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TEST REPORT

VDE-AR-N 4105

Power generation systems connected to the low-voltage distribution network

Report Reference No.: 2504B0884SHA-001

Tested by (name + signature): Issac Chen

Issac Chen

Approved by (name + signature): Sleif Sui

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Applicant's name: Afore New Energy Technology (Shanghai) Co., Ltd.

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

Test specification:

Standard: VDE-AR-N 4105:2018
conjunction with DIN VDE V 0124-100:2020

Test procedure.....: Testing

Non-standard test method.....: N/A

Test Report Form/blank test report

Test Report Form No.: TTRF_VDE_4105_2020_V1.0

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Test item description	PV Grid-interactive inverter
Trade Mark	Afore
Manufacturer.....	Same as applicant
Model/Type reference.....	HNS1000TL-1, HNS1500TL-1, HNS2000TL-1, HNS2500TL-1, HNS3000TL-1
Rating.....	See below Specifications table

Specifications table					
Model	HNS1000T L-1	HNS1500T L-1	HNS2000T L-1	HNS2500T L-1	HNS3000T L-1
PV input					
Vmax PV (Vdc) (absolute Max.)	500	500	500	500	500
Isc PV (absolute Max.) (A)	25	25	25	25	25
Number MPP trackers	1	1	1	1	1
Number input strings	1	1	1	1	1
Max. PV input current (A)	18.5	18.5	18.5	18.5	18.5
MPPT voltage range (Vdc)	50-500	50-500	50-500	50-500	50-500
Vdc range @ full power (Vdc)	60-500	90-500	120-500	150-500	170-500
AC Grid (output)					
Normal AC Voltage (VAC)	L/N/PE, 230Vac				
Frequency (Hz)	50				
Normal AC Current (A)	4.4	6.6	8.7	10.9	13.1
Max. cont. output current (A)	6	9	12	13	15
Normal Power (W)	1000	1500	2000	2500	3000
Rated Apparent Power (VA)	1000	1500	2000	2500	3000
Max. cont. Power (W)	1000	1500	2000	2500	3000
Max. cont. Apparent Power (VA)	1000	1500	2000	2500	3000
Power factor(adjustable)	1.0(-0.8~ +0.8)				
Others					
Protective class	Class I				
Ingress protection (IP)	IP66				
Temperature (°C)	-25°C to +60°C (Derating 45°C)				
Inverter Isolation	Non-isolated				
Overvoltage category	OVC III (AC Main), OVC II (PV)				
Software version	V06				

Test item particulars :			
PGU connect to Grid System	☒ 1/N/PE	☐ 3/PE	☐ 3/N/PE
PGS(kVA)	☒ ≤3.68	☐ ≤13.8	☐ >13.8
Default cos ϕ - reactive power adjusted	☒ No adjusted ☐ a fixed displacement factor cos ϕ . ☐ Standard characteristic curve for cos ϕ (P) ☐ non-Standard characteristic curve for cos ϕ (P)		
Function of cos ϕ - reactive power adjusted	☒ No adjusted ☒ a fixed displacement factor cos ϕ . ☒ Standard characteristic curve for cos ϕ (P) ☒ non-Standard characteristic curve for cos ϕ (P)		
NS protection	☐ Central NS protection ☒ Integrated NS protection		
Voltage –Line to line	☐ arithmetically from the three line-to-neutral voltages ☐ measured separately ☒ N/A		
IP protection class: IP66			
Remark PGS: Power Generation System, PGU: Power Generation unit.			
Possible test case verdicts:			
- test case does not apply to the test object.....: N/A			
- test object does meet the requirement: P(Pass)			
- test object does not meet the requirement: F(Fail)			
Testing :			
Date of receipt of test item.....: 2021-04-29, 2025-09-10			
Date (s) of performance of tests.....: 2021-04-29 to 2021-05-21, 2025-09-10 to 2025-09-18			
General remarks:			
The test results presented in this report relate only to the object (single PV inverter unit) tested. The testing voltage is 230Vac single phase or 400V three phase. The information about Generating Plant is not considered and tested. The inverter is with a power relay at AC output. There are two CPU in inverter. And is constructed redundantly protection. The inverter also has integrated NS protection. Installer and relevant persons shall comply with VDE-AR-N4105 and relevant standard and Grid Code in this standard. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory. "(see Enclosure #)" refers to additional information appended to the report. "(see appended table)" refers to a table appended to the report. Throughout this report a point is used as the decimal separator. Determination of the test result includes consideration of measurement uncertainty from the test equipment and methods. Determination of the test conclusion is based on IEC Guide 115 in consideration of measurement uncertainty.			

The test results presented in this report relate only to the item tested. See general product information next for details information.

The test does not include the faults inside the CPU and software evaluation as agreed with client.

All the tests are performed on single unit.

PF<0 is under-excited condition, PF>0 is over-excited condition

In the report the testing data of inter-harmonics and high frequency harmonics is only for reference to installation.

The clause number in first is about VDE-AR-N 4105 The clause number in bracket is about DIN V VDE V 0124-100

General product information:

The test results presented in this report relate only to the object (single PV inverter unit) tested. The testing voltage is 230Vac, 50Hz. single phase, the information about Generating Plant is not considered and tested. Password protection is for parameter setting by Screen, And not available for operators.

The testing item is a grid-interactive inverter for indoor or outdoor installation.

The Inverter is single-phase type and non-isolated between input and output.

The inverter is connected to the DC input and AC output by connectors.

The inverter has single channels DC input whose MPPT is independent. Please see Rating table

The inverter has adjustable power factor function.

All Mode are same except for output power. The function was achieved by software.

The testing is performed on typical model of Max. Power.

Part testing (5.4.4.3 Harmonics, 5.7.4.2.3 Active power feed-in at over-frequency) were performed on model of Min. power.

The software version used for the testing is:

CPU	Part Name	Version
CPU1	DSP	V06
CPU2	HMI	V06
CPU3	CPLD	V06

The PV inverter default setting is PGU<13.8kVA and PGS < 13.8kVA.

The inverter doesn't provide the reactive power. And the PF is default value.

Abbreviations used in the report:

PGU: Power Generation unit.

PGS: Power Generation System

In: Rated current of power generation unit.

Copy of marking plate:



Model:	1000	1500	2000	2500	3000	3600
HNSxxxTL-1	☐	☐	☐	☐	☐	☐
Pdc Max (W)	2000	3000	4000	5000	6000	7200
Voc PV Max (V)	500	500	500	500	500	600
Vdc MPPT (V)	50-500					70-550
Idc Max (A)	18.5					
Isc PV Max (A)	25					
Pac Nom (W)	1000	1500	2000	2500	3000	3600
Iac Max (A)	6	9	12	13	15	17.5
Vac Nom (V)	L/N/PE, 230Vac					

Model:	3000	3600	4000	5000
HNSxxxTL	☐	☐	☐	☐
Pdc Max (W)	6000	7200	8000	10000
Voc PV Max (V)	600			
Vdc MPPT (V)	70-550			
Idc Max (A)	18.5*2			
Isc PV Max (A)	25*2			
Pac Nom (W)	3000	3600	4000	5000
Iac Max (A)	15	17.5	20	24
Vac Nom (V)	L/N/PE, 230Vac			
Fac Nom (Hz)	50			
Power Factor	1 (-0.8~+0.8 adjustable)			
Protective Class	I			
Operating temperature range	-25 ~ +60 C (Derating 45°C)			
IP Degree	IP66			

S/N

S06299-01



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VDE-AR-N 4105			
Clause	Requirement - Test	Result - Remark	Verdict
4	General framework conditions		
4.1	Provisions and regulations	NA for PGU testing	N/A
4.2	Application procedure and connection relevant documents	NA for PGU testing	N/A
4.3	Initial start-up of the power generation system	NA for PGU testing	N/A
5	Network connection		
5.1	Principles for determination of the network connection point	NA for PGU testing	N/A
5.2	Rating of the network equipment	NA for PGU testing	N/A
5.3	Permissible voltage change	NA for PGU testing	N/A
5.4	Network interactions		N/A
5.5	Connection criteria		
5.5.1	General		P
	When connecting a power generation system or a storage unit, the technical connection conditions of the network operator shall be observed.	Shall be considered full feed-in that in accordance with VDE-AR-N 4100 in the power system	P
5.5.2	PAV, E monitoring (feed-in limitation)	No such functional	N/A
5.5.3	Power generation systems ready for connection		N/A
5.6	Three-phase inverter systems	PV single-phase inverter	N/A
5.7	Behaviour of the power generation system at the network		
5.7.1	General		
	For frequencies between 47,5 Hz and 51,5 Hz, automatic disconnection from the network due to a frequency deviation is not permitted. The actual operating principle and the associated exceptions are detailed in 5.7.4.3. Frequency-dependent active power control is implemented in the open-loop control of the power generation units.		P
5.7.2	Steady-state voltage stability/reactive power supply		P
5.7.2.1	General boundary conditions		P
5.7.2.2	Reactive power supply at $\Sigma S_{E_{max}}$		P
5.7.2.2.1	General		P
	It is permissible in certain cases described in 5.7.2.2.2 and 5.7.3 to reduce the active power supply to the benefit of the reactive power supply. This is not considered a reduction of the active power supply in the context of network security management. Power generation systems shall comply with the reactive power supply irrespective of the number of feed-inphases under normal operating conditions in the voltage tolerance band $U_n \pm 10\%$.		P
5.7.2.2.2	Type 2 systems – inverters only		P

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Clause	Requirement - Test	Result - Remark	Verdict
5.7.2.2.3	Type 2 systems – Asynchronous generators (directly connected to the network and principally not able to control any reactive power)	Inverter only	N/A
5.7.2.2.4	Type 1 systems and type 2 systems – stirling generators and fuel cells	Inverter only	N/A
5.7.2.3	Reactive power supply smaller than PEmax		P
5.7.2.4	Methods for reactive power supply	(See appended table)	P
	a) reactive power voltage characteristic curve Q(U); or		P
	b) displacement factor/active power characteristic curve $\cos \phi$ (P); or		P
	c) fixed displacement factor $\cos \phi$.		P
	The Q(U) rule applies only to three-phase power generation units connected to the three-phase current system.		P
5.7.2.5	Requirements for reactive power methods of type 2 systems (inverters only) and type 1 systems		P
	In the delivery state, none of the three reactive power methods specified in 5.7.2.4 is set as default. During the commissioning of power generation units, the method specified by the network operator shall be set by the system installer. Without the setting of the method specified by the network operator, power generation units shall not feed in any power.		P
5.7.2.6	Special aspects regarding the extension of power generation systems		P
5.7.3	Dynamic network stability		P
5.7.3.1	General	(See appended table)	P
5.7.3.2	Dynamic network stability for type 1 units Transient stability – Reaction to network faults		N/A
5.7.3.3	Dynamic network stability for type 2 units and storage units		P
	The following conditions apply to all type 2 power generation units and storage units: As long as the line-neutral-voltages at the generator terminals of the power generation unit or storage unit do not exceed the limit curves shown in Figure 12 (red for the under-voltage limit curve, blue for the over-voltage limit curve), both the power generation unit and the storage unit shall neither become unstable nor disconnect from the network throughout the operating range.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	For evaluating the curves, the smallest respective value of the line-neutral-voltages at the power generation unit or the storage unit shall be used in case of a voltage drop, and the highest respective value of the line-neutral- voltages at the power generation unit or the storage unit shall be used in case of a voltage rise. As far as the set values for the NS protection given in Table 2 (column "Inverter(s)") anticipate the requirements given in Figure 12 in certain working points, merely the checking of the set values for NS protection is required for the verification procedure.		P
	If the voltage at the generator terminals falls below $< 0,8 U_n$ or exceeds $> 1,15 U_n$ (onset of fault), type 2 power generation units and storage units shall ride through voltage drops without feeding current into the network of the network operator (limited dynamic network stability).		P
	This requirement is deemed to be met, if the current fed in by the power generation unit(s) and/or the storage unit in any line conductor does not exceed 20 % of the rated current I_r within 60 ms and 10 % of I_r within 100 ms upon a voltage drop below $0,8 U_n$ or a voltage rise above $1,15 U_n$.		P
	Behaviour after the end of a fault If, after the end of a fault, the network voltage resumes a value within the voltage band from $-15 \% U_n$ to $+10 \% U_n$ and the active current of the power generation unit and/or the storage unit has been reduced during the network fault, it shall, immediately after the end of the fault, be increased to its pre-fault value as quickly as possible. The transient period shall not exceed a maximum of 1 s. The reactive power supply follows 5.7.2.5 in its time-related behaviour. In case of rotating machinery, the transient period shall not exceed a maximum of 6 s. At voltages of $1,15 U_n$, the power generation units and storage units shall not disconnect from the network for a period of up to 60 s after the onset of the fault. If the tripping of the self-protection of the power generation units and/or the storage unit is imminent, these units can adjust their reactive power behaviour such as to prevent self-protection tripping.		P
5.7.4	Active power output		P
5.7.4.1	General		P
	In cases where set-points are specified by a third party (e. g. direct marketing) and of network security management in accordance with 5.7.4.2, the new set-point shall be approached with the customer installation's power gradients listed below in relation to the network connection point. Implementation of those power gradients directly at the power generation units or storage units is sufficient for meeting the requirement.	The active power can be remote-controlled on the communication interface	P
5.7.4.2	Network security management		P
5.7.4.2.1	Types of power generation systems and storage units	The active power can be remote-controlled on the communication interface	P

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Clause	Requirement - Test	Result - Remark	Verdict
	Photovoltaic systems		P
	Cogeneration of power and heat (CHP) systems, wind, biogas, hydroelectric power as well as landfill and sewage gas systems		N/A
	Storage units buffering EEG or KWKG systems		N/A
	Any EEG and KWKG systems with an intelligent measurement system		N/A
	Any power generation systems and storage units other than those indicated above		N/A
5.7.4.2.2	Implementation of network security management		P
5.7.4.2.3	Active power adjustment at over-frequency and under-frequency	(See appended table) The starting frequency can be set from 50.2 to 50.5Hz, And, power gradient S=2%-12% adjustable Default 50.2 and power gradient S=5% setting.	P
5.7.4.4	Voltage-dependent active power reduction		N/A
5.7.5	Short-circuit contribution Due to the operation of a power generation system, the short-circuit current of the low-voltage network is increased by the short-circuit current of the power generation system. Therefore, the short-circuit current of the power generation system to be expected at the network connection point shall be indicated in accordance with 4.2. For the determination of the initial short-circuit AC current contribution I _{kA} of a power generation system, the following roughly estimated values can be assumed: – for synchronous generators: 8 times the rated current; – for asynchronous generators: 6 times the rated current; – for generators and storage units with inverters: the rated current. If the power generation system causes a short-circuit current increase in the network operator's network in excess of the rated value, then connection owner and network operator shall agree upon appropriate measures limiting the short-circuit current from the power generation system accordingly.		P
6	Construction of the power generation system/network and system protection (NS protection)		P
6.1	General requirements	PV Inverter	N/A
	The network and system protection (NS protection) is a type-tested protective device with a NS protection certificate (see Form E.6) wherein all protective functions specified in 6.5 are installed. The NS protection acts on the interface switch in accordance with 6.4. Depending on the sum of the maximum apparent powers of all power generation systems and storage units connected to the same network connection point ΣS_{Amax} , the following conditions apply to the NS protection:		P

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Clause	Requirement - Test	Result - Remark	Verdict
6.2	Central NS protection	Integrated NS protection	N/A
6.3	Integrated NS protection		P
6.4	Interface switch	The PSU include integrated interface switch and is type tested in the report	P
6.4.1	General	PGU with integrated NS protection.	P
	For the connection of the power generation system to the network operator's low-voltage network or to the remaining customer installation, an interface switch shall be used. The interface switch is controlled by the NS protection and automatically triggers if at least one protective function responds.	Integrated interface switch has been type tested in compliance with DIN EN 62109	P
	The functional check of the interface switch shall be carried out according to a) or b) or c): a) by using an interface switch which, in its active state, requires a control voltage to be applied continuously and which disconnects automatically when this voltage is no longer applied. The operational connection and disconnection processes shall be monitored; b) by connection and disconnection of the interface switch via the NS protection and monitoring its proper functioning (e. g. break contact of a monitoring contact) at least once daily; c) by using the integrated interface switch and the integrated NS protection for PV and battery inverters in compliance		P
6.4.2	Central interface switch		NA
6.4.3	Integrated interface switch		P
	In the case of integrated NS protection, the NS protection can be integrated in the programmable system control of the power generation units (e.g. in the inverter control). If so, then both the test button and the sealing may be omitted, however, password protection is required, if the protective function U > is adjustable. The integrated NS protection acts on an integrated interface switch (see 6.4.3).	unadjustable for U	P
6.5	Protective devices and protection settings		P
6.5.1	General		P
	The purpose of NS protection is to disconnect the power generation system from the network in the event of inadmissible voltage and frequency values (also refer to DIN VDE 0100-551 (VDE 0100-551)). This is meant to prevent inadvertent feed-in from the power generation system into a partial network separated from the main distribution network.		P
6.5.2	Protective functions		P

VDE-AR-N 4105			
Clause	Requirement - Test	Result - Remark	Verdict
	The NS protection shall be provided with a means for preventing unauthorised access (z. B. sealable, password protection). The rise-in-voltage protection $U >$ shall be designed such as to be adjustable in the NS protection (see Table 2, Footnote b). Additionally, the time delay of the voltage drop protection $U <$ and $U <<$ for directly coupled synchronous and asynchronous generators with $P_n > 50 \text{ kW}$ shall also be designed such as to be adjustable in the NS protection (see Table 2, Footnote d). Any other protective functions listed in 6.5.1 are either to be installed permanently, i. e. not adjustable, in the NS protection or to be provided with an additional separate protection against unauthorised access (e. g. password protection) for preventing modifications.	(See appended table)	P
6.5.3	Islanding detection	(See appended table)	P
6.6	Further requirements for power generation systems	Shall be considered in PGS	NA
7	Metering for billing purposes		NA
8	Operation of the system		P
8.1	General		P
8.2	Special aspects of the management of the network operator's network		NA
8.3	Connection conditions and synchronisation		P
8.3.1	General		P
	Power generation systems and storage units shall be connected to the network operator's network only if a suitable device determines that both the mains voltage and the mains frequency are within the tolerance range of 85 % U_n to 110 % U_n or 47,5 Hz to 50,1 Hz, respectively, for a period of at least 60 seconds. Additionally, the delay times for the reconnection of a generator and the staggered times applicable when connecting several generators shall be sufficient for safely finishing any control and adjustment processes within the power generation system and/or the storage unit caused by the connection. In case of power generation systems and storage units being reconnected to the network operator's network at the tripping of the NS protective device or the PAV, E monitoring, the active power of controllable power generation systems and storage units supplied to the network operator's network shall not exceed the gradient of 10 % of the active power P_{Amax} per minute. Non-controllable power generation systems and storage units can connect after 1 min to 10 min (random generator) or later.	(See appended table)	P
8.3.2	Connection of synchronous generators		N/A
8.3.3	Connection of asynchronous generators		N/A

VDE-AR-N 4105			
Clause	Requirement - Test	Result - Remark	Verdict
8.3.4	Connection of power generation units and storage units with inverters Power generation units with inverters (such as photovoltaic systems) and storage units with inverters shall only be connected with $k_{max} \leq 1,2$.		P
8.4	Special aspects regarding the planning, installation and operation of power generation systems and storage units each with $P_{Amax} \geq 135$ kW		NA
9	Verification of electrical properties		P
	Annex A: Explanations (informative)		---
	Annex B: Connection examples and measurement strategies (informative)		---
	Annex C: Examples of meter panel configurations (informative)		---
	Annex D: Examples for the connection evaluation of power generation systems -Connection of a 20 kW PV system (informative)		---

Appendix table1

5.4.4.1(5.2.2) Rapid voltage changes

Operation type1:	Switching on at any power level (without default to primary energy source)		
Operation type2:	start-up at P _n (reference condition) with circuit breaker reclosing		
Operation type3:	Switching on at any power level (without default to primary energy source)		
	K _i (limit <1.2)		
Test condition	Test 1: cosφ=1	Test 2: cosφ=0.90over-excited	Test 3: cosφ=0.90under-excited
Operation type1	0.312	0.310	0.311
Operation type2	0.310	0.310	0.312
Operation type3	0.311	0.312	0.311

Switching actions	K _i
Marking operation without default (to primary energy carrier)	0.149
Worst case at switch over of generator sections	0.150
Marking operation at reference conditions (of primary energy carrier)	0.145
Breaking operation at nominal power	0.312
Worst case value of all switching operations K _i max	0.310

Remark: Max. Power model can represent the other model

5.4.4.2 (5.2.3) Flicker

Remark: only test Max. Power

Flicker	Angle of network impedance Ψ_{K^*}	32°
L1	Long-term flicker strength P _{It} :	0.17
L2	Long-term flicker strength P _{It} :	--
L3	Long-term flicker strength P _{It} :	--

	Result			
Parameter	Limit value	L1 result	L2 result	L3 result
P _{It}	0.65(12)	0.17	--	--
P _{st}	1.00	0.19	--	--
dc (%)	3.3%	0.24	--	--
d max (%)	4%	0.71	--	--
d(t)%	3.3%(500ms)	0	--	--

Remark: Max. Power model can represent the other model

5.4.4.3(5.2.4) Harmonics and inter-harmonics

Testing at one inverter condition

TABLE: Harmonic current limit test (EN 61000-3-2)							P
Model	HNS1000TL-1						
Harm nic	L1		L2		L3		Limits -A
	Magnitude (A)	% of Fundament al	Magnitude (A)	% of Fundament al	Magnitude (A)	% of Fundament al	
01	4.58	--	--	--	--	--	--
02	0.069	1.513	--	--	--	--	1.08
03	0.090	1.959	--	--	--	--	2.3
04	0.016	0.345	--	--	--	--	0.43
05	0.029	0.628	--	--	--	--	1.14
06	0.007	0.163	--	--	--	--	0.30
07	0.021	0.450	--	--	--	--	0.77
08	0.003	0.069	--	--	--	--	0.23
09	0.006	0.139	--	--	--	--	0.40
10	0.007	0.145	--	--	--	--	0.184
11	0.012	0.254	--	--	--	--	0.33
12	0.007	0.157	--	--	--	--	0.153
13	0.022	0.487	--	--	--	--	0.21
14	0.005	0.108	--	--	--	--	0.131
15	0.018	0.390	--	--	--	--	0.15
16	0.006	0.131	--	--	--	--	0.115
17	0.008	0.180	--	--	--	--	0.132
18	0.011	0.240	--	--	--	--	0.102
19	0.012	0.257	--	--	--	--	0.118
20	0.007	0.144	--	--	--	--	0.092
21	0.014	0.309	--	--	--	--	0.107
22	0.005	0.112	--	--	--	--	0.084
23	0.007	0.153	--	--	--	--	0.098
24	0.010	0.209	--	--	--	--	0.077
25	0.016	0.350	--	--	--	--	0.09
26	0.009	0.188	--	--	--	--	0.071
27	0.010	0.220	--	--	--	--	0.083
28	0.004	0.082	--	--	--	--	0.066
29	0.006	0.132	--	--	--	--	0.078
30	0.007	0.161	--	--	--	--	0.061
31	0.013	0.293	--	--	--	--	0.073
32	0.008	0.175	--	--	--	--	0.058
33	0.005	0.109	--	--	--	--	0.068
34	0.003	0.061	--	--	--	--	0.054
35	0.005	0.100	--	--	--	--	0.064
36	0.004	0.088	--	--	--	--	0.051
37	0.009	0.200	--	--	--	--	0.061
38	0.005	0.108	--	--	--	--	0.048
39	0.004	0.096	--	--	--	--	0.058
40	0.003	0.064	--	--	--	--	0.046
THD	--	2.952	--	--	--	--	5%
PWHD	--	--	--	--	--	--	22%

	TABLE: Harmonic current limit test (EN 61000-3-2)						P
Model	HNS3000TL-1						
Harmonic	L1		L2		L3		Limits -A
	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	
01	13.233	--	--	--	--	--	--
02	0.162	1.221	--	--	--	--	1.08
03	0.076	0.571	--	--	--	--	2.3
04	0.030	0.230	--	--	--	--	0.43
05	0.089	0.675	--	--	--	--	1.14
06	0.010	0.073	--	--	--	--	0.30
07	0.032	0.245	--	--	--	--	0.77
08	0.007	0.056	--	--	--	--	0.23
09	0.016	0.118	--	--	--	--	0.40
10	0.006	0.046	--	--	--	--	0.184
11	0.020	0.150	--	--	--	--	0.33
12	0.009	0.066	--	--	--	--	0.153
13	0.025	0.186	--	--	--	--	0.21
14	0.007	0.053	--	--	--	--	0.131
15	0.016	0.120	--	--	--	--	0.15
16	0.004	0.027	--	--	--	--	0.115
17	0.014	0.104	--	--	--	--	0.132
18	0.008	0.063	--	--	--	--	0.102
19	0.012	0.091	--	--	--	--	0.118
20	0.006	0.046	--	--	--	--	0.092
21	0.011	0.082	--	--	--	--	0.107
22	0.004	0.030	--	--	--	--	0.084
23	0.015	0.112	--	--	--	--	0.098
24	0.011	0.085	--	--	--	--	0.077
25	0.012	0.087	--	--	--	--	0.09
26	0.008	0.061	--	--	--	--	0.071
27	0.006	0.046	--	--	--	--	0.083
28	0.005	0.041	--	--	--	--	0.066
29	0.015	0.112	--	--	--	--	0.078
30	0.011	0.083	--	--	--	--	0.061
31	0.013	0.101	--	--	--	--	0.073
32	0.010	0.072	--	--	--	--	0.058
33	0.006	0.046	--	--	--	--	0.068
34	0.004	0.027	--	--	--	--	0.054
35	0.020	0.148	--	--	--	--	0.064
36	0.008	0.061	--	--	--	--	0.051
37	0.013	0.097	--	--	--	--	0.061
38	0.006	0.047	--	--	--	--	0.048
39	0.007	0.053	--	--	--	--	0.058
40	0.005	0.035	--	--	--	--	0.046
THD	--	1.668	--	--	--	--	5%
PWHD	--	---	--	---	--	---	22%

5.4.4.8(5.2.6) I dc -Direct current injection

5.4.4.8+5.2.6 TABLE: Direct current injection								P
Model	HNS1000TL-1							
Rated output current (A)	Power P/Pn [%]	Measured DC output current						Limit [%]
		L1 [A]	L1 [%]	L2 [A]	L2 [%]	L3 [A]	L3 [%]	
4.35	100%	0.009	0.21%	--	--	--	--	0.5%
4.35	66%	0.019	0.44%	--	--	--	--	0.5%
4.35	33%	0.020	0.46%	--	--	--	--	0.5%
Supplementary information: Main voltage 230V								

5.4.4.8+5.2.6 TABLE: Direct current injection								P
Model	HNS3000TL-1							
Rated output current (A)	Power P/Pn [%]	Measured DC output current						Limit [%]
		L1 [A]	L1 [%]	L2 [A]	L2 [%]	L3 [A]	L3 [%]	
13.04	100%	0.009	0.07%	--	--	--	--	0.5%
13.04	66%	0.008	0.06%	--	--	--	--	0.5%
13.04	33%	0.008	0.06%	--	--	--	--	0.5%
Supplementary information: Main voltage 230V								

5.6+5.3.2 Asymmetry calculation for three-phase inverter

5.6+5.3.2	TABLE: Asymmetry calculation for three-phase inverter						NA
Model							
Three-phase inverter							
Test voltage: 230 V. 50 Hz							
NO.	Test condition		Power asymmetry [VA]				
	cos φ	P/PEmax	I	II	III	IV	VI
1	1.00	100%	---	---	---	---	---
2	1.00	50%	---	---	---	---	---
3	max. under-excited	100%	---	---	---	---	---
4		50%	---	---	---	---	---
5	max. over-excited	100%	---	---	---	---	---
6		50%	---	---	---	---	---
Max. Power Asymmetry [VA]			---		Limitation [VA]		---

5.7.2 Power Factor

Limit:

Default : 1 ± 0.01

0.90 to 0.90 20% P to 100%

Model	HNS1000TL-1							
step	U_n				$1.09U_n$			
	Voltage (P to N.V)	S (VA)	P (W)	$\cos\phi$	Voltage (P to N. V)	S (VA)	P (W)	$\cos\phi$
a) noraml	230.76	1044	1040	0.996	250.76	1042	1040	0.998
b) before	230.69	1017	963	0.947	250.78	1020	967	0.948
c) after	230.72	1054	997	0.946	250.77	1056	999	0.946
$S_{E_{max600}}$ (VA)					1056			
$P_{E_{max600}}$ (W)					1040			

Model	HNS3000TL-1							
step	U_n				$1.09U_n$			
	Voltage (P to N.V)	S (VA)	P (W)	$\cos\phi$	Voltage (P to N. V)	S (VA)	P (W)	$\cos\phi$
a) noraml	230.63	3049	3037	0.996	250.75	2995	2983	0.996
b) before	230.36	3052	2893	0.948	250.73	2986	2828	0.947
c) after	230.45	2998	2836	0.946	250.84	3008	2846	0.946
$S_{E_{max600}}$ (VA)					3052			
$P_{E_{max600}}$ (W)					3037			

	Power factor test								
Model	HNS1000TL-1								
Power Level (% of VA)	20%	30%	40%	50%	60%	70%	80%	90%	100%
U=Un	230V								
P(W)	209	331	423	519	610	714	810	911	1040
S(VA)	211	334	426	523	614	718	815	916	1044
PF	0.991	0.992	0.992	0.993	0.993	0.994	0.994	0.995	0.996
0.91 Un	0.91 Un								
P(W)	232	324	423	515	607	715	809	910	1040
S(VA)	234	326	426	518	611	719	813	914	1043
PF	0.992	0.993	0.993	0.994	0.994	0.995	0.995	0.996	0.997
1.09Un	1.09Un								
P(W)	252	287	418	518	607	707	808	909	1038
S(VA)	255	290	422	522	612	712	814	914	1043
PF	0.990	0.991	0.991	0.992	0.992	0.993	0.993	0.994	0.995
Remark: PF<0 is under-excited condition, PF>0 is over-excited condition									

	Power factor test								
Model	HNS3000TL-1								
Power Level (% of VA)	20%	30%	40%	50%	60%	70%	80%	90%	100%
U=Un	230V								
P(W)	605	903	1205	1506	1815	2111	2400	2700	3045
S(VA)	609	908	1211	1512	1822	2117	2407	2705	3048
PF	0.994	0.995	0.995	0.996	0.996	0.997	0.997	0.998	0.999
0.91 Un	0.91 Un								
P(W)	602	904	1206	1501	1810	2106	2398	2701	3028
S(VA)	605	908	1211	1507	1815	2112	2403	2706	3031
PF	0.995	0.996	0.996	0.996	0.997	0.997	0.998	0.998	0.999
1.09Un	1.09Un								
P(W)	601	903	1202	1503	1813	2110	2400	2695	2993
S(VA)	605	908	1209	1511	1822	2118	2407	2703	2999
PF	0.993	0.994	0.994	0.995	0.995	0.996	0.997	0.997	0.998
Remark: PF<0 is under-excited condition, PF>0 is over-excited condition									

5.7.2.2 The Default is a fixed displacement factor $\cos\phi$

limit +0.95 to -0.95. time <10S

Model	HNS1000TL-1								
Set Value	100% of S			50% of S			20% of S		
	Un 230V	1.09Un 250V	0.91Un 209V	Un 230V	1.09Un 250V	0.91Un 209V	Un 230V	1.09Un 250V	0.91Un 209V
+0.90	--	--	--	--	--	--	--	--	--
+0.91	--	--	--	--	--	--	--	--	--
+0.92	--	--	--	--	--	--	--	--	--
+0.93	--	--	--	--	--	--	--	--	--
+0.94	--	--	--	--	--	--	--	--	--
+0.95	0.950	0.950	0.950	0.946	0.946	0.947	0.946	0.947	0.946
+0.96	0.962	0.962	0.962	0.957	0.956	0.959	0.959	0.961	0.957
+0.97	0.966	0.967	0.968	0.971	0.968	0.969	0.970	0.966	0.966
+0.98	0.977	0.976	0.979	0.980	0.977	0.980	0.981	0.977	0.977
+0.99	0.986	0.987	0.987	0.991	0.987	0.989	0.989	0.987	0.987
1	0.996	0.997	0.997	0.996	0.998	0.996	0.997	0.998	0.999
-0.99	-0.987	-0.986	-0.987	-0.988	-0.986	-0.986	-0.986	-0.987	-0.987
-0.98	-0.976	-0.979	-0.978	-0.976	-0.977	-0.977	-0.977	-0.976	-0.977
-0.97	-0.967	-0.968	-0.967	-0.968	-0.967	-0.967	-0.967	-0.967	-0.966
-0.96	-0.957	-0.956	-0.958	-0.958	-0.956	-0.957	-0.956	-0.956	-0.957
-0.95	-0.946	-0.946	-0.949	-0.947	-0.946	-0.946	-0.948	-0.951	-0.952
-0.94	--	--	--	--	--	--	--	--	--
-0.93	--	--	--	--	--	--	--	--	--
-0.92	--	--	--	--	--	--	--	--	--
-0.91	--	--	--	--	--	--	--	--	--
-0.90	--	--	--	--	--	--	--	--	--
settling time(s)	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Remark: PF<0 is under-excited condition, PF>0 is over-excited condition									

Model	HNS3000TL-1								
Set Value	100% of S			50% of S			20% of S		
	Un 230V	1.09Un 250V	0.91Un 209V	Un 230V	1.09Un 250V	0.91Un 209V	Un 230V	1.09Un 250V	0.91Un 209V
+0.90	--	--	--	--	--	--	--	--	--
+0.91	--	--	--	--	--	--	--	--	--
+0.92	--	--	--	--	--	--	--	--	--
+0.93	--	--	--	--	--	--	--	--	--
+0.94	--	--	--	--	--	--	--	--	--
+0.95	0.949	0.951	0.950	0.946	0.946	0.947	0.946	0.946	0.947
+0.96	0.961	0.961	0.961	0.957	0.958	0.958	0.956	0.959	0.957
+0.97	0.968	0.967	0.967	0.968	0.966	0.969	0.967	0.967	0.966
+0.98	0.979	0.978	0.977	0.979	0.977	0.980	0.978	0.978	0.976
+0.99	0.988	0.988	0.989	0.990	0.987	0.987	0.988	0.987	0.987
1	0.996	0.997	0.996	0.997	0.998	0.996	0.997	0.997	0.998
-0.99	-0.987	-0.986	-0.988	-0.988	-0.987	-0.986	-0.988	-0.987	-0.987
-0.98	-0.978	-0.976	-0.978	-0.978	-0.977	-0.976	-0.977	-0.977	-0.978
-0.97	-0.967	-0.966	-0.968	-0.967	-0.967	-0.966	-0.968	-0.966	-0.966
-0.96	-0.958	-0.956	-0.958	-0.960	-0.957	-0.958	-0.956	-0.956	-0.957
-0.95	-0.947	-0.948	-0.949	-0.949	-0.948	-0.947	-0.950	-0.953	-0.954
-0.94	--	--	--	--	--	--	--	--	--
-0.93	--	--	--	--	--	--	--	--	--
-0.92	--	--	--	--	--	--	--	--	--
-0.91	--	--	--	--	--	--	--	--	--
-0.90	--	--	--	--	--	--	--	--	--
settling time(s)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Remark: PF<0 is under-excited condition, PF>0 is over-excited condition									

5.7.2 COS Φ (P)

Point1		Point2		Point3		Point4	
P/P-EMax	cos ϕ	P/P-EMax	cos ϕ	P/P-EMax	cos ϕ	P/P-EMax	cos ϕ
0.2	1	0.5	1	1	0.95	---	---

P _{Emax}				30000 W			
% of P _{Emax}	set-value of cos ϕ	First time		Second time		Third time	
		P	cos ϕ	P	cos ϕ	P	cos ϕ
20%	1.00	617	0.994	617	0.994	617	0.994
30%	1.00	915	0.995	915	0.995	914	0.995
40%	1.00	1218	0.997	1216	0.997	1218	0.997
50%	1.00	1523	0.998	1525	0.998	1524	0.998
60%	-0.98	1802	-0.990	1802	-0.990	1807	-0.991
70%	-0.96	2089	-0.979	2091	-0.979	2090	-0.979
80%	-0.94	2399	-0.969	2400	-0.969	2400	-0.969
90%	-0.92	2682	-0.962	2685	-0.962	2678	-0.962
100%	-0.90	2853	-0.952	2850	-0.952	2838	-0.952
90%	-0.92	2680	-0.962	2675	-0.961	2641	-0.962
80%	-0.94	2391	-0.969	2400	-0.969	2399	-0.969
70%	-0.96	2086	-0.980	2090	-0.979	2090	-0.979
60%	0.98	1799	-0.990	1806	-0.990	1809	-0.990
50%	1.00	1522	0.998	1524	0.998	1530	0.998
40%	1.00	1220	0.997	1220	0.997	1215	0.997
30%	1.00	912	0.996	914	0.996	911	0.996
20%	1.00	610	0.995	616	0.995	614	0.995
PF<0 is under-excited condition, PF>0 is over-excited condition							

5.7.2 PF Q (U)

Voltage			VAR		
Rated Voltage		230Vac (400V)	Rated Power		3KVA
Voltage	% Vrated	Voltage (V)	VAR	% P	
V1	93%	213.9	Q1-capacitive	-30%	-900Var
V2	97%	223.1	Q2	0	
V3	103%	236.9	Q3	0	
V4	107%	246.1	Q4- inductive	30%	900Var
Remark:					

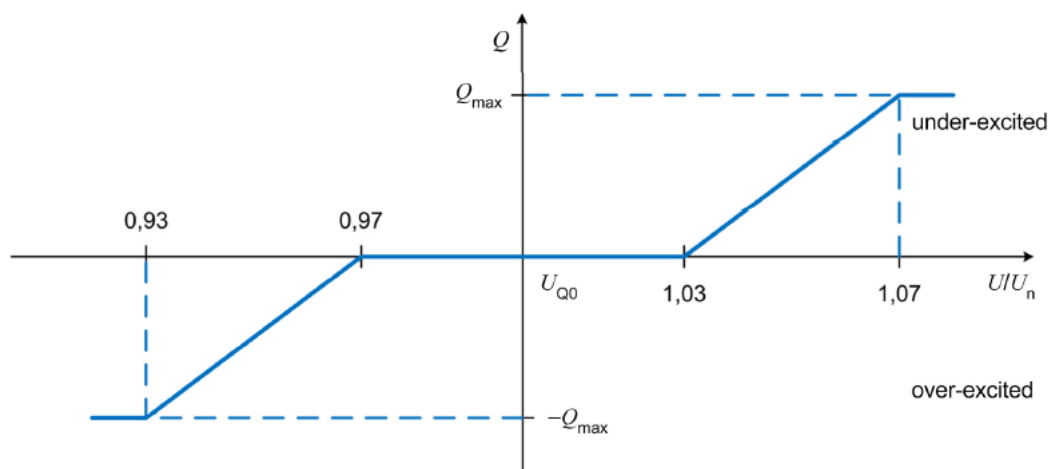
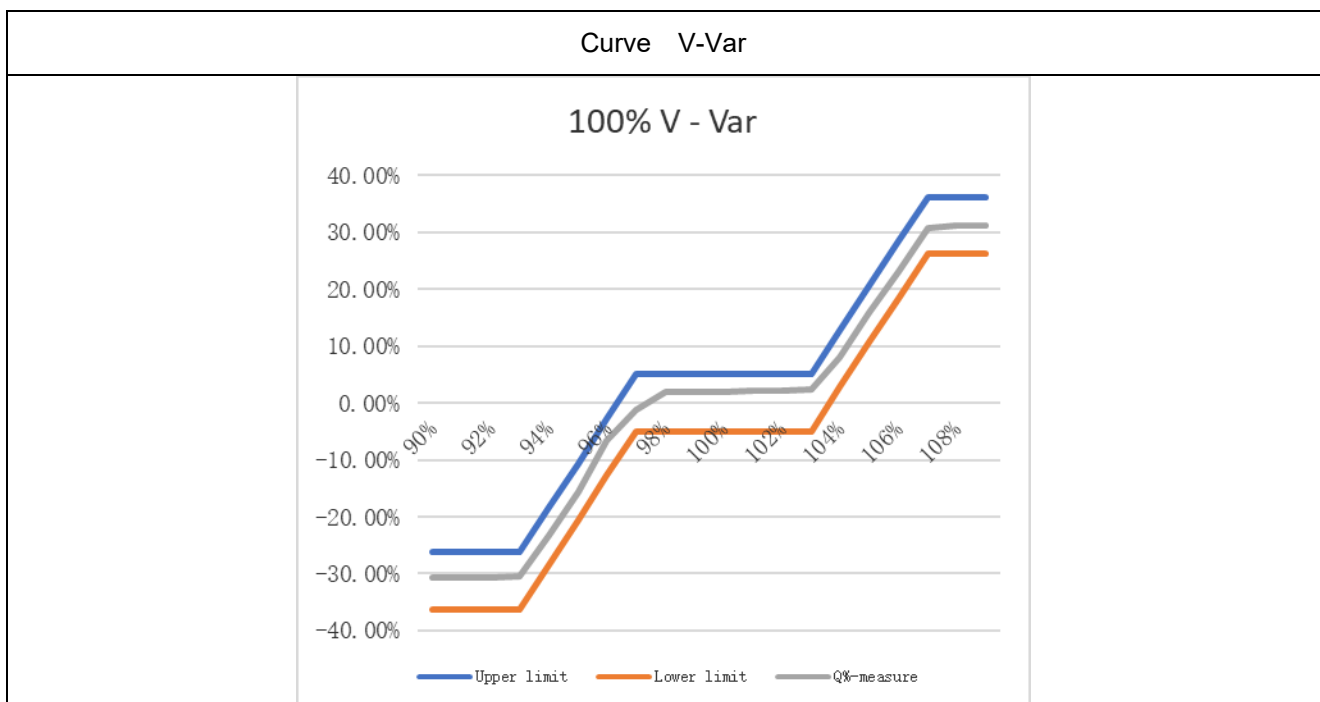
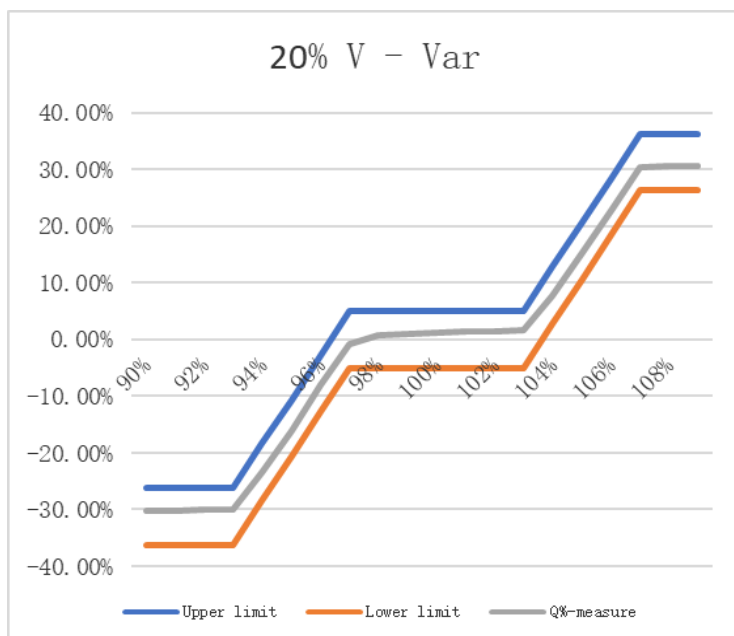
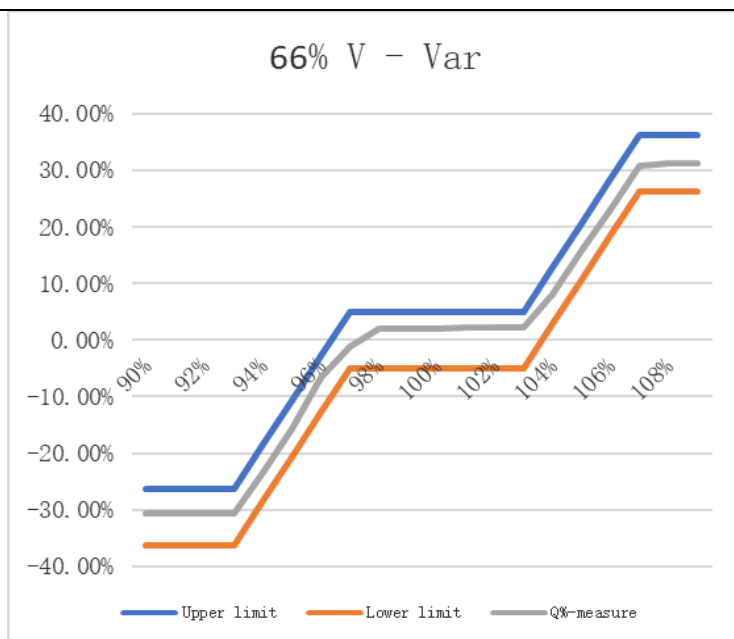


Figure 7 – Standard $Q(U)$ characteristic curve

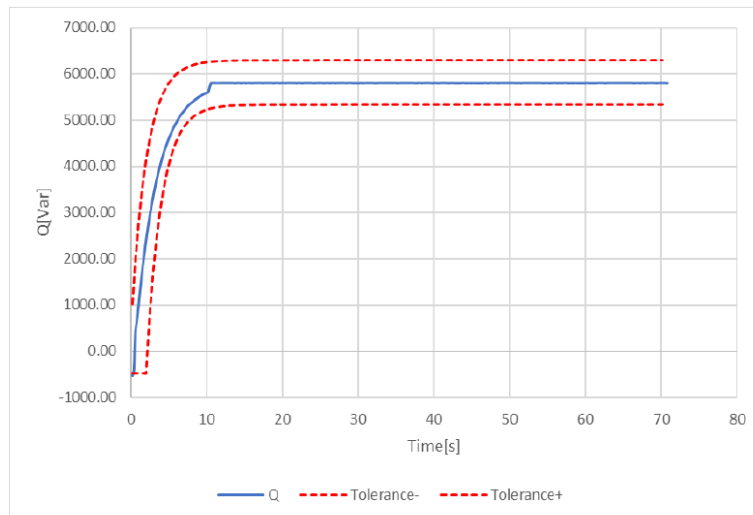




5.7.2 PF – Power Factor(Reactive power response time)

Q(U) condition							
	Voltage Setting U_{PGU}	Target Q	Measurement Q_{SOII} [Var]	Measurement Q_{Start} [Var]	Response time T_{MESS} [s]	Parameterized response time T (s)	Dynamic as PT1
1	$Un + \Delta U_{ind,Y}$	Inductive, 0.95Q max	-1417	-126	6.1	10 s	Pass
4	$Un + \Delta U_{cap,Y}$	Capacitive, 0.95Q max	1434	-114	6.6	10 s	Pass

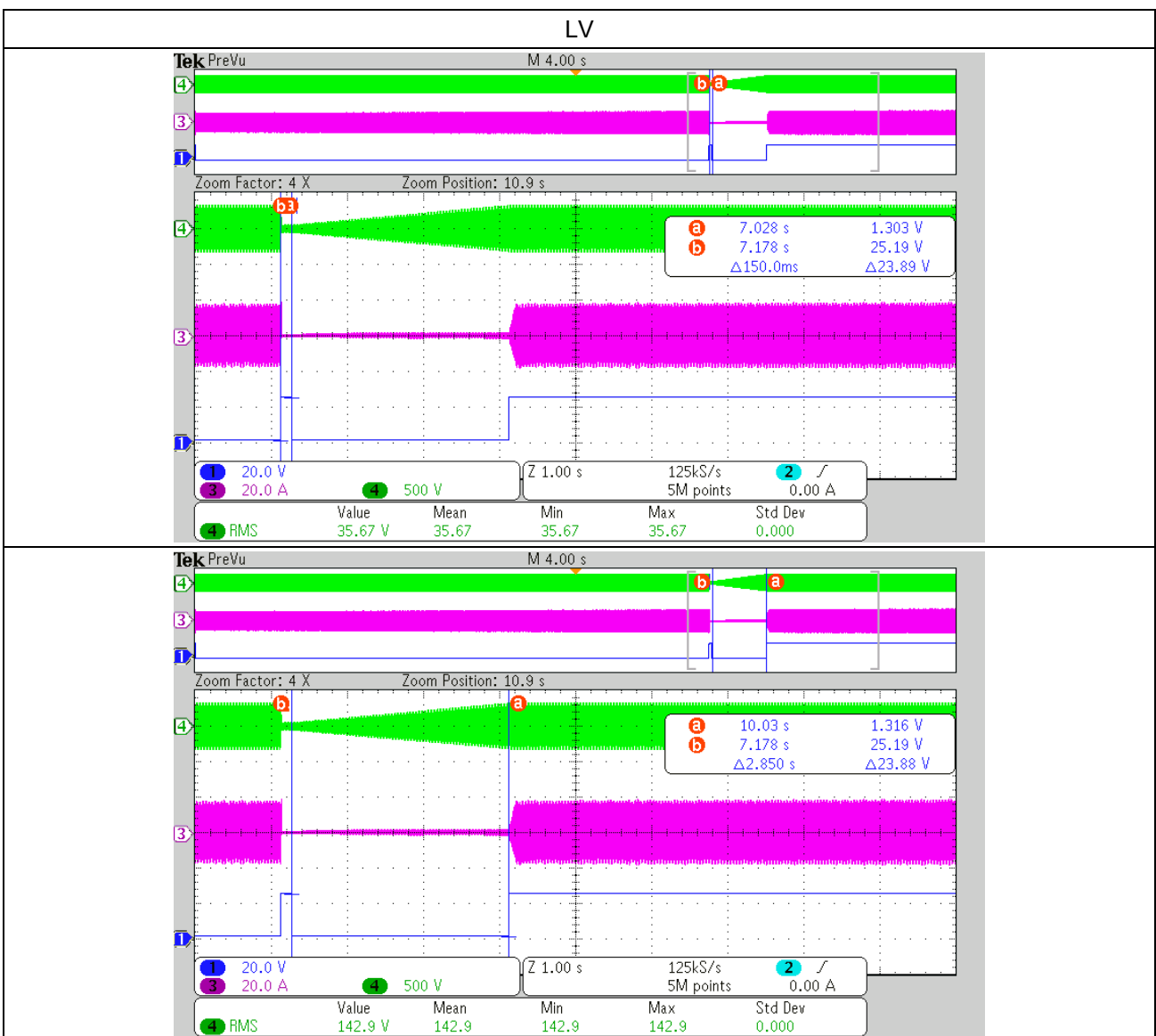
Displacement factor $\cos \phi$ condition							
	Voltage Setting U_{PGU}	Target Q	Measurement Q_{SOII} [Var]	Measurement Q_{Start} [Var]	Response time T_{MESS} [s]	Parameterized response time T (s)	Dynamic as PT1
1	Un	Inductive, 0.95Q max	-1452	-122	6.9	10 s	Pass
4	Un	Capacitive, 0.95Qmax	1461	-119	6.3	10 s	Pass



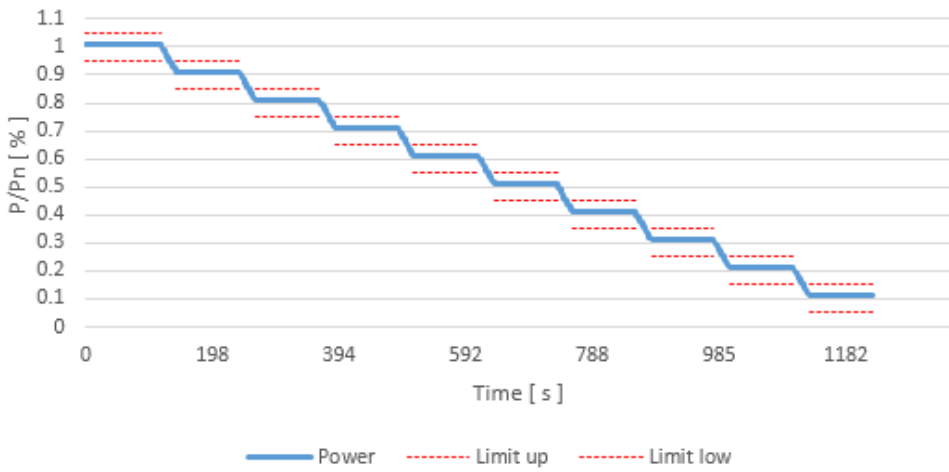
5.7.3.3 Dynamic network stability for type 2 units and storage units (OUVRT)

5.7.3.3 Dynamic network stability for type 2 units and storage units (OVRT)				
Rated voltage				230Vac
Region	Voltage (% Rated)	Voltage(V)	Ride-Through Until	OP.Mode
HV3	120% < V ≤ 125%	276-285	0.1s	☒ Operation
HV2	115% < V ≤ 120%	264-274	5s	☒ Operation
HV1	110% < V ≤ 115%	253-262	60s	☒ Operation
NN	85% ≤ V ≤ 110%	195-251	Indefinite	☒ Operation
LV	See picture			

Note: For LV3 or HV1 the EUT shall cease to energize in not more than 0.16 s (and not trip).
Renew to normal model when 88%-110%. And back to Max power



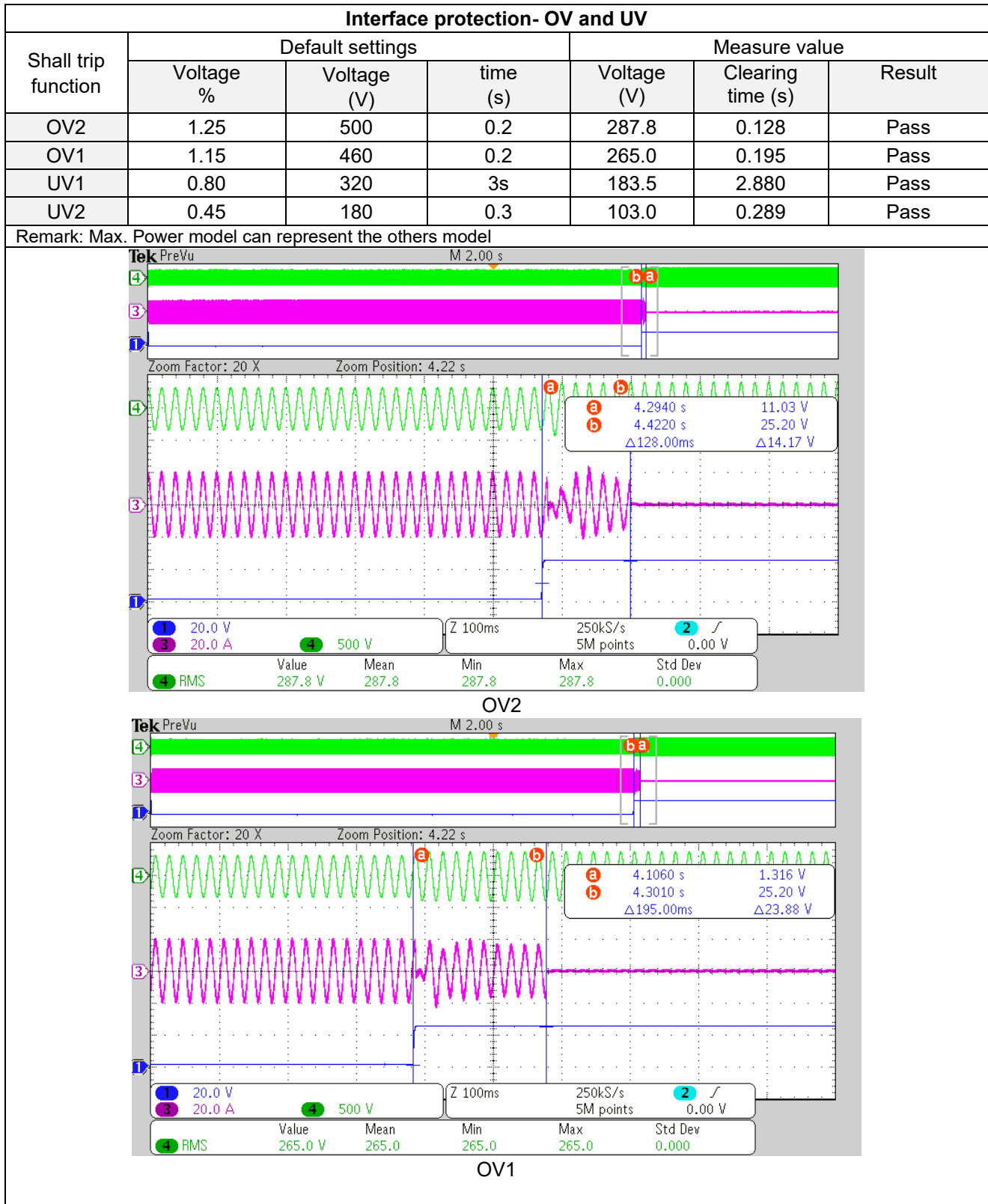
5.7.4.2.1(5.4.3) Active power reduction through setpoint specification

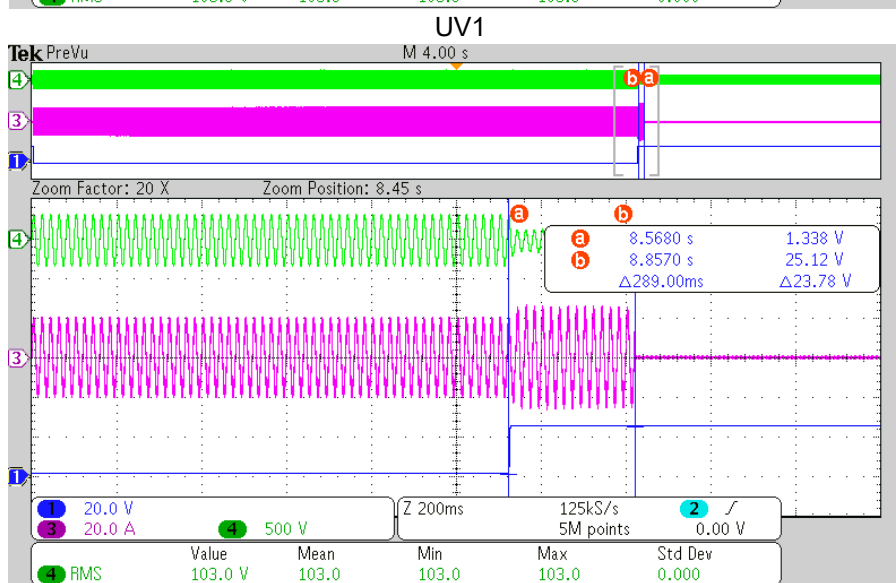
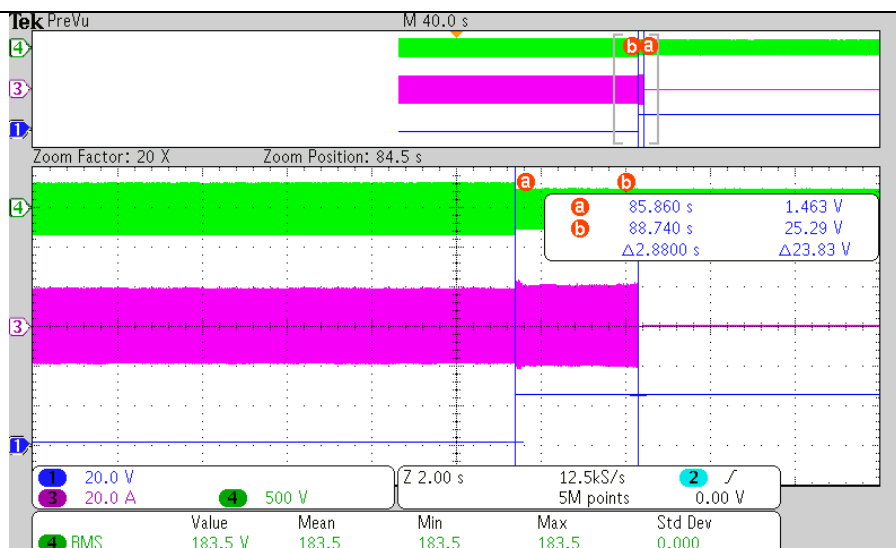
Model	HNS3000TL-1			
Measurement Item	Power Setting [W]	Actual Power [W]	Tolerance of power [%]	$\Delta P / P_n$ [%]
100%	3000	3020	100.66	0.66
90%	2700	2735	91.17	1.17
80%	2400	2430	81.00	1.00
70%	2100	2126	70.86	0.86
60%	1800	1825	60.83	0.83
50%	1500	1520	50.67	0.67
40%	1200	1220	40.67	0.67
30%	900	920	30.67	0.67
20%	600	620	20.67	0.67
10%	300	320	10.65	0.65
Limitation of $\Delta P / P_n$	$\pm 5\%$			
 Power gradient (100%Pn ->5%Pn) [W/s]: 12.39W/s Power gradient (5%Pn ->100%Pn) [W/s]: 11.30W/s Limitation of gradient [W/s] 0.33%Pn – 0.66%Pn				
Power gradient (100%Pn ->5%Pn) [W/s]:	12.39W/s			
Power gradient (5%Pn ->100%Pn) [W/s]:	11.30W/s			
Limitation of gradient [W/s]	0.33%Pn – 0.66%Pn			

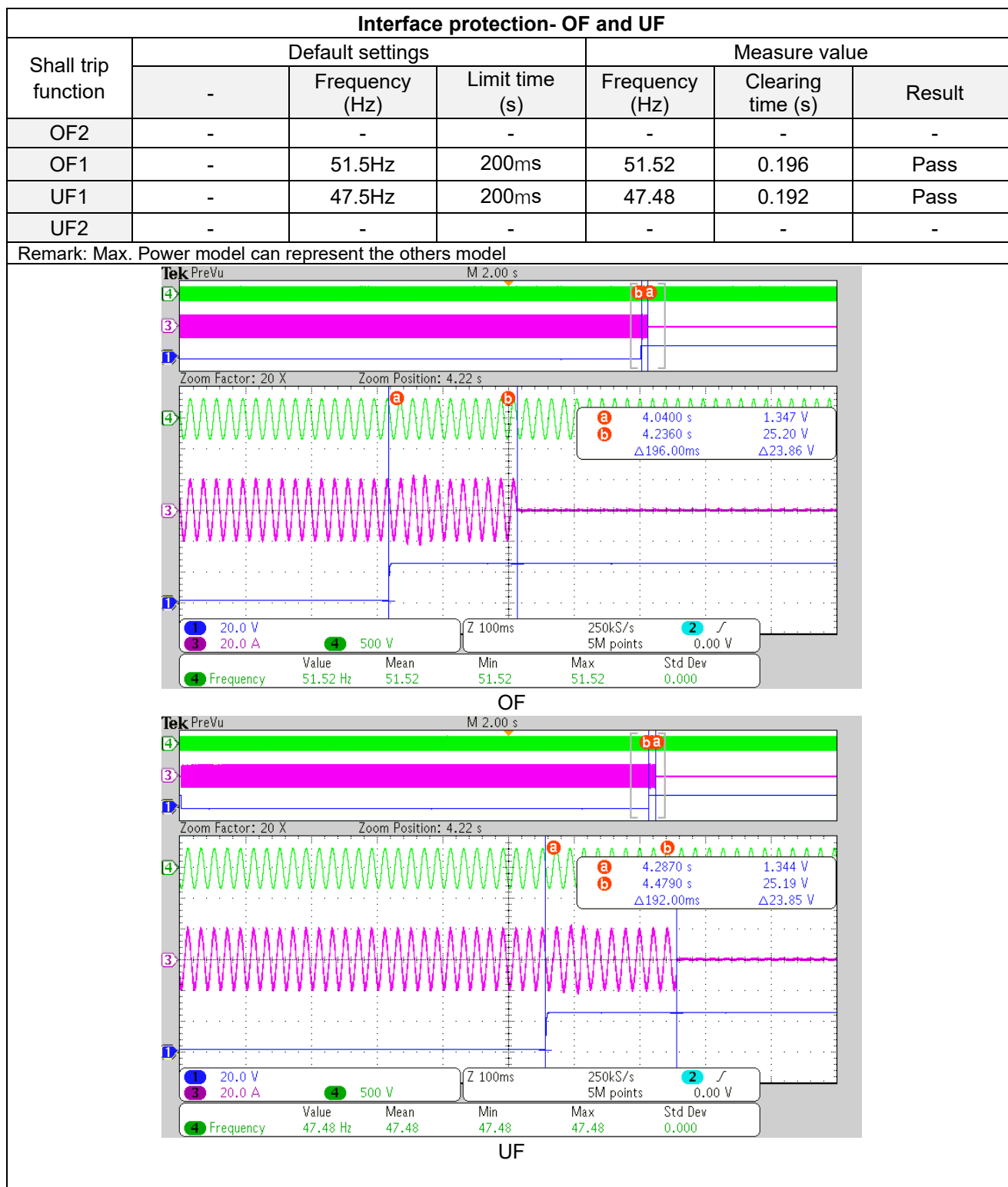
5.7.4.2.3(5.4.4) Active power adjustment at over-frequency

Model	HNS3000TL-1				
Frequency (Hz)	P (%)	Upper limit	Lower limit	W%-measure	P(w)
50.00	100.00%	105.00%	95.00%	100.60%	3018
50.20	100.00%	105.00%	95.00%	100.83%	3025
50.40	96.60%	101.60%	91.60%	99.43%	2983
50.60	93.20%	98.20%	88.20%	95.27%	2858
50.80	89.80%	94.80%	84.80%	91.03%	2731
51.00	86.40%	91.40%	81.40%	87.03%	2611
51.20	83.00%	88.00%	78.00%	83.07%	2492
51.40	79.60%	84.60%	74.60%	78.93%	2368
51.60	76.20%	81.20%	71.20%	74.90%	2247
51.80	72.80%	77.80%	67.80%	70.73%	2122
51.95	70.25%	75.25%	65.25%	67.73%	2032
51.80	72.80%	77.80%	67.80%	69.57%	2087
51.60	76.20%	81.20%	71.20%	73.23%	2197
51.40	79.60%	84.60%	74.60%	77.50%	2325
51.20	83.00%	88.00%	78.00%	81.40%	2442
51.00	86.40%	91.40%	81.40%	85.70%	2571
50.80	89.80%	94.80%	84.80%	89.70%	2691
50.60	93.20%	98.20%	88.20%	93.83%	2815
50.40	96.60%	101.60%	91.60%	97.60%	2928
50.20	100.00%	105.00%	95.00%	100.70%	3021
50.00	100.00%	105.00%	95.00%	100.80%	3024

6.5.2 Interface protection







6.5.2 Interface protection (Overvoltage 10 min mean protection)

Overvoltage 10 min mean protection- setting 110%						
	V	Hold time (S)	On/Off state Finally		Trip time(S)	Limit time(S)
100% Un	230.0	600	☒ On	☐ Off	---	---
112% Un	257.6	>600	☐ On	☒ Off	500	600
100% Un	230.0	600	☒ On	☐ Off	---	---
108% Un	248.4	>600	☒ On	☐ Off	---	---
106% Un	243.8	>600	☒ On	☐ Off	---	---
114% Un	262.2	600	☐ On	☒ Off	242	375
Remark: the disconnect time within 600s & 300s is pass.						

6.5.3 Islanding detection

tested condition and run on time

Model		HNS3000TL-1							
No.	PEUT ¹⁾ (% of EUT rating)	Reactive load (% of QL in 6.1.d)1)	PAC ²⁾ (% of nominal)	QAC ³⁾ (% of nominal)	Run on time (ms)	P _{PEUT} (W)	Actual Q _f	V _{DC}	Remarks ⁴⁾
1.	100	100	0	0	208	3000	1.00	355	Test A at BL
2.	66	66	0	0	206	1980	1.00	310	Test B at BL
3.	33	33	0	0	207	990	1.00	256	Test C at BL
4.	100	100	-5	-5	196	3000	0.99	355	Test A at IB
5.	100	100	-5	0	193	3000	0.99	355	Test A at IB
6.	100	100	-5	+5	186	3000	1.02	355	Test A at IB
7.	100	100	0	-5	207	3000	1.00	355	Test A at IB
8.	100	100	0	+5	204	3000	1.00	355	Test A at IB
9.	100	100	+5	-5	199	3000	0.96	355	Test A at IB
10.	100	100	+5	0	194	3000	0.98	355	Test A at IB
11.	100	100	+5	+5	200	3000	0.99	355	Test A at IB
12.	66	66	0	-5	184	1980	0.93	310	Test B at IB
13.	66	66	0	-4	187	1980	0.98	310	Test B at IB
14.	66	66	0	-3	193	1980	0.99	310	Test B at IB
15.	66	66	0	-2	193	1980	0.98	310	Test B at IB
16.	66	66	0	-1	201	1980	0.96	310	Test B at IB
17.	66	66	0	1	195	1980	0.98	310	Test B at IB
18.	66	66	0	2	192	1980	1.01	310	Test B at IB
19.	66	66	0	3	187	1980	0.95	310	Test B at IB
20.	66	66	0	4	190	1980	1.02	310	Test B at IB
21.	66	66	0	5	186	1980	0.98	310	Test B at IB
22.	33	33	0	-5	183	990	0.96	256	Test C at IB
23.	33	33	0	-4	191	990	0.93	256	Test C at IB
24.	33	33	0	-3	196	990	0.97	256	Test C at IB
25.	33	33	0	-2	196	990	0.96	256	Test C at IB
26.	33	33	0	-1	205	990	0.95	256	Test C at IB
27.	33	33	0	1	199	990	0.94	256	Test C at IB
28.	33	33	0	2	194	990	0.97	256	Test C at IB
29.	33	33	0	3	192	990	1.01	256	Test C at IB
30.	33	33	0	4	186	990	0.97	256	Test A at BL
31.	33	33	0	5	182	990	0.99	256	Test B at BL

Remark:

1) PEUT: EUT output power

2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

Model		HNS3000TL-1							
No.	$P_{EUT}^{1)}$ (% of EUT rating)	Reactive load (% of QL in 6.1.d)1)	$PAC^{2)}$ (% of nominal)	$QAC^{3)}$ (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Qf	V_{DC}	Remarks ⁴⁾
condition value.									
4) BL: Balance condition. IB: Imbalance condition.									

8.3 Connection conditions and synchronisation

Requirement	Table 3 — Automatic reconnection after tripping	
	Parameter	Default setting
	Lower frequency	49.5Hz
	Upper frequency	50.1Hz
	Lower voltage	85 % Un
	Upper voltage	110 % Un
	Observation time	60s
	Active power increase gradient	10%/min

8.3 Connection conditions and synchronisation				
Parameter			Default setting	Re-connection or time
Lower frequency	49.5Hz		49.45Hz	☐ Yes ☒ No
			49.55Hz	☒ Yes ☐ No
Upper frequency	50.1Hz		50.15Hz	☐ Yes ☒ No
			50.05Hz	☒ Yes ☐ No
Lower voltage	85 % Un		84%	☐ Yes ☒ No
			86%	☒ Yes ☐ No
Upper voltage	110 % Un		111%Un	☐ Yes ☒ No
			109%Un	☒ Yes ☐ No
Observation time			90s	60.4
Active power increase gradient			10% /min	9.98%/min

Appendix table 2 -Photos of the product

Overview

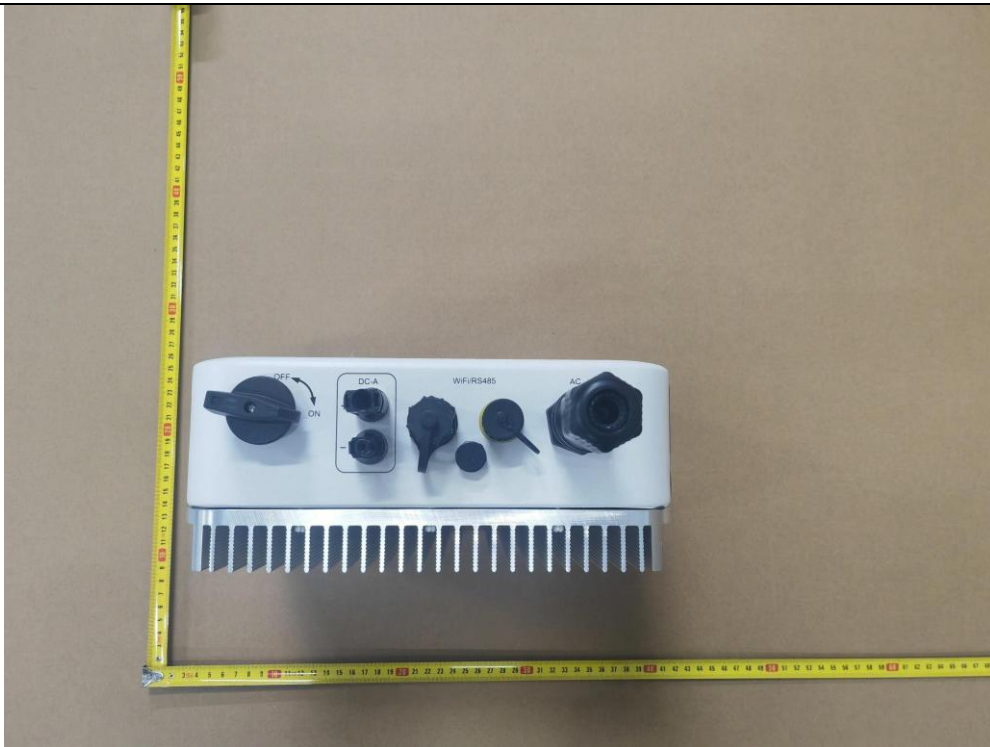


Overview



Appendix table3 -Photos of the product

Overview



Overview

