DNV·GL

Certificate No:
TAE00003SJ
Revision No:
1

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Li-Ion Battery System

with type designation(s)
Transfluid TF-Lithium Battery System

Issued to
Transfluid S.P.A.
Gallarate VA, Italy

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 **2019-11-11**
This Certificate is valid until **2024-11-10**.
DNV GL local station: **Italy/Malta CMC**

for **DNV GL**

Approval Engineer: **Uwe Supke**

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.

Job Id: **262.1-025921-2**
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Product description

Transfluid TF-Lithium battery System is a modular and scalable solution for battery-powered, hybrid vessels and off-shore units.
The system consists in three basic battery modules 51,2Vdc-200Ah; 96Vdc 100 Ah and 200Ah.
They can be connected in series to form a string obtaining up to 384 Vdc and/or paralleled up to 32 parallels to increase the total capacity.
In case of paralleled modules or strings an external certified master controller (MCR unit) concentrates and manages the communications among the modules.
When more than 8 parallels are required for the application one or more expanders (part number KBI0063002*) are added to the master controller. The expander has the same identical MCR enclosure, same connectors but there is no electronic inside and it is provided for easy plug and play connection.
All modules are equipped with integrated Battery Management System (BMS) that monitors relevant parameters, the modules are interconnected electrically and by means of a communication bus that provides an interface with external systems/control devices.
Every module has an integrated heater to allow operation at low ambient temperatures.

Battery system:
A battery system consists in one or more modules (identical capacity) connected in series and or in parallel to the DC bus.
For configurations with modules connected in series the first one of the string acts as a master and the other are configured as slaves.
The following TF-Lithium battery module configurations are covered by this type approval:

Basic stand alone modules

Product Code	Architecture	Nominal Voltage	Capacity	Energy	Cells Type	Firmware release
KBP0063026	Single Element	51,2V	200Ah	10,2 kWh	200Ah	4.0.26.42
KBP0063029	Single Element	96V	100Ah	9,6 kWh	100Ah	4.0.26.42
KBP0063030	Single Element	96V	200Ah	19,2 kWh	200Ah	4.0.26.42

Basic series of modules

Product Code	Architecture	Nominal Voltage	Capacity	Energy	Cells Type	Firmware release
KBP0063027	Series of 51,2V modules	140,8V	200Ah	28,2 kWh	200Ah	6.0.3.3
KBP0063031	Series of 96V-100Ah modules	288V	100Ah	28,8 kWh	100Ah	6.0.3.3
KBP0063032	Series of 96V-200Ah modules	288V	200Ah	57,6 kWh	200Ah	6.0.3.3
KBP0063028	Series of 96V-100Ah modules	384V	100Ah	38,4 kWh	100Ah	6.0.3.3
KBP0063033	Series of 96V-200Ah modules	384V	200Ah	76,8 kWh	200Ah	6.0.3.3

Parallels of above mentioned modules:

Product Code	Architecture	Nominal Voltage	Capacity	Energy	Cells Type	Firmware release
KBP0063xxx	1S-2 to 32P	51,2	From 400 to 6400Ah	Max 41 kWh	200Ah	4.0.26.42
KBP0063xxx	1S-2 to 32P	96V	From 200 to 6400Ah	Max 614,4 kWh	100Ah or 200Ah	4.0.26.42
KBP0063xxx	3S-2 to 32P	140,8V	From 400 to 6400Ah	Max 901,1 kWh	200Ah	6.0.3.3

KBP0063xxx	3S-2 to 32P	288V	From 200 to 6400Ah	Max 1843,2 kWh	100Ah or 200Ah	6.0.3.3
KBP0063xxx	4S-2 to 32P	384V	From 200 to 6400 Ah	Max 2457,6 kWh	100Ah or 200Ah	6.0.3.3

The last three digits of the product code are assigned in sequence according to the given configuration. For type approval identification the label will also be stamped with the "architecture" identification where xS is the number of modules connected in series for each string and xP the number of parallels that can be from 2 to 32.

Master controllers MCR and connectors expanders

Product Code	Description	Firmware release
MCR0063002*	Control elements with 4 ports for modules connection	7.0.2.30
KBI0063002*	Connectors expander with 4 additional device/parallels	Not applicable Junction box only

*The last three digit may vary to just represent the different number of ports/connectors available or configuration variant (from 2 to 8 ports for example)

Battery modules
The battery module includes cells, control and balancing circuit (BMS), HV contactor, fuse and power/communication/control connectors
Cell chemistry: Lithium-Iron Phosphate LFP (LiFePO4)
Nominal Voltage/Capacity: 96 V 100 or 200 Ah;
Cut-off Voltage: Charge = 109,5 V - Discharge = 82,5 V
Max charge/discharge current 100Ah module: Charge = 80A (0,8C) - Discharge= 200A (2C)
Max charge/discharge current 200Ah module: Charge = 160A (0,8C) - Discharge= 400A (2C)
Nominal Voltage/Capacity: 51,2 V 200Ah
Cut-off Voltage: Charge = 58,4 V - Discharge = 44 V
Max charge/discharge current 200Ah module: Charge = 160A (0,8C) - Discharge= 400A (2C)
Hardware version for all battery modules is: 1
Operating temperature: -15/+ 45°C
Enclosure housing : Stainless Steel
IP protection, Interlock: IP65, HVIL
Weight 51,2V 200 Ah: 130 kg
Weight 96V 100 Ah: 120 kg
Weight 96V 200 Ah: 220 kg
Weight MCR: 7 kg
Weight EXP : 6 kg
Internal cells connection: up to 30 cells in series per 96V modules or up to 16 cells per 51,2V modules (depends upon requested final target voltage)

Battery Management System (BMS):
The BMS is integrated within the module, it protects and monitors the cells keeping them within voltage and temperature range both in charging and discharging mode. It also monitor the current flow during charge and discharge mode giving relevant warnings, alarms and if necessary disconnecting the HV contactor to protect the single module.
A built in independent temperature protection system is hardwired with the HV contactor, in case of module over-temperature detection the module is disconnected form the DC bus.
IP protection: IP65

Master Controller (MCR)
This is necessary only for the parallel configurations. The master controller acts as a signal interface between the physical single battery modules/strings and the external devices presenting a single "virtual battery" with the total system capacity, global monitoring, alarms, State of Charge (SOC) and State of Health (SOH).
Hardware version: 1 for all battery systems

IP protection: IP65

Expander (KBI)
This is necessary only for the parallel configurations having more than 8 parallels. The expander acts as a junction box to expand the number of connectors of a single MCR. It has the same identical enclosure and connectors of the MCR but there is no electronic inside.
IP protection: IP65

Firmware releases according to the product table/description
The Type Approval covers hardware and software listed under Product description. Hard and software versions are declared within the proprietary BMS software.

Place of manufacture
FLASH BATTERY (formerly Kaitek)
Sant Ilario d'Enza RE
Italy

Location classes

Temperature:	Class A (electronics Class B)
Humidity:	Class A
Vibration:	Class A
EMC:	Class A
Enclosure:	Class C

Approval conditions

A DNV GL product certificate according to DNV GL-RU-SHIP Pt.6 Ch.2 Sec.1 Table 2 is required for each delivery of a battery system.
The following documentation shall be submitted for approval:

- Reference to this type approval certificate
- Copy of the safety description Flash Battery TA.02.05 Rev.6, dated 2019-09-30
- E120 Technical specification of the battery system that is subject for vessel certification
- E170 Electric schematic diagram of the battery system showing internal arrangement of battery modules, battery strings, including switch gear and control gear
- I030 Project-specific Battery System Block Diagram
- I020 Functional description, including
  - Project-specific overall description of the battery management system
  - Software and hardware versions of BMS and MCR
  - Other relevant information not covered by the safety description
- Z252 Test procedure at manufacturer (routine tests)

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

A special charger, fully managed by the battery BMS, is required for the charging. This will be selected by Transfluid according to the specific battery configuration to grant the max. charging current approved limits (according to TA.02.10).

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 the 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
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 (01-2018), DNVGL-RU-SHIP Pt.4 Ch.8, DNVGL-RU-SHIP Pt.4 Ch.9, DNVGL-CG-0339 Sec.3 Items 6–9,12,14 (11-2016), DNVGL-CP-0418 (09-2018).
Propagation testing acc. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1 [4.2.2.1] (opt.1: no propagation between cells)
Propagation Test Report Kaitek TA.04.12 Rev.1, dated 2019-09-25.
Safety Function and Sensor Failure Test acc. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1 [4.1.5.2]
The requirements acc. NMA Circular RSV 12-2016 are fulfilled. The propagation test 1 (item 3.1 in NMA circular) was successful passed with no progagation between the cells.

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 of factory samples, selected at random from 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 of the 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