

# FACT SHEET - Marine

## X2 BMS 12/24

X2 BMS is an upgraded version of MasterLi BMS including IDA balancing and pre-charge of Load relay.



### Key Features and Design

- Developed for lithium Cell Pack consisting of individual 3.2 V LiFePO<sub>4</sub> cells.
- Supports 12 V or 24 V systems, i.e. 4 cells or 8 cells in series.
- Introduces new BMS technologies adopted for systems in yachts:  
Combines lithium and lead batteries as starter, manage safe charging, intelligent dynamic balancing and new super-safe low voltage protection.
- Protects each individual cell against overvoltage, undervoltage and over / under temperature at different temperature when charging / discharging.
- A Cell Pack can consist of several cells in parallel to increase the capacity. X2 BMS manages up to 1 600 Ah per cell assembled in parallel and connected four in series for 12 V or eight for 24 V.
- Central design and no unprotected cell boards with continuous standby current during winter storage as well as in the event of Low Voltage Protection cut-off.
- High Performance balancing by Intelligent Dynamic Algorithm (IDA), which manages large cells and optimizes charging.
- BMS Control displays multi-level LED / Buzzer alerts to make it safe to utilize 93-95% of the battery's true capacity.

---

**Notice of Copyright:** X2 BMS © Fact Sheet Copyright © 2021 all rights reserved.  
No part of this document may be reproduced in any form without the consent of MasterLi AB, Sweden.

---

## System Basics

X2 BMS performs balancing of cells in series, protects and controls battery with external relay and/or direct connection to charge controllers.

### Basic protections:

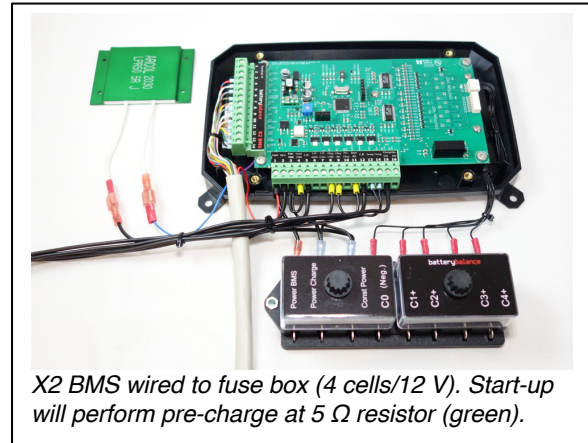
- Over-charging
- Over-discharging
- Over-temperature
- Under-temperature
- Balancing control the battery cells

### Unique features for X2 BMS:

- X2 Technology combines Lithium and lead
- Charge Management System
- Intelligent Dynamic Balancing
- Dual low voltage protection
- Warning system with LED / Buzzer
- Output to control latching (bi-stable) relay
- Pre-disconnect (AFD) output
- Inbuilt pre-charge for both load and charge relay

### System 500+ A includes the following:

- X2 BMS-12/24                      Master unit (red)
- BMS Control                        Anodized alu-panel (black)
- Fuse Boxes and harness        Plastic boxes with ATO fuses and wires to connect BMS and Control
- 2 pcs Relays 500+ A              Gigavac DC-relay. Optional latching (bi-stable) Load Relay



*X2 BMS wired to fuse box (4 cells/12 V). Start-up will perform pre-charge at 5 Ω resistor (green).*

## New technologies launched by batterybalance – X2 BMS

X2 BMS introduces new technologies that enable lithium systems as safe and reliable replacement for traditional lead battery systems.

1. The X2 BMS design combines lead and lithium. The “X2” stands for management of two different batteries by combining the start lead battery (or aux) and the lithium battery into one system. This unique feature creates many benefits in yacht installations.
2. The new design is compatible with all chargers, thanks to the built in Charge Management System. The CMS will turn off absorption and float charging, which will maximize the life of the lithium battery.
3. High performance cell balancing with the new Intelligent Dynamic Algorithm, will keep all cells in balance without absorption nor float charging. (Absorption is extended high voltage for a few hours).
4. The new Low Voltage Protection is the safest solution of all existing battery systems.

## Safety

X2 BMS meets all high demands that are required for a safe and reliable battery system.

- Low Voltage Protection must never be triggered incorrectly to cause blackout that may incur dangerous situations for the boat and crew.
- Low Voltage Protection must protect in case of no charging during an extended period.
- The battery must be protected from premature aging due to imbalance of cells.

*“BMS has the ability to cut-off the power to critical equipment such as navigation and autopilot, but must never do it incorrectly or unexpectedly.”*

*“The BMS is there to protect and maximize the lifetime of the battery, but if the system is poor, it could damage battery or chargers.”*

*“Yacht owners require a reliable system that safeguards against blackouts as well as protects the lithium battery and chargers from damage.”*

## Compatible with existing equipment

- Supports existing installations, i.e. 12/24 V equipment for lead batteries.
- Charger with lithium profile or settings for AGM-lead battery can be adapted to the X2 BMS, due to the built in Charge Management System.

- Combined charger / inverter can be adapted to the system.
  - Victron Multi / Quattro can be connected to X2 BMS and wired without interface and CAN.
  - The system can also be adopted with other combined charger/inverter brands.
- No shunt is required with X2 BMS.
- Starter and/or Aux batteries are controlled and managed by X2 BMS.

## Quality and design

X2 BMS is designed and manufactured according to standards sanctioned by leading responsible authorities, such as: DNV GL AS Maritime (Det Norske Veritas® incl. Germanischer Lloyd) and the American Boat & Yacht Council (ABYC).

To maximize the life of the battery system, the life of BMS device must match the life of the lithium cells. Quality has been a top priority to achieve maximum life expectancy.

- Manufactured to withstand a marine environment with salt water, humidity and other harsh conditions. BMS and Control are assembled with high-quality electronics, covered with epoxy coating to protect the circuit board. Assembly materials also include stainless steel screws, anodized aluminium and thermoplastic.
- CE certified. Made in Sweden.

## Multiple functions to control relays and/or remotes in a dual system

X2 BMS will protect the battery by controlling relays and / or by remote connected to chargers. Since there are many different chargers and consumers in a yacht, the safest system is to protect battery with two relays; one on the load side and another on the charge side.

**Load Relay** - protects from discharging:

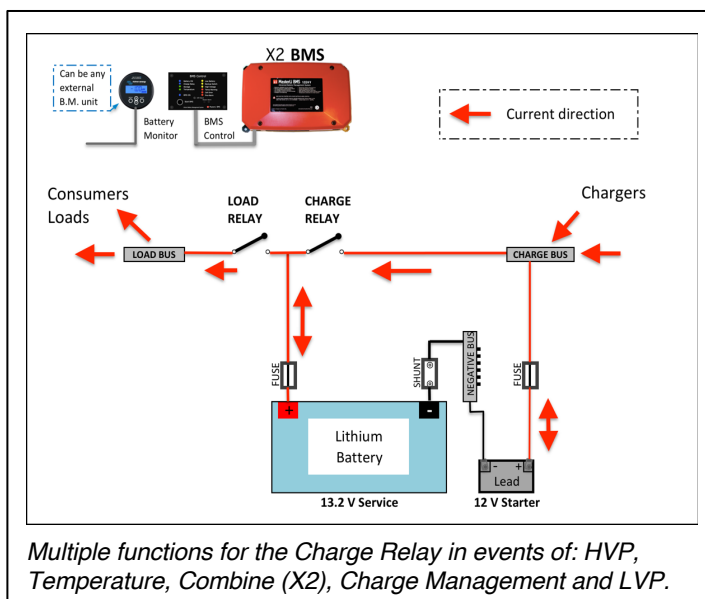
- Low Cell Voltage (LVP)
- High Temperature (HTP > 55° C)
- Isolate Battery during storage

**Charge Relay** - protects from charging:

- High Cell Voltage (HVP)
- High Charge temperature (> 45° C)
- Low Charge Temperature (< 2° C)
- Isolate Battery during storage

**Charge Relay** also operates as follows:

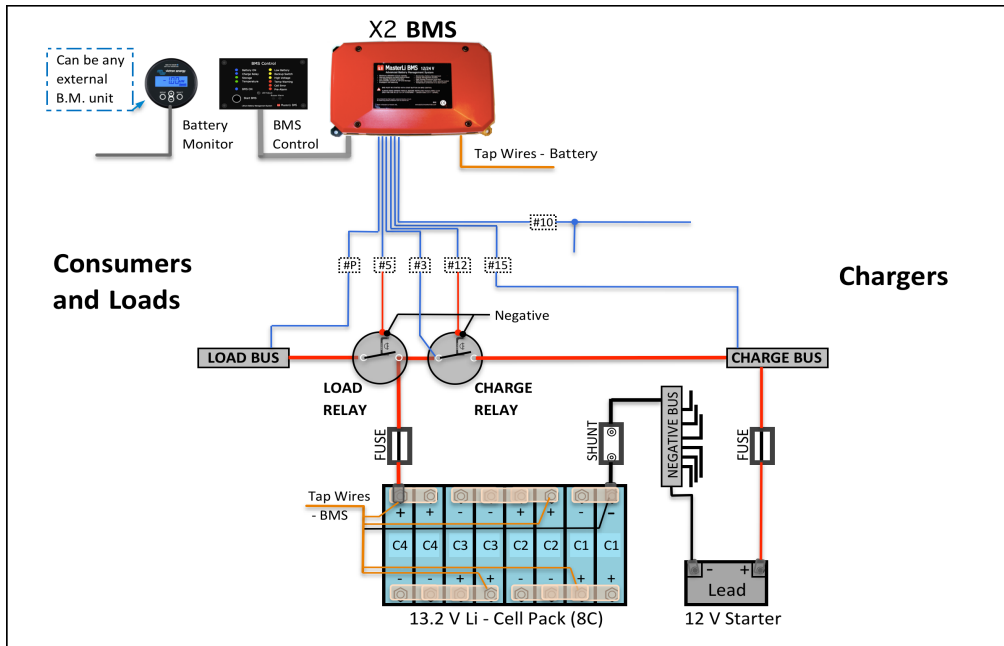
- Combine / Isolate as "X2" of lithium and lead battery (starter or aux).
- Disconnect / reconnect according to Charge Management System (CMS).
- Disconnect in event of Low Voltage (LVP) and completely isolate the lithium battery.



The Charge Relay control has multiple functions including **X2 technology** and **Charge Management System**.

- When there is no charge, the Charge Relay opens and isolates the two batteries (**X2-technology**).
- When the Charge Relay is open and charging is switched ON, the relay will close.\*

\*) Exception is when the Charge relay will remain open according to the CMS regulation. X2 BMS has a built-in **Charge Management System (CMS)** that does not allow the Charge Relay to close when the lithium battery is full. The advantage of CMS is to obtain maximum life, since the lithium battery should not be FLOAT charged.



### Tailor-made outputs for yacht installations to control relays / remotes

X2 BMS is equipped with several tailor-made outputs including a pre-signal, which can be used to operate alternators as well as other controllers with a remote signal. It communicates with Victron Multiplus, Quattro or Phoenix inverter, which connects by single standard wire and a small signal relay.

Maximum current per output; 20 A (peak), enables connection of three DC relays per output and “unlimited” numbers of remotes. (Signal to close a DC relay creates an inrush current of 4 - 7 A).

#### Five different BMS outputs (@) can be used to control:

- Remote on/off of Loads @ 1 #5
- Remote on/off of Chargers @ 4 or 3 #10 or #9
- Remote on/off of Victron Multi charger/inverter @ 3 and 1 #9 and #5
- Remote on/off of MPPT solar controllers @ 4 or 3 #10 or #9
- Remote on/off of Alternator control @ 4 #10
- Remote on/off of SSR as Victron BP220 @ 5 or 1 #12 or #5
- DC Charge Relay 500+ A non-latching @ 5 #12
- DC Load Relay 500+ A non-latching @ 1 #5
- DC Load Relay 500+ A latching (bi-stable) @ 2 #6 and #7

Note: #XX is output number at BMS terminal B. The #10 output is a pre-signal of 2 seconds prior charge disconnect of #9 and #12. SSR is a MOSFET-relay that has limited current and power loss at high current.

### Monitoring

Charge status monitoring (SOC %) is not built into the X2 BMS, since an external battery monitor is more convenient and accurate. The external battery monitor is excellent for planning when recharging will be required. However, the battery monitor measures the current and makes an estimate of the state of charge (SOC) based on the capacity set in the battery monitor. Most often, the SOC calculation is not entirely true, because the battery monitor has not been synchronized for a while and also because the capacity set is not the same as the true capacity of the lowest cell.



The **BMS Control** has a pre-warning system that makes it safe to utilize 93 – 95% of the lithium battery’s true capacity. In event of low voltage, a three-stage Pre-Alarm with duration time of approx. 10 hours yellow LED, 27 minutes red LED and 2 minutes Buzzer.

More information regarding Pre-alarm and Status LEDs in the User Manual on page 12 – 15.

## BMS Control – condition / action overview

STATUS of BATTERY ON, CHARGE RELAY, STORAGE, TEMPERATURE, BMS ON							
Name	Condition	Action BMS Control				Action Remote / Relay	
		Battery ON	LED - solid	Buzzer	LOAD	CHARGE	
Battery ON	Load Relay ON	Battery ON				ON	
Charge Relay	Charge Relay ON		Charge Relay		Temperature	ON	ON
Storage *	All cells > 3.0 V and temp OK during 10 min. *			Storage	Temperature	ON	
Temperature	Battery temperature +2° - +45° C				Temperature	ON	
BMS ON	Power to BMS	BMS ON				ON	

*\*) Storage LED must be used as a double-check indicator of correct storage level for the lithium cells. Use Storage LED indicator together with the Battery Monitor which calculating SOC. Recommended cell storage is at about 50 - 70% SOC. However, SOC is calculated for battery and not individual cells and can be incorrect. Cell voltage measured in a fair temperature is correct as long as neither charging nor discharging has affected the voltage for the last half hour or so.*

LOW CELL VOLTAGE							
Name	Condition	Duration time	Action BMS Control			Action Remote / Relay	
			Battery ON	LED - Flashing	Buzzer	LOAD pulse	LOAD
Low Battery Alert	Any cell < 3.0 V during 10 min.*	10 hours*		Low Voltage			
Low Voltage - Warning 1	Any cell < 3.0 V during 3 min.**	27 minutes**		Low Voltage	Pre-Alarm		
Low Voltage - Warning 2	Any cell < 3.0 V during 28 min.	2 minutes	OFF	Low Voltage	Pre-Alarm	2 min.	
Low Voltage Protection 1	Any cell < 3.0 V during 30 min.					OFF	OFF
Low Voltage - Warning 3	Any cell < 3.0 V dur. 10 sec.***	50/60 seconds***	OFF	Low Voltage	Pre-Alarm	50 sec.	
Low Voltage Protection 2	Any cell < 3.0 V during 1 min.					OFF	OFF
Low Voltage Cell Error	Any cell < 3.0 V dur. 10 sec.****				Cell Error	10 sec.	

*\*) The duration depends on the discharge rate; 10 hours until Pre-Alarm, refers to e.g. 5 amps discharge @ 400 Ah battery. Ten-minute trip delay filters out occasional voltage drops.  
 \*\*) 3 minutes trip delay filters out occasional voltage drops.  
 \*\*\*) 10 seconds trip delay filters out occasional voltage drops.  
 \*\*\*\*) 10 seconds trip delay. Note, if Cell Error will be triggered, it is most probably a false reading due to fuse or poor wire and for this reason no action of relay/remote will cause blackout. Event of Cell Error require troubleshooting.*

HIGH CELL VOLTAGE							
Name	Condition	Duration time	Action BMS Control - LED / Buzzer			Action Remote / Relay	
			Charge Relay	LED - Flashing	Buzzer	AFD (pre)	CHARGE
Unbalanced cells Alert (HV)	Any cell > 4.2 V			High Voltage			
High Voltage Pre-Warning	Any cell > 4.2 V			High Voltage	Pre Alarm	10 sec.	
High Voltage Protect (HVP)	Any cell > 4.2 V		OFF	High Voltage	Pre Alarm	OFF 2 sec	OFF
High Voltage Cell Error *	Any cell > 4.2 V				Cell Error	10 sec.	

*\*) 10 seconds trip delay filters out occasional voltage drops. Note, if Cell Error will be triggered, it's most probably false reading due to fuse or poor wire and of this reason will not trigger relay/remote action nor balancing. Event of Cell Error require troubleshooting.*

BATTERY TEMPERATURE - CHARGING							
Name	Condition	Duration time	Action BMS Control - LED / Buzzer			Action Remote / Relay	
			Charge Relay	Temp. LED	LED - Flashing	Buzzer	AFD (pre)
Over Temperature Alert	> 43° C and Charging			OFF	Temp Warning	Pre Alarm	10 sec.
Over Temp. (no charging)	> 43° C						
Over Temperature Protection	> 45° C		OFF	OFF			OFF 2 sec
Under Temperature Alert	< 4° C and Charging			OFF	Temp Warning	Pre Alarm	10 sec.
Under Temp. (no charging)	< 4° C						
Under Temperature Protection	< 2° C		OFF	OFF			OFF 2 sec

BATTERY TEMPERATURE - DISCHARGING								
Name	Condition	Duration time	Action BMS Control - LED / Buzzer			Action Remote / Relay		
			Battery ON	Charge Relay	Temp. LED	LED - Flashing	Buzzer	LOAD
Over Temperature Alert	> 45° C			OFF	OFF			
Over Temperature Alert	> 55° C		OFF*	OFF	OFF	Temp Warning	Pre Alarm	2 min.
Over Temperature Protection	> 55° C		OFF*	OFF	OFF			
Under Temperature Alert	< 2° C			OFF	OFF			
Under Temperature Protection	For example -20° C **			OFF	OFF	See note**		

*\*) 10 seconds delayed  
 \*\*) Lithium battery will not be damaged during discharge in freezing degrees and of this reson system has no protection which will cut-off (create blackout) However, the user must note that the battery capacity will be temporarily reduced at freezing temperatures and it's not recommended to use battery < -20° C*

## System schematics

### 12 V system with common chargers in a yacht (Schematics 12:1)

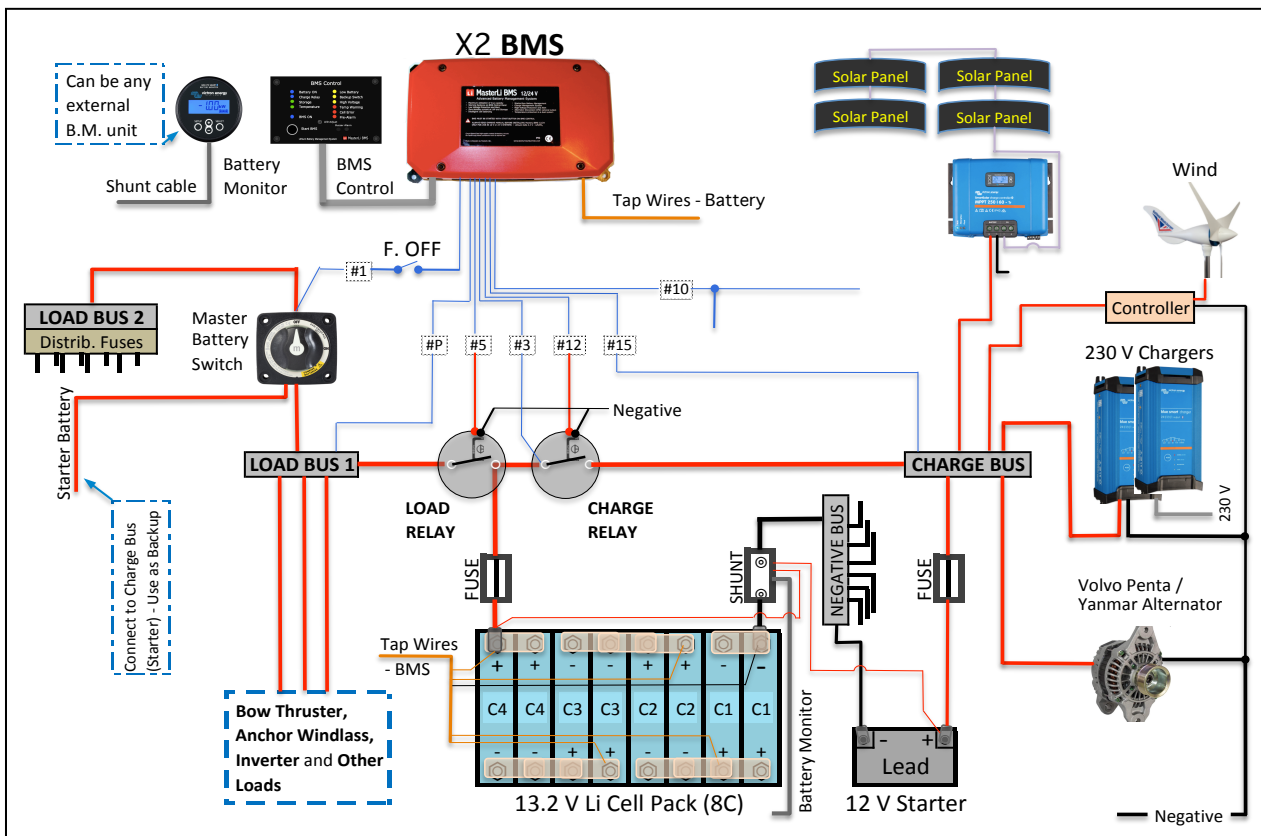
When equipped with Gigavac (500+ A) contactors, X2 BMS will manage bow thruster as well as high power inverters. The Gigavac contactors can handle peak current of 1000 A during max 70 seconds. X2 BMS manages extra contactors (load relays) in parallel for continuous high current installations.

**Wind generator and hydro generator** works safely in the X2-system since wind/hydro controllers always are powered by starter / aux. When turbine is spinning, wind/hydro controllers must be powered ON (at output connected to a battery), otherwise the controller will break. An isolater must never be used together with Wind / Hydro generator. When X2 BMS is off during winter storage, wind and solar can float charge starter as well as third bow battery (lead).

**Please note**, different schematics including connection of latching (bi-stable) relay, second starter, bow battery, Balmar alternator, Victron Multi charger/inverter, Mastervolt Combi charger/inverter, different solar controllers, hydro generator, as well as system of 24 V are presented in the User Manual.

### Schematic 12:1

Fuse box connections to BMS are excluded in the schematic below.



DATA SHEET X2 BMS - 12/24 V		batterybalance		Version 21:1
<b>GENERAL</b>				
BMS nominal voltage	12 or 24 V			
BMS min - max input voltage	7 - 36 V			
Number of cells in series (4S/8S, 2P4S/2P8S, 3P4S/3P8S, ...)	4 or 8			
Lithium chemistry (Only)	LiFePO4			
Shunt required to connect to BMS	No			
Needs of DC/DC or external regulation of alternator	No			
Needs of CAN to control Victron Multi charger/inverter	No			
Needs of pre-charge unit for charge or load relay	No			
Optional BMS Control with status / alerts	Yes			
BMS unit power consumption, average	50 mW			
BMS unit stand-by power (when OFF or event of LVP)	0.0 mW			
Circuit Board protection for harsh and humid conditions (Coat)	Epoxy			
Protection category when BMS unit is wall mounted upright	IP 22			
BMS dimensions L x W x H	220 x 135 x 44 mm			
Weight	0.32 kg			
<b>BALANCING and MEASUREMENT</b>				
Dual advanced Multicell Monitors of 3rd generation	Yes			
Ultra high Cell voltage resolution	0.1 mV			
Cell voltage accuracy (measured by dual Multicell Monitors)	+/- 0.2 mV			
Intelligent Dynamic Balancing Algorithm - balancing booster	Yes			
<i>Algorithm uses memory of detected unbalance and if necessary will continue balancing when chargers switched off or in float voltage.</i>				
Heatsink on balancing resistors	Yes			
Overheat protection by dual temp sensors on circuit board	Yes			
High performance balancing algorithm will stop at cell delta	+/- 3 mV			
Cell balancing current @3.55 V and 7.15 Ohm resistors	0,50 A			
Recommended cell capacity, max (nominal Ah)	1 600 Ah			
Recommended cell capacity, min (nominal Ah)	200 Ah			
Temperature accuracy by thermistor probe at 20° C	+/- 0.2° C			
<b>TEMPERATURE and OPERATION of BMS unit</b>				
Operating temperature, max	+ 75° C			
Operating temperature, min	- 40° C			
Storage temperature, max	+40° C			
Storage temperature, min	- 25° C			
<b>RELAY OPERATION of Contactors, Remotes or SSRs</b>				
BMS current limitation of Battery (Load/Charge)	None			
BMS operates external DC relays or remote control directly to Chargers/Loads				
<i>DC Relay can be contactor as Gigavac, Kilovac, Blue Sea Syst - all good for 500+ amps</i>				
<i>Output signal to close such contactors creates an inrush current of 3.5 - 7 A</i>				
Max inrush current, each output	20 A			
Max continuous current, each output	5 A			
Total numbers of outputs to DC relay / Remote	5			
Max DC relays (contactors) in parallel connection, each output	3			
Output DC Relay, Load for non-latching relay / remote	1			
Output DC Relay, Load for latching relay (bi-stable) Open/Close	1 / 1			
Voltage to control Load relay or remote control (Load Com)	12 or 24 V			
Output DC Relay, Charge Protection (HVP and Temp)	1			
Output DC Relay, X2 combine / CMS	1			
Output DC Relay, Charge AFD (pre-disconnect 2 seconds)	1			
Voltage to control Charge relay or Remote control (Com input)	12 or 24 V			
<b>FUSES (optional external fuse boxes)</b>				
Recommended Cell Balancing fuse	2 A			
Recommended Input Pwr fuse	2 A			
Recommended Constant Pwr fuse	2 A			
Recommended Relay fuse, 12 / 24 V (per contactor)	5 / 3 A			
<b>FIRMWARE settings</b>				
Under Voltage Protection, LVP1 (after 30 min alerts), lowest cell	<	V		
Under Voltage Protection, LVP2 (after 60 sec alerts), lowest cell	<	V		
Over Voltage Protection, HVP (after alerts), highest cell	>	V		
Balance start voltage (at least one cell)	>	V		
Balance end voltage max (= HVP)	>	V		
Balance end voltage min (when normal mode i.e. fine tuning balancing)	<	V		
Balance end voltage according to IDA (when large unbalance)	None			
Battery max temperature; Load relay switch off (after pre-alert)	>	+55° C		
Battery min temperature; Load relay switch off	None			
Battery max temperature; Charge relay switch off (after pre-alert)	>	+45° C		
Battery min temperature; Charge relay switch off (after pre-alert)	<	+2° C		
<b>OUTPUTS Terminal A to BMS CONTROL (5 V, max 20 mA)</b>				
#1-2 Start up activation during 30 seconds after #1-#2 closed by push-button				
#3	BMS ON			
#4	Load Relay ON	Battery ON		
#5	Charge Relay ON	Charge Allowed		
#6	Temperature OK (measured on Battery)	+2° - +45° C		
#7	Storage OK (only when temperature is OK)	V		
#8	High Voltage alert	V		
#9	Low Battery alert	... V		
#10	Pre-Alarm before Load / Charge relay open due to LVP, HVP or Temp.			
#11	High Temperature	> +55° C		
#12	Cell Error	< :		
#13	Buzzer	Dual 2x 87 dB 2.4 kHz		
#14	Negative			
<b>OUTPUTS / INPUTS Terminal B</b>				
#1	Power IN	Connects to Battery Switch, which operates BMS OFF		
#2	Negative			
#3	Aux / Cont	Continuous power 12/24 V direct from battery		
#4	Load COM	Input voltage to operate: #5, #6 and #7		
#5	Load output	Normal Open - closed when discharge is allowed		
#6	Open Load	2 seconds pulse for operating Latching contactor		
#7	Close Load	6 seconds pulse for operating Latching contactor		
#8	Charge COM	Input voltage to operate: #9, #10 and #12		
#9	Charge NO	Closed when charging allowed i.e. not HVP and Temp OK		
#10	Pre-signal (AFD)	Will Open 2 seconds pre #9 and pre #12		
#11	CMS / X2	Input from #9 by jumper (= #9 + #12)		
#12	Charge output	Closed when charging allowed by X2, CMS and by #9		
#13	Temp sens	Input for temperature probe		
#14	Temp sens	Input for temperature probe		
#15	Charge Pwr12	Only for 12V connected to Charge Bus (when use of #12)		
#16	Charge Pwr24	Only for 24V connected to Charge Bus (when use of #12)		
<b>INPUTS Terminal C</b>				
4-Cells socket	Connect tap wires to each of four cells and to battery minus			
8-Cells socket	Connect tap wires to each of eight cells and to battery minus			