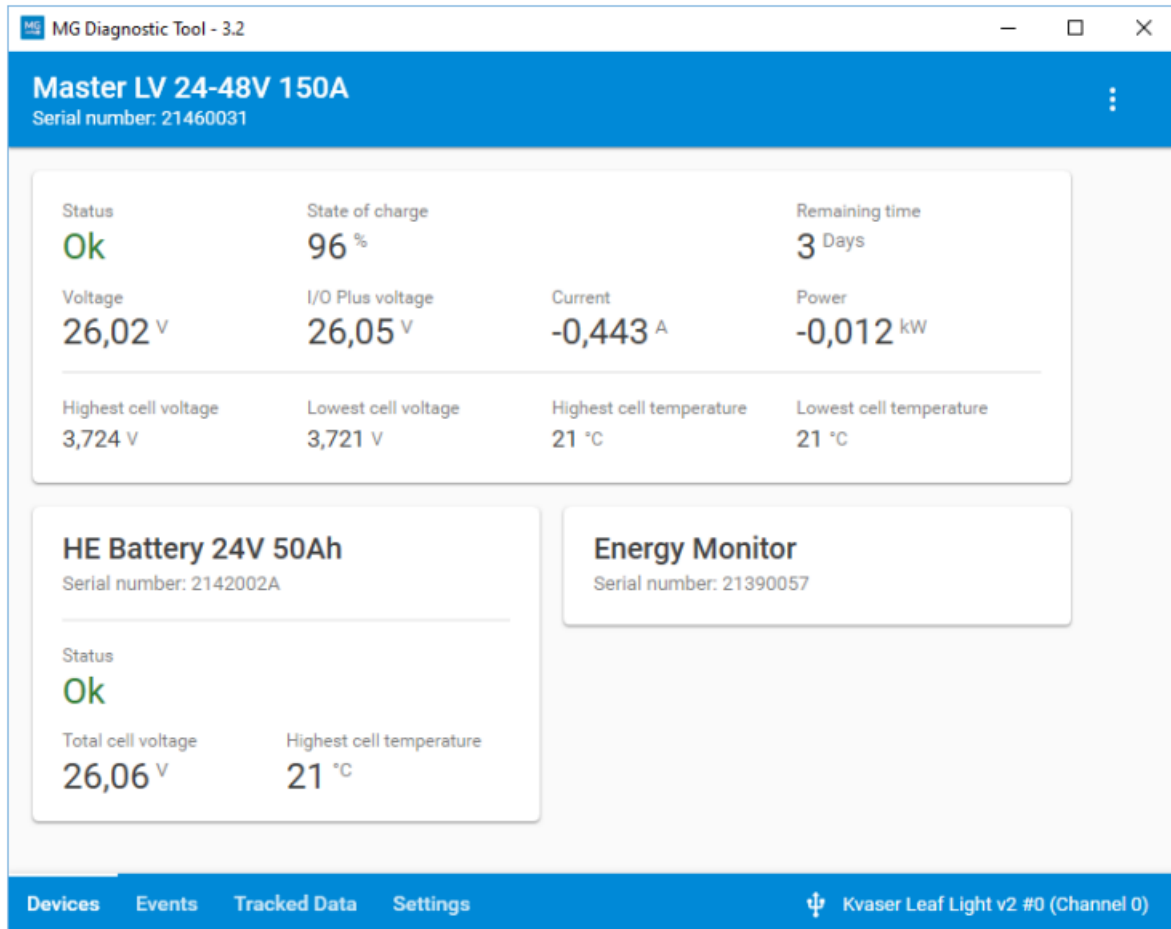


Figure 13 - Main screen of Diagnostic Tool

The Diagnostic Tool can be downloaded from the Download Center: MG Diagnostic Tool

## 9.3 Bluetooth

The internal Bluetooth module in the MG Master LV is disabled by default. There are three ways to turn on the Bluetooth option.

1. Using the MG Diagnostic Tool. Go to Settings and enable Bluetooth.
2. Press the start/stop button in a fast 3 times sequence when the MG Master LV is Normal operation or Failsafe. A fast 3 beep and status LED blink sequence will confirm the enabling.
3. Using the MG Energy Monitor. Go to Settings and enable Bluetooth.

### NOTICE:

Disable the Bluetooth is only possible using the MG Diagnostic Tool or MG Energy Monitor. The next step is to install the MG Connect App (Apple or Android) on your phone or tablet and make a connection with the MG Master LV.



Figure 14 - Screenshot of the MG Connect App on an iPad

## 9.4 Updating firmware

The firmware of the MG Master LV can only be updated using the MG Diagnostic Tool. After connecting the latest version of the MG Diagnostic Tool it will notify if there is a new firmware available.



### NOTICE:

The MG Master LV updated the connected battery modules automatically, if needed, at the first start-up. This will take some time during the start-up after the firmware update.

## COMMISSIONING

Table 12 shows a list of points that need to be checked after installation.

### Table 12 – Commissioning steps procedure

	Description
<input type="checkbox"/>	Is a risk assessment performed?
<input type="checkbox"/>	Are the location and placement requirements in chapter 7.2 and 7.3 met?
<input type="checkbox"/>	Is the MG Master LV installed in a location where there is no possibility fluids can enter? For example installation under the seams of hatches.
<input type="checkbox"/>	Is the MG Master LV clean from any dust, metal pieces and loose wires?
<input type="checkbox"/>	Are the correct fuses placed in the MG Master LV?
<input type="checkbox"/>	Are all power connections tightened with 10 Nm?
<input type="checkbox"/>	Are all BMS CAN-Bus cables connected?
<input type="checkbox"/>	Are CAN-bus termination resistors installed in the correct way?
<input type="checkbox"/>	Is there any equipment connected directly to the batteries? This is not allowed.
<input type="checkbox"/>	Are the functions of the Allow-to-charge/Allow-to-discharge or CAN-Bus control of all charger and loads working properly?
<input type="checkbox"/>	Perform a charge/discharge test run and measure the temperature of the power connection terminals during the test. Is there excessive heat generation in the system or system components?
<input type="checkbox"/>	Make pictures of the installation.
<input type="checkbox"/>	Send the pictures and this form together with the system commissioning form to <a href="mailto:support@mgen.ergysystem.eu">support@mgen.ergysystem.eu</a> with the subject: <project name> – Commissioning.

## OPERATION

This chapter will describe the user operation of the battery system. The basic user actions are as following:

- Start system;
- Stop system;
- Reset system;



### NOTICE:

Check the manual of the MG Smart Link MX when using multiple Master LV's in parallel.

### 11.1 States of operation

The Master LV has several states where it can operate in.

- Normal operation: The battery system is running. The main safety contactor of the Master LV is closed and charging and discharge is possible;
- Standby: The battery system is off.
- Waiting (combined mode only): The Master LV is waiting for a command from the MG Smart Link MX. This is only the case when the setting "Combined battery mode" is enabled.

- Failsafe: In this state the Status indicator is blinking red and beeping. The main safety contactor is opened and no power can be charged or discharged;

### 11.2 Starting the battery system

The start/stop button should be pressed for at least 2 seconds to start the battery system. The Master LV begins to pre-charge the DC bus until the voltage has reached a safe level to close the main safety contactor. After closing the main safety contactor the chargers and loads are activated if possible. The system is now in Normal operation.

### 11.3 Stopping the battery system

The start/stop button should be pressed for at least 2 seconds to stop the battery system. The Master LV first stops all chargers and loads if possible and then opens the main safety contactor. The system is now in Standby.

### 11.4 Resetting from failsafe

If the Master LV is in failsafe state, there are two possibilities: Stop the system or reset the system.

- To stop the system press the start/stop button for at least 2 seconds;
- To reset the system press the start/stop button shortly. No longer than 1 second.



#### NOTICE:

The failsafe is only active for 10 minutes. After this time the Master LV will go to Standby automatically to save energy.

## DIAGNOSTICS AND TROUBLESHOOTING

Diagnostic and troubleshooting can be achieved in several ways.

- Connecting the MG Diagnostic Tool;
- Connecting the MG Connect App;
- Looking/listening at the Status indicator;

### 12.1 Troubleshooting procedure

The below troubleshooting procedure will help you finding and solving the issue with the system.

## Support

- Consult the manual**  
 Not familiar with your MG product? All information about MG products can be found in the manuals on our download center.
 [Read Manuals](#)
- Watch installation videos**  
 Watch the installation videos on our YouTube channel. Each video explains step by step how to install your MG product.
 [Show Videos](#)
- Contact service point**  
 MG Service Point dealers and system integrators are trained worldwide to give you the best support.
 [Find Service Point](#)
- Contact MG Support**  
 If the above options did not resolve your issue, you may contact MG Support directly. In order to provide you with the best possible service, a snapshot of your system will be included in your Support Request.
 [Request MG Support](#)

### 12.2 Status indicator

Table 13 shows the meaning of the status LED and buzzer.

Table 13 – Status indication reference

Status LED state	Description
Off	System is in standby mode. Press Start button to start up the system.
Blinking green slow	Waiting for start command.
Flashing green slow	Waiting for DC-Bus equal to battery bank voltage.
On	Running.
Blinking red / no beep	In Secondary Bootloader
Blinking green/red fast	Updating firmware of connected batteries.
Flashing/beeping 2 times	Battery communication error (check BMS CAN-Bus cables).
Flashing/beeping 3 times	Under or overvoltage detected (check charger or load settings).
Flashing/beeping 4 times	Under or over temperature detected (check battery temperatures).
Flashing/beeping 5 times	Pre-charge time out occurred (check if pre-charge current is below 10A).
Flashing/beeping 6 times	Pre-charge fuse broken (check the pre-charge fuse).
Flashing/beeping 7 times	Battery configuration failure (check BMS CAN-Bus cables).
Flashing/beeping 8 times	Interlock loop open (check interlock loop configuration in Diagnostic Tool).
Flashing/beeping 9 times	Battery firmware updating failure (check BMS CAN-Bus cables and then contact manufacturer).
Flashing/beeping 10 times	Main safety contactor failure (contact manufacturer).
Flashing/beeping 11 times	Internal measurement failure (contact manufacturer).
Flashing/beeping 12 times	System instability problem detected (contact manufacturer).
Flashing/beeping 13 times	No appropriate firmware found for connected battery (contact manufacturer).

## SERVICE

### 13.1 Maintenance

For maintenance it will be sufficient to inspect the following points once a year:

- Check the electrical connections on torque.
- Check if all communication connections are mated.
- Check for traces of water, oil, moisture, any other fluids or dust.
- Check for signs of corrosion.
- Clean the device.
- Check status with the MG Diagnostic Tool, MG Connect App or MG Energy Portal.



#### **ELECTRICAL HAZARD:**

Do not pour or spray water directly onto the device. When cleaning the device be aware that the connected battery string is a permanent energy source. Even when the device is turned off, the battery power connections might carry dangerous voltage levels.

### 13.1.1 Cleaning

Cleaning of the device is best done using a dry or slightly damp cloth. Limit the use of cleaning agents. If a cleaning agent is to be used, use an electrically non-conductive cleaning agent is advised.

It is important to keep the battery spaces clean and tidy in order to minimise the need for cleaning.

Prevent the use of moisture, vaporizing agents, oil, grease, etc. in the vicinity of the device.

### 13.2 End-of-life

The battery module is considered end-of-life if the SOH is decreased to 70 %. After this period it is strongly advised to replace the battery module to ensure safety.

### 13.3 Disposal

Batteries marked with the recycling symbol must be processed via a recognized recycling agency. By agreement, they may be returned to the manufacturer. Batteries must not be mixed with domestic or industrial waste.

## BOUNDARY LIMITS

The boundary limits that are used for internal measurements and timeouts are listed in this chapter.

A level will be triggered when a boundary condition is true for a defined period of time.

The tables with the boundary limits consist of:

- Name, description of the situation;
- Action, action on respond of the boundary, set/clear or fail-safe;
- Boundary condition, contains a value that is needed for an action in combination with the time. This depends on the master strategy setting, default or performance;
- Time that the boundary condition has to be present before it will be triggered. Times indicated with “+” start counting if the previous boundary condition above is set;

### 14.1 Battery pack voltage

Name	Level	Boundary condition	Time
Hardware failure warning	Set	= invalid	30 sec.
	Clear	= valid	30 sec.
Hardware failure warning	Set	$\geq$ Over voltage critical or $\leq$ under voltage critical <sup>1</sup>	10 sec.
	Clear	$<$ Over voltage critical or $>$ under voltage critical <sup>1</sup>	10 sec.

<sup>1</sup> Critical battery cell over or under voltage times number of cells per battery module in series times number of battery modules in battery pack in series.

### 14.2 Positive DC-bus voltage

Name	Level	Boundary condition	Time
hardware failure warning	Set	= invalid	30 sec.
	Clear	= valid	30 sec.
Hardware failure warning	Set	$\geq$ Over voltage critical or $\leq$ under voltage critical <sup>1</sup>	10 sec.
	Clear	$<$ Over voltage critical or $>$ under voltage critical <sup>1</sup>	10 sec.
Hardware failure critical	Fail-safe	Contactors closed and $\geq 104\%^2$ of the battery pack voltage or $\leq 96\%^2$ of the battery pack voltage	5 sec.

1 Critical battery cell over or under voltage times number of cells per battery module in series times number of battery modules in battery pack in series.

2 The 4% has a minimum of 1500mV and a maximum of 3000mV

### 14.3 Battery pack current

Name	Level	Boundary condition	Time
Hardware failure warning	Set	= invalid	30 sec.
	Clear	= valid	30 sec.

### 14.4 PCBA master temperature

Name	Level	Boundary condition	Time
Hardware failure warning	Set	= invalid	30 sec.
	Clear	= valid	30 sec.
Over temperature master warning	Set	$\geq 90,0\text{ }^{\circ}\text{C}$	30 sec.
	Clear	$< 90,0\text{ }^{\circ}\text{C}$	30 sec.

### 14.5 Private CAN-bus communication timeout

Name	Level	Boundary condition	Time
Private CAN-bus communication timeout warning	Set	= not received all required data	10 sec.
	Clear	= received all required data	0 sec.
Private CAN-bus communication timeout critical	Fail-safe	= not received all required data	30 sec.

#### 14.6 Pre-charge DC-bus only for PC+ devices

Name	Level	Boundary condition	Time
Overloaded	Fail-safe	DC-bus voltage does not rises to a boundary of the battery pack voltage	1 up to 10 sec.

#### 14.7 Pre-charge DC-bus only for 72-96V devices

Name	Level	Boundary condition	Time
Overloaded	Fail-safe	DC-bus voltage does not rises to a boundary of the battery pack voltage	500 up to 5 000 ms.

### TECHNICAL SPECIFICATIONS

The technical specifications of this product can be downloaded from the MG Download Center: <https://downloads.mgenergysystems.eu/masterlv>

### DIMENSIONS

The dimensions of this product can be downloaded from the MG Download Center. <https://downloads.mgenergysystems.eu/masterlv/drawings>

### CONTACT DETAILS

For specific questions please feel free to contact us.

#### 17.1 Sales

For sales related questions, please contact a local dealer.

For specific sales questions, please contact our sales team:

#### MG Sales team

[sales@mgenergysystems.eu](mailto:sales@mgenergysystems.eu)

#### 17.2 Technical support

For technical support, please follow the steps below:

1. Consult the Manual.

Manual can be found on the MG Download Center.

2. Watch the Installation Videos.

Videos can be found on MG's You Tube channel.

3. Check Your Software Version.

Check and update the products software version to latest using the MG Connect App (Apple or Android) or MG Diagnostic Tool.

4. Contact MG Service Point.


5. Contact MG technical support. Send an email with your technical questions to

[support@mgenergysystems.eu](mailto:support@mgenergysystems.eu).



























Documents / Resources

	<p><a href="#">MG Master LV Battery Management Controller</a> [pdf] Installation Guide</p> <p>Master LV Battery Management Controller, Master LV, Battery Management Controller, Management Controller, Controller</p>
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References

-  [MG Energy Systems | Energy Storage Systems | Modular & Scalable](#)
-  [MG Download Center](#)
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