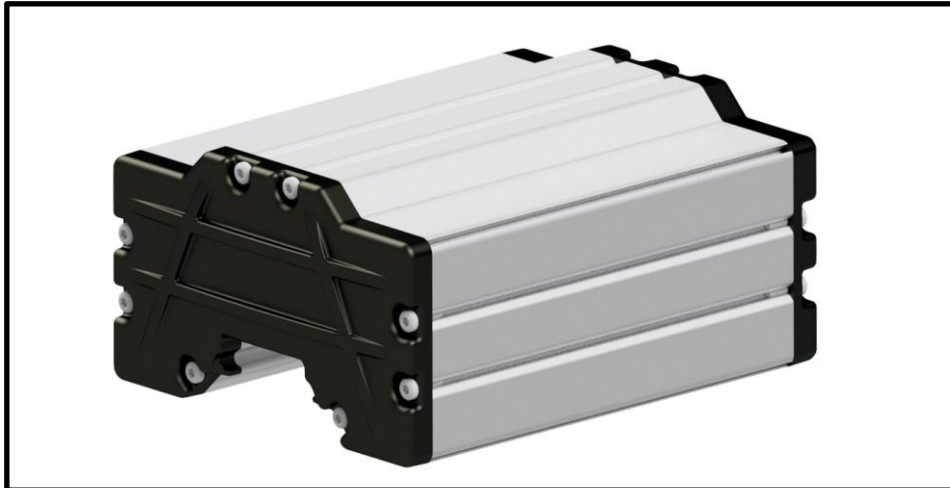


36V BATTERY

USER GUIDE



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REV.	CHANGE DETAILS	DATE OF ISSUE
01	Initial Release	23.04.2020
02	Updated version	12.07.2021
03	Updated version	04.12.2020
04	Disposal information added	18.02.2022
05	Added certifications	16.05.2022
06	Rating plate update	31.08.2022
07	Changed fuse value and operating temperature	15.09.2022
08	Logo and company details changed, label changed, other minor changes	02.09.2024

Approvals			
Names	Position	Signature	Date
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1 INTRODUCTION

This document is intended to provide users with information to ensure the correct use of a Lithium Ion battery pack.

It is assumed that the user of this manual is both technically qualified, trained in the use of electrical equipment involving high voltages, and is familiar with the installation of the battery pack in the intended application.

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For the safe operation and installation of the Lithium Ion battery pack, this document should be reviewed prior to unpacking the battery pack from its original packaging.

EMBS shall not liable for any damage or failure of the battery resulting from deviation from instructions in this guide, mishandling, unauthorized modification or poor maintenance once received by the customer.

Please note that Lithium batteries have a low internal impedance and can provide damaging currents if misconnected.

It should be noted that the battery system has been prepared for the purposes of test and development of the application and battery. Warranty of fitness for purpose and assurance of any particular performance are specifically excluded.

The batteries to which this document refers bear serial numbers which are visible on the lower external surface of the battery;

For connection, and use instructions, please refer to the relevant sections below.

If you have any questions regarding this User Pack, or require any further information, please contact the following.

EMBS Sp. z o.o.

ul. Alberta Einsteina 36

PL-44-109 Gliwice

+48 (0) 32 330 2650

contact@embatterysystems.com

In case of emergency call:

+1 (205) 419 - 5174

Product Code: 03546


Glossary:

-Application: device/system that battery described in this document will supply energy to.

-BMS: Battery Management System.

-CAN, CAN bus: Controller Area Network, communication standard.

-CC, CV: Constant Current, Constant Voltage, refers to charging stages of the battery.

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- CE: Conformance Européenne, usually refers to CE mark or declaration of conformity that confirm that product was validated for European marked.
- Customer: party that has contract with Manufacturer for delivery of the battery described in this document.
- DBC: file containing CAN database for decoding raw CAN bus data to meaningful signals.
- EMC: Electro Magnetic Compatibility.
- End User: person or company that is using battery in their final application.
- EMBS, Manufacturer: EMBS Sp. z o.o.
- PoC: Proof of Concept prototype, not fully validated, not certified. See Prototype.
- Product: battery described in this document.
- Prototype: early version of battery that should be only used by the Customer to internal testing and validation, cannot be sold or placed on the marked or used by End User. Not covered by warranty, not fully validated, not certified.
- Public Use: usage of the battery (or application with battery installed) by the Customer or by End User outside controlled testing environment, especially when used in public places or 3rd party locations.
- REACH: Restriction, Evaluation and Authorisation of Chemicals, refers to EU regulation EC 1907/2006.
- RFI: Radio Frequency Interference.
- RoHS: Restriction of Hazardous Substances, refers to EU directive 2002/95/EC.
- Safety box: UN certified wooden or aluminum transportation box, filled with vermiculite. Necessary for transportation of battery prototypes which are not UN 38.3 certified.
- SDS (MSDS, PSDS): Safety Data Sheet, Material Safety Data Sheet, Product Safety Data Sheet. Documents containing important information in regard to safety features and hazardous materials of the component (for example MSDS for Li-ion cell) or whole product (PSDS).
- SoC, SOC: State of Charge (in %).
- UN 38.3 – United Nations Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (document symbol ST/SG/AC.10/11), chapter 38.3 Lithium metal and Lithium Ion Batteries. Set of test (confirm by proper certificate and test report) required for transportation of Lithium Ion batteries.
- WEEE: Waste Electrical and electronic equipment, refers to EU directive 2012/19/EU.

2 PRODUCT DESCRIPTION

The EMBS Lithium-Ion battery assembly is a prototype proprietary rechargeable battery system intended for development and testing of application and battery.

The battery system comprises 30 Li-ion 21700 cells connected in 10S3P configuration, giving a maximum battery voltage of 42,0V when fully charged. The cells are connected using purpose made nickel connectors, which are projection-resistance welded to the cells. The cells are located and supported in a plastic structure.

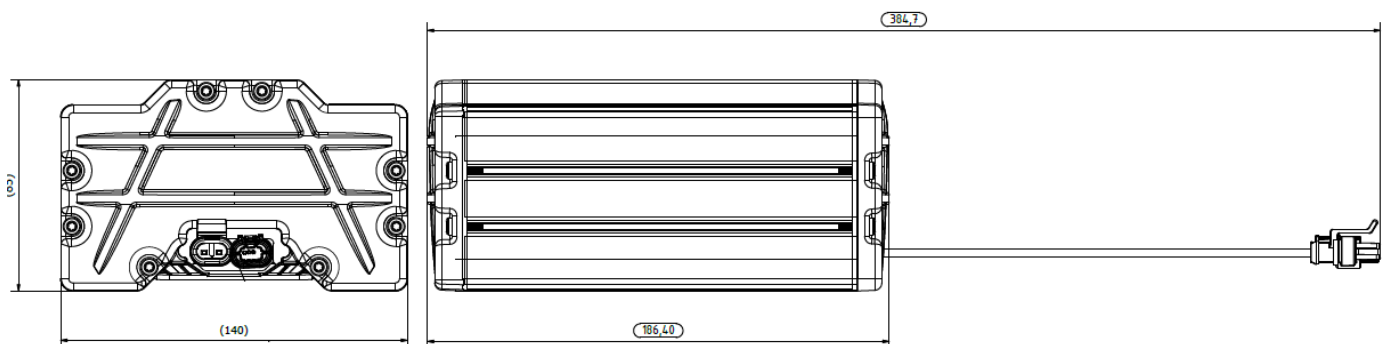
The battery management system (BMS) is included. Battery pack condition are monitored and controlled. **For safety reason battery was equipped with fuse 30A.**

The battery system comprises Li-ion 21700 cells. Provision is made for cell voltage and temperature measurements, along with pack current measurement, to be transmitted to the Battery Management System.

The battery management system (BMS) monitors the battery pack condition and controls charging and discharging. Other electronic components including shunts and fuses are also contained within the battery pack enclosure.

The Battery Management System (BMS) included monitors the following battery functions:-

- Cell protection from hazardous voltage levels
- Cell protection from over-current conditions
- Cell protection from high temperatures



10S3P

Figure 1 – General Battery Layout

3 PERFORMANCE

Battery ingress protection level is IP54, therefore batteries should be stored indoors, and care must be exercised when using them in wet conditions.

The batteries should not be subject to temperatures exceeding the limits shown in table 1.

Specification Details	Nominal Value	Comment
Dimensions (mm) (Approx)	186 x 140 x 85 mm	10S3P
Cell ambient Charge Temperature Range	0°C to +45°C	Maximum continuous current 7 A (peak 15 A)
Cell ambient Discharge Temperature Range	-5°C to +45°C *	Maximum continuous current 20 A (peak <30 A)
Storage Temperature Range ≤ 3 Months	≥-10°C and ≤+40°C	
Nominal Voltage	36,6V	3.6V/cell
Voltage Limits		
Maximum Voltage	42,0 V	4.2V/cell
Minimum Voltage	29,0 V	29,0V/cell
Nominal Capacity	14,7 Ah	10S3P
Nominal Energy	534 Wh	10S3P

Table 1 – 36V Lithium Ion Battery pack – Key Parameters

Do not exceed 20A continuous current at any time during discharge and 7A when charge.

*Do not continuously discharge battery pack if ambient temp. is below 0°C. It is allowed to discharge in ambient temp. below 0°C (up to -20°C) if the following conditions are met:

- initial battery temp. is >10°C
- operating time is <0,5h (-20°C to 0°C). If BMS detect battery temp. below 0°C, discharging will switch off.

Do not charge the batteries at temperatures below 0°C, or until sufficient time has elapsed to ensure that the cell internal temperatures (following prolonged storage or transport in cold conditions, for example) have returned to an acceptable range.

Use only dedicated charger. Typical charger for li-ion battery has a 3 stage charging profile.

1st stage is CC (constant current) phase.

2nd stage is CV (constant voltage phase).

3rd stage is charging-end stage

Each battery is protected with an internal 30A fuse.

Do not connect batteries in parallel at any time. Do not connect the batteries in series at any time.

4 CONNECTION OF THE BATTERY, CHARGING, DISCHARGING.

The battery is fitted with two t-pole connector. Main power connector:

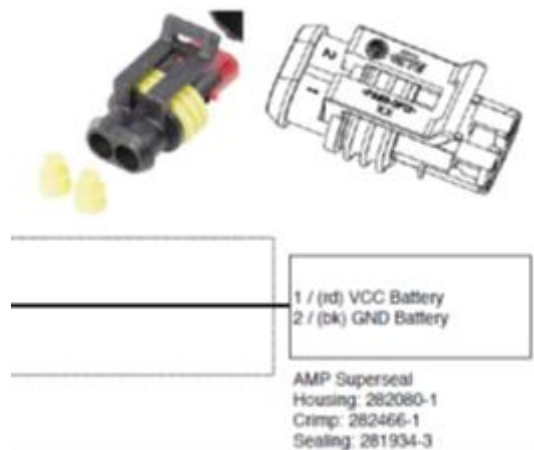


Figure 2 – Main power connector

Communication connector:

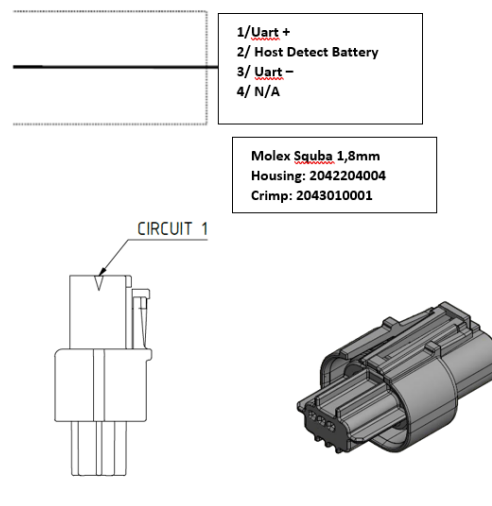


Figure 3 – Communication connector

To activate (wake up) battery Host Detect Battery (HDB) pin needs to be shorted to VCC (main positive terminal)

5 PROTECTION FUNCTIONS AND TROUBLESHOOTING GUIDE

Protection functions:

BMS will act in case of:	Set value	Reaction	Recover
SC – “Short circuit”	≥ 100A up to 200μs	Discharging will be switched off.	BMS will try power up again every 5th second
OC - “Over Current”	≥ 22A up to 1280ms	Discharging will be switched off.	BMS will try to power up again every 5th second
OV – “Over Voltage”	If any of cells voltages will increase above 4,3V within time of 1 second	Charging will be switched off	Overvoltage release voltage limit is 4,15V/cell within time up to 20 seconds
UV – “under voltage”	If any of cells’ voltage will decrease below 2,5V	Discharging will be switched off.	UV release voltage limit is 3,00V/cell within time up to 20 seconds
OT – “Over Temperature”	if battery temperature will increase above 55°C[DS1]	Charging will switch off	Charging will switch on after battery temperature is 50°C
	if battery temperature will increase above 60°C	Discharging will be switched off.	Discharging will switch on after battery temperature is 55°C
UT – “under Temperature”	if battery temperature will decrease below 0°C	Charging will switch off	Charging will switch on after battery temperature is 5°C
	if battery temperature will decrease below -5°C	Discharging will be switched off.	Discharging will switch on after battery temperature is 0°C

Troubleshooting guide:

Parameter	Battery Behaviour	Action to reset
Overcurrent	BMS will cause battery shutdown	Switch off application. Ensure load is within approved limits. Restart application.
	Fuse will blow	Request support from EMBS
Overvoltage	BMS will cause battery shutdown	Switch off application. Ensure load is within approved limits. Restart application.
Undervoltage	BMS will cause battery shutdown	Switch off application. Charge battery. Restart application.
Overtemperature	BMS will cause battery shutdown	Switch off application. Allow to cool. Restart application.

OBSERVED FAULT	POSSIBLE CAUSE	POSSIBLE SOLUTIONS
Battery will not discharge	Connectors incorrectly fitted	Check all connectors to the battery have been correctly fitted.
	Fuse blown or cell in over-discharge state BMS has detected conditions are not acceptable	Request support from EMBS
Battery will not charge	Connectors incorrectly fitted	Check all connectors to the battery have been correctly fitted. Ensure correct signals are present
	Battery already fully charged	Request support from EMBS
	Fuse blown or cell in overcharge state	

	BMS has detected conditions are not acceptable Damage or incorrect charger	Use different (dedicated) charger
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If in doubt, please contact EMBS, at the address provided in section 1 above.

6 WARRANTY

Do Not Open the Lithium Ion Battery System enclosure.

Unauthorized removal of the main battery pack cover is potentially dangerous and will void any applicable warranty.

Contact EMBS Customer Service for further information. See section 1 for contact details.

7 MAINTENANCE & STORAGE

The Lithium Ion Battery System is designed to be maintenance free when in use following the recommended operating and charging instructions.

If the battery is stored or not to be used it is to be maintained as follows;

The Battery will need to be maintenance charged to a 50% SOC every **6 months**.


The battery must not be left at a low state of charge or with a pack voltage below 29V (Open circuit) for any significant period of time (i.e. greater than one week).

Prior to use following any period of storage, the pack should be fully charged up to a pack voltage of at least 38V (~70% SOC).

For maintenance, inquires and questions, see section 1 for contact details.

8 SERVICE

There are no user serviceable parts in this battery. If the battery should malfunction or is considered to be defective, contact EMBS Customer Service for further information. See section 1 for contact details

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9 GENERAL SAFETY INFORMATION

The design of the Lithium Ion Battery System is intended to provide a safe store of electrical energy when operated and stored as detailed within this document. The following subsections outline specific safety precautions that must be observed when using the battery pack.

In addition to these precautions, safety-warning labels are located on the product, which serve to highlight specific dangers. It is important that users of the battery pack understand the meaning of these labels, the details of which can be found below.

If any of the following precautions or label explanations are not understood, or if there are any further questions, contact EMBS Customer Support for guidance (see section 1 for contact details).

The safety information contained within this section may not include all regulations for local working premises. It is therefore important that personnel working with this battery system must review applicable local, federal and state regulations as well as the industry standards regarding this product.

EMBS shall not be held responsible or liable for any damage or failure due to mishandling or poor maintenance once received and accepted by the customer

Venting

In the unlikely event of a cell venting, the Battery housing is designed to fail, in a manner to allow these gases to vent to the atmosphere.

Tampering

WARNING DO NOT REMOVE COVER

There are no user serviceable parts. Servicing of the battery packs must be undertaken by EMBS staff; see section 1 for contact details.

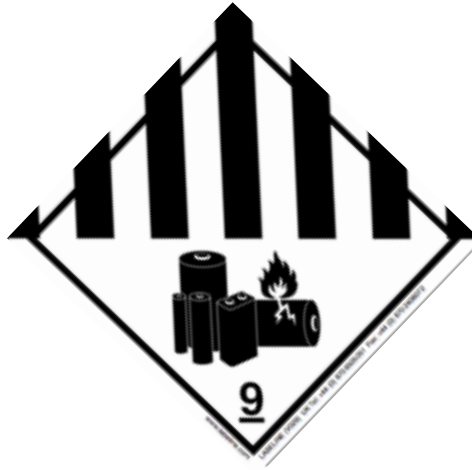


Figure 4 – Miscellaneous Hazard

9 MISCELLANEOUS HAZARD

Department of Transportation Class 9 – Miscellaneous dangerous goods hazard warning

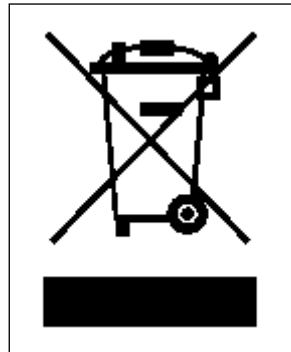


Figure 5 – WEEE

Waste Electrical and Electronic Equipment Directive (WEEE)

At the end of battery life this product should be recycled by returning to manufacturer or disposed of in an ecologically-friendly manner as per the EU WEEE directive. End-Users are responsible for successful waste management of batteries and accumulators are responsible for potential effects on the environments and human health.

The End-users are obliged to desirability of not disposing of waste batteries and accumulators as unsorted municipal waste and of participating in their separate collection so as to facilitate treatment and recycling;

10 UNPACKING, HANDLING, STORAGE AND DISPOSAL

10.1 UNPACKING

The Battery Packs are shipped as complete units securely enclosed in a wooden shipping box.

To remove the unit, first remove any fixing straps and then open the lid fixing latches and lift off the lid. The unit will be packed securely within the box.

Carefully remove any wrapping or packing from the unit and inspect the outer casing for signs of transport damage e.g. large dents or cracks in the case walls or other similar evidence of damage.

In the event of damage, do not open the main cover but notify EMBS of the concern and do not use the battery pack (see section 1 for contact details).

10.2 HANDLING

The following guidelines are provided to ensure the safe handling of the 36V Lithium Ion Battery.

The weight of each Lithium Ion Battery is approximately 3,048 kg (excluding packaging). The dimensions are approximately 186 x 140 x 85 mm. It is therefore recommended that the Battery system be lifted with care. It should not be dropped.

The customer is responsible for the review and application of all applicable regulations as well as industry standards for lifting this product.

Do not modify or alter the battery. In case it is necessary to modify or alter the battery, contact EMBS at the address provided.

10.3 STORAGE

The Li-ion cells, which form the main components of the battery pack, will lose stored energy when the battery pack is not being used. The rate at which the cells deplete depends on the initial State of Charge (SOC) and the storage temperature.

Do not leave the battery pack for a long time in a fully charged state.

The battery should not be left for any length of time in a fully discharged state

To prolong battery life it is recommended that the battery pack be stored at a 50% SOC. This can be achieved by charging to 100% SOC and then discharging to 50%.

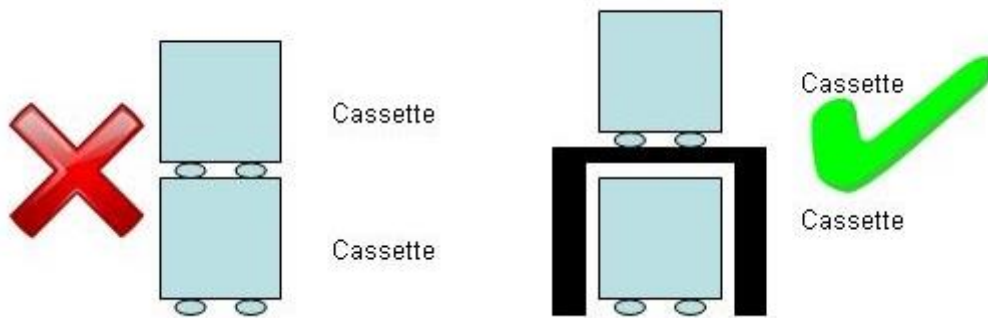
If the battery pack is intended to be stored for an extended period of time a maintenance charge is required, see Section 7 for details.

The recommended storage temperature for the battery pack is +5°C to +40°C, with battery life prolonged when storage temperatures are kept as low as possible.

Battery packs should be stored in dry and cool conditions and NEVER exposed to extreme heat or fire.

Battery packs should be isolated from corrosive substances.


DO NOT STACK BATTERY SYSTEMS DIRECTLY ON TOP OF EACH OTHER.



In storage, all external electrical connections from the Application Input/Output Interface and the power connector should be removed and connector inserts, where supplied, fitted.

DO NOT PLACE ANY HEAVY OBJECTS ON THE BATTERY SYSTEM OR THE INTER-CONNECTING CABLES.



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The Lithium Ion Battery System contains many different materials, including Li-ion cells, which must be disposed of in accordance with the applicable regulations. Use only a suitably licensed recycling facility approved for cells containing Lithium.

11 COMPATIBILITY GUIDELINES

EMC: Battery passed EMC test according EN 61000-4-6:2014. Application shall be additionally tested.

CE: battery was checked for CE compliance, declaration of conformity is available.

UN 38.3: battery was validated for UN 38.3, certificate is available.

12 HAZARDS & INCIDENTS

In this section, specific risks for the Lithium Ion Battery System are identified and recommended actions in the event of an incident are outlined.

To avoid serious injury or death from severe burns or electric shock, never breach or remove the high voltage battery pack cover under any circumstance, including fire.

When subjected to mechanical, thermal or electrical abuse that leads to the activation of the cell safety valve and/or the rupture of the battery container the battery pack is at risk of fire, venting or spills.

12.1 FIRE

It is recommended that the incident commander allow the battery pack to burn itself out.

During this operation, fire crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke. Avoid inhaling the fumes from the fire using self-contained breathing apparatus to avoid breathing irritant fumes where possible.

Note that if the electrolyte of the battery cell is heated or fire is present the electrolyte may decompose or catch fire in which case very dangerous gases e.g. Hydrofluoric Acid (HF) may be emitted. HF has a safety exposure of 6ppm for 15 minutes.

See below for further details of risks associated with spilled electrolyte.

12.2 AFTER FIRE

Allow the battery pack to cool down to room temperature after any incident before cleaning up is commenced.

Cover damaged cells or cell modules with dry sand and store in a non-flammable environment, prior to removal to a licensed disposal facility.

12.3 SPILLS & VENTING

Lithium cells contain electrolyte which may spill or leak out if a battery module is cracked or otherwise physically damaged. Venting of liquid electrolyte or electrolyte vapour will occur if internal cell pressure exceeds a safe limit, due to overheating, overcharging or excess current conditions.

The Li-ion battery electrolyte contains Lithium hexafluorophosphate, alkaline carbonates and organic solvents which are damaging to human tissues. The electrolyte is flammable with a low flash point.

Avoid skin or eye contact as this may cause severe irritation or burns. Avoid breathing of vapours or gases

Skin contact:

Immediately wash the contact region with soap and plenty of water.

Eye contact:

Immediately flush eyes with water continuously for at least 15 minutes.

Seek medical attention immediately.

Respiratory contact:

Immediately move to fresh air

Seek medical attention immediately

To clean up the spill the following is recommended:

- Restrict access to area until clean up complete.
- Wear suitable protective clothing.
- Wear neoprene or natural rubber gloves.
- Wear safety glasses or goggles.
- Stop the leak if safe to do so.
- Absorb the spill with an inert absorbent (dry sand or earth).
- Small spills can be cleaned with clean absorbent cloth.
- Place contaminated absorbent into suitable waste container.
- Waste must be disposed of in accordance with the relevant national, regional or local environmental control regulations.

13 SERIAL NUMBER

Batteries to which this document refers bear serial numbers of the following form

SN			
YY	DDD	LL	NNNN
Year	Day	Prod. Line No.	Piece No.

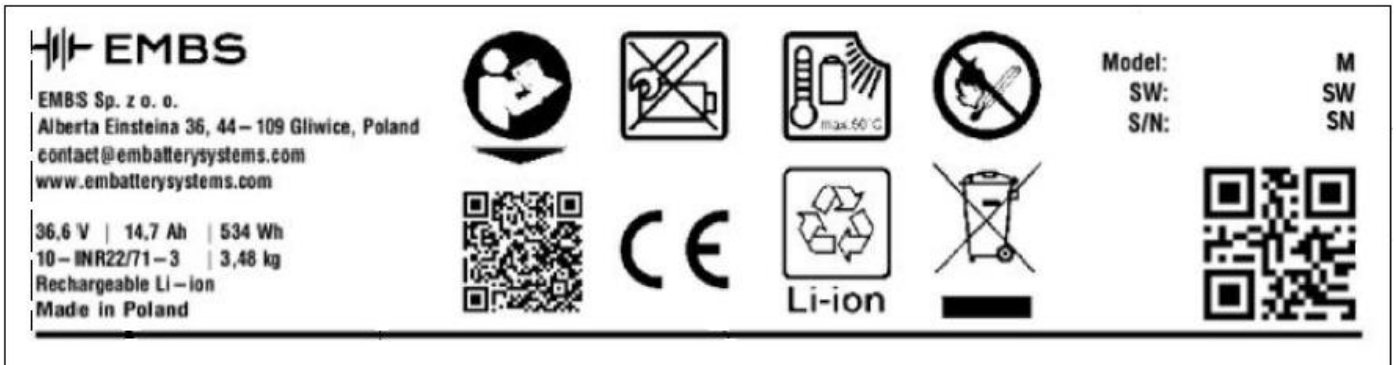


Figure 6 – Nameplate view

14 APPENDICES

1 – Declaration of Conformity (CE)