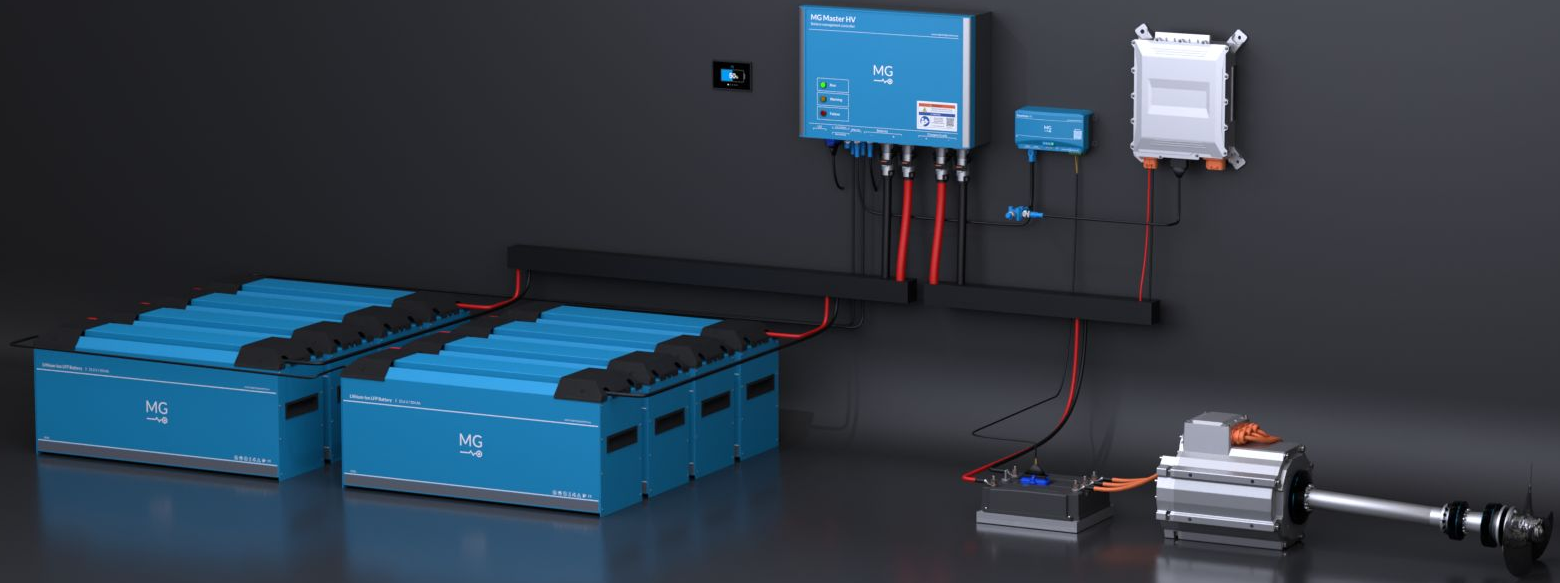
High Voltage Systems
Part II

MG


MG Master HV
MG
MG
MG

High Voltage
Master HV

Available for
144V tot 900V*

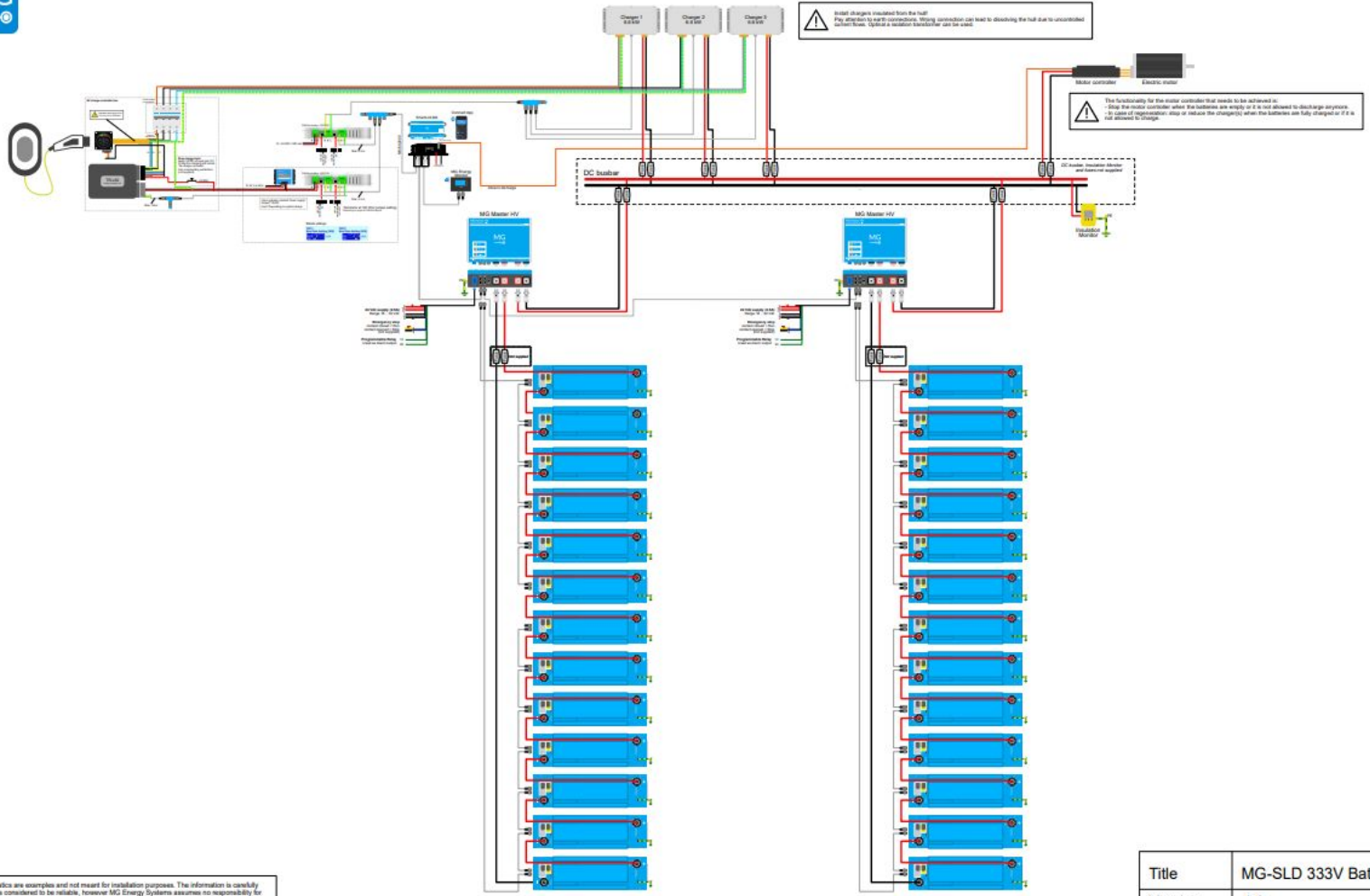
*also possible from > 48V, type approval)

Master HV


MG Master HV
Battery management controller
www.mgenergysystems.eu
MG
Run
Warning
Failure
WARNING
CAUTION: Risk of electric shock.
NOTICE
I/O
Aux. CAN-Bus
BMS CAN-Bus
Diagnostics
Batteries
Chargers/Loads

Why HV ?

+	More efficient Higher power outputs Engines are more compact Inverters are more compact
−	Complexity of the system Less availability of standard components CAN-bus and EMC



These schematics are examples and not meant for installation purposes. The information is carefully checked and is considered to be reliable, however MG Energy Systems assumes no responsibility for any inaccuracies.

Refer to the manual for additional installation instructions

Title	MG-SLD 333V Battery System Electrical Propulsion
Version	1.0
Date	23-01-2023

Installation Examples

144 - 900 Vdc

LFP series

360 Vdc - 100 kWh
Concrete Mixer

LFP series

360 Vdc - 100 kWh
Concrete Mixer

RS series

525 Vdc - 300 kWh
Electric Foundation Rig

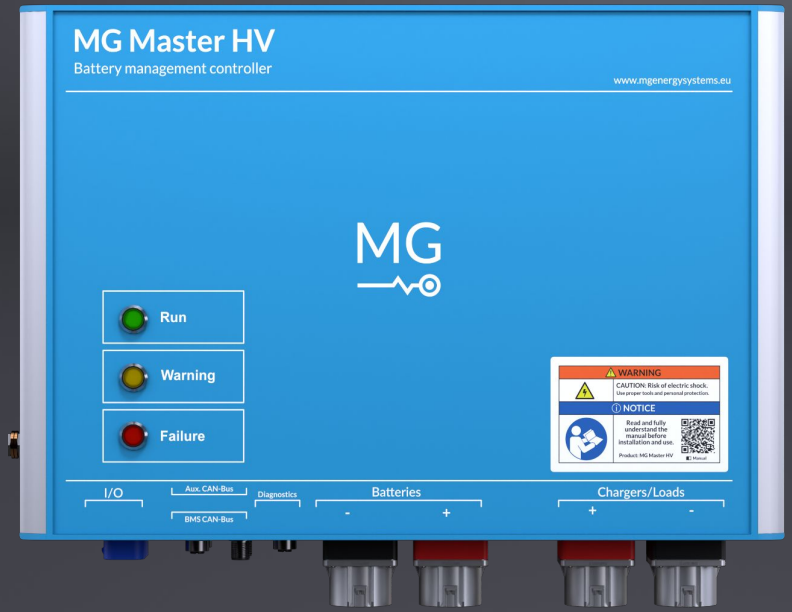
RS series

525 Vdc - 300 kWh

Master HV

Explained

Battery Management System



- State-Of-Health tracking
- State-Of-Charge tracking
- Monitoring of all battery parameters
  - Cell voltage
  - Temperatures
  - Balancing
  - Internal event logging

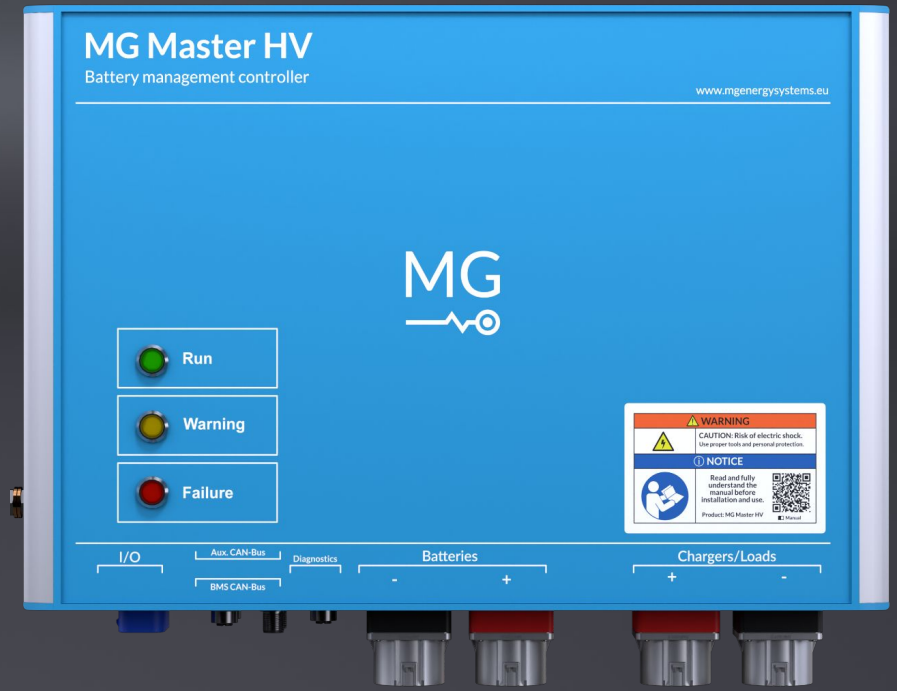
Master HV Types

300 A

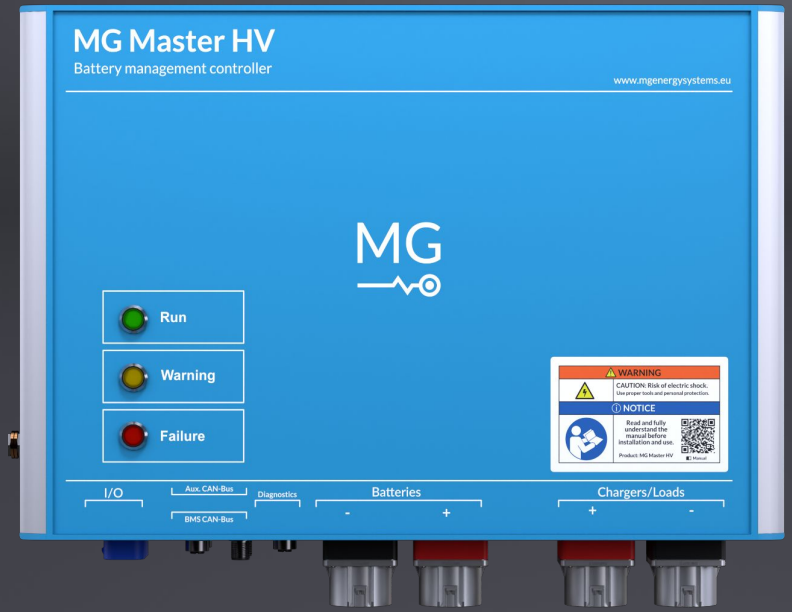
500 A
500 A Gen 2

When Master HV?

- Systems **>144V**
- Type approval projects **DNV-GL** and **Lloyd's** with system voltage **≥48V**



Integrated Pre-Charge Circuit

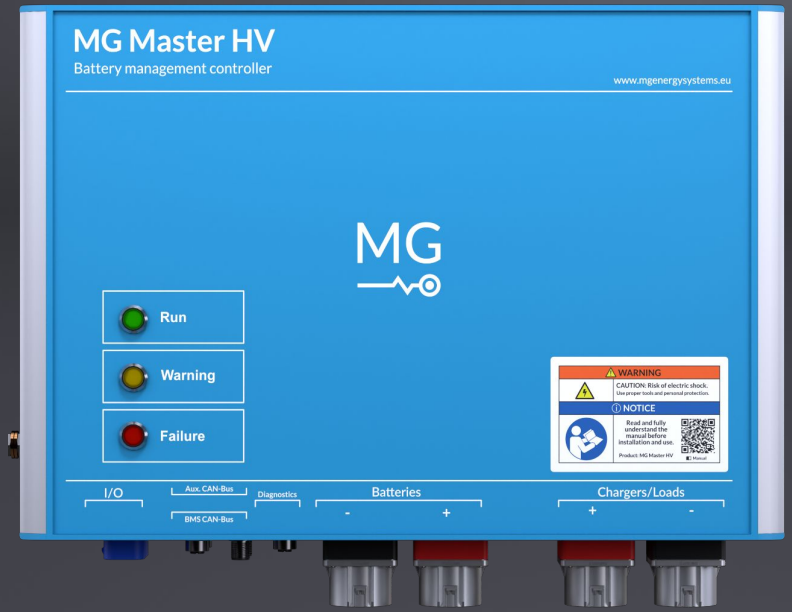


Pre-charging

load → battery string voltage level

Prevents the safety contactor from welding and/or damage of load connected equipment

EMS Integration



PLC CAN-Bus control Start/Stop/Reset

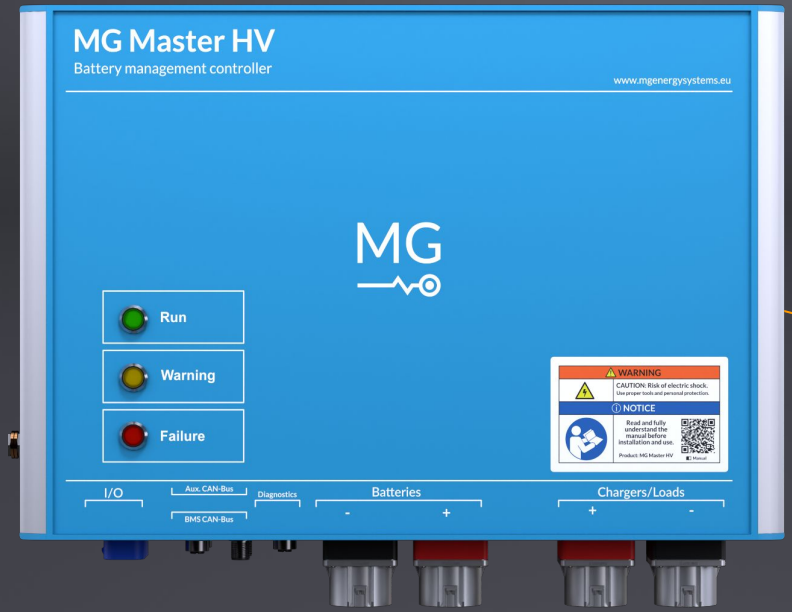
BMS limits for chargers/inverters available

Heart-beat protection

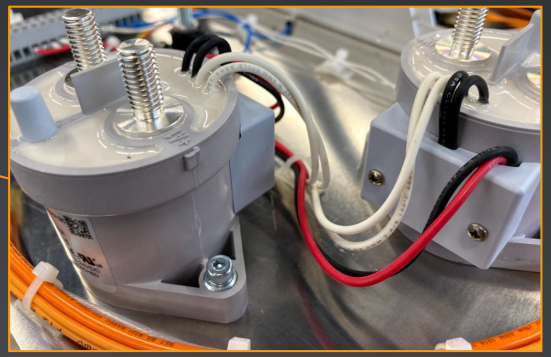
Protocols:

NMEA2000 (J1939 compatible)

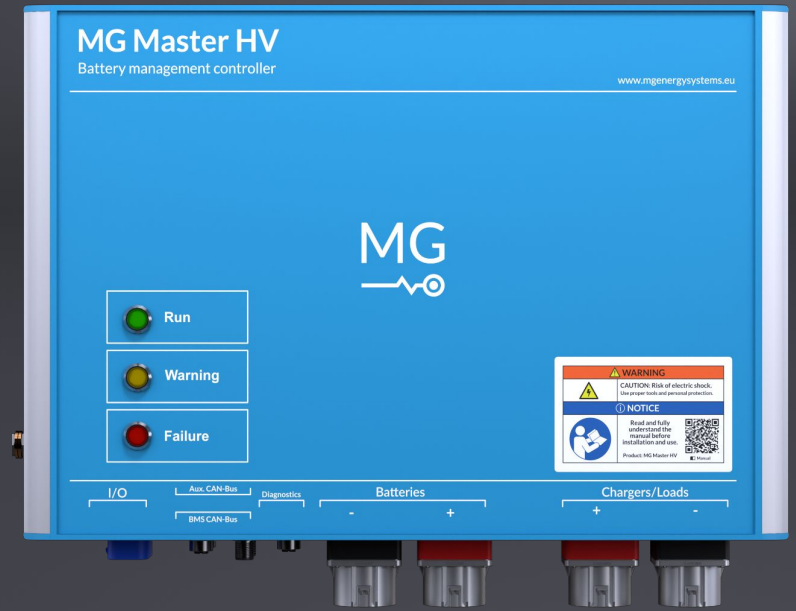
Safety Contactors



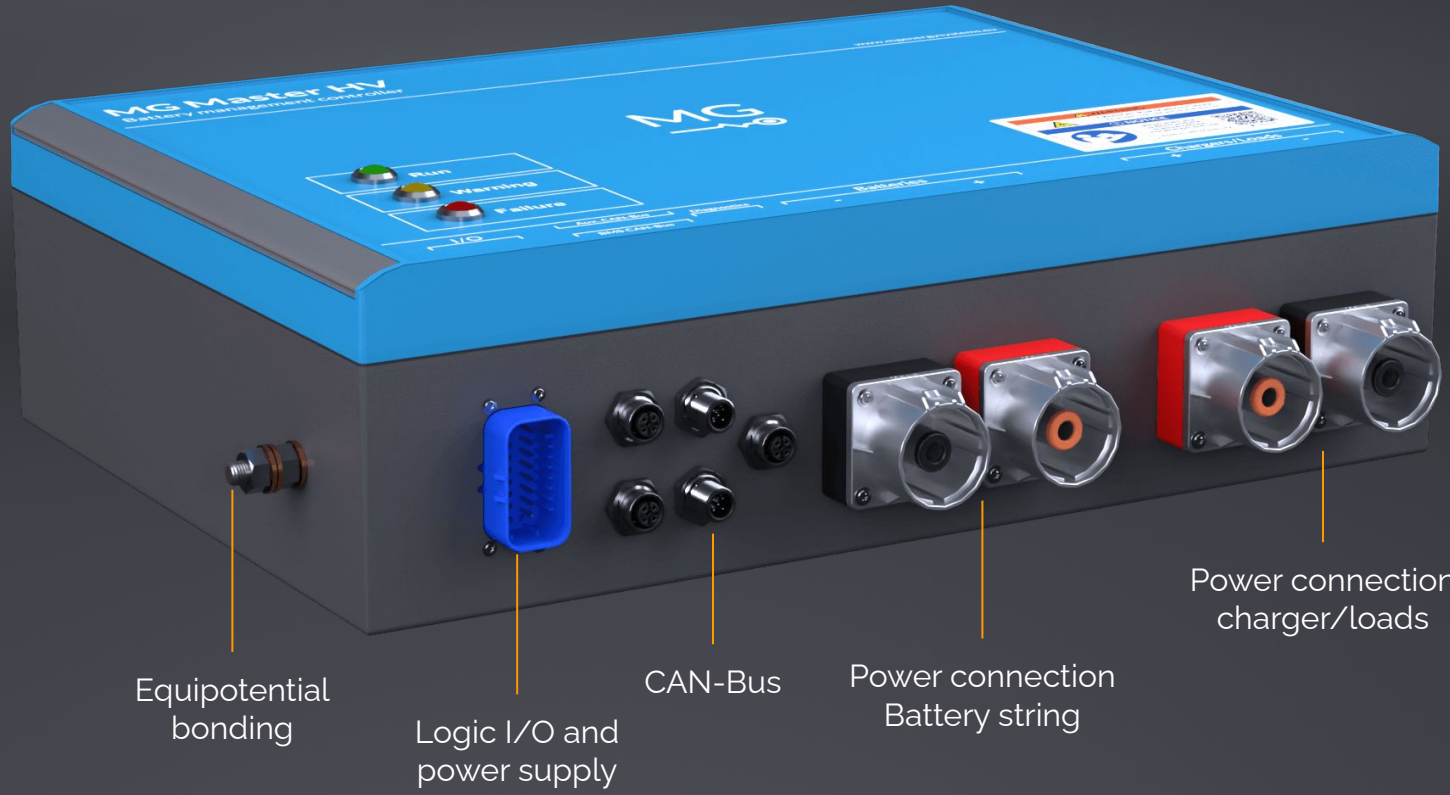
Safety contactors in positive and negative power paths



(HVIL) High Voltage Interlock Loop



- HVIL hard-wired loop
- Battery system is operable as long as the loop is closed
- The main contactors open without intervention of the software
- All power, I/O and connectors have a built-in HVIL as a standard


MG Master HV
Battery management controller
Run
Warning
Failure
Equipotential bonding
Logic I/O and power supply
CAN-Bus
Power connection Battery string
Power connection charger/loads

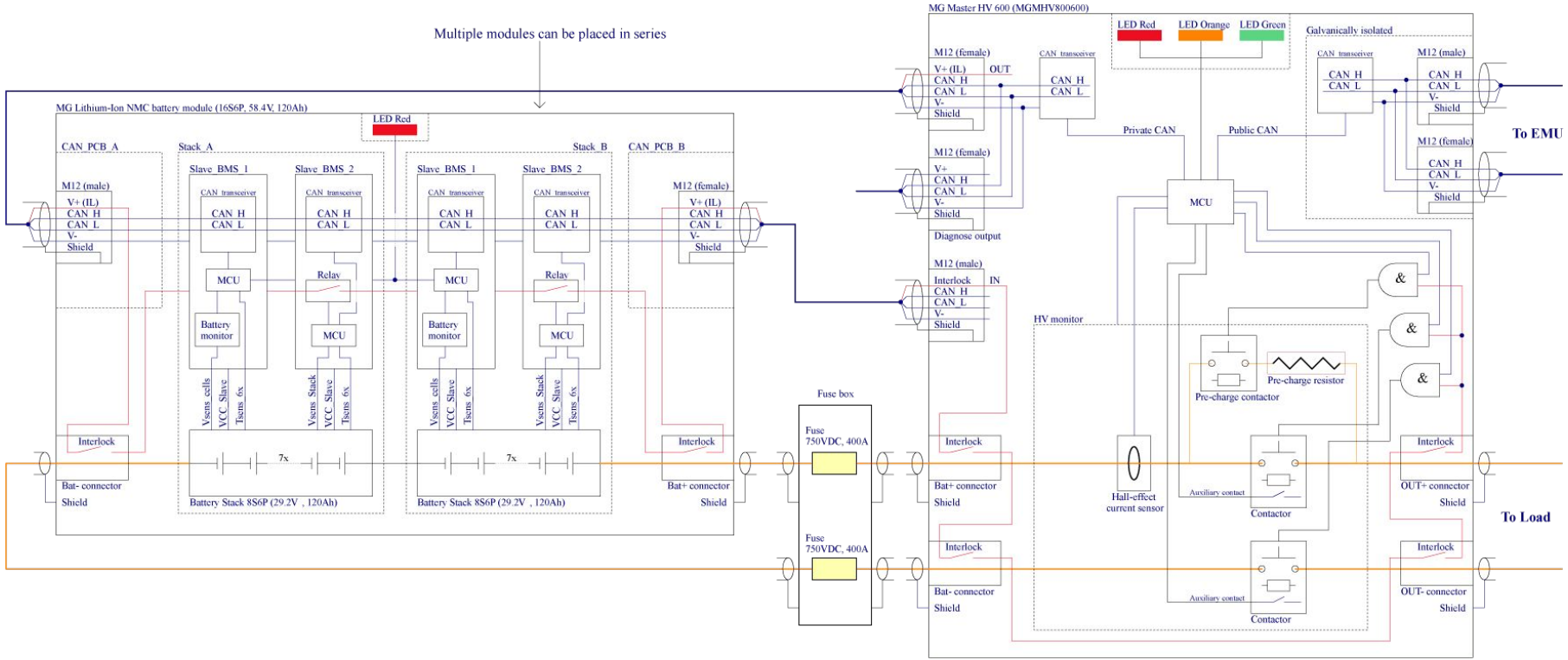
EMS CAN-bus

BMS CAN-bus

CAN-bus Diagnostic port

- Used to connect with the “Diagnostic Tool” software
- Used to connect MG Energy Monitor

BMS Block Schematic



Cables, Connectors & Fuses

- Use High Voltage cable
- Use fuses with the right voltage and current specification
- Use Interlock Loops to prevent access to live parts
- Use Insulation measurement device for safety
- Battery system must be floating from the chassis

USB-CAN Interface

Lithium-Ion **LFP** Battery
(High-Energy)

HV, M12 up to **460 Vdc**
Max. 16 in series

Lithium-Ion
RS Battery module
(High-Energy)

Up to **900 Vdc**

Up to **460 Vdc**
max. 16 in series
Unlimited strings
in parallel

LFP

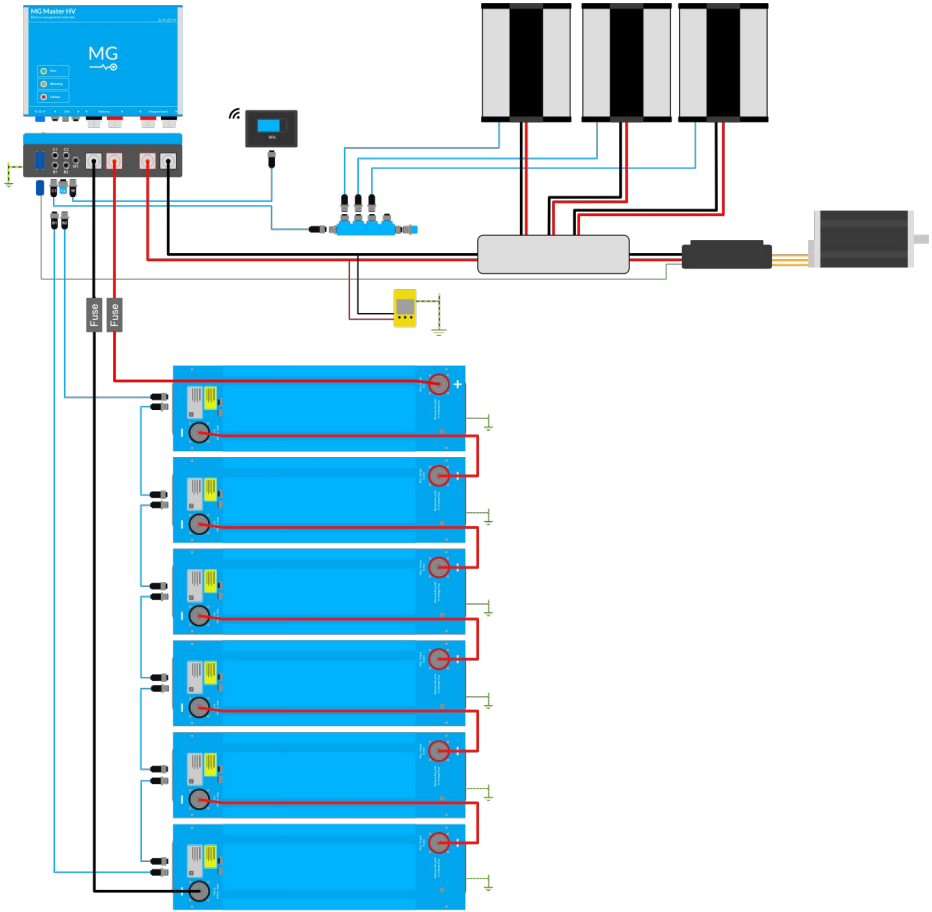
Up to **900 Vdc**
max. 16 in series
Unlimited strings
in parallel

RS

LFP Series

144 V System

LFP Battery Modules
+
Master HV



LFP Series

144V **Redundant** System

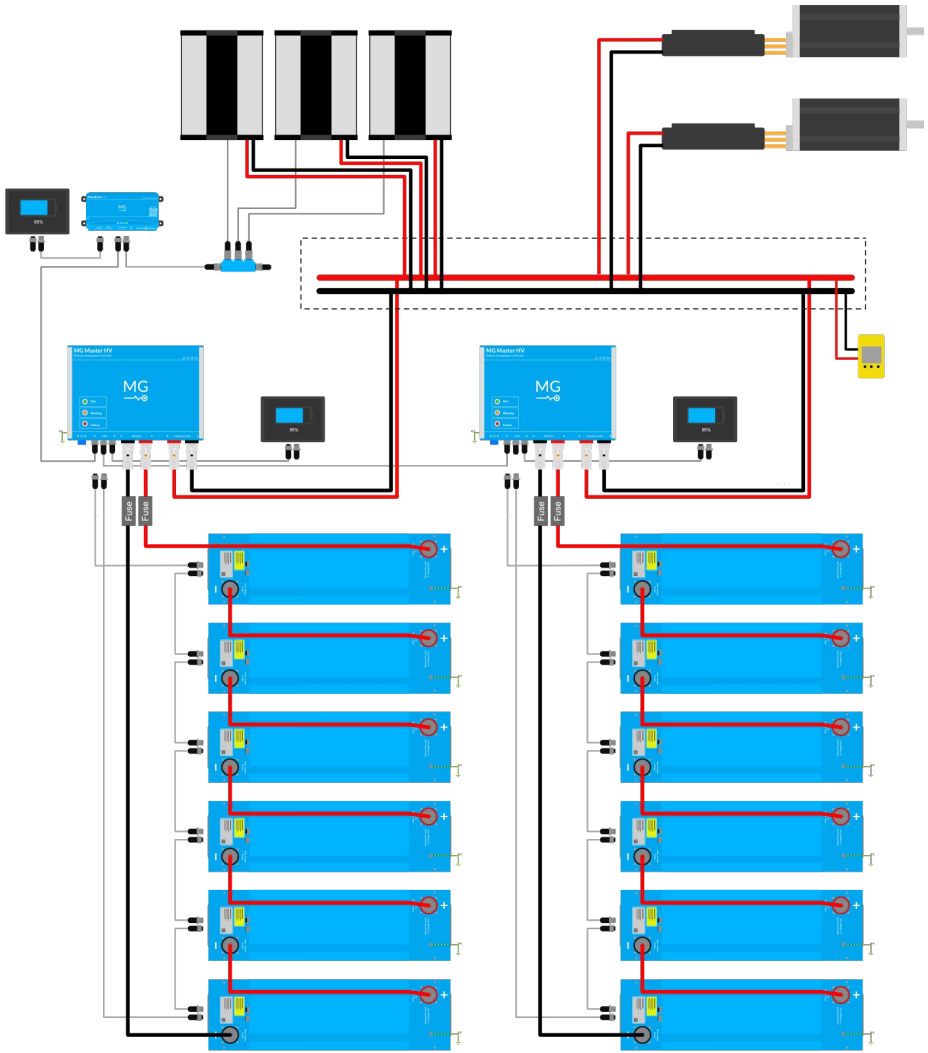
LFP Battery Modules

+

2x Master HV

+

SmartLink MX



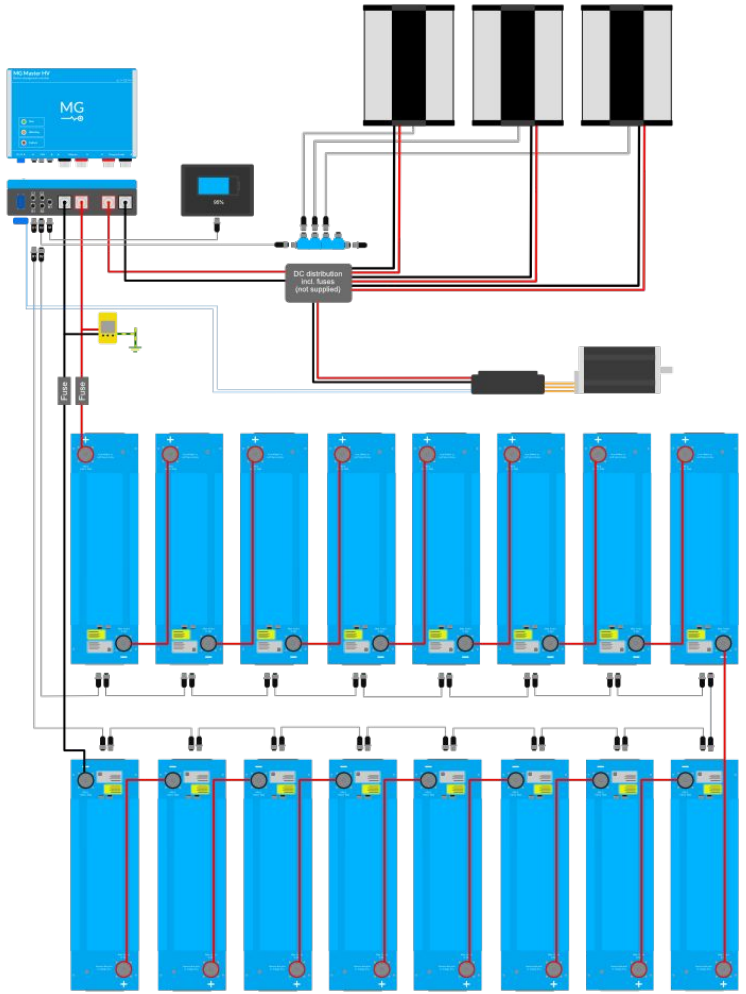
LFP Series

410V System

16x LFP Battery Modules (Serial)

+

Master HV



RS Series

High performance battery module

RS Series

High Performance
Liquid cooled
Highest safety standards
Redundant BMS

CESNI

TYPE APPROVED PRODUCT
DNV·GL
MARITIME

Lloyd's Register Marine

RS Battery Modules

44 V

51 V

58 V

Flexible in Design

In series up to 900 Vdc
unlimited parallel strings

RS12S4P

8.4 kWh

43.8 Vdc

192 Ah

75 kg

RS14S3P

7.4 kWh

51.1 Vdc

144 Ah

69 kg

RS16S3P

8.4 kWh

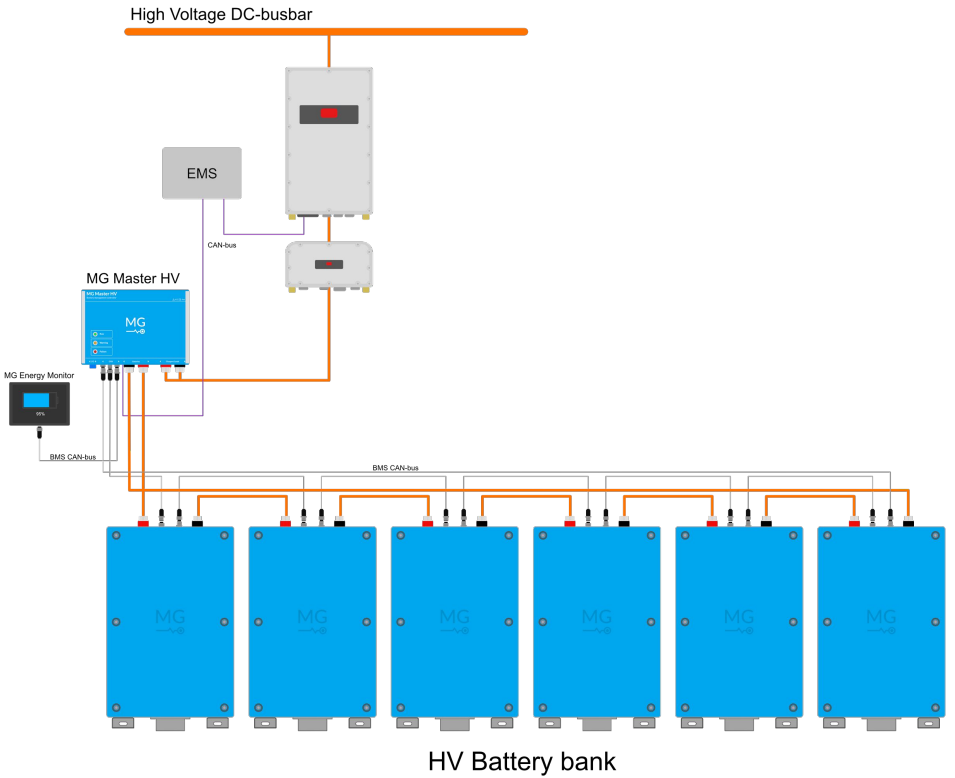
58.4 Vdc

144 Ah

75 kg

System Example

6 x RS Battery Modules in series
1x MG Master HV



RS Series
Recreational & Yacht Industry

Hotel load
Electric propulsion
Hybrid systems

RS Series
Professional & Commercial Vessels

Water taxi
Ferries
Workboat

DNV-GL, ES-TRIN & Lloyds
as a standard

Certifications

- **DNV-GL**
- **ES-TRIN** IEC 62619 and 62620
- **Lloyds**

Front View

M12 CAN-Bus

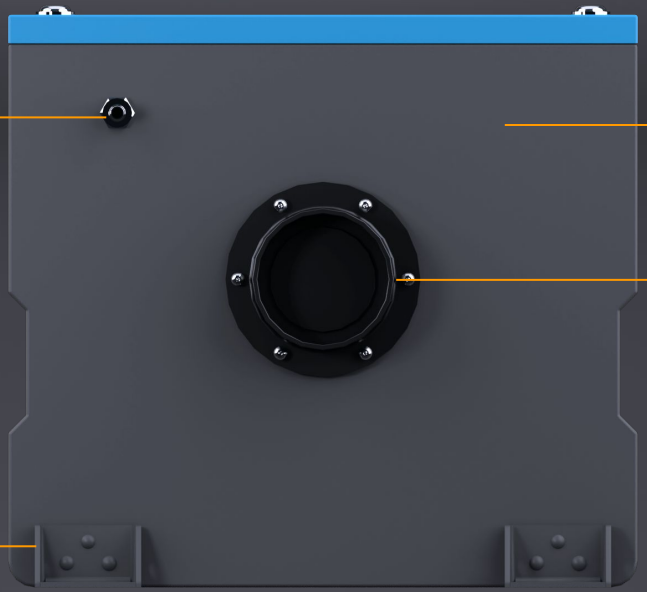
Amphenol PowerLok connectors 300/500 Series

Liquid cooling connections

Identification label

Mounting connections and equipotential bonding

Rear View


Module propagation protection system (PPS) connection
IP65 Steel enclosure
Gas exhaust with rupture disk
Mounting connections and equipotential bonding

Power Connection Options

Amphenol Powerlok 300 series

- Overmolded connectors up to 95 mm2
- Separate connectors up to 70 mm2

Amphenol Powerlok 500 series

- Only overmolded connectors up to 150 mm2

Amphenol Powerlok 500 series GEN 2

- Separate connectors up to 120 mm2

NOTE:

Choose 500 series GEN 2 for shorter delivery times and flexibility in cable lengths.

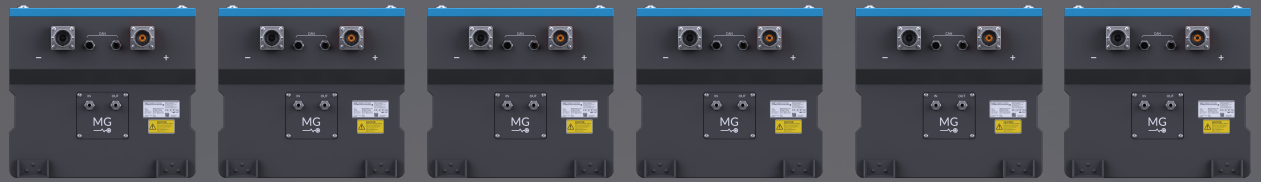
Equipotential bonding

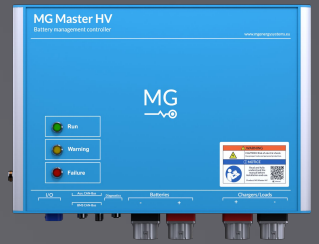
System Overview

The RS battery system consists of:

- ➔ One or multiple RS battery modules per string
- ➔ One MG Master HV battery management controller per string
- ➔ One or multiple strings in a system

RS battery string





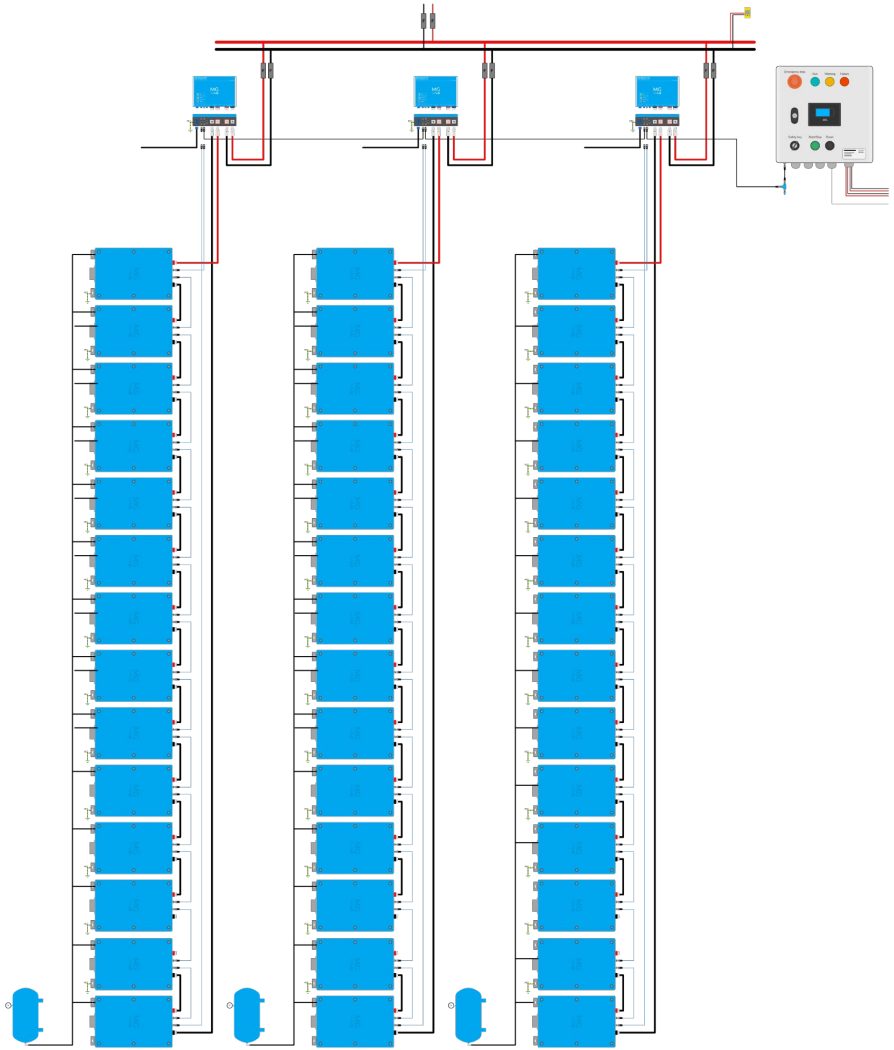
RS Series

3x **Masters HV** in parallel

RS Battery Modules - 14x serial

MG SmartLink PLC

DNV-GL and **LLoyd's** certification

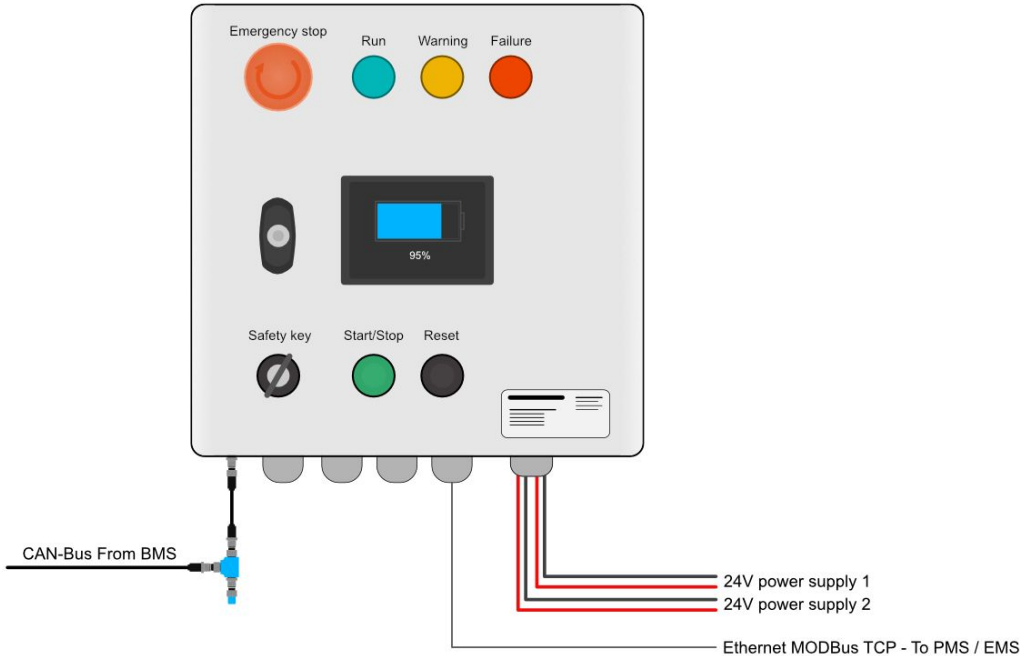


SmartLink PLC

For **parallel redundant** battery systems

Two or more Masters HV

DNV-GL and **LLoyd's** certification

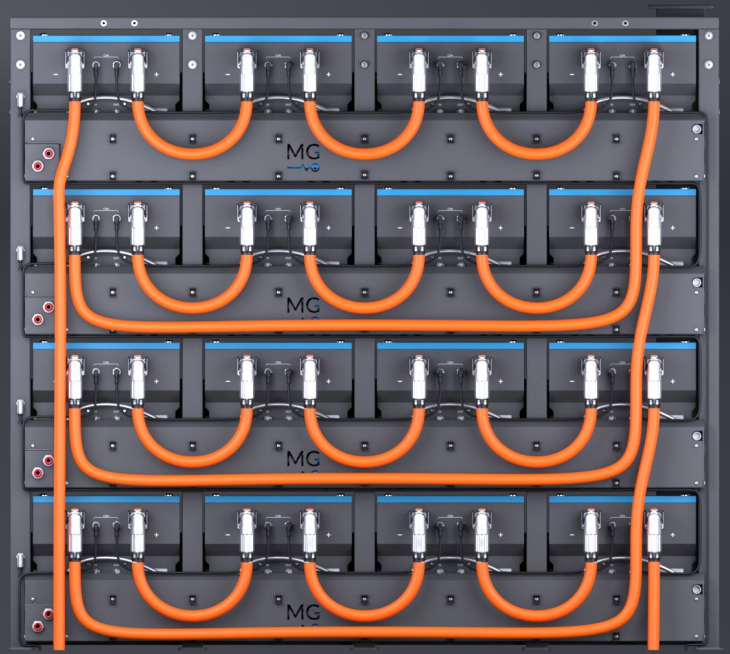


Modular Rack System

Power connection with Amphenol PowerLok
300 series up to 300A
500 series up to 500A
CAN-Bus connections: M12

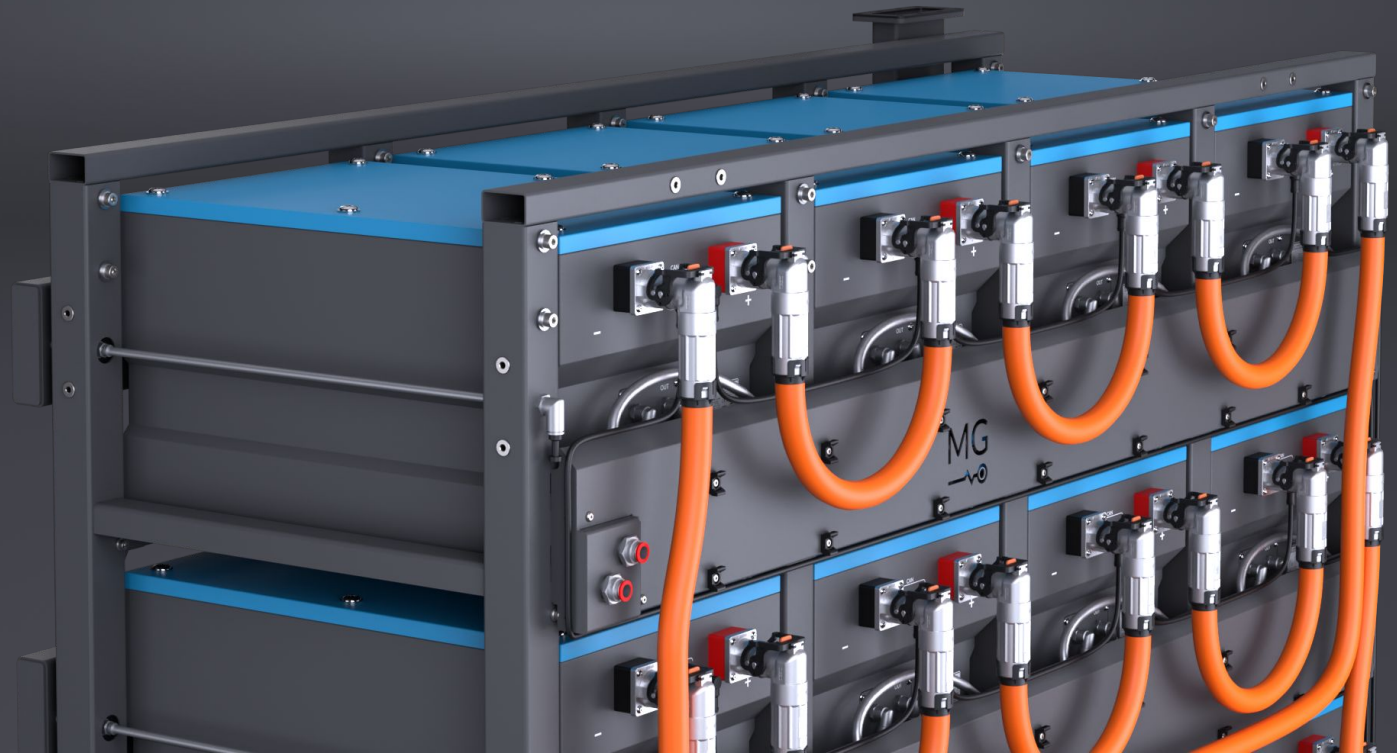
Rack system includes:

- Integrated Liquid cooling manifolds
- Integrated gas exhaust system
- Slide-in system
- Fully modular



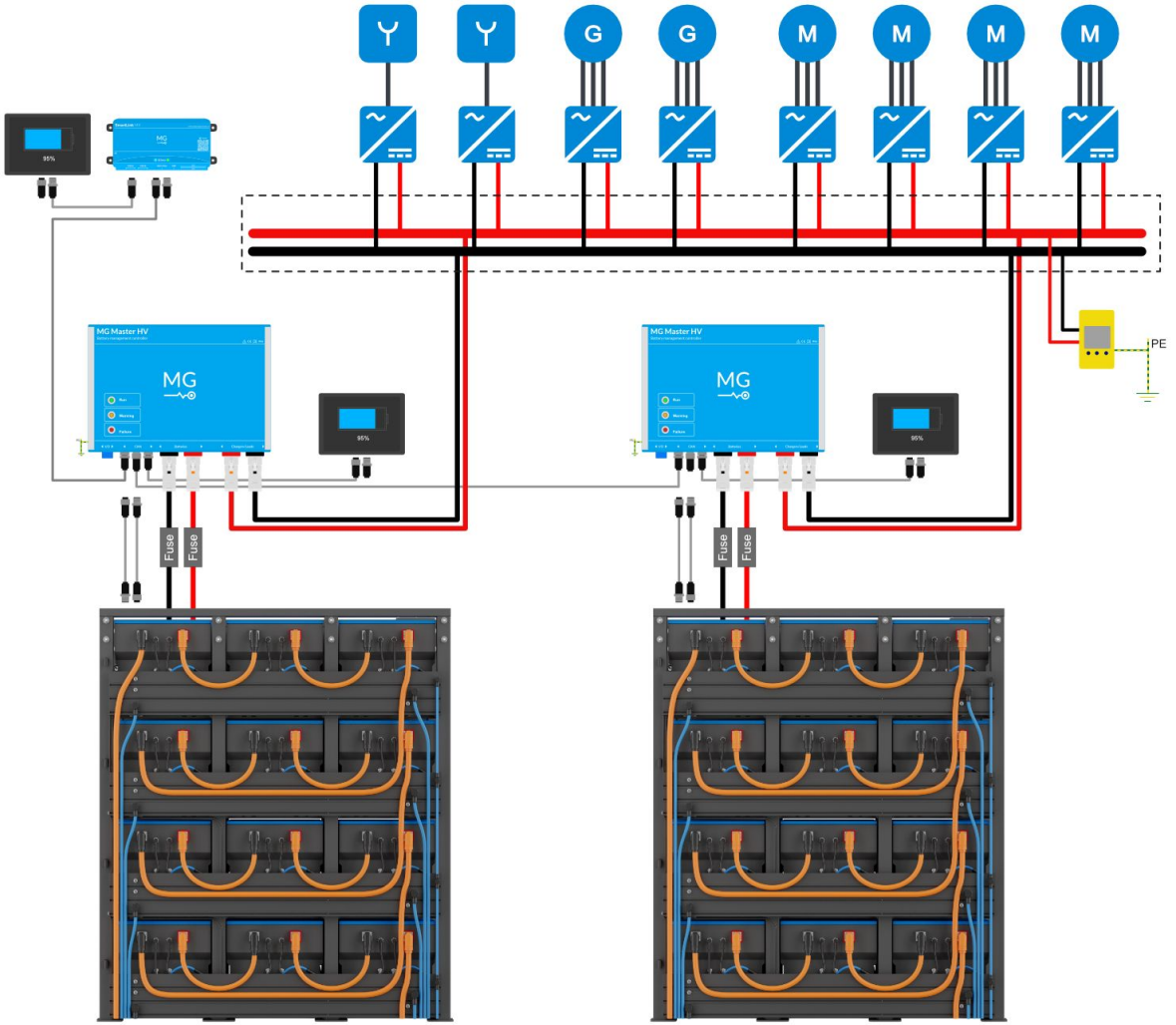
16x RS module - 134.4 kWh

Rack Features - Liquid Cooling

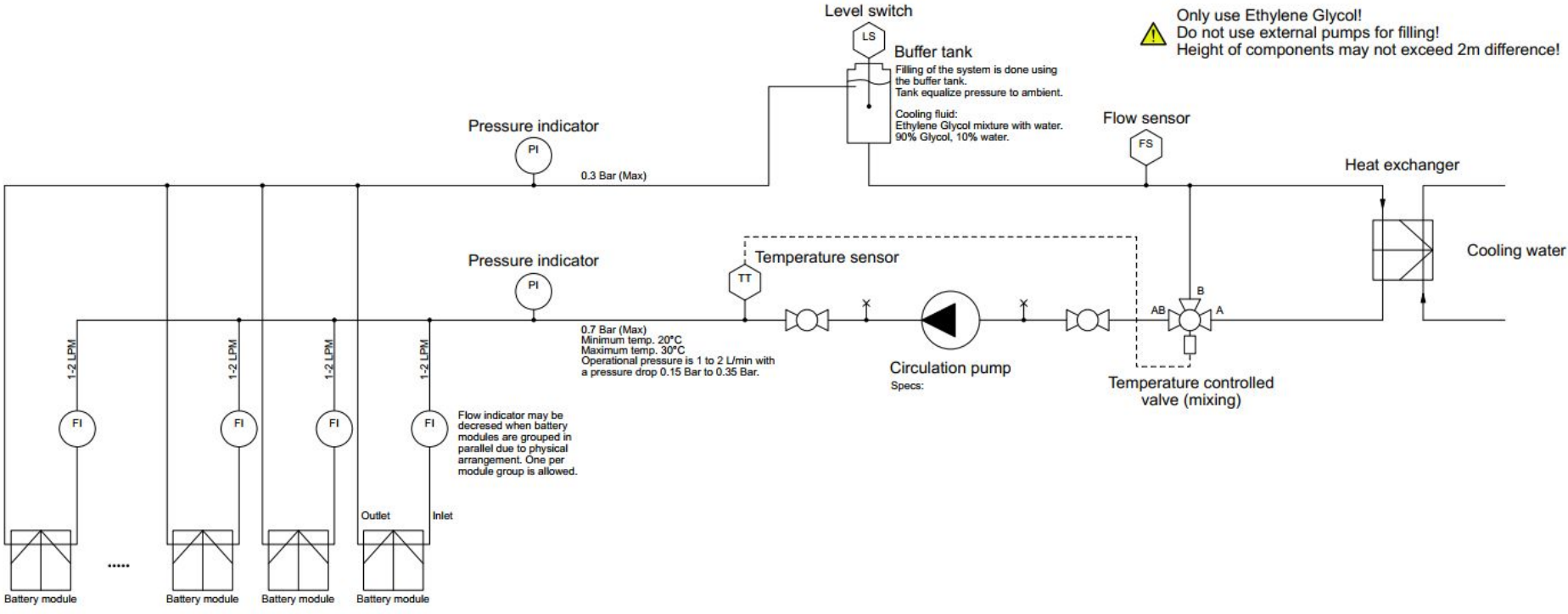


RS Rack

Redundant System



Liquid Cooling Set-Up



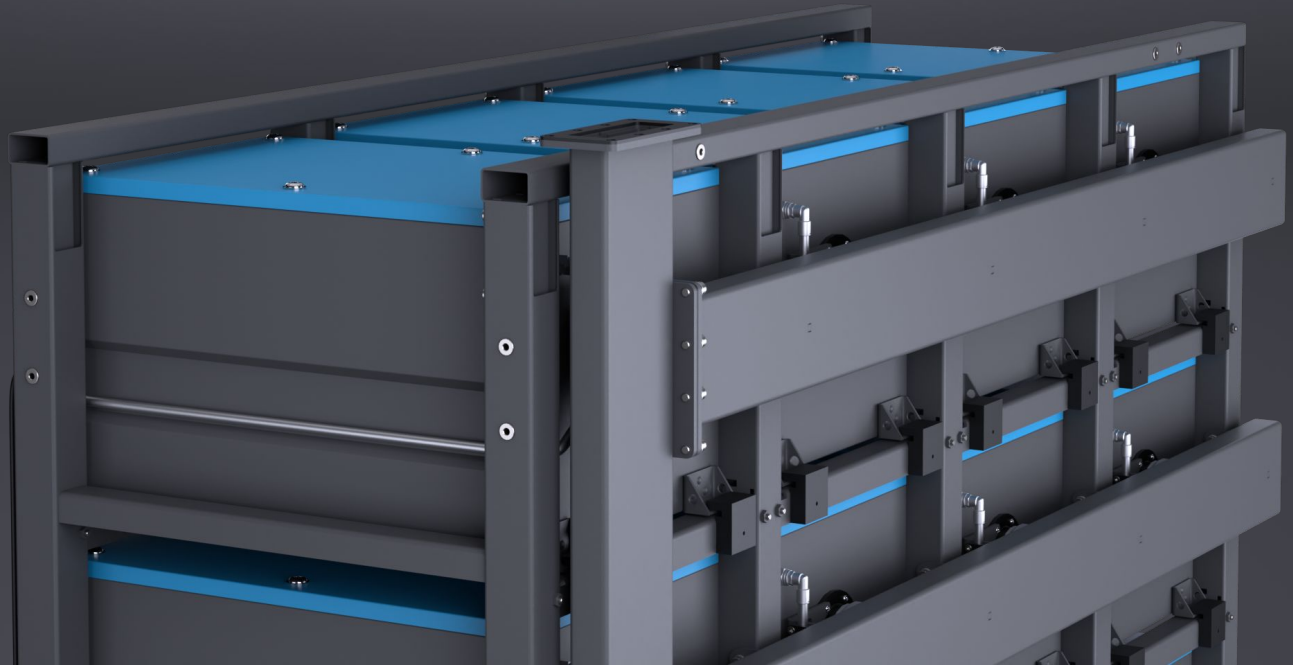
Liquid Cooling Set-Up

- All modules connected in parallel
- Pressless return. No obstructions in the return line of the batteries
- Ethylene Glycol with of 90% Glycol and 10% water
- Coolant inlet range: 20 ˚C to 30 ˚C. Non condensing.
- Maximum inlet pressure: 0.7 Bar
- Maximum outlet pressure: 0.3 Bar
- Operational flow: 1 to 2 l/min. Depending on charge/discharge rates
- Add overpressure valves to the inlet and outlet lines
- Do not use any valves in the return line
- Use a pump that cannot exceed maximum pressure

Test cooling system first without batteries connected. Make a loop at each battery module.

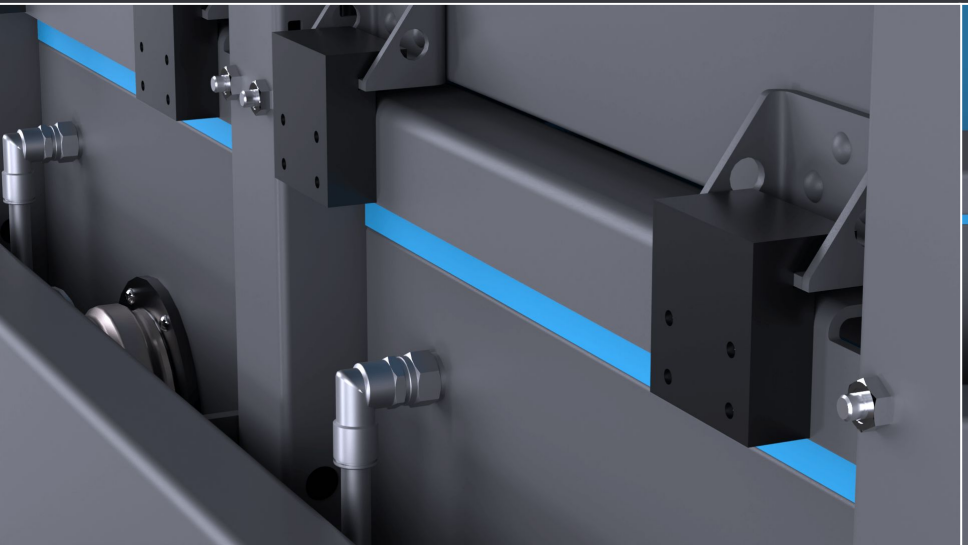
Rack Features - Exhaust System

Exhaust System: Gas extraction ICE Thermal Runaway
HAZARD: Gas is toxic and explosive



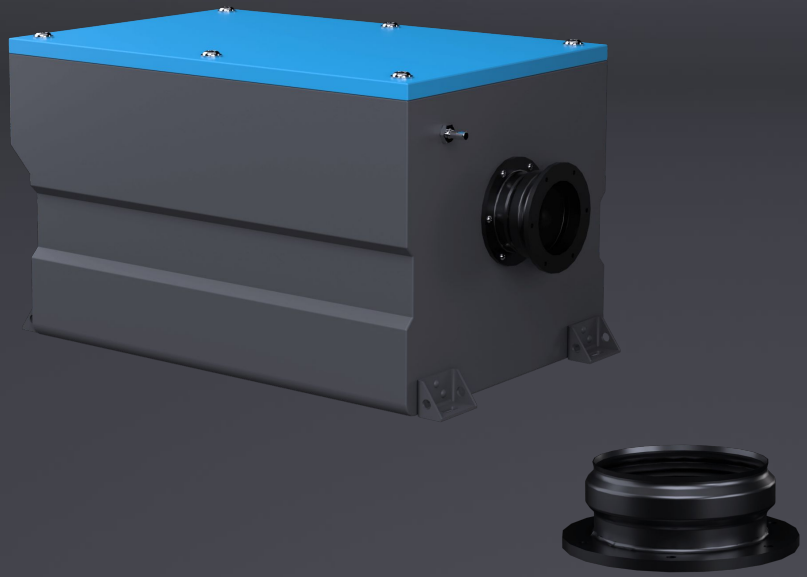
Exhaust System Requirements

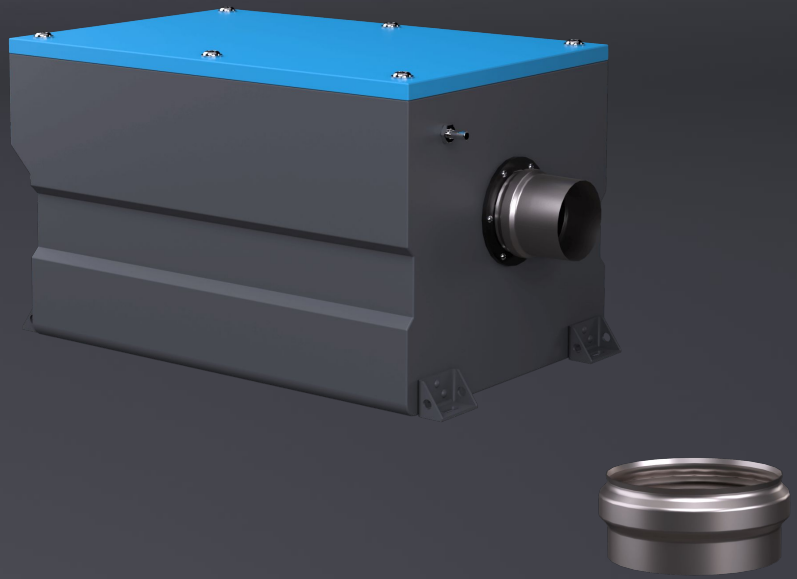
- Steel or stainless steel
- Gas tight connections
- (Recommended) add drain to lowest point for extracting liquids
- (Recommended) add nozzle to clean the ducting from any gas



Exhaust System Requirements

- Optional Exhaust Parts





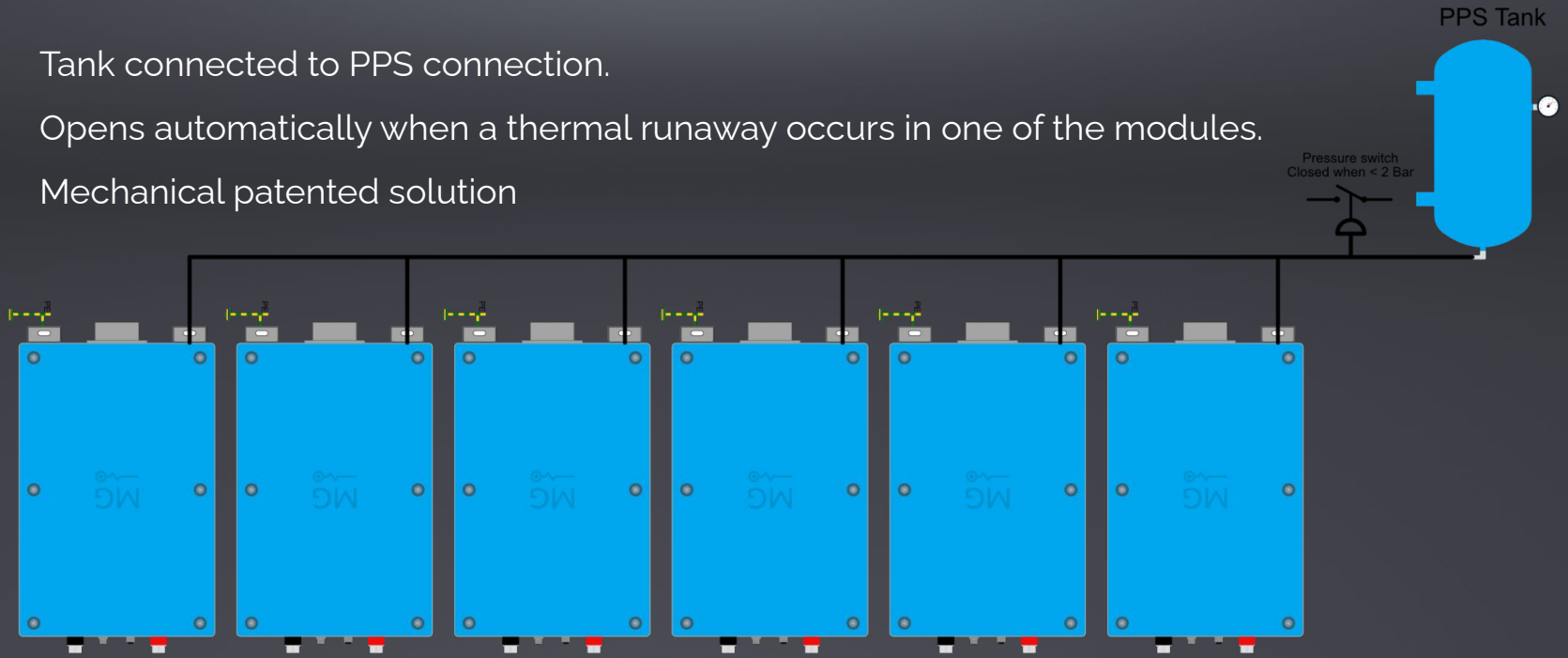
Cell Level Propagation Protection (PPS)

Automatic fire suppression with liquid to prevent cell level propagation

Tank connected to PPS connection.

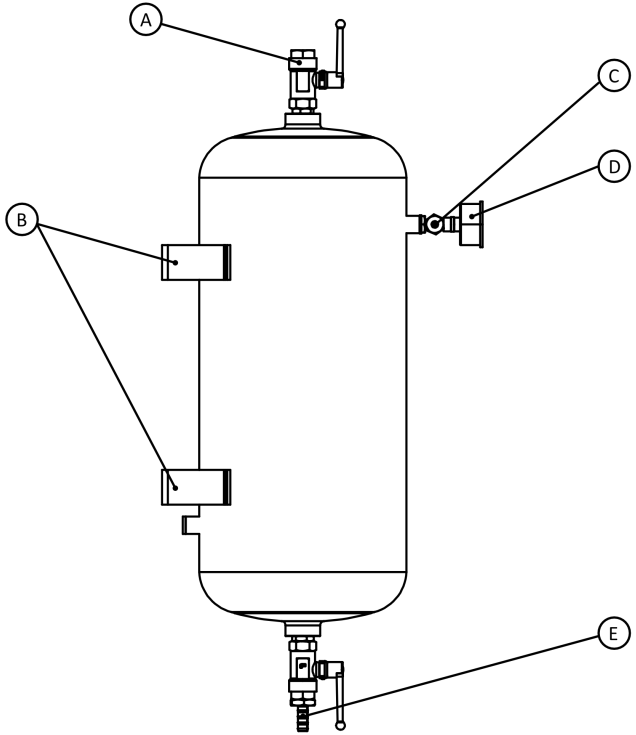
Opens automatically when a thermal runaway occurs in one of the modules.

Mechanical patented solution



PPS Tank

- 1 PPS tank per battery string
- 25L tank with 12L of fluid
- Pressure 2-3 Bar
- Under pressure alarm detection
- Fluid: Ethylene Glycol



Part	Description
A	Filling point including valve. 15 mm.
B	Mounting points. 14 mm holes.
C	Schrader valve for pressurizing the PPS tank.
D	Pressure gauge.
E	PPS fluid outlet (connections to battery modules). Use 9 mm inner hose diameter.

Watertaxi
Rotterdam (NL, 6 Ferries)

RS series
134 Vdc - 134 kWh
Electric propulsion, redundant

Doeksen

Ferry (NL)

RS series

700 Vdc - 4 x 77 kWh

Bow thruster

Electric Boats

Powercat 3400 (NZ)

RS series

350 Vdc - 46 kWh

Serial hybrid system

Alilaguna

Passenger Boat (IT)

RS series

700 Vdc - 4 x 77 kWh

Hybrid Propulsion

MG