



TYPE APPROVAL CERTIFICATE

Certificate no.:
TAE00003SJ
Revision No:
3

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 rules for classification – Ships, offshore units, and high speed and light craft

DNV rules for classification – Inland navigation vessels

Application:

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

Issued at **Høvik** on **2024-11-25**

for **DNV**

This Certificate is valid until **2029-11-10**.

DNV local unit: **Italy/Malta CMC**

Approval Engineer: **Uwe Supke**

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.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to USD 300 000.

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 51.2V-210Ah, 102.4V-105Ah, 102.4V- 210Ah.

They can be connected in series to form a string obtaining up to 409,6 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.

Cells:

The specifications of single cell are:

Producer	EVE
Product Model	LF105
Nominal Capacity	105Ah
Nominal Voltage	3,20V
Weight	1,98Kg
Housing	Prismatic Aluminium case
Cycle Life	≥ 2000 cycles (@90% DOD)

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
KBP0063042	single element	51,2 V	210 Ah	10,7 kWh	210 Ah	4.0.26
KBP0063046	single element	102,4 V	105 Ah	10,7 kWh	105 Ah	4.0.26
KBP0063053	single element	102,4 V	210 Ah	21,5 kWh	210 Ah	4.0.26

Basic series of modules

Product Code	Architecture	Nominal Voltage	Capacity	Energy	Cells Type	Firmware release
KBP0063056	Series of 51,2 V-210 Ah modules	up to 153,6 V	210 Ah	up to 32,2 kWh	210 Ah	6.0.4
KBP0063054	Series of 102,4 V-105 Ah modules	307,2 V	105 Ah	32,2 kWh	105 Ah	6.0.4
KBP0063052	Series of 102,4 V-210 Ah modules	307,2 V	210 Ah	64,5 kWh	210 Ah	6.0.4
KBP0063055	Series of 102,4 V-105 Ah modules	409,6 V	105 Ah	43 kWh	105 Ah	6.0.4
KBP0063047	Series of 102,4 V-210 Ah modules	409,6 V	210 Ah	86 kWh	210 Ah	6.0.4

Parallels of above mentioned modules:

Product Code	Architecture	Nominal Voltage	Capacity	Energy	Cells Type	Firmware release
KBP0063XXX	1S - 2 to 32P	51,2 V	from 420 to 6720 Ah	max 344 kWh	210 Ah	6.0.4
KBP0063XXX	1S - 2 to 32P	102,4 V	from 210 to 6720 Ah	max 688,1 kWh	105 or 210 Ah	6.0.4
KBP0063XXX	3S - 2 to 32P	up to 153,6 V	from 420 to 6720 Ah	max 1032,2 kWh	210 Ah	6.0.4
KBP0063XXX	3S - 2 to 32P	307,2 V	from 210 to 6720 Ah	max 2064,4 kWh	105 or 210 Ah	6.0.4
KBP0063XXX	4S - 2 to 32P	409,6 V	from 210 to 6720 Ah	max 2752,5 kWh	105 or 210 Ah	6.0.4

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*	MCR-Control elements with 4 ports for modules connection	7.0.2
KBI0063002*	EXPANDER-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: 102.4 V 105Ah or 210Ah;
Cut-off Voltage: Charge = 115.2 V- Discharge = 88 V
Max charge/discharge current 105Ah module: Charge = 84A (0,8C) - Discharge= 210A (2C)
Max charge/discharge current 210Ah module: Charge = 168A (0,8C) - Discharge= 420A (2C)
Nominal Voltage/Capacity: 51,2 V 210Ah
Cut-off Voltage: Charge = 57.6 V- Discharge = 44 V
Max charge/discharge current 210Ah module: Charge = 168A (0,8C) - Discharge= 420A (2C)
Hardware version for all battery modules is: 1
Operating temperature: -10/+ 45°C
Enclosure housing: Stainless Steel
IP protection, Interlock: IP65, HVIL
Weight 51.2V 210 Ah: 112 kg
Weight 102.4V 105 Ah: 112 kg
Weight 102.4V 210 Ah: 200 kg
Weight MCR: 7 kg
Weight EXP: 6 kg

Internal cells connection: up to 32 cells in series per 102.4V 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 monitors 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 from 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

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 product certificate according to DNV 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.8, dated 2023-10-06
- 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 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 which will be installed on a DNV classed vessel 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 for evaluation and approval before implemented on board.

Type Approval documentation

Document No.	Rev.	Title
TA.01.01	12	Type Approval Document List
TA.01.02	2	Glossary and Definitions
TA.02.00	9	Product List and Specification
TA.02.01	7	Mechanical Drawing
TA.02.02	9	Electrical Drawing
TA.02.03	6	Functional description of the battery architecture
TA.02.04	9	Battery connection
TA.02.05	8	Safety Description
TA.02.06	5	Battery control signal format
TA.02.07	5	Data communication protocol
TA.02.08	5	Hardware and firmware revision information
TA.02.09	5	Product marking information
TA.02.10	5	Operating characteristics and condition
TA.03.01	5	Functional description
TA.03.02	5	Block diagram
TA.03.03	6	Power Supply arrangement
TA.03.04	4	List of controlled and monitored points
TA.03.05	4	Documentation of SOH and SOC calculation
TA.03.06	5	Safety function implementation
TA.03.07	5	Sensors failures detection
TA.03.08	5	Cell balancing
		<i>Test report FLASH BATTERY</i>
TA.04.00	10	Test Plan (EVE cells)
TA.04.01	2	Battery Production Routine Test
TA.04.00	7	Test Plan (Sinopoly cells)
TA.04.02	1	Independent safety function test
TA.04.03	1+3	Undervoltage protection BMS
TA.04.04	1+3	Cell balancing
TA.04.05	1+2	Overcharge with voltage
TA.04.06	1+2	SOC validation
TA.04.07	1+2	Capacity validation
TA.04.08	1	Sensor failures
TA.04.09	1	Alarms and shutdowns
TA.04.10	1	Communication failure
TA.04.11	1	Overheating control
TA.04.12	2	Propagation/internal thermal runaway
		<i>Test report EMC – NEMKO</i>
362776-2TRFEMC		NEMKO-EMC_96V 400Ah, dated 2019-02-07
362776-3TRFEMC		NEMKO-EMC_288V 100Ah, dated 2019-02-07
404051-3TRFEMC		NEMKO-EMC_384V-100Ah, dated 2020-12-01
REP013388		NEMKO-EMC_409,6V-210Ah, dated 2023-07-07
		<i>Test report climatic, IP</i>
20AMB11496		ICEPI Protection degree tests - MCR, dated 2020-09-01
20AMB09671		ICEPI Protection degree tests – 48V 200 Ah, dated 2020-09-01
20AMB09675		ICEPI Protection degree tests – 96V 200 Ah, dated 2020-09-01
20AMB09679		ICEPI Protection degree tests – 96V 100 Ah, dated 2020-09-01
23AMB05070	01	TÜVAUSTRIA Protection degree test - Model: T4M, dated 2023-05-26
23AMB05074	01	TÜVAUSTRIA Protection degree test - Model: T8M, dated 2023-05-26

19AMB05275		ICEPI Climatic tests - 288V 100Ah, dated 2019-06-21
19AMB05258		ICEPI Climatic tests - 96V 400Ah, dated 2019-06-21
		<i>Test report vibration - BPS</i>
2019RT009A		BPS-Vibration test_MCR, dated 2019-04-03
2019RT010		BPS-Vibration test_288V 100Ah, dated 2019-03-29
2019RT017		BPS-Vibration test_96V 400Ah, dated 2019-05-10
2020RT032		BPS-Vibration test_144V 200Ah, dated 2020-11-17
		<i>UN Cell test reports</i>
ZJ20160425U01		MCM Tech Type: SP-LFP100AHA, 3,2V 100Ah 320Wh
ZJ20160425U02		MCM Tech Type: SP-LFP200AHA, 3,2V 200Ah 640Wh
RZUN2020-3412-TS		UN cell test Type G03075 12,8V 210Ah 2688Wh
RZUN2020-3413-TS		UN cell test Type G03072 25,6V 105Ah 2688Wh
01052000000319-2(E)		UN 38.3 cell test Type LF105 (EVE) 3,2V 105Ah 336Wh
210403016SHA	001	Gas analysis acc. UL9540A2019 LF105 3,2V 105Ah, dated 2021-06-30

Tests carried out

Type tests according to applicable DNV GL rules and standards as listed below have been carried out.
 DNV-RU-SHIP Pt.6 Ch.2 Sec.1 (07-2022), DNV-RU-SHIP Pt.4 Ch.8, DNV-RU-SHIP Pt.4 Ch.9,
 DNV-CG-0339 Sec.3 Items 6–9,12,13,14 (08-2021), DNV-CP-0418 (09-2021) comprehensive of
 IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-6, CISPR 16-2-1, 16-2-3.
 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:2 dated 2023-09-13(EVE).
 Safety Function and Sensor Failure Test acc. DNV-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 propagation 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