CROATIAN REGISTER OF SHIPPING

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Certificate No. 03-001940/031645

TYPE APPROVAL CERTIFICATE

This is to certify that this product complies with the Rules for the classification of ships, Part 1 - General requirements, Chapter 3 - Type approval of products.

TYPE AND DESCRIPTION OF PRODUCT:

Lithium-ion battery systems:

AYK A-69A Battery System
AYK A-88A Battery System
AYK A-103A Battery System
AYK A-176A Battery System
AYK B-176A Battery System

MANUFACTURER:

AYK Energy Ltd.
Placa Guillemo 3, 1st floor
Andorra la Vella, AD500
Andorra

THE PRODUCT MEETS FOLLOWING RULES/REGULATIONS:

Croatian Register of Shipping: **Rules for the classification of ships,**
Part 1 – General Requirements, Part 12 – Electrical Equipment

FURTHER DETAILS OF THE PRODUCT AND CONDITIONS FOR CERTIFICATION ARE GIVEN OVERLEAF.

APPROVAL IS VALID UNTIL: **2027-02-23**

Place and date: Split, 2023-02-23

Seal

Marinko Popović, dipl.ing.

NOTE: This certificate is not valid for equipment, the design or manufacture of which has been varied or modified from the specimen tested. The manufacturer should notify Croatian Register of Shipping of any modification or changes to the product in order to obtain a valid certificate.

DETAILED PRODUCT DESCRIPTION:

The AYK Battery is designed to be modular and can be scaled up to 1000VDC. The smallest entity of the battery is the battery module. Battery modules can be connected in series to form a string. The voltage of the string depends on the number of modules connected in series. Strings are connected in parallel to form a battery bank. The maximum number of modules connected in series is twenty-four (24), and the maximum number of strings connected in parallel is ten (10).

Each string has a Single String Controller Unit where the BMS control layer resides. This level of the BMS is called the Acquisition layer. The BMS control layer performs the safety and control functions for the string and communicate with the Multi String Manager (MSM).

Battery system is designed so that thermal propagation does not occur between cells.
Battery system is designed to emit possible off-gas from modules directly into the dedicated gas extraction ventilation duct.
Battery modules are designed with integrated smoke detection system and fire suppression system.

AYK A-69A Battery System

Battery Cell

Cell Model	LF90
Nominal Capacity	90 Ah
Nominal Voltage	3.2 V
Minimum Voltage	2.5 V
Maximum Voltage	3.65V
Maximum Continuous Charge Current	3C
Maximum Continuous Discharge Current	3C
Maximum Pulse Discharge Current	4C

Battery Module	**A-69A**
Cell Arrangement	12S2P
Module Voltage Range	36 to 43.2 VDC
Nominal Voltage	38.4 VDC
Capacity	180 Ah
Energy	6.9 kWh
Peak Charge Current	540 A (3C)
Peak Discharge Current	540 A (3C)
RMS Current	180 A (1C)

String configuration

Voltage	Modules in series	Energy 12S2P (A-069A)
400 V	9	62.1 kWh
500 V	12	82.6 kWh
600 V	14	96.6 kWh
700 V	16	110.4 kWh
800 V	18	124.2 kWh
900 V	21	144.9 kWh
1000 V	24	165.6 kWh

Multi String Configuration

Strings	400 V	500 V	600 V	700 V	800 V	900 V	1000 V	
1	62	83	97	110	124	145	166	kWh
2	124	166	193	221	248	290	331	kWh
3	186	248	290	331	373	435	497	kWh
4	248	331	386	442	497	580	662	kWh
5	311	414	483	552	621	725	828	kWh
6	373	497	580	662	745	869	994	kWh
7	435	580	676	773	869	1014	1159	kWh
8	497	662	773	883	994	1159	1325	kWh
9	559	745	869	994	1118	1304	1490	kWh
10	621	828	966	1104	1242	1449	1656	kWh

Battery Module A-69A hardware & software ID

AYK Part Number	A0022: EVE LF90 Rev. 01
Module level BMS board	P0030 Rev. 03
Module level BMS software	1.1.9
Smoke detector board	P0035 Rev. 02
Smoke detector board software	1.1.9
Valve driver board	P0036 Rev. 02
Valve driver board software	1.1.9

AYK A-88A Battery System

Battery Cell

Cell Model	LF230
Nominal Capacity	230 Ah
Nominal Voltage	3.2 V
Minimum Voltage	2.5 V
Maximum Voltage	3.65V
Maximum Continuous Charge Current	1C
Maximum Continuous Discharge Current	1C
Maximum Pulse Discharge Current	3C

Battery Module	**A-88A**
Cell Arrangement	12S1P
Module Voltage Range	36 to 43.2 VDC
Nominal Voltage	38.4 VDC
Capacity	230 Ah
Energy	8.8 kWh
Peak Charge Current	230 A (1C)
Peak Discharge Current	230 A (1C)
RMS Current	115 A (0.5C)

String configuration

Voltage	Modules in series	Energy 12S1P (A-088A)
400 V	9	79.2 kWh
500 V	12	105.6 kWh
600 V	14	123.2 kWh
700 V	16	140.8 kWh
800 V	18	158.4 kWh
900 V	21	184.8 kWh
1000 V	24	211.2 kWh

Multi String Configuration

Strings	400 V	500 V	600 V	700 V	800 V	900 V	1000 V	
1	79	106	123	141	158	185	211	kWh
2	158	211	246	282	317	370	422	kWh
3	238	317	370	422	475	554	634	kWh
4	317	422	493	563	634	739	845	kWh
5	396	528	616	704	792	924	1056	kWh
6	475	634	739	845	950	1109	1267	kWh
7	554	739	862	986	1109	1294	1478	kWh
8	634	845	986	1126	1267	1478	1690	kWh
9	719	950	1109	1267	1426	1663	1901	kWh
10	792	1056	1232	1408	1584	1848	2112	kWh

Battery Module A-88A hardware & software ID

AYK Part Number	A0042: EVE LF230 Rev. 03
Module level BMS board	P0030 Rev. 03
Module level BMS software	1.1.9
Smoke detector board	P0035 Rev. 02
Smoke detector board software	1.1.9
Valve driver board	P0036 Rev. 02
Valve driver board software	1.1.9

AYK A-103A Battery System

Battery Cell

Cell Model	LF90
Nominal Capacity	90 Ah
Nominal Voltage	3.2 V
Minimum Voltage	2.5 V
Maximum Voltage	3.65V
Maximum Continuous Charge Current	3C
Maximum Continuous Discharge Current	3C
Maximum Pulse Discharge Current	4C

Battery Module	**A-103A**
Cell Arrangement	12S3P
Module Voltage Range	36 to 43.2 VDC
Nominal Voltage	38.4 VDC
Capacity	270 Ah
Energy	10.3 kWh
Peak Charge Current	810 A (3C)
Peak Discharge Current	810 A (3C)
RMS Current	270 A (1C)

String configuration

Voltage	Modules in series	Energy 12S3P (A-103A)
400 V	9	92.7 kWh
500 V	12	123.6 kWh
600 V	14	144.2 kWh
700 V	16	164.8 kWh
800 V	18	185.4 kWh
900 V	21	216.3 kWh
1000 V	24	247.2 kWh

Multi String Configuration

Strings	400 V	500 V	600 V	700 V	800 V	900 V	1000 V	
1	93	124	144	165	185	216	247	kWh
2	185	247	288	330	371	433	494	kWh
3	278	371	433	494	556	649	742	kWh
4	371	464	577	659	742	865	989	kWh
5	464	618	721	824	927	1082	1236	kWh
6	556	746	865	989	1112	1298	1483	kWh
7	649	865	1009	1154	1298	1514	1730	kWh
8	742	989	1154	1318	1483	1730	1978	kWh
9	834	1112	1298	1483	1669	1947	2225	kWh
10	927	1236	1442	1648	1854	2163	2472	kWh

Battery Module A-103A hardware & software ID

AYK Part Number	A0035: EVE LF90 Rev. 01
Module level BMS board	P0030 Rev. 03
Module level BMS software	1.1.9
Smoke detector board	P0035 Rev. 02
Smoke detector board software	1.1.9
Valve driver board	P0036 Rev. 02
Valve driver board software	1.1.9

AYK A-176A Battery System

Battery Cell

Cell Model	LF230
Nominal Capacity	230 Ah
Nominal Voltage	3.2 V
Minimum Voltage	2.5 V
Maximum Voltage	3.65V
Maximum Continuous Charge Current	1C
Maximum Continuous Discharge Current	1C
Maximum Pulse Discharge Current	3C

Battery Module	**A-176A**
Cell Arrangement	12S2P
Module Voltage Range	36 to 43.2 VDC
Nominal Voltage	38.4 VDC
Capacity	460 Ah
Energy	17.6 kWh
Peak Charge Current	460 A (1C)
Peak Discharge Current	460 A (1C)
RMS Current	230 A (0.5C)

String configuration

Voltage	Modules in series	Energy 12S2P (A-176A)
400 V	9	158.4 kWh
500 V	12	211.2 kWh
600 V	14	246.4 kWh
700 V	16	281.6 kWh
800 V	18	316.8 kWh
900 V	21	369.6 kWh
1000 V	24	422.4 kWh

Multi String Configuration

Strings	400 V	500 V	600 V	700 V	800 V	900 V	1000 V	
1	158	211	246	282	317	370	422	kWh
2	317	422	493	563	634	739	845	kWh
3	475	634	739	845	950	1109	1267	kWh
4	634	845	986	1126	1267	1478	1690	kWh
5	792	1056	1232	1408	1584	1848	2112	kWh
6	950	1267	1478	1690	1901	2218	2534	kWh
7	1109	1478	1725	1971	2218	2587	2957	kWh
8	1267	1690	1971	2253	2534	2957	3379	kWh
9	1426	1901	2218	2534	2851	3326	3802	kWh
10	1584	2112	2464	2816	3168	3696	4224	kWh

Battery Module A-176A hardware & software ID

AYK Part Number	A0005: EVE LF230 Rev. 03
Module level BMS board	P0030 Rev. 03
Module level BMS software	1.1.9
Smoke detector board	P0035 Rev. 02
Smoke detector board software	1.1.9
Valve driver board	P0036 Rev. 02
Valve driver board software	1.1.9

AYK B-176A Battery System

Battery Cell

Cell Model	LF230
Nominal Capacity	230 Ah
Nominal Voltage	3.2 V
Minimum Voltage	2.5 V
Maximum Voltage	3.65V
Maximum Continuous Charge Current	1C
Maximum Continuous Discharge Current	1C
Maximum Pulse Discharge Current	3C

Battery Module	**B-176A**
Cell Arrangement	12S2P
Module Voltage Range	36 to 43.2 VDC
Nominal Voltage	38.4 VDC
Capacity	460 Ah
Energy	17.6 kWh
Peak Charge Current	460 A (1C)
Peak Discharge Current	460 A (1C)
RMS Current	230 A (0.5C)

String configuration

Voltage	Modules in series	Energy 12S2P (B-176A)
400 V	9	158.4 kWh
500 V	12	211.2 kWh
600 V	14	246.4 kWh
700 V	16	281.6 kWh
800 V	18	316.8 kWh
900 V	21	369.6 kWh
1000 V	24	422.4 kWh

Multi String Configuration

Strings	400 V	500 V	600 V	700 V	800 V	900 V	1000 V	
1	158	211	246	282	317	370	422	kWh
2	317	422	493	563	634	739	845	kWh
3	475	634	739	845	950	1109	1267	kWh
4	634	845	986	1126	1267	1478	1690	kWh
5	792	1056	1232	1408	1584	1848	2112	kWh
6	950	1267	1478	1690	1901	2218	2534	kWh
7	1109	1478	1725	1971	2218	2587	2957	kWh
8	1267	1690	1971	2253	2534	2957	3379	kWh
9	1426	1901	2218	2534	2851	3326	3802	kWh
10	1584	2112	2464	2816	3168	3696	4224	kWh

Battery Module B-176A hardware & software ID

AYK Part Number	A0034: EVE LF230 Rev. 01
Module level BMS board	P0030 Rev. 03
Module level BMS software	1.1.9
Smoke detector board	P0035 Rev. 02
Smoke detector board software	1.1.9
Valve driver board	P0036 Rev. 02
Valve driver board software	1.1.9

Single String Controller

SSC Unit Specification

Control Power	220 V AC converted to 24 V DC
Max String Voltage	1000 V DC
Max Bus Vultage	1000 V DC
Max Current	500 A
String Isolation	Motorized Breaker
Short Circuit Trip	2500 A magnetic trip
Short Circuit Breaking Capacity	40 kA

SSC hardware & software ID

A0017-02 Assembly A0017	Rev. 02
String Controller BMS Board	P0032 Rev. 01
String Controller BMS Software	1.1.9
Current measurement Software	1.1.9
HVI Board	P0033 Rev. 03
Buss Voltage Measurement Software	1.1.9
String Voltage Measurement Software	1.1.9
ABB_Breaker_SACE_TMAX_T5	

Multi String Manager

MSM Unit specification

Control Power Supply	220 V AC
Power Consumption	100 W
Controller	Intel x86 Single Board Controller
Display	13.3" touch panel LCD
Mass Storage	1 TB HDD
Remote Emergency Stop	Resistor matching input
Local Emergency Stop	Button on enclosure
Master Fire-Fighting Valve Control	Yes
Gas Extraction Fan Monitoring	Yes
Chiller Control (option)	Yes
Max Number of Single String Controllers in Bank	10

MSM hardware & software ID

A0016-02 Assembly A0016	Rev. 02
Hardware Interface Board	P0110 Rev.03
Software Version for Interface Board	1.1.9
Software Version Board	1.1.131
Software Version Touch Panel	1.1.131

APPLICATION / LIMITATIONS:

Product is approved for use on board vessels, floating and fixed units classed by CRS.
Product certification is required, supervision during manufacture and testing in presence of CRS surveyor.
Type approval covers hardware and software listed in the Product description.
Each battery bank is to be fed by external pressurized fresh water source 4-8 bar for fire suppression system.
Gas extraction ventilation duct of the battery bank is to be routed to a safe location outside the battery room.

TYPE APPROVAL DOCUMENTATION:

1. Cell specifications, doc.: LF90 (3.2V 90Ah) Product Specification (Version E), LF230-S01-LF-EVE.
2. Module and system specification, doc: DOC2156-02 AYK A-69A Battery System Data Sheet, DOC2157-02 AYK A-103A Battery System Data Sheet, DOC2158-02 AYK A-88A Battery System Data Sheet, DOC2159-02 AYK B-176A Battery System Data Sheet, DOC2085-04 AYK A-176A Battery System Data Sheet.
3. System design description, doc.: DOC2186-01 AYK Battery Design Description (General).
4. Module drawings, doc.: DWG2031-01 A-88A Module Design, DWG2033-01 A-69A Module Design, DWG2034-01 B-176A Module Design, DWG2035-01 A-103A Module Design, DWG2041-01 A-176A Module Design.
5. Risk analysis, doc.: DOC2022-01 AYK Battery HAZID input to system Risk Analysis.
6. Manuals for operation, installation and maintenance of the system, doc.: DOC2028-02 AYK Battery Operations Manual, DOC2030-02 AYK Battery Maintenance Manual, DOC2168-02 AYK System Installation Instruction.
7. IEC 62619 type test reports, doc.: Test Report A-88A Battery Module Vibration, EVEB20201119001, GZEC-R20112003B01V0.
8. IEC 62620 type test reports, doc.: EVE20201225001_English, Cell Test Report LF90 (Translation), Cell Test Report LF90 Original (CEPRI-SY8-2018-020).
9. Cell UN38.3 test reports, doc.: LF90 UN38.3, 01052000003024-1(E).
10. BMS safety functions description and test procedure, doc.: DOC2021-04 AYK Battery Safety Description, DOC2088-01 Over Charge with Voltage Test Procedure, DOC2089-02 Over Charge with Current Test Procedure, DOC2090-02 Over Heating Control test procedure, DOC2091-01 Independent safety function test.
11. Function test reports, doc.: DOC2095-01 Test Report AYK Battery Over Charge with Voltage Test, DOC2096-01 Test Report AYK Battery Over Charge with Current Test, DOC2097-01 Test Report AYK Battery Over Heating Control test, DOC2098-01 Test Report AYK Functional Tests for Type Approval, DOC2099-01 Test Report AYK Battery SoC Algorithm Verification, DOC2100-01 Test Report Independent Safety Function Test.
12. FAT and SAT test procedure, doc.: DOC2026-04 AYK Battery Factory Acceptance Test Procedure, DOC2027-03 AYK Battery Site Acceptance Test Procedure.
13. Quality plan for software design, doc.: DOC2084-01 AYK Software Quality Plan.
14. Thermal runaway test, doc.: DOC2081-03 AYK Battery Module Thermal Runaway Propagation test, DOC2094-02 Test Report A-176A Battery Module Thermal Runaway Propagation, DOC2174-02 Test Report A-88A Battery Module Thermal Runaway Propagation, DOC2179-01 Test Report A-69A Battery Module Thermal Runaway Propagation.
15. Key components list, doc.: DOC2115-02 AYK Key Components List.
16. System block diagram, doc.: DOC2175-01 AYK System Block Diagram.

MARKING OF PRODUCT:

In accordance with IEC 62620 – Marking and identification (The Manufacturer and Type Designation of the product, serial number, date of manufacture, rated capacity, nominal voltage, …).

CONDITIONS FOR CERTIFICATION:

All changes in components and software are to be recorded as long as the system is in use on board. The records of all changes are to be forwarded to CRS for evaluation and approval. Major changes in the software are to be approved before on-board application.