

**TESTING FOR THE VERIFICATION OF COMPLIANCE
OF PV INVERTER WITH :**

**UNE 217002: 2020-10, INVERSORES PARA CONEXIÓN
A LA RED DE DISTRIBUCIÓN.**

**ENSAYOS DE LOS REQUISITOS DE INYECCIÓN DE
CORRIENTE CONTINUA A LA RED, GENERACIÓN DE
SOBRETENSIONES Y SISTEMA DE DETECCIÓN DE
FUNCIONAMIENTO EN ISLA.**

Protocol. PE.T-LE-62

Test Report Number : **2220/0003-A-AM1⁽¹⁾**

⁽¹⁾This Test Report complements Test Report No.2220/0003-A. See Test Report Historical revision table on page 2.

Type..... : **Bidirectional Converter**

Tested Model : **MIN 6000TL-XH2**

Variants Models : Refer page 7

APPLICANT

Name : **SGS Tecnos S.A. (Certification Body)**

Address..... : C/ Trespaderne, 29 - Edificio Barajas 1
28042 MADRID (Spain)

Hired by : **Shenzhen Growatt New Energy Co., Ltd.**

Address..... : 4-13/F, Building A, Sino-German(Europe) Industrial Park,
Hangcheng Ave, Bao'an District, Shenzhen, China

TESTING LABORATORY

Name : **SGS Tecnos, S.A (Electrical Testing Laboratory)**

Address..... : C/ Trespaderne, 29 - Edificio Barajas 1
28042 MADRID (Spain)

Conducted (tested) by : Michael Tong
(Project Engineer)




Reviewed & Approved by : Roger Hu
(Technical Reviewer)



Date of issue..... : **2024/01/04**

Number of pages : **30**

The testing marked with “(*)” is not under ENAC accreditation. No quantitative general conclusion is referred to the accredited testing.

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Data Provided By The Client:


The following data has been provided by the applicant:

1. Any information regarding technical characteristics of the equipment (ratings, operation modes, software and hardware versions, dimensions and weight).
2. Equipment operation & construction information (manuals, electrical diagrams, information about components, operation procedures).
3. Documental information (brand and models names, address or other information about applicant, company or manufacturer).
4. Other information remarked within this report.

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Test Report Historical Revision:

Test Report Version	Date	Resume
2220/0003-A 2220/0003-A-AM1	2020/01/13 2024/01/04	First issuance 1. Update the standard; 2. Add the MIN -XH2 series and MIN -XA series. 3. Update the applicant and factory information. 4. Modified the start voltage, MPPT voltage range at full power, max. input current and max. input short current for MIN -XE series and MIN -X series and MIN -XH series. After evaluation, clause 4.1, 4.2 and 4.6 were repeated test for spot check.

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1 SCOPE

SGS Tecnos, S.A (Electrical Testing Laboratory) has been contracted by SGS Tecnos, S.A. (Certification body), in order to perform the testing according the UNE 217002: 2020-10," Inversores para conexión a la red de distribución. "Ensayos de los requisitos de inyección de corriente continua a la red, generación de sobretensiones y sistema de detección de funcionamiento en isla." according to requirements of regulation and standard shown on table below:

REGULATION AND STANDARD REQUIREMENTS		TESTING STANDARD
O.M. TED/749/2020	IEC 62116	UNE 217002: 2020-10
Anexo I, clause 5.3		Limitation of the DC injection into the grid side
Anexo I, clause 2.3.6.		Overvoltage generation
	6.2 ⁽¹⁾	Unintentional islanding

⁽¹⁾ maximum respond time of 2 seconds.

In addition, it has been testing the following clauses considering requirements of RD 647/2020.

- Frequency and Voltage trip limits and trip times
- Self - reconnection
- Power Factor

2 GENERAL INFORMATION

2.1 Testing Period and Climatic conditions

The necessary testing has been performed between October 18th of 2023 and October 23rd of 2023.


All the tests and checks have been performed at climatic conditions:

Temperature	25 ± 10 °C
Relative Humidity	50 ± 20 %
Pressure	90 ± 10 kPa

SITE TEST

Name: **Dongguan BALUN Technology Co., Ltd.**
Address: Room 104, 204, 205, Building 1, No. 6, Industrial South Road, Songshan Lake District, Dongguan, Guangdong, China

2.2 Equipment under Testing

Apparatus type/ Installation: Bidirectional Converter / Fixed
Manufacturer/ Supplier/ Installer: Single phase/fixed installation
Manufacturer: **Shenzhen Growatt New Energy Co., Ltd.**
Trademark: 
Model/ Type: MIN 6000TL-XH2
Serial Number: YEM0DB025
Software Version: AL1.0
Rated Characteristics: Internal (integrated in the Software of the inverter)
Input: 190~500 V_{dc} MPPT voltage range at full power;
550 V_{dc} max., 2*16 A_{dc} max.
Output: 230 V_{ac}; 50 Hz; max. output current: 27.2 A_{ac};
rated output power: 6.0 kW.




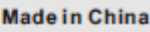
Date of manufacturing: 2024

Test item particulars

Input: PV or PV and battery or only battery
Output: AC, L/N/PE
Class of protection against electric shock: Class I
Degree of protection against moisture: IP 66
Type of connection to the main supply: Single phase – Fixed installation
Cooling group: Natural convection
Modular: No
Internal Transformer: No


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Copy of marking plate (representative):

 Hybrid Inverter	
Model name	MIN 6000TL-XH2
PV data	
Max. PV voltage	550 d.c.V
PV voltage range	40-550 d.c.V
PV Isc	24 d.c.A*2
Max. input current	16 d.c.A*2
DC data	
Max. DC voltage	550 d.c.V
DC voltage range	360-550 d.c.V
Max. DC current	17 d.c.A
AC data	
Max. input/output power	5000/6000 W
Max. apparent power	6000 VA
Nominal output voltage	230 a.c.V
Max. input/output current	22.7/27.2 a.c.A
Nominal output frequency	50/60 Hz
Power factor range	0.8leading~0.8lagging
Others	
Safety level	Class I
Ingress protection	IP66
Operation ambient temperature	-30°C - +60°C
VDE0126-1-1	
	
 	

Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side of enclosure and visible after installation.
3. Labels of other models are as the same with **MIN 6000TL-XH2's** except the parameters of rating.

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The sample tested is one of the productions select in the moment of the start the test, based on:
Representative selection, random selection and System with all the elements required to do the test.

Equipment under testing:

- **MIN 6000TL-XH2**

Variant model:

- MIN 6000TL-XE
- MIN 5000TL-XE
- MIN 4600TL-XE
- MIN 4200TL-XE
- MIN 3600TL-XE
- MIN 3000TL-XE
- MIN 2500TL-XE
- MIN 6000TL-X
- MIN 5000TL-X
- MIN 4600TL-X
- MIN 4200TL-X
- MIN 3600TL-X
- MIN 3000TL-X
- MIN 2500TL-X
- MIN 6000TL-XH
- MIN 5000TL-XH
- MIN 4600TL-XH
- MIN 4200TL-XH
- MIN 3600TL-XH
- MIN 3000TL-XH
- MIN 2500TL-XH
- MIN 5000TL-XH2
- MIN 4600TL-XH2
- MIN 4200TL-XH2
- MIN 3600TL-XH2
- MIN 3000TL-XH2
- MIN 2500TL-XH2
- MIN 6000TL-XA
- MIN 5000TL-XA
- MIN 4600TL-XA
- MIN 4200TL-XA
- MIN 3600TL-XA
- MIN 3000TL-XA
- MIN 2500TL-XA

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The variants models have been included in this test report without tests because the following features don't change regarding to the tested model:

- Same connection system and hardware topology.
- Same control algorithm.
- Output power within $1/\sqrt{10}$ and 2 times of the rated output power of the EUT or Modular inverters.
- Same Firmware Version.

The models of MIN 6000TL-XE, MIN 4600TL-XE, MIN 4200TL-XE, MIN 3600TL-XE, MIN 3000TL-XE, MIN 2500TL-XE and MIN 5000TL-XE are identical on topological schematic circuit diagram and control solution codes except for input/output rating.

The models of MIN 6000TL-X, MIN 4600TL-X, MIN 4200TL-X, MIN 3600TL-X, MIN 3000TL-X, MIN 2500TL-X and MIN 5000TL-X are identical on topological schematic circuit diagram and control solution codes except for input/output rating.

The models of MIN 6000TL-XH, MIN 4600TL-XH, MIN 4200TL-XH, MIN 3600TL-XH, MIN 3000TL-XH, MIN 2500TL-XH and MIN 5000TL-XH are identical on topological schematic circuit diagram and control solution codes except for input/output rating.

The models of MIN 6000TL-XH2, MIN 4600TL-XH2, MIN 4200TL-XH2, MIN 3600TL-XH2, MIN 3000TL-XH2, MIN 2500TL-XH2 and MIN 5000TL-XH2 are identical on topological schematic circuit diagram and control solution codes except for input/output rating.

The models of MIN 6000TL-XA, MIN 4600TL-XA, MIN 4200TL-XA, MIN 3600TL-XA, MIN 3000TL-XA, MIN 2500TL-XA and MIN 5000TL-XA are identical on topological schematic circuit diagram and control solution codes except for input/output rating.

The difference between MIN -X, MIN -XE, MIN -XH, MIN -XH2 and MIN -XA series is as following:


1. IGBT Module and IGBT discrete is used in the MIN -XH & MIN -XA series, and IGBT discrete is used in the MIN -XH2 series, and IGBT Module is used in the MIN -X & MIN -XE series.
2. There is one pair of DC input connected to DC link in the MIN -XH, MIN -XH2 and MIN -XA Series in addition, the MIN -X and MIN -XE series are none.
3. There is one common inductor and DC current sample for addition DC input in the MIN -XH, MIN -XH2 and MIN -XA series, but the MIN -X and MIN -XE series are none.
4. There is a PCBA of power supply from AC grid in the MIN -XH, MIN TL-XH2 and MIN -XA series, but the MIN -X and MIN -XE series are none.
5. Thers is PV input in the MIN -XH, MIN -XH2, MIN -XE and MIN -X series, but the MIN -XA series are none.
6. The MPPT voltage range at full power and Max. PV input current and Max. short circuit current are different between MIN -XH series and MIN -XH2 series.

The results obtained apply only to the particular sample tested that is the subject of the present test report.

The most unfavourable result values of the verifications and tests performed are contained herein.

Throughout this report a point (~~comma~~) is used as the decimal separator.

Information within this section has been provided by client.

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2.3 REFERENCE VALUES

The values presented in the following table have been used for calculation of referenced values (p.u.; %) through the report if not otherwise indicated.

Reference Values for the EUT MIN 6000TL-XH2	
Rated power, P_n in W	6000
Rated apparent power, S_n in VA	6000
Maximum power, P_{max} in W	6000
Maximum apparent power, S_{max} in VA	6000
Rated wind speed (only WT), v_n in m/s	N/A
Rated current, I_n in A	26.0
Rated output voltage, (Phase to Neutral) U_n in Vac	230
Note: In this report p.u. values are calculated as follows: -For Active & Reactive Power p.u values are reference to P_n -For Currents p.u values, the reference is always I_n -For Voltages p.u values, the reference is always U_n	

2.4 Test Equipment List

Owner	No.	EQUIPMENT	TRADEMARK/ MODEL	S/N	CALIBRATION PERIOD
BALUN	1	Power Analyzer	YOKOGAWA/ WT3000	91R334075	2023/06/17 to 2024/06/16
	2	Power Analyzer	DEWETRON/ DEWE2-PA7	BZ-DGD-L119	2022/11/03 to 2023/11/02
	3	Current probe	HIOKI/ CT6863-05	BZ-DGD-L026-1	2023/02/20 to 2024/02/19
	4	Current probe	HIOKI/ CT6863-05	BZ-DGD-L026-2	2023/02/20 to 2024/02/19
	5	Temperature & Humidity Meter	CEM/ DT-322	BZ-DGD-L270	2022/10/25 to 2023/10/24
	6	Power Analyzer	YOKOGAWA/ WT1800	GLFXY23052201	2023/06/17 to 2024/06/16
SGS	7	True RMS Multimeter	Fluke/ 15B	GZE012-43	2022/11/11 to 2023/11/10

Note: Voltage direct measurement through power analyzer, the voltage probes were used with the digital oscilloscope. All measurement equipment was used inside their corresponding calibration period. Copy of all calibration certificates are available at the laboratory for reference.

2.5 Measurement Uncertainty

Magnitude	Uncertainty
Voltage measurement uncertainty	±1.5 %
Current measurement uncertainty	±2.0 %
Frequency measurement uncertainty	±0.2 %
Time measurement uncertainty	±0.2 %
Power measurement uncertainty	±2.5 %
Phase Angle	±1 °
Temperature	±3°C
<p>Note1: Measurements uncertainties showed in this table are maximum allowable uncertainties. The measurement uncertainties associated with other parameters measured during the tests are in the laboratory at disposal of the petitioner.</p> <p>Note2: Where the standard requires lower uncertainties that those in this table. Most restrictive uncertainty has been considered and should be reported in this report.</p>	

2.6 FACTORY INFORMATION

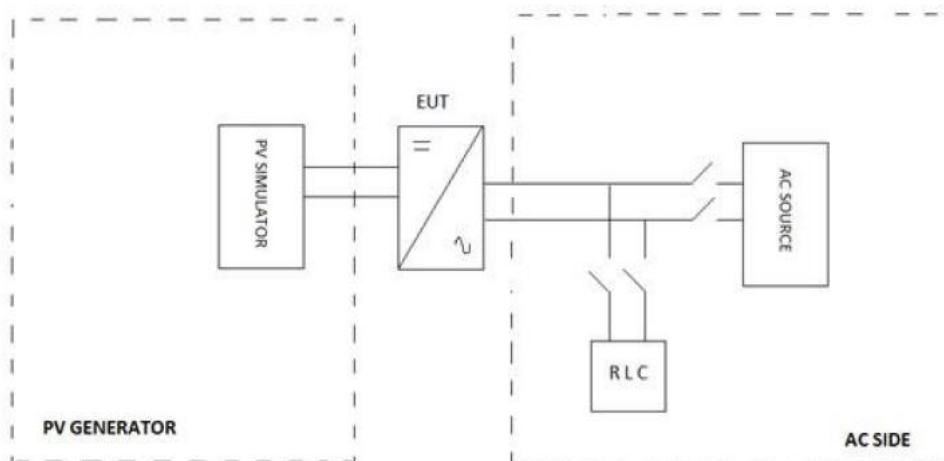
Factory Name.....: **Guangdong Growatt New Energy Co., Ltd.**
Factory Address: Growatt Industrial Park, No.17 Pingheng Road
Pingtan Town, Huiyang District, HuiZhou,
Guangdong, P.R. China.

2.7 Definitions

IA	Auxiliary inverter
EUT/ESE	Equipment under testing
In	Nominal Current
M	Change for real power
N	Change for reactive power
OF	Over frequency
OV	Over voltage
Pn	Nominal Power
Q _f	Quality factor
Tm	Time measured
UF	Under frequency
Un	Nominal Voltage
UV	Under voltage
VHOV	Very high over voltage

2.8 Test set up.

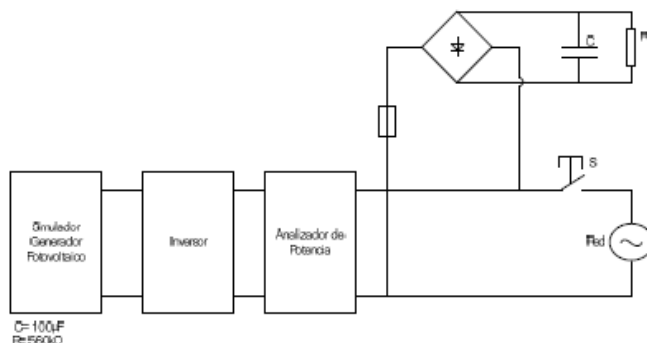
Below is the simplified construction of the test set up.



Current and voltage clamps have been connected to the inverter output for all the tests.

All the tests and checks have been performed in accordance with the reference Standard as specified previously. The used quality factor of resonant load was $Q_f=1$.

For overvoltage generation test, the following test set up has been done.



The test bench used includes:

EQUIPMENT	TRADEMARK / MODEL	RATED CHARACTERISTICS	OWNER / ID.CODE
DC Source	KEWELL/IVS-60KW	0-1000 V; 110 A MAX	BZ-DGD-L194
AC Source	KEWELL/KACM-75-33	0-300 V; 80 A MAX	BZ-DGD-L193
RLC load	Qunlin / ACLT-3820H	68 kW, 68 kVAr	BZ-DGD-L063
Adjustable resistance	BX8-27	10 kΩ ~ 1 MΩ	--
Adjustable capacitor box	BC8-13	1uF to 200uF	--

3 RESUME OF TEST RESULTS

INTERPRETATION KEYS

Test object does meet the requirement : **P** Pass
 Test object does not meet the requirement : **F** Fails
 Test case does not apply to the test object : **N/A** Not applicable
 To make a reference to a table or an annex..... : See additional sheet
 To indicate that the test has not been Performed : **N/P** Not Performed

O.M.TED/ 749/2020	RD 647/2020	IEC 62116	UNE 217002: 2020 ⁽¹⁾	REPORT SECTION	STANDARD REQUIREMENTS	
Section	Section	Section	Section	Section	Title	Results
Anexo I, clause 5.3	--		4.1	4.1	Limitation of the DC injection into the grid side	P
Anexo, I clause 2.3.6	--	--	4.2	4.2	Overvoltage generation	P
--	--	6.2	4.3	4.3	Unintentional islanding	N/P
--	RD 647/2020	--	--	4.4	Frequency and Voltage trip limits and trip times	N/P (*)
--	RD 647/2020	--	--	4.5	Self - reconnection	N/P (*)
--	RD 647/2020	--	--	4.6	Power Factor	P (*)

⁽¹⁾ The standard 217002 :2020 provides the procedure to be followed while the regulation O.M.TED/749/2020 and standard IEC 62116 provide the requirements to be complied.

(*) This test is not under ENAC accreditation. No quantitative general conclusion is referred to the accredited testing.

Note: Decision Rule of Statements of conformity evaluated according to Guidelines ILAC G8:09/2019 and IEC 115:2023 (4.3.3 / 4.4) & ISO/IEC Guide 98-4 (8.3.12).

Decision Rules used: Binary Statement for Simple Acceptance (Guard Band with respect to the limit $w=0$).

Specific Risk: Probability of False Accept or Reject lower than 50 %, (PFA / PFR < 50 %)
 Measurement uncertainty is not applied when statements of conformity is the simple acceptance.

For more information see ILAC G8/09 & 115 Guidelines.

4 TEST RESULTS

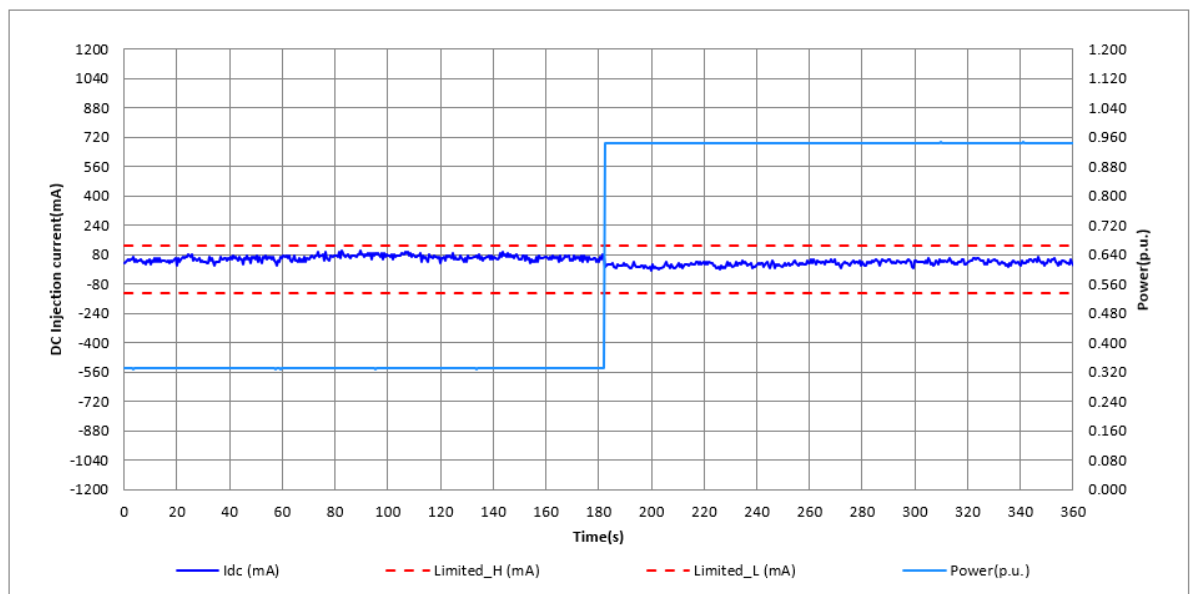
4.1 LIMITATION OF DC INJECTION

The verification of DC component emission test has been measured according to the chapter 4.1 of the standard. DC current injection shall be $\leq 0.5 \% I_n$ which is 130 mA.

DC component emission test		
Power Lever	Min ~ 33%Pn	Medium ~ 95%Pn
Watt(W)	1980	5668
Vrms(V)	229.8	230.3
Arms(A)	8.6	24.6
PF	0.998	1.000
d.c.(mA)	100	65
d.c (% In) ⁽¹⁾	0.38	0.25

⁽¹⁾ The values obtained are in percentage with respect to the value of the rated current 26.0 A per Phase.

DC component emission test



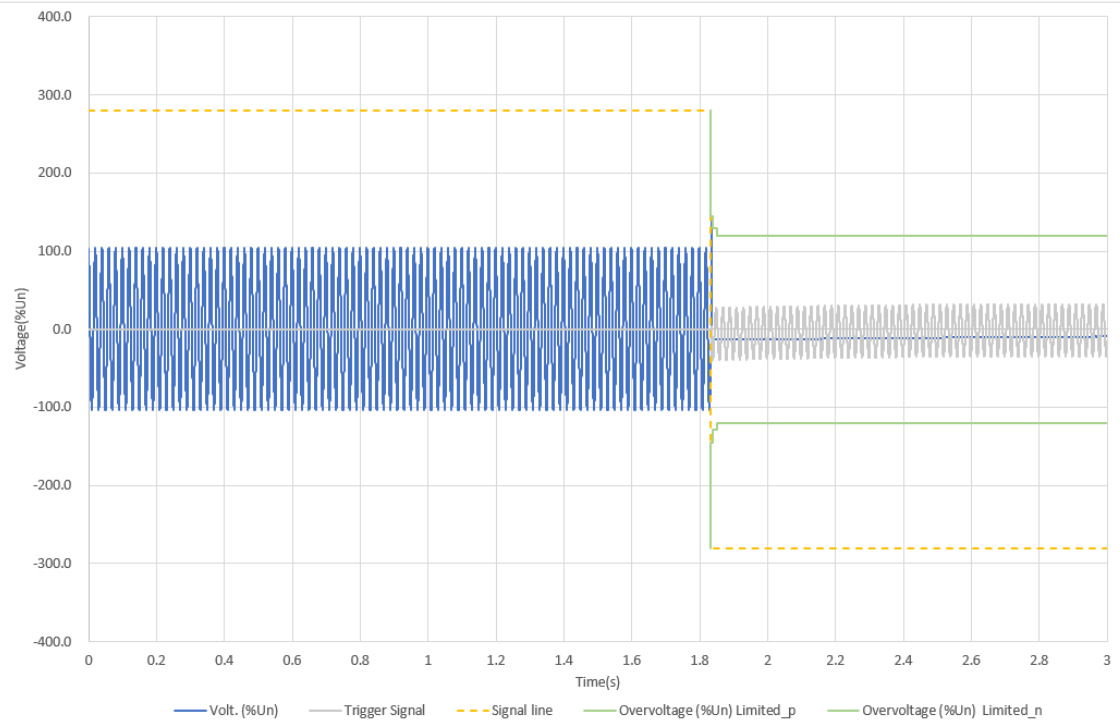
4.2 OVERVOLTAGE GENERATION

The purpose of this test is to verify that the inverter complies with the transient voltage limits specified below when the grid is disconnected from the inverter. The transient voltage limits have been measured according to the chapter 4.2 of the standard UNE 217002: 2020-10, considering requirements from Anexo I, clause 2.3.6 of Orden Ministerial TED/749/2020.

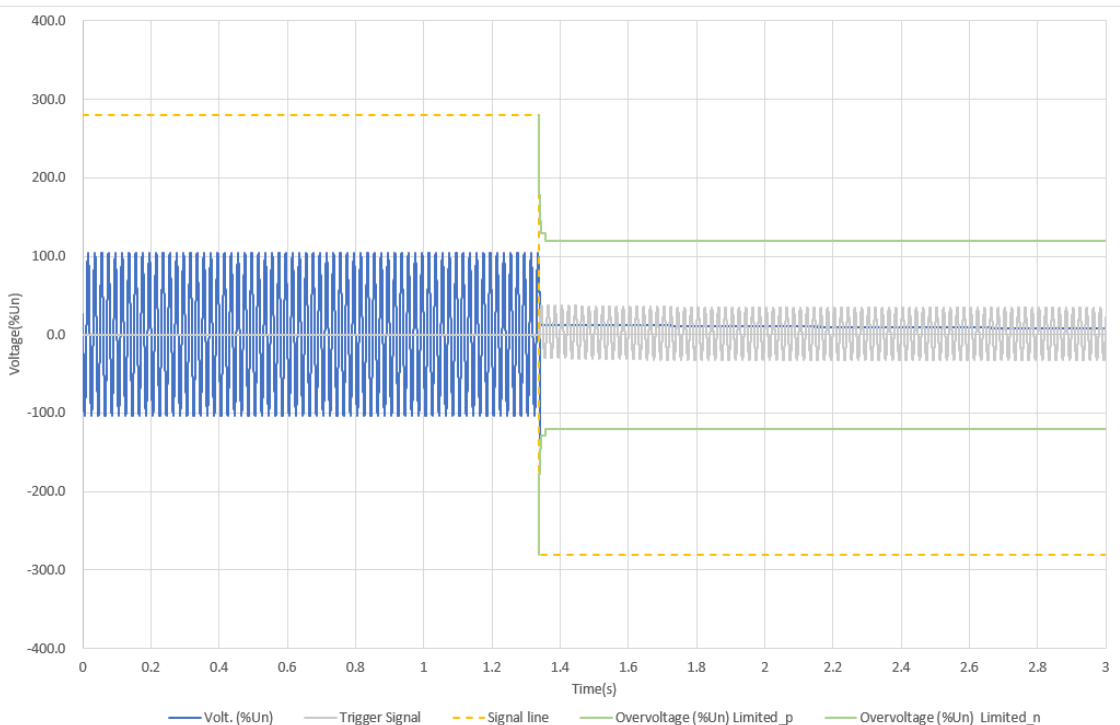
Overvoltage value measured (%Un) at 100%Pn				
Overvoltage duration (s)	Overvoltage limit value (%Un)	Test 1	Test 2	Test 3
0.0002	±280	-76.3	+82.3	+77.5
0.0006	±218	-75.9	+80.6	+77.8
0.002	±178	-69.3	+74.5	+71.2
0.006	±145	+138.8	-137.5	-140.1
0.02	±129	-13.5	+12.8	+14.7
0.06	±120	-13.4	+12.8	+14.7
0.2	±120	-13.3	+12.7	+14.6
0.6	±120	-12.8	+12.2	+14.0

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100 %Pn – Test 1

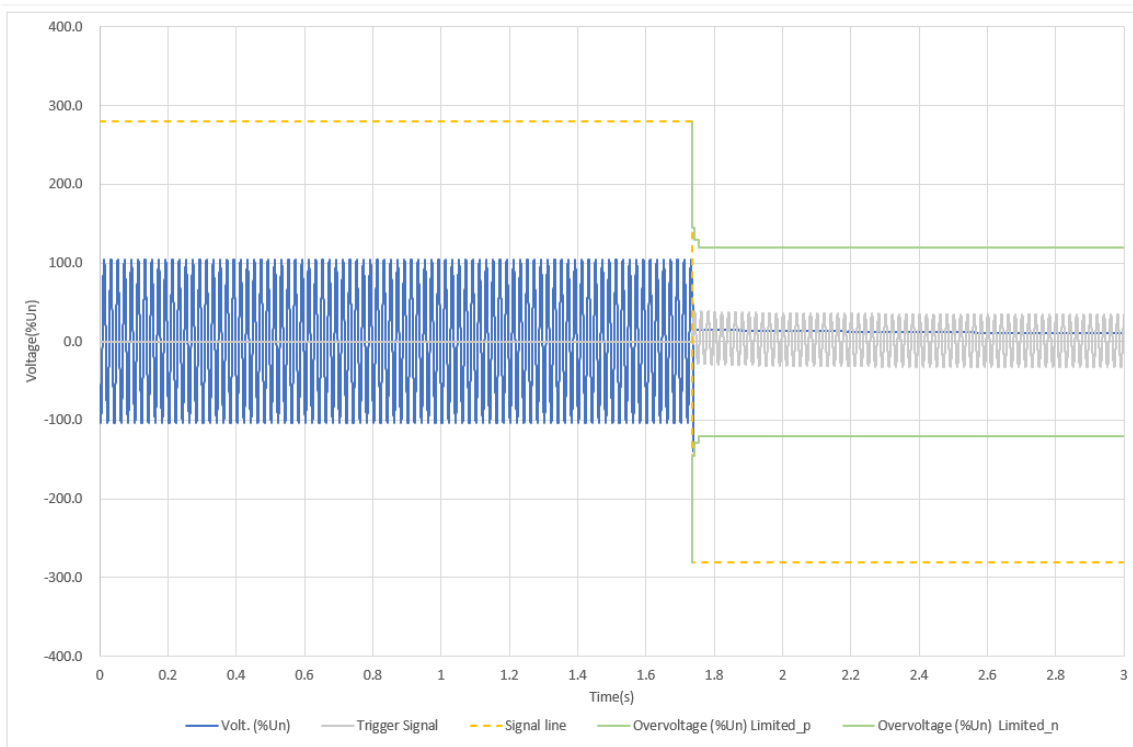



100 %Pn – Test 2



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100 %Pn – Test 3



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4.3 UNINTENTIONAL ISLANDING

Anti-Islanding requirements are detailed in the chapter 4.3 of the standard. Test A is at full power, Test B is at 66 %P_n, Test C is at 33 %P_n.

As the inverter can be connected to the LV network, compliance with these requirements have been verified according to the standard IEC 62116 (maximum respond time of 2 seconds). The following conditions with an IA inverter have been tested:

- Condition 1: EUT and IA with islanding prevention activated.
- Condition 2: EUT with islanding prevention activated and IA deactivated.
- Condition 3: EUT and IA with islanding prevention deactivated.

Tests were not performed.


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4.4 FREQUENCY AND VOLTAGE TRIP LIMITS AND TRIP TIMES(*)

(*) This test is not under ENAC accreditation. No quantitative general conclusion is referred to the accredited testing

Thresholds stated in the Real Decreto 1699/2011 modified by Real Decreto 647/2020 have been considered.

Tests were not performed.

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4.5 SELF-RECONNECTION(*)

(*) This test is not under ENAC accreditation. No quantitative general conclusion is referred to the accredited testing

Self-reconnection tests have been performed according to Real Decreto 647/2020.

The inverter must be capable to reconnect when voltage and frequency are within the normal ranges according to standard.

Tests were not performed.

4.6 POWER FACTOR FIXED(*)

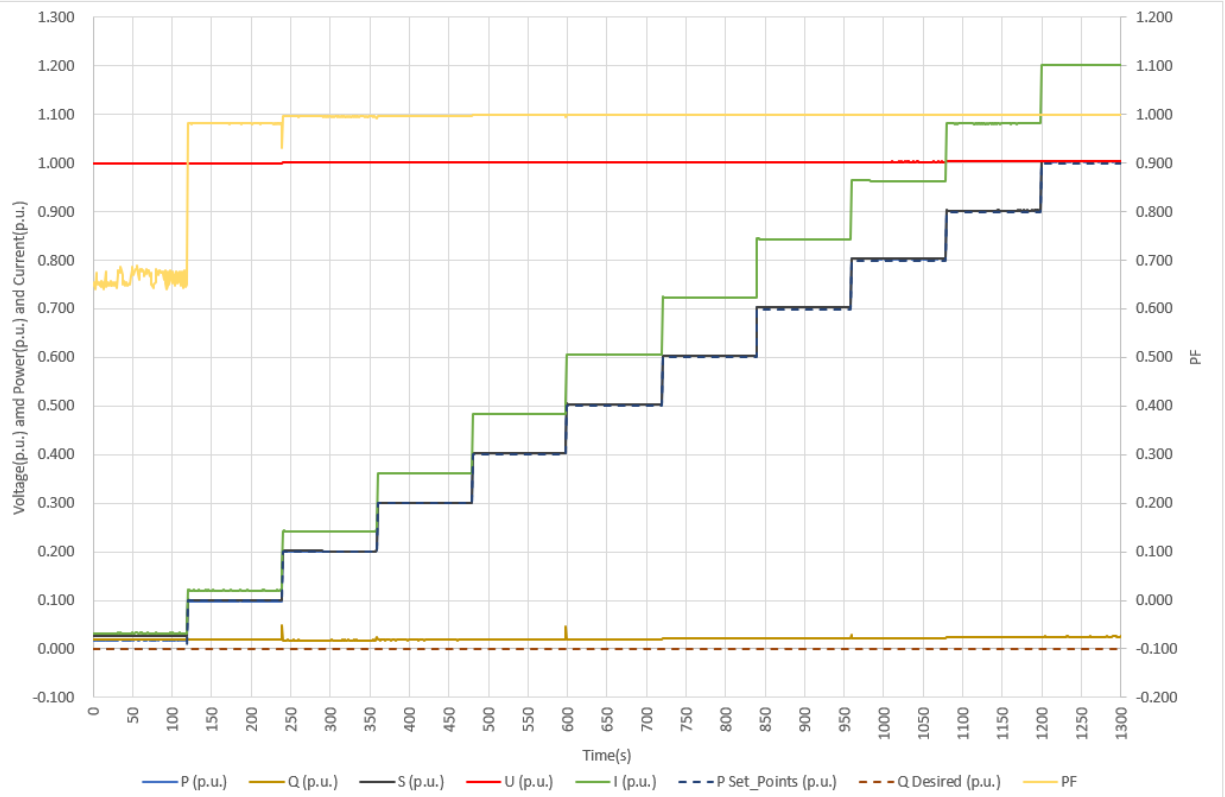
(*) This test is not under ENAC accreditation. No quantitative general conclusion is referred to the accredited testing.

According to Real Decreto 647/2020, the power factor of the energy supplied to the distribution company's network must be as close as possible to unity and, in any case, higher than 0.98, when the installation operates at powers higher than 25 percent of its nominal power.

Power Factor fixed (PF=1 & Q=0%Sn)								
P set (%Sn)	U measured (p.u.)	I measured (p.u.)	P measured (p.u.)	Q measured (p.u.)	S measured (p.u.)	PF Desired	PF Measured	PF Deviation
0	1.000	0.032	0.018	0.020	0.027	1.000	0.663	---(1)
10	1.000	0.121	0.099	0.019	0.101	1.000	0.981	-0.019
20	1.001	0.242	0.201	0.018	0.202	1.000	0.996	-0.004
30	1.001	0.361	0.300	0.018	0.301	1.000	0.998	-0.002
40	1.001	0.484	0.402	0.019	0.403	1.000	0.999	-0.001
50	1.002	0.605	0.504	0.020	0.504	1.000	0.999	-0.001
60	1.002	0.724	0.603	0.022	0.604	1.000	0.999	-0.001
70	1.002	0.843	0.703	0.022	0.703	1.000	0.999	-0.001
80	1.003	0.963	0.803	0.023	0.803	1.000	1.000	0.000
90	1.003	1.082	0.902	0.024	0.903	1.000	1.000	0.000
100	1.004	1.202	1.003	0.025	1.003	1.000	1.000	0.000

(1) No tolerance of Power Factor was defined when active power level below 10%Sn.

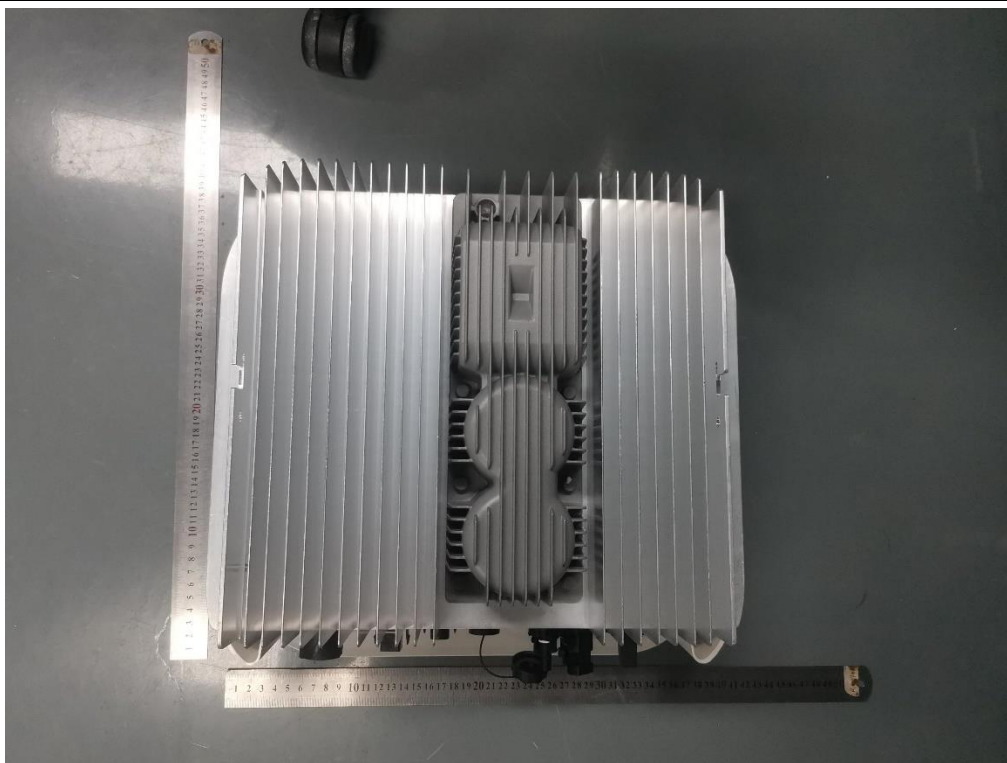
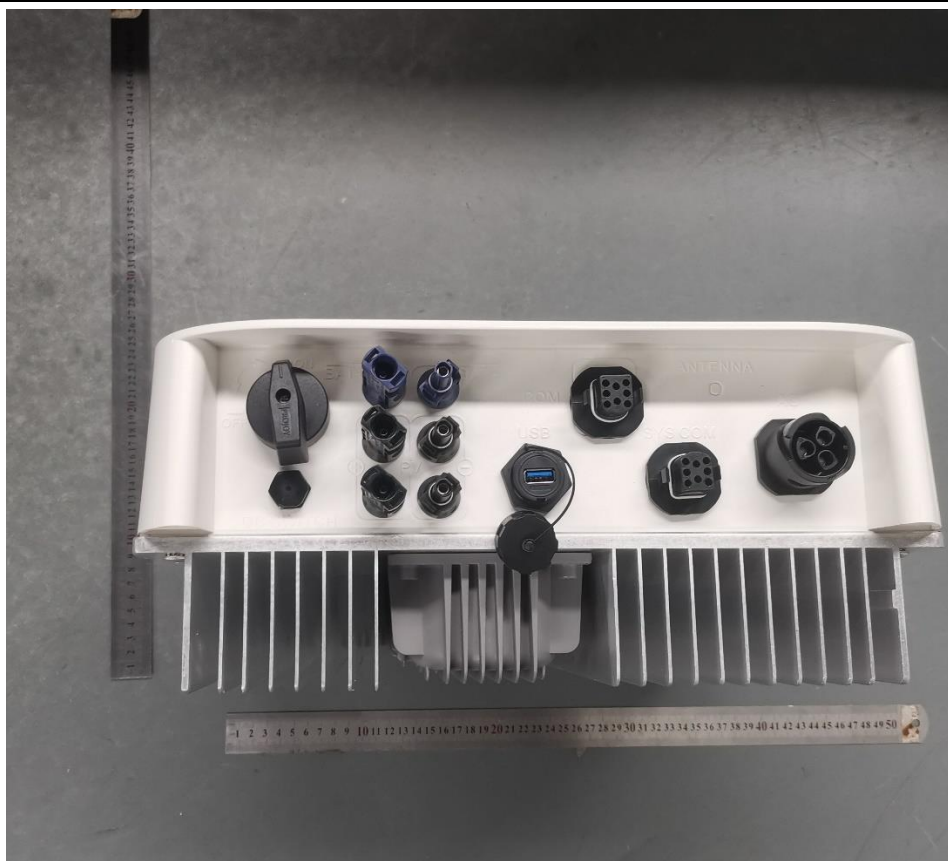
Result Chart over Time



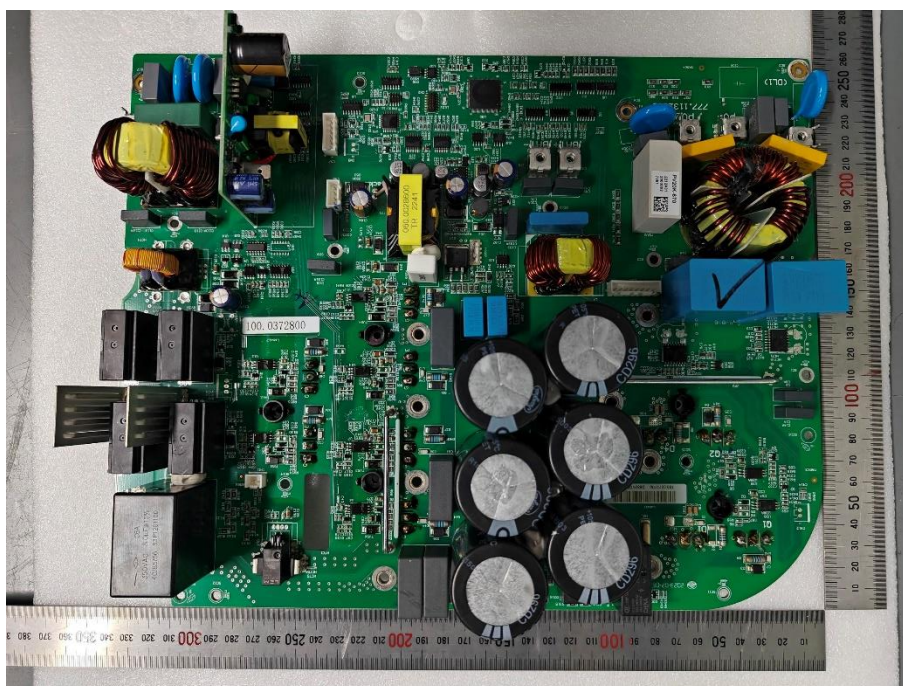
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5 PICTURES**Front view****Side view**

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Back view**Connectors**

Internal view



Serial Number and Software Version

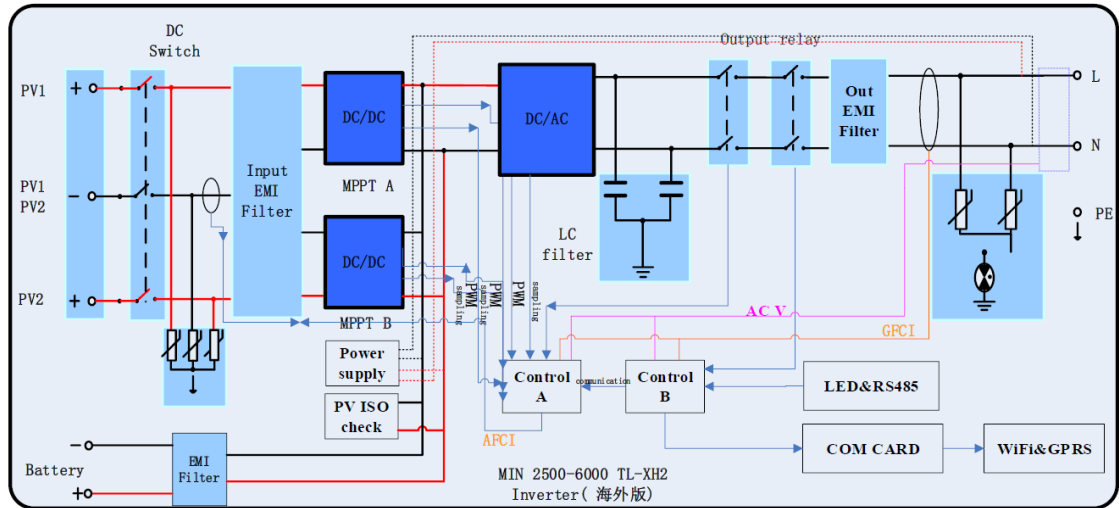


System Info

FW Ver: AL1.0(ALBA-06010115)
Com Ver: ZABA-15
SN: ZNL1234567
Mode: S03B08D00T00P0FU01M003C
Modbus Ver: V1.49

6 ELECTRICAL SCHEMES

Electrical scheme



-----END OF REPORT-----