DNV·GL

Certificate No:
TAE00003SJ

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**

Approval Engineer: **Uwe Supke**

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.

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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 two basic battery modules 96Vdc 100 Ah and 200Ah. They can be connected in series to form a string obtaining up to 288 Vdc and/or paralleled to reach up to 800 Ah capacity. In case of paralleled modules or strings an external certified master controller (MCR unit) concentrates and manages the communications among the modules. 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:

Product Code	Nominal Voltage	Capacity	Energy	Architecture	Cells Type
KBP0063015	96V	*100Ah	9,6kWh	Single Element	100Ah
KBP0063016	96V	*200Ah	19,2kWh	Single Element	200Ah
KBP0063017	288V	100Ah	28,8kWh	Single Element	100Ah
KBP0063018	288V	200Ah	57,6kWh	Single Element	200Ah
KBP0063019	96V	100Ah	9,6kWh	Parallel Element	100Ah
KBP0063020	96V	200Ah	19,2kWh	Parallel Element	200Ah
KBP0063021	288V	100Ah	28,8kWh	Parallel Element	100Ah
KBP0063022	288V	200Ah	57,6kWh	Parallel Element	200Ah
KBS0063001	96V	300Ah	28,8kWh	Parallel Element	100Ah
KBS0063002	96V	400Ah	38,4kWh	Parallel Element	200Ah
KBS0063003	96V	600Ah	57,6kWh	Parallel Element	200Ah
KBS0063004	96V	800Ah	76,8kWh	Parallel Element	200Ah
KBS0063005	288V	300Ah	86,4kWh	Parallel of Series Element	100Ah
KBS0063006	288V	400Ah	115,2kWh	Parallel of Series Element	200Ah
KBS0063007	288V	600Ah	172,8kWh	Parallel of Series Element	200Ah
KBS0063008	288V	800Ah	230,4kWh	Parallel of Series Element	200Ah
MCR0063001	---	---	---	Parallel Controller	---

* Basic modules. All the other are derived combining these two basic modules

For configuration where single modules or strings are connected in parallel there is additional master controller (MCR also covered by this certification).

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 capacity: 100Ah or 200Ah
Nominal Voltage: 96 V
Cut-off Voltage: Charge = 109,5 V - Discharge = 82,5 V
Max constant Current 100Ah module: Charge = 80A (0,8C) - Discharge= 200A (2C)
Max constant Current 200Ah module: Charge = 160A (0,8C) - Discharge= 400A (2C)
Operating temperature: -15/+ 45°C
Enclosure housing : Stainless Steel
IP protection, Interlock: IP44, HVIL
Weight 100 Ah: 120 kg
Weight 200 Ah: 220 kg

Weight MCR: 7 kg
Internal cells connection: 30 cells in series

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.

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
Software releases according to the following table:

Product Code	Firmware Release
KBP0063015	4.0.26.19
KBP0063016	4.0.26.19
KBP0063017	6.0.2.24
KBP0063018	6.0.2.24
KBP0063019	4.0.26.19
KBP0063020	4.0.26.19
KBP0063021	6.0.2.24
MCR0063001	7.0.2.16

Firmware releases are marked with the following version number scheme:
T.C.M.m
Where:

	Description	Value	Firmware type
T	firmware type identification number, according to the following table	4	Single element 96V Battery
		6	Series element 288V Battery
		7	Control Unit element
C	customization (customer) identification number	0	Default value
M	Major firmware revision number	XX	
m	minor firmware revision number	XX	

Place of manufacture
Kaitek
Sant Ilario d'Enza PR
Italy

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

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 Kaitek 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