EQUIPMENT CERTIFICATE

Certificate No.:	Issued:	Valid until:	GCC class
TC-GCC-DNV-SE-0124-09657-1	2024-03-01	Unlimited	TC_I

Issued for:

Inverter series AF[1-6]K-SL/ASL/SLP (PPM Type A)

With specifications and software version as listed in Annex 2

Issued to:

Afore New Energy Technology (Shanghai) Co., Ltd.

Building 7, No.333 Wanfang Rd，Minhang District, Shanghai, China. 201112

According to:

DNV-SE-0124, 2021-10: Certification of Grid Code Compliance

PTPiREE, 2021-04: Conditions and procedures for using certificates in the process of connecting power generating modules to power networks

32016R0631, 2016-04: Requirements for Generators (NC RfG)

PSE, 2018-12: Requirements of general application resulting from Commission Regulation (EU) 2016/631 of 14 April 2016

detailed in Annex 1

Based on the document:

CR-GCC-DNV-SE-0124-09657-A072-1	Network Code Requirements for a PGU of Type A - Poland, Certification Report, dated 2024-03-01

Further assessment information, including scope and conditions, is found in Annex 1. Description of the inverter series and type tests performed is found in Annex 2 and Annex 3 respectively. Annexes are an explicit and inseparable part of the certificate. The certificate shall only be distributed with all annexes.

Hamburg, 2024-03-01

For DNV Renewables Certification

Bente Vestergaard
Service Line Leader for Type Certification

DAkkS Deutsche Akkreditierungsstelle D-ZE-22290-01-00

By DAkkS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Hamburg, 2024-03-01

For DNV Renewables Certification

Rui Cai
Project Manager

EQUIPMENT CERTIFICATE – ANNEX 1

Conditions, assessment criteria and scope of assessment

Provided that the conditions listed in section 1 are considered at project level, the inverter series as further specified in Annex 2 comply with the requirements within scope of this certification, as specified in section 3.

1 Conditions

- Changes of the system design, hardware or the software of the certified inverter series are to be approved by DNV.
- Inverter settings must finally be agreed and checked at project level to ensure grid code compliance, based on the requirements of relevant System Operator (SO). For the functionalities within scope of this certification, more information about the settings assessed is found in Control Settings in section 4.2 as well as the corresponding assessment sections 5.1 - 5.4 of the certification report CR-GCC-DNV-SE-0124-09657-A072-1.
- The capability of remote control has been shown on unit level but must finally be ensured at project level, considering any further requirements of relevant System Operator (SO) and the full communication network. For the functionalities within scope of this certification, this concerns:
  - Remote cessation of active power (see section 5.3)
  - Remote blocking and control of LFSM-O (see section 5.4).

  of the certification report CR-GCC-DNV-SE-0124-09657-A072-1.

2 Assessment criteria and normative references for this certificate:

/A/ Service Specification DNV-SE-0124: Certification of Grid Code Compliance, DNV, March 2016 amended October 2021

/B/ Conditions and procedures for using certificates in the process of connecting power generating modules to power networks, Warunki i procedury wykorzystania certyfikatów w procesie przyłączenia modułów wytwarzania energii do sieci elektroenergetycznych, version 1.2, PTPiREE, dated 2021-04-28, (in the following: PTPiREE 2021-04)

/C/ Requirements of general application resulting from Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG) – as approved by the decision of the President of the Energy Regulatory Office DRE.WOSE.7128.550.2.2018.ZJ dated January 2nd 2019, Wymogi ogólnego stosowania wynikające z Rozporządzenia Komisji (UE) 2016/631 z dnia 14 kwietnia 2016 r. ustanawiającego kodeks sieci dotyczący wymogów w zakresie przyłączenia jednostek wytwórczych do sieci (NC RfG), PSE S.A., dated 2018-12-18 zatwierdzone Decyzją Prezesa Urzędu Regulacji Energetyki DRE.WOSE.7128.550.2.2018.ZJ z dnia 2 stycznia 2019 r, (in the following: PSE 2018-12)

/D/ Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators, published in the Official Journal of the European Union L112/1, The European Comission, 27/04/2016. Document 32016R0631, (in the following: NC RfG)

3 Scope of assessment and results

The following functionalities have been assessed based on the rules for the use of equipment certificates for Power Park Modules (PPMs), as specified in chapter 7 and 9 of the PTPiREE 2021-04 /B/. The functions denoted “Not Applicable” in the table of chapter 7 has not been included.

Capability	NC RfG /D/	PSE 2018-12 /C/	Type A	Assessment result (*)
Frequency range	13.1(a)	13.1(a)(i)	x	Compliant
Rate of Change of Frequency (RoCoF) withstand capability, df/dt	13.1(b)	13.1(b)	x	Compliant
Remote cessation of active power	13.6	13.6	x	Compliant
Remote control of active power	14.2	14.2(b)		Compliant
Limited Frequency Sensitive Mode – over frequency (LFSM-O)	13.2	13.2(a), (b), (f)	x	Compliant

(*) Please note also the corresponding conditions for compliance, as stated in section 1.

Schematic description and technical data of the generating units

1 Schematic description of the units

The AFORE inverter series AF[1-6]K-SL/ASL/SLP, consisting of: AF1K-SL-1, AF1.5K-SL-1, AF2K-SL-1, AF2.5K-SL-1, AF3K-SL-1, AF3.6K-SL-1, AF3K-SL, AF3.6K-SL, AF4K-SL, AF4.6K-SL, AF5K-SL, AF5.5K-SL, AF6K-SL, AF1K-SL-0, AF1.5K-SL-0, AF2K-SL-0, AF2.5K-SL-0, AF3K-SL-0, AF3.6K-SL-0, AF4K-SL-0, AF4.6K-SL-0, AF5K-SL-0, AF5.5K-SL-0, AF6K-SL-0, AF1K-ASL-1, AF1.5K-ASL-1, AF2K-ASL-1, AF2.5K-ASL-1, AF3K-ASL-1, AF3.6K-ASL-1, AF3K-ASL, AF3.6K-ASL, AF4K-ASL, AF4.6K-ASL, AF5K-ASL, AF5.5K-ASL, AF6K-ASL, AF1K-ASL-0, AF1.5K-ASL-0, AF2K-ASL-0, AF2.5K-ASL-0, AF3K-ASL-0, AF3.6K-ASL-0, AF4K-ASL-0, AF4.6K-ASL-0, AF5K-ASL-0, AF5.5K-ASL-0, AF6K-ASL-0, AF4K-SLP, AF4.6K-SLP, AF5K-SLP, AF5.5K-SLP, AF6K-SLP.

All of them run at 230 V rated output voltage with a rated active power output of 1 kW to 6 kW. The different output power variants are achieved through derating via software. They have same circuit, PWB layout and software except slight differences in DC side summarized as follows.

Model AF*-SL-0 and AF*-ASL-0 (*= 1K, 1.5K, 2K, 2.5K, 3K, 3.6K, 4K, 4.6K, 5K, 5.5K, 6K) have no PV input and no PV switch, only connected to battery on DC side, the apparent power is just limited by the battery itself, not other changes, so the value is the same as its rated active power. The other models among the series convert electrical energy generated by photovoltaic modules (DC) to one-phase alternating current (AC).

Model AF*-SL-1 and AF*-ASL-1 (*= 1K, 1.5K, 2K, 2.5K, 3K, 3.6K) have one PV input string and one PV switch, model AF*-SL and AF*-ASL (*= 3K, 3.6K, 4K, 4.6K, 5K, 5.5K, 6K), AF*-SLP (*= 4K, 4.6K, 5K, 5.5K, 6K) have 2 PV input strings and one PV switch.

Model AF*-SL-0, AF*-SL-1, AF*-SL and AF*-SLP have same appearance. Model AF*-ASL-0, AF*-ASL-1, AF*-ASL have another kind of appearance which is different from the formers such as using different colours by the customer's request, but has no impact on the electrical components and circuit at all. There are no further differences in the hardware or firmware used, as stated by the manufacturer.

The electrical data of the inverter series is summarized in the following section.

2 Technical data of main components

According to the documents provided by the manufacturer, the following components are used.

EQUIPMENT CERTIFICATE – ANNEX 2

2.1 General Specifications

Unit	AF1K-SL-1	AF1.5K-SL-1	AF2K-SL-1	AF2.5K-SL-1	AF3K-SL-1
No. of phases	1	1	1	1	1
Maximum apparent power	1 kVA	1.5 kVA	2 kVA	2.5 kVA	3 kVA
Rated active power	1 kW	1.5 kW	2 kW	2.5 kW	3 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF3.6K-SL-1**	**AF3K-SL**	**AF3.6K-SL**	**AF4K-SL**	**AF4.6K-SL**
No. of phases	1	1	1	1	1
Maximum apparent power	3.6 kVA	3 kVA	3.6 kVA	4 kVA	4.6 kVA
Rated active power	3.6 kW	3 kW	3.6 kW	4 kW	4.6 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF5K-SL**	**AF5.5K-SL**	**AF6K-SL**	**AF1K-SL-0**	**AF1.5K-SL-0**
No. of phases	1	1	1	1	1
Maximum apparent power	5 kVA	5.5 kVA	6 kVA	1 kVA	1.5 kVA
Rated active power	5 kW	5.5 kW	6 kW	1 kW	1.5 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF2K-SL-0**	**AF2.5K-SL-0**	**AF3K-SL-0**	**AF3.6K-SL-0**	**AF4K-SL-0**
No. of phases	1	1	1	1	1
Maximum apparent power	2 kVA	2.5 kVA	3 kVA	3.6 kVA	4 kVA
Rated active power	2 kW	2.5 kW	3 kW	3.6 kW	4 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF4.6K-SL-0**	**AF5K-SL-0**	**AF5.5K-SL-0**	**AF6K-SL-0**	
No. of phases	1	1	1	1	
Maximum apparent power	4.6 kVA	5 kVA	5.5 kVA	6 kVA	
Rated active power	4.6 kW	5 kW	5.5 kW	6 kW	
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	

EQUIPMENT CERTIFICATE – ANNEX 2

Certificate No.:
TC-GCC-DNV-SE-0124-09657-1

Unit	AF1K-ASL-1	AF1.5K-ASL-1	AF2K-ASL-1	AF2.5K-ASL-1	AF3K-ASL-1
No. of phases	1	1	1	1	1
Maximum apparent power	1 kVA	1.5 kVA	2 kVA	2.5 kVA	3 kVA
Rated active power	1 kW	1.5 kW	2 kW	2.5 kW	3 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF3.6K-ASL-1**	**AF3K-ASL**	**AF3.6K-ASL**	**AF4K-ASL**	**AF4.6K-ASL**
No. of phases	1	1	1	1	1
Maximum apparent power	3.6 kVA	3 kVA	3.6 kVA	4 kVA	4.6 kVA
Rated active power	3.6 kW	3 kW	3.6 kW	4 kW	4.6 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF5K-ASL**	**AF5.5K-ASL**	**AF6K-ASL**	**AF1K-ASL-0**	**AF1.5K-ASL-0**
No. of phases	1	1	1	1	1
Maximum apparent power	5 kVA	5.5 kVA	6 kVA	1 kVA	1.5 kVA
Rated active power	5 kW	5.5 kW	6 kW	1 kW	1.5 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF2K-ASL-0**	**AF2.5K-ASL-0**	**AF3K-ASL-0**	**AF3.6K-ASL-0**	**AF4K-ASL-0**
No. of phases	1	1	1	1	1
Maximum apparent power	2 kVA	2.5 kVA	3 kVA	3.6 kVA	4 kVA
Rated active power	2 kW	2.5 kW	3 kW	3.6 kW	4 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Unit	**AF4.6K-ASL-0**	**AF5K-ASL-0**	**AF5.5K-ASL-0**	**AF6K-ASL-0**	
No. of phases	1	1	1	1	
Maximum apparent power	4.6 kVA	5 kVA	5.5 kVA	6 kVA	
Rated active power	4.6 kW	5 kW	5.5 kW	6 kW	
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	
Unit	**AF4K-SLP**	**AF4.6K-SLP**	**AF5K-SLP**	**AF5.5K-SLP**	**AF6K-SLP**
No. of phases	1	1	1	1	1
Maximum apparent power	4 kVA	4.6 kVA	5 kVA	5.5 kVA	6 kVA
Rated active power	4 kW	4.6 kW	5 kW	5.5 kW	6 kW
Rated AC-voltage (phase to neutral)	230 V	230 V	230 V	230 V	230 V
Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz

2.2 DC Input

Unit	AF1K-SL-1, AF1.5K-SL-1, AF2K-SL-1, AF2.5K-SL-1, AF3K-SL-1, AF3.6K-SL-1, AF1K-ASL-1, AF1.5K-ASL-1, AF2K-ASL-1, AF2.5K-ASL-1, AF3K-ASL-1, AF3.6K-ASL-1	AF3K-SL, AF3.6K-SL, AF4K-SL, AF4.6K-SL, AF5K-SL, AF5.5K-SL, AF6K-SL, AF3K-ASL, AF3.6K-ASL, AF4K-ASL, AF4.6K-ASL, AF5K-ASL, AF5.5K-ASL, AF6K-ASL	AF4K-SLP, AF4.6K-SLP, AF5K-SLP, AF5.5K-SLP, AF6K-SLP
Min. MPPT voltage	80 V	80 V	80 V
Max. MPPT voltage	500 V	500 V	500 V
Max. DC input voltage	550 V	550 V	550 V
Max. DC input current	1 x 18.5 A	2 x 18.5 A	2 x 18.5 A
Battery Input	N/A	N/A	N/A

2.3 Battery Input

Unit	AF1K-SL-0 AF1K-ASL-0	AF1.5K-SL-0 AF1.5K-ASL-0	AF2K-SL-0 AF2K-ASL-0
Battery Voltage Range	40 – 60 V	40 – 60 V	40 – 60 V
Max. Current	25 A	40 A	50 A
DC Input	N/A	N/A	N/A
Unit	**AF2.5K-SL-0 AF2.5K-ASL-0**	**AF3K-SL-0, AF3K-ASL-0 AF3.6K-SL-0, AF3.6K-ASL-0**	**AF4K-SL-0, AF4.6K-SL-0, AF5K-SL-0, AF5.5K-SL-0, AF6K-SL-0, AF4K-ASL-0, AF4.6K-ASL-0, AF5K-ASL-0, AF5.5K-ASL-0, AF6K-ASL-0**
Battery Voltage Range	40 – 60 V	40 – 60 V	40 – 60 V
Max. Current	63 A	80 A	120 A
DC Input	N/A	N/A	N/A

2.4 Software Version

Unit	AF1K-SL-1, AF1.5K-SL-1, AF2K-SL-1, AF2.5K-SL-1, AF3K-SL-1, AF3.6K-SL-1, AF3K-SL, AF3.6K-SL, AF4K-SL, AF4.6K-SL, AF5K-SL, AF5.5K-SL, AF6K-SL, AF1K-SL-0, AF1.5K-SL-0, AF2K-SL-0, AF2.5K-SL-0, AF3K-SL-0, AF3.6K-SL-0, AF4K-SL-0, AF4.6K-SL-0, AF5K-SL-0, AF5.5K-SL-0, AF6K-SL-0, AF1K-ASL-1, AF1.5K-ASL-1, AF2K-ASL-1, AF2.5K-ASL-1, AF3K-ASL-1, AF3.6K-ASL-1, AF3K-ASL, AF3.6K-ASL, AF4K-ASL, AF4.6K-ASL, AF5K-ASL, AF5.5K-ASL, AF6K-ASL, AF1K-ASL-0, AF1.5K-ASL-0, AF2K-ASL-0, AF2.5K-ASL-0, AF3K-ASL-0, AF3.6K-ASL-0, AF4K-ASL-0, AF4.6K-ASL-0, AF5K-ASL-0, AF5.5K-ASL-0, AF6K-ASL-0, AF4K-SLP, AF4.6K-SLP, AF5K-SLP, AF5.5K-SLP, AF6K-SLP
Firmware version	1.01
Software version	1.16

2.5 Unit transformer

The transformer is not part of the generating unit and consequently has not been part of the assessment.

2.6 Grid Protection

The protection is not part of certification scope

2.7 Control settings

The control interface allows for the selection of different parameter sets via the “Safty” field, which provide default settings based on specific grid codes and national requirements. For this certification report the parameter set called “Fra-IL60Hz Poland” in the display interface, was assessed for the functionalities within scope of this certification.

It should be noted that compliance can be achieved also with other parameter sets and control settings, but that changes to control settings will affect the inverter control behaviour which can thus affect compliance. It should be noted the final settings must be agreed on project level in agreement with relevant system operator.

Protection settings has not been part of the assessment. Since these could intervene with and affect the compliance of the assessed functionalities, this must be further assessed at project level.

EQUIPMENT CERTIFICATE – ANNEX 3

Type tests

1 Type tests

Tests were performed between 2022-12-16 and 2023-01-06 in the Afore lab, Shanghai in P.R. China. All tests were performed under ISO-17025 accreditation and they were performed on the AFORE AF6K-SL unit and some tests were repeated for AFORE AF1K-SL-1 unit.

The results used for assessment are documented in the measurement report(s) as specified below:

Scope	Reference
Frequency range	Section 3.1 of /1/
Rate of Change of Frequency (RoCoF) withstand capability, df/dt	Section 3.2 of /1/
Remote cessation of active power	Section 3.3 of /1/
Limited Frequency Sensitive Mode – over frequency (LFSM-O)	Section 3.4 of /1/

Test report(s)	Document number	Content
/1/	10304979-SHA-TR-04-A	Measurement of power control characteristics of a Hybrid inverter of the type AF6K-SL according to FGW TG3 Rev. 25

The tests results have been assessed against the requirements of PSE 2018-12 /C/ and NC RfG /D/. Further details are described in the corresponding certification report CR-GCC-DNV-SE-0124-09657-A072-1.