DNV·GL

TYPE APPROVAL CERTIFICATE

Certificate No:
TAE00003XW
Revision No:
3

This is to certify:

That the Li-Ion Battery System

with type designation(s)
AKASystem 15 OEM 37Ah PRC, AKASYSTEM 15 OEM 50 PRC

Issued to
AKASOL AG
Darmstadt, Hessen, Germany

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 **2021-01-26**

This Certificate is valid until **2025-03-23**.
DNV GL local station: **Augsburg**

Approval Engineer: **Andreas Andrecht**

for **DNV GL**

Digitally Signed By: Schaarmann, Arne
Location: DNV GL SE Hamburg, Germany
Signing Date: 2021-02-25

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

The AKASystem 15 OEM is a liquid-cooled, high-energy, lithium-ion battery solution for safe and reliable use in battery-powered vessels and hybrid solutions. Twelve cells are mounted to one module with build in cell supervising circuit module (CSC). Fifteen of these modules are combined to one battery system with included central control unit, Battery Management Unit (BMU).
The BMU is the main electronic control system that manages the battery. Main functions are protecting the battery from operating outside its safe operating area, monitoring its state and calculating secondary data like State of Charge (SOC) and State of Health (SOH). The BMU is a hardware combination of the individual components Battery Management Master (BMM) and Safety Control Unit (SCU). The BMM is the main monitoring and controlling unit for example for state of charge, state of health, balancing and many more. The SCU is a redundant controller to provide functional safety of the battery system. The SCU monitors the results of measurements, which are taken from the HV sensors (voltages / current) or sent by the CSC. The CSC measures the voltages and temperatures of the cells and provides also the resistors for passive balancing for each cell. The measured values are sent to BMM and SCU via a proprietary CAN.

Idification AKASystem 15 OEM 37Ah PRC

Battery System Part Nr.:	3000079304 (production location Langen) or 1M000984 (production location Darmstadt)
BMU SW Version:	18 50 03.07.012 04-00059
CSC SW Version:	18 27 05.00.000 04-00053

Idification AKASystem 15 OEM 50 Ah PRC

Battery System Part Nr.:	A00001M001660 A00001M001770 (BMU insulated fastened)
BMU SW Version:	20 37 03.20.017 19-00117
CSC SW Version:	18 27 05.00.000 04-00053

Cell Specification

Li-ion NMC Cell 37Ah		Value	Unit
Nominal Voltage		3,67	V
Max. Voltage		4,20	V
Min. Voltage		2,1	V
Rated Capacity @ 1 C		37	Ah
Operating Temperature	Min.	-30	°C
	Max.	60	°C
Charge Current	Cont.	55 (1.5C)	A
	Peak (10s)	111 (3C)	A
Discharge Current	Cont.	55 (1.5C)	A
	Peak (10s)	166 (4.5C)	A

Li-ion NMC Cell 50Ah		Value	Unit
Nominal Voltage		3,60	V
Max. Voltage		4,25	V
Min. Voltage		2,80	V
Rated Capacity @0,33 C		50,0	Ah
Operating Temperature	Min.	-30	°C
	Max.	60	°C
Charge Current	Cont.	68 (1,4C)	A
	Peak (10s)	175 (3,5C)	A
Discharge Current	Cont.	141 (2,8C)	A
	Peak (10s)	315 (6,7C)	A

Module Specification

Module 37Ah 12s1p	Value	Unit
Nominal Voltage	44,4	V
Max. Voltage	50,4	V
Min. Voltage	36	V
Configuration	12s1p	
Rated Capacity @ 1 C	37	Ah
Energy	1,62	kWh
Number of voltage sensors	13	
Number of temperature sensors	9	

Module 50Ah 12s1p	Value	Unit
Nominal Voltage	43,3	V
Max. Voltage	51	V
Min. Voltage	33,6	V
Configuration	12s1p	
Rated Capacity @ 0,33 C	50	Ah
Energy	2,17	kWh
Number of voltage sensors	13	
Number of temperature sensors	9	

Battery System Specification 15 OEM 37Ah

AKASystem 15 OEM 37Ah PRC (liquid-cooled)		Value	Unit
Number of serial modules per tray		15	
Number of serial cells per module		12	
Number of parallel cells per module		1	
Nominal Voltage		661	V
Max. Voltage		756	V
Min. Voltage		540	V
Rated Capacity		37	Ah
Peak Discharge Power (10s)		110	kW
Peak Charge Power (10s)		73	kW
Continuous power (RMS)		36	kW
Peak Discharge Current (10s)		166	A
Peak Charge Current (10s)		111	A
Continuous power (RMS)		55	A
Energy		24,5	kWh
Operating Temperature range	Min.	-25	°C
	Max.	58	°C
Dimensions	Height	150	mm
	Width	700	mm
	Length	1680	mm
Weight		238	kg
Ingress Rating		IP 67	

Battery System Specification 15 OEM 50Ah

AKASystem 15 OEM 50Ah PRC (liquid-cooled)		Value	Unit
Number of serial modules per tray		15	
Number of serial cells per module		12	
Number of parallel cells per module		1	
Nominal Voltage		655	V
Max. Voltage		756	V
Min. Voltage		540	V
Rated Capacity		50	Ah
Peak Discharge Power (10s)		206,5	kW
Peak Charge Power (10s)		114,6	kW
Continuous power (RMS)		49,1	kW
Peak Discharge Current (10s)		315	A
Peak Charge Current (10s)		175	A
Continuous power (RMS)		75	A
Energy		32,8	kWh
Operating Temperature range	Min.	-25	°C
	Max.	58	°C
Dimensions	Height	150	mm
	Width	700	mm
	Length	1680	mm
Weight		254	kg
Ingress Rating		IP 67	

Location Classes

Temperature Class D
Humidity Class B
Vibration Class A
EMC Class B
Enclosure Class C (IP67)

Application/Limitation

Gas detector
Gas detectors must be installed in the battery space as described in the safety description.

External Controller
The type approval covers the use of AKASystem 15 OEM as one tray system. For the operation of the system with more than one battery tray an external controller is needed. The DNVGL type approval is mandatory required for the external controller but excluded from this certificate.

Approval conditions

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

Battery system:

- Reference to this type approval certificate
- Copy of the safety description (document 3030312TEN0015 version 1.3 dated 2020-02-18)
- 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, battery strings, switch unit, emergency stop and independent safety system
- Z060 Functional description, including o Project-specific overall description of the battery management system
    - Software and hardware versions of BMU and CSC
    - capacity calculations for the gas extract ventilation fan
    - other relevant information not covered by the safety description.
- Z252 Test program for product certification, including routine tests specified in applicable rules
- Z265 Calculation report, documentation of the SOC and SOH calculation.

The Type Approval covers hardware and software listed under Product description.

When the type approved software is revised (affecting all future deliveries) DNV GL is to be informed by forwarding updated software version documentation. 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. The independent temperature disconnection is integrated in the system and is not required to be tested during certification. See DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1, Table 7 Tests of battery systems, item 10.

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

3030312TEN0011_System_description_AKASystem15OEM37AhPRC
GDTEN0001_General_Safety_Instructions_AKASOL_Battery_Systems
3030312TEN0015_Safety_Description_AKASYSTEM_OEM_37Ah_PRC
GDTEN0011_General_Manual_AKASOL_Battery_Systems–AKASystem_OEM
3030312TEN0021_BMU_Softwarearchitekture
3030312TEN0004_Battery_System_Assembly_in_Vehicle
3030312AZ0002_Technical_Data_AKASystem_15_OEM_37Ah_PRC
AKASystem_15_OEM_37Ah_PRC_Part_List
3030312TEN0009_Technical_Information_Lithium-Ion_Cell_37Ah_and_37Ah_12s1p_Module
3030312TEN0001_DFMEA_AKASystem_15_OEM_37Ah_PRC
GDTEN0008_AKASOL_Pressure_Relief_Valve_Integration
1M000984_04_AKASYSTEM_OEM_STANDARD
1M000993_01_MANIFOLD
1M000984_System_Schematic
1E019023_BMU_COMPL_V4.1_Full
1E000115_BMU_mRCCB_AkasystemOEM-Singletray

1E010099_CSC-A Power supply
GIGAVAC_GV240 Contactor specification
3030312TEN0002_Overload_Protection
EVpack-fuse-MEV100-1000VDC-EN
BMU_component_overview
FBTEN0001_BMU_Parametersheet
Public_CAN_Matrix
KP-05-01-PA25_Overview_EOL_Testprocedure
160427_PHEV2 37Ah_gas analysis
Testreport_AKASystem OEM 15M_ Propagation_DNVGL_2019-02-20
3030312VAL003_Function und Safety Test_AKS15OEM_Signed DNVGL
1640_PBN_19101001EmU
9113-306a EMC Testreport
2234789KAU-001 Vibration Test Testreport
2234789KAU-002 Vibration Test Testreport
2234789KAU-004 Dry Heat Test Testreport
2234789KAU-005 Damp Heat Cyclic Test Testreport
2234789KAU-006_Rev_01 Cold Test Testreport

AKASYSTEM 15 OEM 50 PRC Propagation test Report No. 1-1296/20-01-02
3-024001VAL004_System_description_AKASYSTEM15OEM50PRC
3-024001TEN0003_Safety_Instructions_OEM_50_V1.0_2020_10_02_EN
3-024001TEN0004_SafetyDescription_AKASYSTEM15OEM50PRC
3-024001TEN0001 User Manual_AKASYSTEM_OEM
3-024001TEN0006_Technical_Data_AKASYSTEM15OEM50PRC
3-024001TEN0007_Technical_Information_Lithium-Ion_Cell_50Ah_and_50Ah_12s1p_Module
3030312TEN0001_DFMEA_AKASystem_15_OEM_50Ah_PRC
1M001660_01_AKASYSTEM_15_OEM_50_PRC
1M001660_System_Schematic
1E019026_BMU-COMPL_4.1_AKASystem
3-024001TEN0008_Overload_Protection
3-024001TEN0009_BMU_Parametersheet
KP-05-01-PA25_Overview_EOL_Testprocedure
3-024001VAL003_Testplan_DNVGL.pdf
UN38_3_Zelltest
U201876D2

Tests carried out

Type tests according to applicable DNV GL rules and standards as listed below have been carried out.
DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1, DNVGL-RU-SHIP Pt.4 Ch.8, DNVGL-RU-SHIP Pt.4 Ch.9, DNVGL-CG-0339, DNVGL-CP-0418
Propagation testing acc. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1 [4.2.2] (with design option 2: No propagation between modules)
Safety Function and Sensor Failure Test acc. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1 [4.1.5.2]

Marking of product

The products to be marked with:

- manufacturer name
- model name
- serial number
- power supply ratings

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