DNV·GL

Certificate No:
TAE00002TZ

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Li-Ion Battery System

with type designation(s)
U27-24XP - 24 Volt Lithium Ion Battery Module

Issued to
Lithium Werks, Inc.
Austin TX, USA

is found to comply with
DNV GL rules for classification – Ships, offshore units, and high speed and light craft

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.

Issued at **Hamburg** on **2018-04-16**
This Certificate is valid until **2023-04-15**.
DNV GL local station: **Houston, Approval CMC**

Approval Engineer: **Andreas Andrecht**

for **DNV GL**

Arne Schaarmann
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

Product description

Battery Module
U27-24XP - 24 Volt Lithium Ion Battery
Based on Lithium Iron Magnesium Phosphate cells, chemistry (LiFeMgPO4)

Specification	U27-24XP	
Nominal Voltage	25.6 V	
Nominal Capacity	69 Ah	
Charge Voltage	29.2 V	
Charge Current	Recommended	35 A
Charge Current	Max Continuous*	70 A
Discharge Voltage	Minimum	20 V
Discharge Current	Max Continuous*	140 A
Pulse Current	30 seconds	210 A
Weight	18.6 kg	
Terminals	Female-Threaded	M8 x 1.25
Exterior Dimensions	(L x W x H) mm	306 x 172 x 225 mm

Operating Temperature	Charging: 0°C to 45°C Discharging: -10°C to 50°C
Storage Temperature	-40°C to 50°C
Operating Humidity	5% to 95%, non-condensing
Water/Dust Resistance	IP56

The U27-24XP Battery Module contains 176 cells in an 8S/22P configuration.

Cell

IFR26650EC Lithium Iron Magnesium Phosphate cell (LiFeMgPO4)	
Voltage	3.2 V
Capacity @ C/5	3.15 Ah
Energy	10.1 Wh
Specific Energy	119 Wh/kg
Energy Density	292 Wh/L
Impedance (1kHz, ACIR/DCIR)	16 mΩ / 25 mΩ
Cycle Life to 80% Rated Capacity	>3000
Recommended Discharge Current	1.6 A
Max Continuous Current >0ºC	6.3 A
Max Pulse Discharge Current, 30s	9.5 A
Minimum Voltage	2.0 V
Temperature	-20ºC to 55ºC
Recommended Charging Current	1.6 A
Max. Continuous Current > 20ºC	6.3 A
10s Pulse Current	9.5 A
Recommended Charging Voltage	3.65 V
Float Voltage	3.45 - 3.85 V
Absolute Max Charge Voltage	4.2 V
Temperature	0ºC to 55ºC
Storage Temperature	-40ºC to 60ºC
Diameter	26.2 mm ± 0.2 mm
Length	65.9 mm ± 0.5 mm
Mass	85 g ± 2 g

Battery Management system
U-Charge Rev2 BMS 3.0
Firmware: U-BMS-LV
Hardware: U-BMS-LV
The Management System (U-BMS-LV) monitors and protects the Battery Modules in a system with up to 1000 volts with external isolation measurement. Up to 65 Modules in total, maximum 34 in series.
The BMS communicates with the battery modules via an RS-485 link.

Excessive Temperature Detection
Performed by the cell CID (current interrupting device).

Location classes

Temperature	Class A
Humidity	Class B
Vibration	Class A
EMC	Class A
Enclosure	IP56

Application/Limitation

Switch Unit/Contactors
The switch unit with fuses and contactors is excluded from this type approval, individual approval and acceptance test should be carried out as part of the product certification.

Battery Management system
Metal enclosure/housing for the Battery Management system is required.

Approval conditions

For each delivery to DNV GL class the following documentation of the battery system is to be submitted for approval:

Switch unit:
- E120 Electrical datasheet
- E140 Assembly schedules and technical data
- E170 Electrical schematic diagram
- E180 Layout of electrical assembly

Battery system:
- Reference to this type approval certificate
- Z072 Safety description
- I130 Project-specific Battery System Block Diagram
- E120 Technical specification of the battery system that is subject for product certification
- E170 Electric schematic diagram of the battery system showing internal arrangement of battery modules, switch unit, emergency stop etc.
- Z060 Functional description, including
  - Project-specific overall description of the battery management system
  - Software and hardware versions
  - interface between the BMS and switching unit
  - other relevant information not covered by the safety description.
- Z252 Test program for product certification, including routine tests specified in applicable rules

The Type Approval covers hardware and software listed under Product description. Hard and software versions are declared within the proprietary Lithium Werks PC software

When the type approved software is revised (affecting all future deliveries) DNV GL is to be informed by forwarding updated software version documentation and updated BMS release note. If the changes are judged to affect functionality for which rule requirements apply a new functional type test may be required and the certificate may have to be renewed to identify the new software version.

Product certificate
Each delivery of the application system is to be certified according to Pt.6, Ch.2, Sec. 1. The certification test is to be performed at the manufacturer of the application system before the system is shipped to the yard. After certification, the clause for application software control will be put into force.

Application software control
All changes in software are to be recorded as long as the system is in use on board. Documentation of major changes is to be forwarded to DNV GL for evaluation and approval before implemented on board.

Type Approval documentation

Tests carried out

BE99307004589-01 Propagation test in accordance to IEC62619 Ed.1 2017
MH61895-M2-IT Test Report IEC 62619
Test Battery System + Safety Function Procedures 26Mar2018
Test Report No. 17-9015 PAConsult Environmental
Test report 071695.025.18 V1.0 EMV MeßTechinkNord / Test report from Queens University EMC lab.

Marking of product

Module p/n 1007527
U-BMS-LV p/n 1004444/3

Periodical assessment

The scope of the periodical assessment is to verify that the conditions stipulated for the Type approval are complied with and that no alterations are made to the product design or choice of materials.
The main elements of the assessment are:

- Inspection on factory samples, selected at random from the production line (where practicable)
- Results from Routine Tests (RT) checked (if not available tests according to RT to be carried out)
- Review of type approval documentation
- Review of possible change in design, materials and performance
- Ensuring traceability between manufacturer's product type marking and Type Approval Certificate.

Periodical assessment is to be performed after 2 years and after 3.5 years. A renewal assessment will be performed at renewal of the certificate.

END OF CERTIFICATE