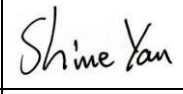
TEST REPORT
CEI 0-21
Reference technical rules for the connection of active and passive users to the LV networks of electrical distribution companies

Report	
Report Number. ..... :	6170209.50
Date of issue..... :	2023-09-26
Total number of pages	158 pages
Testing Laboratory ..... :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Address ..... :	No. 99, Hongye Road, Suzhou Industrial Park Suzhou, 215006, P.R. China
Applicant's name ..... :	Afore New Energy Technology (Shanghai) Co., Ltd.
Address ..... :	Building 7, No.333 Wanfang Rd, Minhang District, Shanghai, China
Test specification:	
Standard..... :	CEI 0-21:2022-03
Test procedure ..... :	Type test
Non-standard test method……..:	N/A
Test Report Form No. ..... :	CEI 0-21_V3.0
Test Report Form(s) Originator ..... :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Master TRF ..... :	Dated 2022-04
Test item description..... :	PV grid-connected inverter
Trade Mark..... :	Afore
Manufacturer ..... :	Afore New Energy Technology (Shanghai) Co., Ltd.
	Building 7, No.333 Wanfang Rd, Minhang District, Shanghai, China
Model/Type reference..... :	HNS1000TL-1, HNS1500TL-1, HNS2000TL-1, HNS2500TL-1, HNS3000TL-1
Ratings..... :	See product marking plate on page 4 and ratings of the test products on page 8.

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	**Testing Laboratory:**	DEKRA Testing and Certification (Suzhou) Co., Ltd.	
Testing location/ address ..... :		No. 99, Hongye Road, Suzhou Industrial Park Suzhou, 215006, P.R. China	
☐	~~**Associated Testing Laboratory:**~~		
~~**Testing location/ address ..... :**~~			
Tested by (name, function, signature) ..... :		Shine Yan (ENG)	
Approved by (name, function, signature) .. :		Sandy Qian (REW)	
☐	~~**Testing procedure: CTF Stage 1:**~~		
~~**Testing location/ address ..... :**~~			
~~**Tested by (name, function, signature) ..... :**~~			
~~**Approved by (name, function, signature) .. :**~~			
☐	~~**Testing procedure: CTF Stage 2:**~~		
~~**Testing location/ address ..... :**~~			
~~**Tested by (name + signature) ..... :**~~			
~~**Witnessed by (name, function, signature) . :**~~			
~~**Approved by (name, function, signature) .. :**~~			
☐	~~**Testing procedure: CTF Stage 3:**~~		
☐	~~**Testing procedure: CTF Stage 4:**~~		
~~**Testing location/ address ..... :**~~			
~~**Tested by (name, function, signature) ..... :**~~			
~~**Witnessed by (name, function, signature) . :**~~			
~~**Approved by (name, function, signature) .. :**~~			
~~**Supervised by (name, function, signature) :**~~			

List of Attachments (including a total number of pages in each attachment):

Annex 1: ISO 9001 certificate (1 pages)

Annex 2: Datasheet of the relay (4 pages)

Annex 3: Pictures of the unit (4 pages)

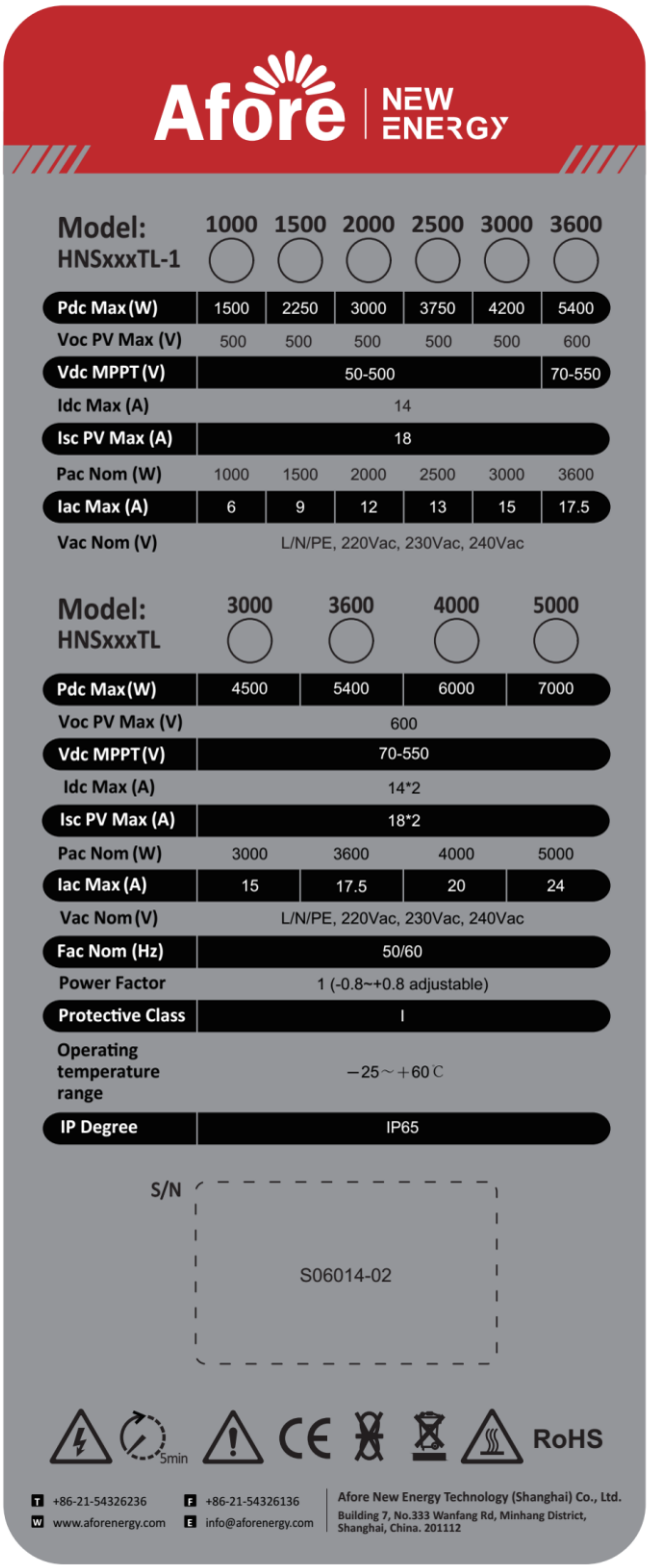
Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
All tests (except clause 4.6 EMC tests)	DEKRA Testing and Certification (Suzhou) Co., Ltd. No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
4.6 EMC tests (The EMC test reports provided by the customer)	1. Intertek Testing Services Shanghai Building No.86, 1198 Qinzhou Road (North), Caohejing Development Zone, Shanghai 200233, China Report No.: 210103056SHA-001 Accreditation Number: 3309.02 (A2LA-ILAC) 2. Shanghai Inspection and Testing Institute of Instruments and Automation Systems Co., Ltd. No.103, Caobao Road, Xuhui District, Shanghai, China Report No.: J22-604-WT-03 Accreditation Number: L0130 (CNAS-ILAC)

Copy of marking plate:

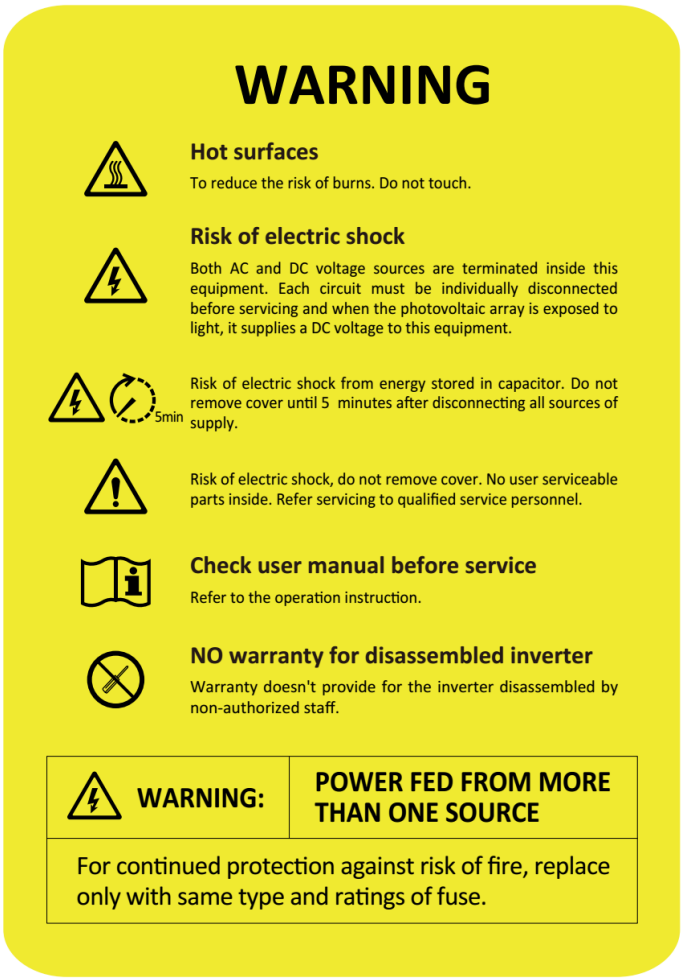
The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

Marking label:



Remark: According to customer's requirement, these models were evaluated under the grid frequency of 50 Hz.

Warning label:



Test item particulars:				
Equipment mobility	:	movable fixed	hand-held transportable	stationary for building-in
Connection to the mains	:	pluggable equipment permanent connection		direct plug-in for building-in
Enviromental category	:	outdoor	indoor unconditional	indoor conditional
Over voltage category Mains	:	OVC I	OVC II	OVC III / OVC IV
Over voltage category PV	:	OVC I	OVC II	OVC III / OVC IV
Mains supply tolerance (%)	:	-90 / +110 %		
Tested for power systems	:	TN		
IT testing, phase-phase voltage (V)	:	N/A		
Class of equipment	:	Class I Not classified	Class II	Class III
Mass of equipment (kg)	:	Refer to the specifications table		
Pollution degree	:	Outside PD3; Inside PD2		
IP protection class	:	IP65		
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)		
- this clause is information reference for installation	:	Info.		
Testing:				
Date of receipt of test item	:	2023-07-10 (samples provided by applicant)		
Date (s) of performance of tests	:	2023-07-11 to 2023-08-11		

General remarks:

The test results presented in this report relate only to the object tested.
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.
The clause 4.6 EMC tests are not in the CNAS scope of DEKRA Testing and Certification (Suzhou) Co., Ltd.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Determination of the test result includes consideration of measurement uncertainty from the test equipment and methods.

Name and address of factory (ies):

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

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

General product information:

The testing unit is a Class I grid-interactive PV inverter for outdoor installation (IP65). The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and two relays. This assures that the opening of the output circuit will also operate in case of one is error.

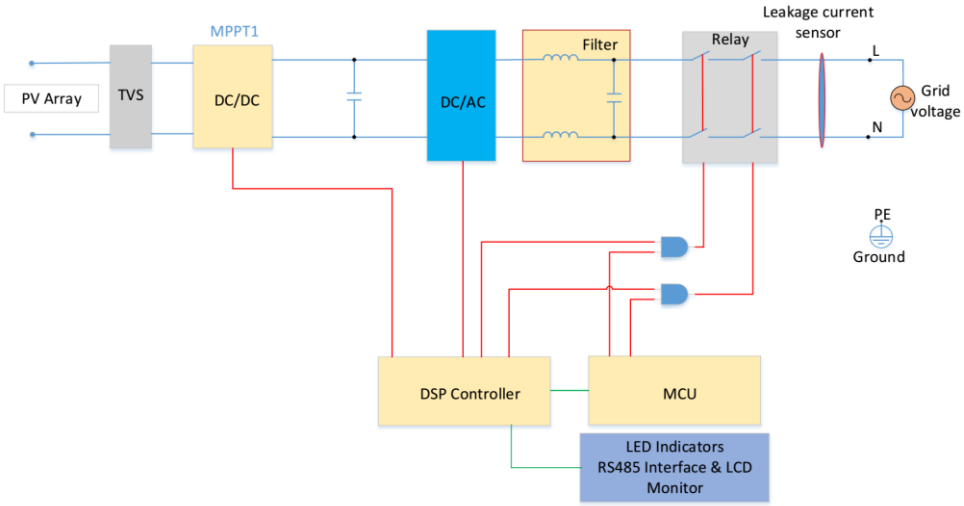
Description of the power circuit:

The internal control is redundant built, it consists of master controller and slave controller, the master controller can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current. The slave controller can control the relays, measures the voltage and frequency. Both controllers communicate with each other.

The voltage and frequency measurement achieved with resistors in serial, which are connected directly to line and neutral. Both controllers get these signals and calculate the data.

The unit provides two relays in series in each phase. The relays were test before each start up. In addition, both controllers can stop the power bridge.

Block Diagram



Model difference:

The models HNS1000TL-1, HNS1500TL-1, HNS2000TL-1, HNS2500TL-1 and HNS3000TL-1 are identical and the output power derated by software.

The product was tested on:
Firmware release (SW): V06

Type of generating unit:

Static Conversion Device	Interface Protection	Interface Protection Device	Rotating Generator Device
Yes	Yes	Yes	No

Specifications table					
Model	HNS1000TL-1	HNS1500TL-1	HNS2000TL-1	HNS2500TL-1	HNS3000TL-1
PV input					
P pv Max(W)	1500	2250	3000	3750	4200
Vmax PV (Vdc) (absolute Max.)	500	500	500	500	500
Isc PV (absolute Max.) (A)	18	18	18	18	18
Number MPP trackers	1	1	1	1	1
Number input strings	1	1	1	1	1
Max. PV input current (A)	14	14	14	14	14
MPPT voltage range (Vdc)	50-500	50-500	50-500	50-500	50-500
Vdc range @ full power (Vdc)	70-500	110-500	145-500	180-500	220-500
AC Grid (output)					
Normal AC Voltage (VAC)	L/N/PE, 220Vac, 230Vac, 240Vac				
Frequency (Hz)	50 / 60				
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)	IP65				
Temperature (℃)	-25℃ to +60℃ (Derating 45℃)				
Inverter Isolation	Non-isolated				
Overvoltage category	OVC III (AC Main), OVC II (PV)				
Software version	V06				

Clause	Test Item	Remark	P / F / N/A
A.4.3.1 & A.4.3.2	Test procedure for maximum/minimum frequency		P
A.4.3.1 & A.4.3.2	Test procedure for maximum/minimum voltage		P
A.4.3.3.1	Insensitivity to harmonics of the frequency relay		P
A.4.3.3.2	Remote trip signal		P
A.4.3.3.3	Communication Signal		P
A.4.3.4	Verification of insensitivity to the frequency derivative		P
A.4.4	Self -test		P
A.4.5	Single fault tolerance		P
A.4.7	Climatic compatibility tests		P
A.4.8	Insulation tests (CEI EN 60255-5)		P
A.4.9	Test for the overload capacity of measuring circuits		P
A.4.11	Automatic mechanism to prevent current imbalance during production		P
B.1 a)/b)	Harmonic current emission		P
B.1 c)	Flicker emission		P
B.1.1	Conditions of connection, reconnection and gradual power supply		P
B.1.2.2.1	Reactive power capability - Inverter in systems with total capacity up to 11.08 kW	≤11.08 kW	N/A
B.1.2.2.2	Reactive power capability - Inverter in systems with total capacity greater than 11.08 kW	>11.08 kW	P
B.1.2.3	Reactive power supply at a given level (greater 11.08 kW systems, but can requested for smaller systems as well)	>11.08 kW *	P
B.1.2.4	Response time to an assigned step level change (greater 11.08 kW systems)	>11.08 kW *	P
B.1.2.5	Automatic supply of reactive power according to the characteristic curve cos φ = f(P)		P
B.1.2.6	Automatic supply of reactive power according to the characteristic curve Q= f(V) (greater 11.08kW systems)	>11.08 kW *	P
B.1.3.1	Automatic limitation of active power for voltage values close to 110% of the rated voltage		P
B.1.3.2	Adjustment of active power in the presence of over-frequency transistors on the transmission network		P
B.1.3.3	Verification of the operating range in voltage and frequency		P
B.1.3.3.1	Reduction of active power in the presence of transient under-frequency on transmission network		P
B.1.3.4	Limitation of active power by external control from the distributor		P
B.1.4.1	Checking the DC component output current		P
B.1.4.2	Checking the protection against DC input		P
B.1.5	Checking insensitivity of voltage dips (LVRT and OVRT(8.5.1-figure 30) capability) [greater 11.08 kW systems]	>11.08 kW *	P
B.1.6	Checking the insensitivity to automatic reclosing during phase discordance		P

Remark:
** The tests described in this paragraph are mandatory only for inverters used in plants with a power greater than 11.08 kW, but at the request of the manufacturer they can also be carried out and documented for smaller size converters.*

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Clause	Requirement - Test	Result - Remark	Verdict

A.3	TABLE: Adjustment ranges for the SPI							P
Voltage values								
Threshold	85% U_n (27.S1)	t_{min} (27.S1)	15% U_n (27.S2)	t_{min} (27.S2)	110% U_n (59.S1)	t_{max} (59.S1)	115% U_n (59.S2)	t_{max} (59.S2)
Range	0.2-1.0 U_n	0.05-5 s	0.05-1.0 U_n	0.05-5 s	1.0-1.2 U_n	0.2-10 s	1.0-1.3 U_n	0.05-1.0 s
Steps	0.05 U_n	0.05 s	0.05 U_n	0.05 s	0.01 U_n	0.1 s	0.01 U_n	0.05 s
Frequency values								
Threshold	49.50 Hz (81<.S1)	t_{min} (81<.S1)	47.50 Hz (81<.S2)	t_{min} (81<.S2)	50.50 Hz (81>.S1)	t_{max} (81>.S1)	51.50 Hz (81>.S2)	t_{max} (81>.S2)
Range	47.0-50.0 Hz	0.05-5s	47.0-50.0 Hz	0.05-5s	50.0-52.0 Hz	0.05-5 s	50.0-52.0 Hz	0.05-5 s
Steps	0.1 Hz	0.05 s	0.1 Hz	0.05 s	0.1 Hz	0.05 s	0.1 Hz	0.05 s

Table 13 - SPI adjustments (with the exception of systems with power less than 800 W)

Protection	Intervention threshold	Intervention time (time elapsing between the instant the anomalous condition detected by the protection starts and the release of the trip command)
Maximum voltage (59.S1, 10 min moving average measurement, in accordance with CEI EN 61000-4-30)	1,10 Vn	Variable according to the initial and final voltage value, maximum 603 s.
Maximum voltage (59.S2)	1,15 Vn	0,2 s
Minimum voltage (27.S1)	0,85 Vn	1,5 s
Minimum voltage (27.S2) *	0,15 Vn	0,2 s
Maximum frequency (81>.S1)** ◊	50,2 Hz	0,1 s
Minimum frequency (81<.S1)** ◊	49,8 Hz	0,1 s
Maximum frequency (81>.S2) ◊	51,5 Hz	0,1 s or 1 s §
Minimum frequency (81<.S2) ◊	47,5 Hz	0,1 s or 4 s §

* The value indicated for the intervention time must be adopted when the total power is higher than 11.08 kW, while for lower powers, an intervention time without intentional delay can be optionally used. In the case of synchronous generators, the value can be raised to 0.7 Vn and t = 0.150 s

** Threshold enabled only with external signal at high value and with high local command.

◊ For voltage values below 0.2 Vn, the maximum / minimum frequency protection must be inhibited.

§ In this regard, see what is reported in the text that follows Figure 35.

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Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A.4.3.2	**TABLE: Test procedure for maximum/minimum frequency (81.S2) (stand alone, use of the SPI on the basis of local information only)**						**P**
Model	HNS3000TL-1						
	Under frequency:			**Over frequency:**			
A) STEPS for trip value [Hz to Hz]:	1.01 threshold -> decrease by max 10mHz steps			0.99 threshold -> increase by max 10mHz steps			
D) STEP trip time [Hz to Hz]:	1.01 threshold -> 0.99 threshold			0.99 threshold -> 1.01 threshold			
Ambient temperature							
Limit [Hz]:	47.50 Hz (81<.S2)			51.50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.49	47.50	47.49	51.50	51.51	51.51	
Trip time limit [ms]:	100 ms			100 ms			
Measurement the trip time [ms]:	97.4	97.4	99.7	95.4	92.0	95.2	
-25°C temperature							
Limit [Hz]:	47.50 Hz (81<.S2)			51.50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.48	47.50	47.50	51.52	51.50	51.51	
Trip time limit [ms]:	100 ms			100 ms			
Measurement the trip time [ms]:	99.3	95.7	99.6	91.0	93.8	95.4	
+60°C temperature							
Limit [ms]:	47.50 Hz (81<.S2)			51.50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.49	47.49	47.48	51.50	51.50	51.52	
Trip time limit [ms]:	100 ms			100 ms			
Measurement the trip time [ms]:	98.6	98.8	95.6	94.9	91.4	95.4	

Assessment criterion:
For frequencies of between 47.5 Hz and 51.5 Hz (±0.1% fn) automatic disconnection from the network as a result of a deviation in frequency is not permitted.
Limit values:
Frequency decrease protectionf<47.5 Hz100 ms
Frequency increase protectionf<51.5 Hz100 ms
Verification is pass when the SPI trip occurs within the following limits for at least 3 consecutive tests:
- ≤ 1% Vn for voltage intervention thresholds
- ±20 mHz for frequency intervention thresholds
- ≤ 3 % ± 20 ms for intervention times
- ≤ 1 % Vn for voltage recovery thresholds
- ±20 mHz for frequency recovery thresholds

For **each repetition** of the tests, the max tolerances of the values are:
Voltage: 2%
Frequency: ±20mHz
Trip times: 1%±20ms

Note:
*If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test.

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Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A.4.3.2	**TABLE: Test procedure for maximum/minimum frequency (81.S2) (use of SPI on the basis of local readings and external information/commands)**						**P**
Model	HNS3000TL-1						
	Under frequency:			**Over frequency:**			
A) STEPS for trip value [Hz to Hz]:	1.01 threshold -> decrease by max 10mHz steps			0.99 threshold -> increase by max 10mHz steps			
D) STEP trip time [Hz to Hz]:	1.01 threshold -> 0.99 threshold			0.99 threshold -> 1.01 threshold			
Ambient temperature							
Limit [Hz]:	47,50 Hz (81<.S2)			51,50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.49	47.48	47.50	51.51	51.51	51.51	
Trip time limit [ms]:	4000 ms			1000 ms			
Measurement the trip time [ms]:	3980	3980	3978	997.0	993.0	995.8	
-25°C temperature							
Limit [Hz]:	47,50 Hz (81<.S2)			51,50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.50	47.49	47.48	51.50	51.52	51.51	
Trip time limit [ms]:	4000 ms			1000 ms			
Measurement the trip time [ms]:	3976	3986	3976	996.0	995.2	994.8	
+60°C temperature							
Limit [ms]:	47,50 Hz (81<.S2)			51,50 Hz (81>.S2)			
Measurement accuracy of the tripping value [Hz]:	47.49	47.49	47.50	51.50	51.52	51.52	
Trip time limit [ms]:	4000 ms			1000 ms			
Measurement the trip time [ms]:	3973	3991	3983	991.6	993.6	999.8	

Assessment criterion:
For frequencies of between 47.5 Hz and 51.5 Hz (±0.1% fn) automatic disconnection from the network as a result of a deviation in frequency is not permitted.
Limit values:
Frequency decrease protectionf<47,5 Hz4000 ms
Frequency increase protectionf<51,5 Hz1000 ms
Verification is pass when the SPI trip occurs within the following limits for at least 3 consecutive tests:
- ≤ 1% Vn for voltage intervention thresholds
- ±20 mHz for frequency intervention thresholds
- ≤ 3 % ± 20 ms for intervention times
- ≤ 1 % Vn for voltage recovery thresholds
- ±20 mHz for frequency recovery thresholds

For **each repetition** of the tests, the max tolerances of the values are:
Voltage: 2%
Frequency: ±20mHz
Trip times: 1%±20ms

Note:
*If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test.

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Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A4.3.2	**TABLE: Test procedure for maximum/minimum frequency functions (81.S1)**						**P**
Model	HNS3000TL-1						
	Under frequency:			**Over frequency:**			
A) STEPS for trip value [Hz to Hz]:	1.01 threshold -> decrease by max 10mHz steps			0.99 threshold -> increase by max 10mHz steps			
D) STEP trip time [Hz to Hz]:	1.01 threshold -> 0.99 threshold			0.99 threshold -> 1.01 threshold			
Ambient temperature							
Tripping threshold limit [Hz]:	49,80 (81<.S1)			50,20 (81>.S1)			
Measurement accuracy of the tripping value [Hz]:	49.80	49.79	49.78	50.20	50.21	50.22	
Trip time limit [ms]:	100			100			
Measurement the trip time [ms]:	93.8	96.2	91.6	95.4	94.2	91.6	
-25°C temperature							
Tripping threshold limit [Hz]:	49,80 (81<.S1)			50,20 (81>.S1)			
Measurement accuracy of the tripping value [Hz]:	49.79	49.79	49.80	50.20	50.20	50.21	
Trip time limit [ms]:	100			100			
Measurement the trip time [ms]:	92.6	92.6	97.4	97.0	93.6	97.8	
+60°C temperature							
Tripping threshold limit [Hz]:	49,80 (81<.S1)			50,20 (81>.S1)			
Measurement accuracy of the tripping value [Hz]:	49.78	49.79	49.78	50.22	50.22	50.20	
Trip time limit [ms]:	100			100			
Measurement the trip time [ms]:	99.1	98.2	97.1	96.6	99.2	91.2	
Note: Threshold enabled only with external signal at high value and with high local command.							

Assessment criterion:
For frequencies of between 49.8 Hz and 50.2 Hz automatic disconnection from the network as a result of a deviation in frequency is not permitted.
Limit values:
Frequency decrease protectionf<49.8 Hz100 ms
Frequency increase protectionf<50.2 Hz100 ms
Verification is pass when the SPI trip occurs within the following limits for at least 3 consecutive tests:
- ≤ 1% Vn for voltage intervention thresholds
- ±20 mHz for frequency intervention thresholds
- ≤ 3 % ± 20 ms for intervention times
- ≤ 1 % Vn for voltage recovery thresholds
- ±20 mHz for frequency recovery thresholds

For **each repetition** of the tests, the max tolerances of the values are:
Voltage: 2%
Frequency: ±20mHz
Trip times: 1%±20ms

Note:
*If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test (such as -25°C / +60°C).

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A.4.3.2	**TABLE: Test procedure for maximum/minimum voltage (27.S1)**		**P**
Model:	HNS3000TL-1		
	Under voltage:		
A) STEPS for trip value [V to V]:	1.1 threshold -> decrease by 0.5% Vn steps		
D) STEP for trip time [V to V]:	1.1 threshold -> 0.9 threshold		
Ambient temperature			
Limit [V]:	195,5 V (27.S1)		
Measurement accuracy of the tripping value [V]:	195.32	195.37	195.02
Trip time limit [ms]:	1500 ms		
Measurement the trip time [ms]:	1493	1489	1485
-25°C temperature			
Limit [V]:	195,5 V (27.S1)		
Measurement accuracy of the tripping value [V]:	195.36	195.45	195.07
Trip time limit [ms]:	1500 ms		
Measurement the trip time [ms]:	1493	1488	1496
+60°C temperature			
Limit [V]:	195,5 V (27.S1)		
Measurement accuracy of the tripping value [V]:	195.25	195.27	195.44
Trip time limit [ms]:	1500 ms		
Measurement the trip time [ms]:	1493	1489	1493

Note:
Verification is pass when the SPI trip occurs within the following limits for at least 3 consecutive tests:
- ≤ 1% Vn for voltage intervention thresholds
- ±20 mHz for frequency intervention thresholds
- ≤ 3 % ± 20 ms for intervention times
- ≤ 1 % Vn for voltage recovery thresholds
- ±20 mHz for frequency recovery thresholds

For **each repetition** of the tests, the max tolerances of the values are:
Voltage: 2%
Frequency: ±20mHz
Trip times: 1%±20ms
*If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test (such as -25°C / +60°C).

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Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A.4.3.2	**TABLE: Test procedure for maximum/minimum voltage (27.S2) (59.S2)**						**P**
Model	HNS3000TL-1						
	Under voltage:			**Over voltage:**			
A) STEPS for trip value [V to V]:	1.1 threshold -> decrease by 0.5% Vn steps			0.9 threshold -> increase by 0.5% Vn steps			
D) STEP for trip time [V to V]:	1.1 threshold -> 0.9 threshold			0.9 threshold -> 1.08 threshold			
Ambient temperature							
Limit [V]:	34.5 V (27.S2)			264.5 V (59.S2)			
Measurement accuracy of the tripping value [V]:	34.48	34.46	34.50	264.53	264.62	264.57	
Trip time limit [ms]:	200 ms			200 ms			
Measurement the trip time [ms]:	190.4	197.4	198.3	199.4	192.4	195.4	
-25°C temperature							
Limit [V]:	34.5 V (27.S2)			264.5 V (59.S2)			
Measurement accuracy of the tripping value [V]:	34.38	34.44	34.35	264.68	264.51	264.69	
Trip time limit [ms]:	200 ms			200 ms			
Measurement the trip time [ms]:	199.5	196.1	191.3	190.7	191.5	193.6	
+60°C temperature							
Limit [V]:	34.5 V (27.S2)			264.5 V (59.S2)			
Measurement accuracy of the tripping value [V]:	34.31	34.42	34.47	264.53	264.57	264.62	
Trip time limit [ms]:	200 ms			200 ms			
Measurement the trip time [ms]:	192.7	193.5	197.5	193.6	194.6	195.6	

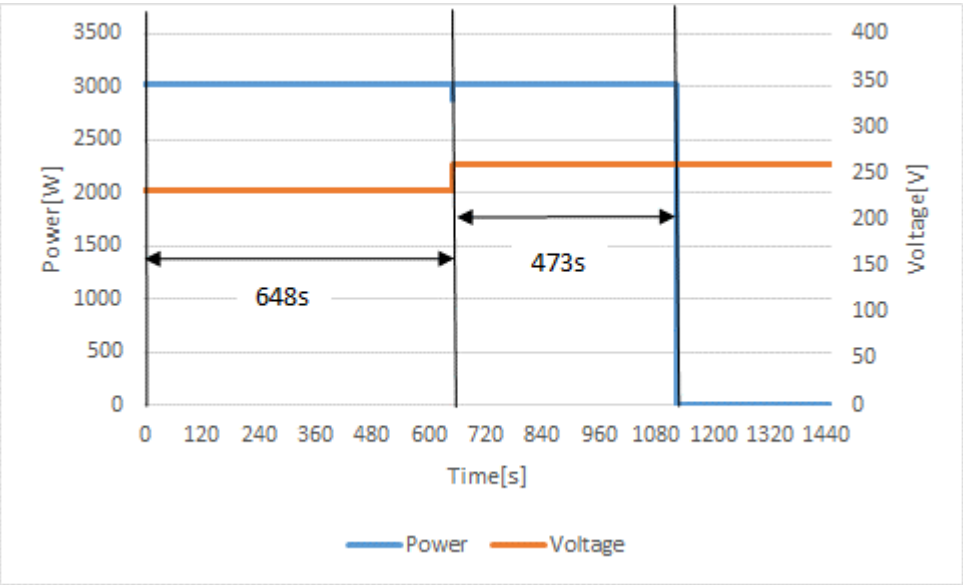
Note:
Verification is pass when the SPI trip occurs within the following limits for at least 3 consecutive tests:
- ≤ 1% Vn for voltage intervention thresholds
- ±20 mHz for frequency intervention thresholds
- ≤ 3 % ± 20 ms for intervention times
- ≤ 1 % Vn for voltage recovery thresholds
- ±20 mHz for frequency recovery thresholds

For **each repetition** of the tests, the max tolerances of the values are:
Voltage: 2%
Frequency: ±20mHz
Trip times: 1%±20ms
*If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test (such as -25°C / +60°C).

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.1 & A.4.3.2	**TABLE: Measuring the rise-in voltage protection as a running 10-minute mean value (59.S1)**		**P**
Model:	HNS3000TL-1		
Test:		Disconnection time:	Limit:
a)	The voltage is set to 100% U_n and held for 600 s. Thereafter the voltage is set to 112% U_n (257.6 V). Disconnection must take place within 603 s.		
	Phase 1	473	≤ 603 s
	Phase 2	-	
	Phase 3	-	
b)	The voltage is set to U_n for 600 s and then to 108% U_n (248.4 V) for 600 s. No disconnection should take place.		
	Phase 1	No disconnection	Disconnection should not take place.
	Phase 2	-	
	Phase 3	-	
c)	The voltage is set to 106 % U_n (243.8 V) and held for 600 s. Thereafter the voltage is set to 114 % U_n (262.6 V). Disconnection must take place within 300 s or about 50 % of the disconnection time measured in point a).*		
	Phase 1	278	The disconnection time should be about 50 % of the value measured in a). *
	Phase 2	-	
	Phase 3	-	

Note:
*If the setting value is set to 600 s, then the disconnection time can be in the range between 225 s and 375 s.



a)

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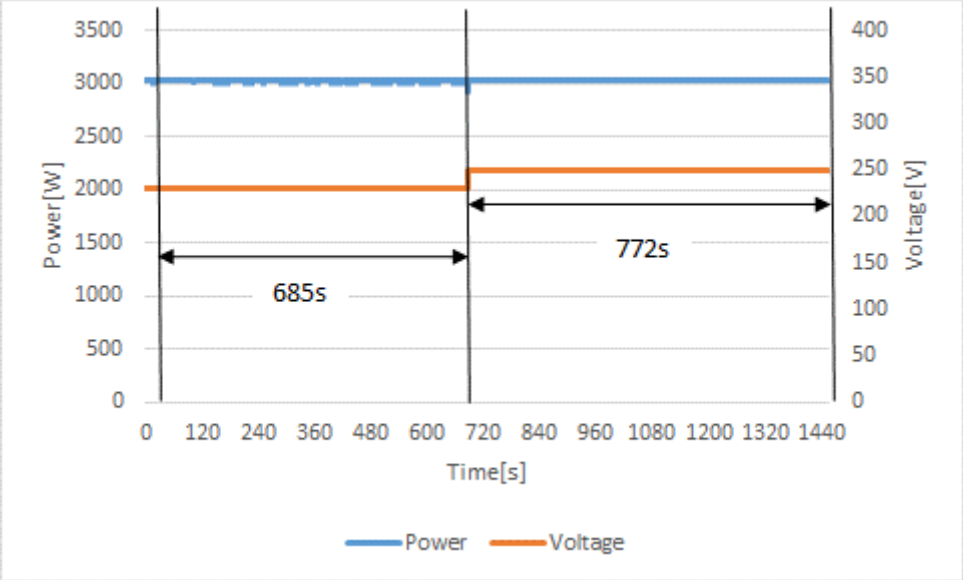
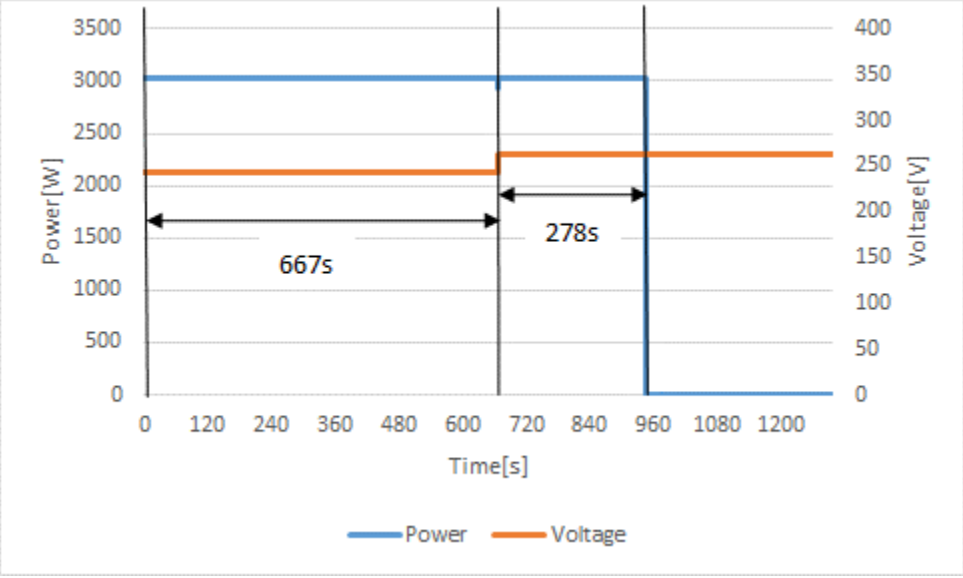
Clause	Requirement - Test	Result - Remark	Verdict



b)



c)

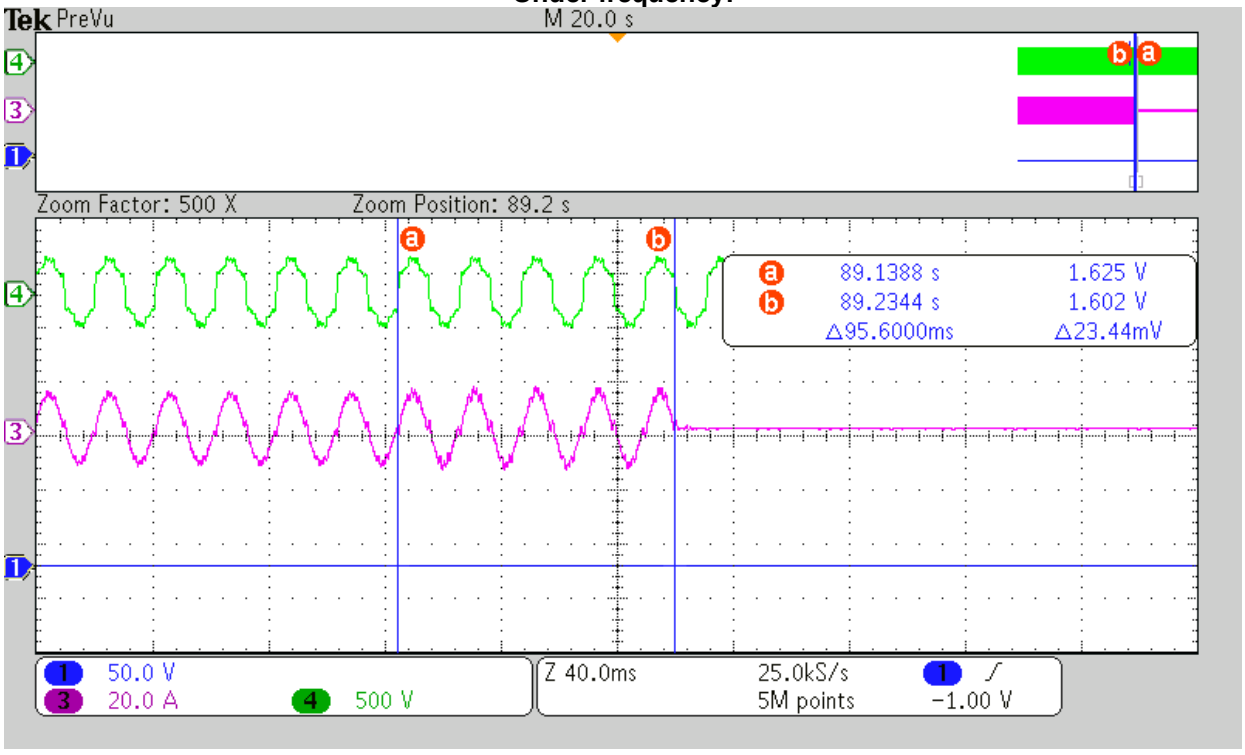
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.3.1	**TABLE: Insensitivity to harmonics of the frequency relay**								**P**
Mode	HNS3000TL-1								
Grid simulator settings according to Table 17:	Harmonics order:	2nd	3rd	5th	7th	9th	11th	13th	17th
	$\%U_n$:	4.0	10.0	12.0	10.0	3.0	7.0	6.0	4.0

Operating time of the monitoring device:

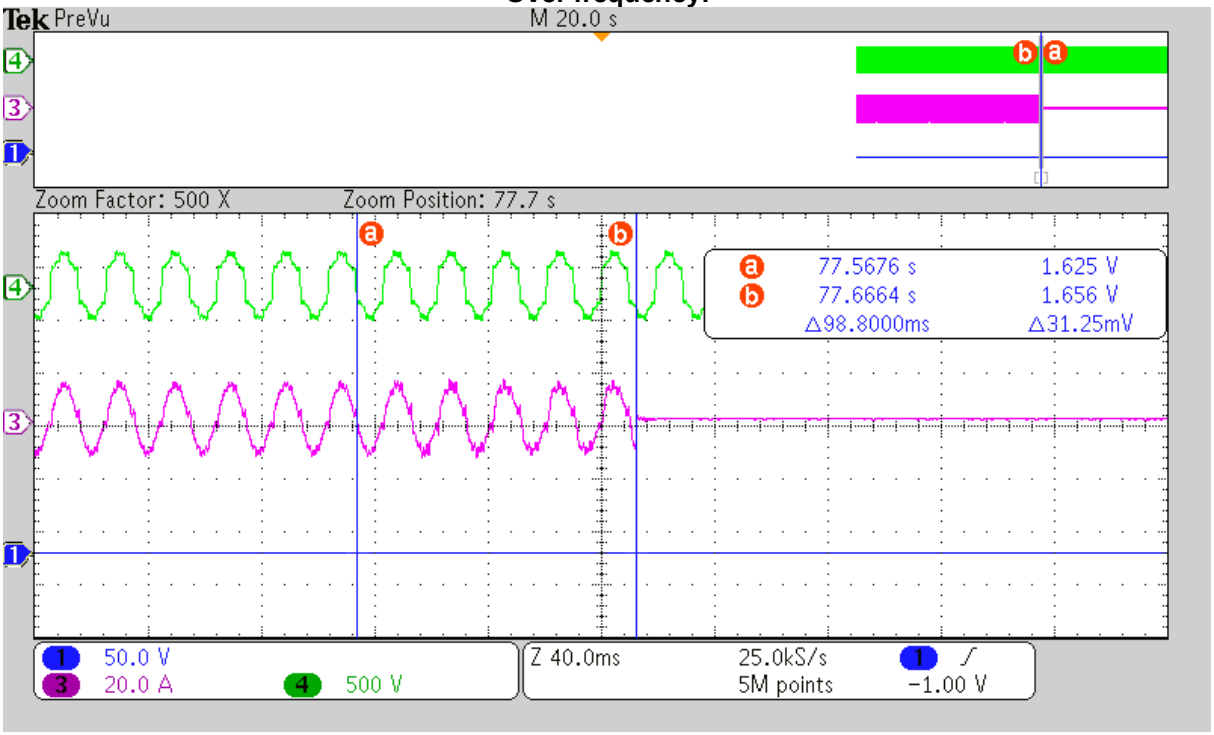
	Under frequency:			**Over frequency:**		
A) STEPS for trip value [Hz to Hz]:	1.01 threshold -> decrease by max 10mHz steps			0.99 threshold -> increase by max 10mHz steps		
D) STEP trip time [Hz to Hz]:	1.01 threshold -> 0.99 threshold			0.99 threshold -> 1.01 threshold		
Limit [Hz]:	47.50 Hz			51.50 Hz		
Measurement accuracy of the tripping value [V]:	47.48	47.49	47.49	51.52	51.51	51.52
	100 ms			100 ms		
Measurement the trip time [ms]:	95.6	94.8	96.8	98.8	93.2	98.0

Under frequency:



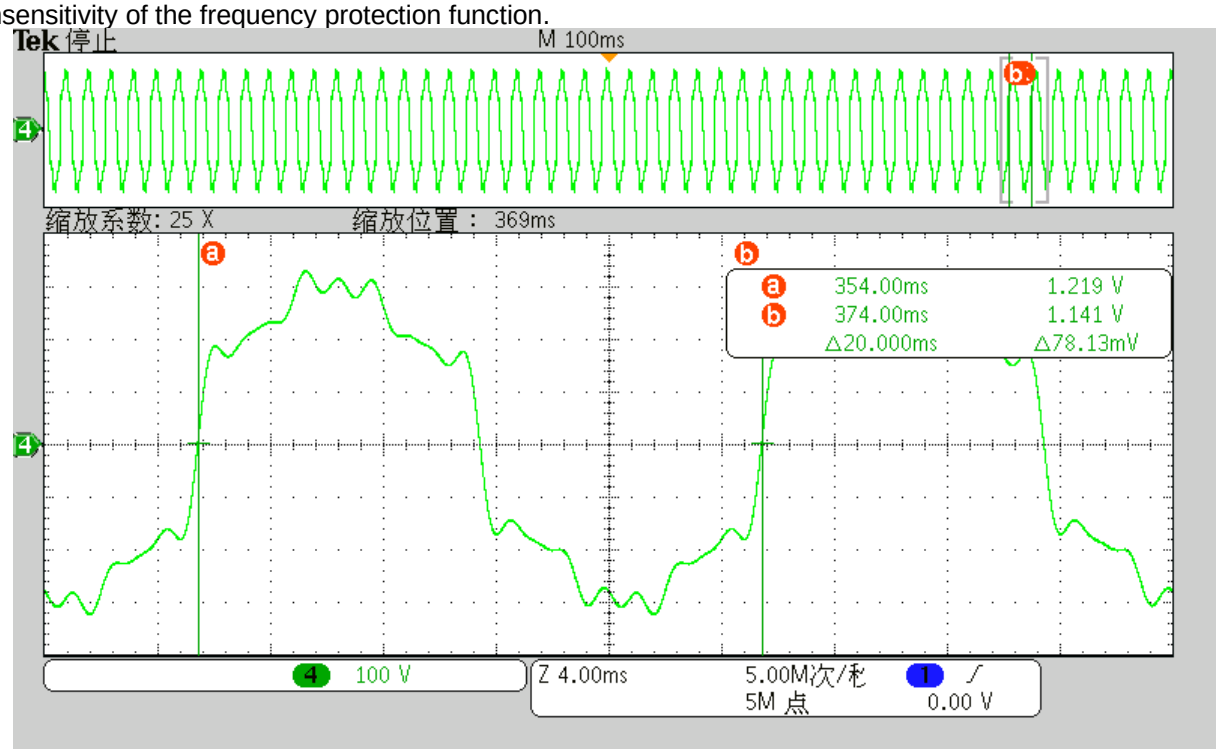
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Over frequency:



Note:
The setting value and the trip value of the frequency may not vary by more than **±20mHz** and **3%±20ms**. Differences between the test values: **±20mHz** and **1%±20ms.**

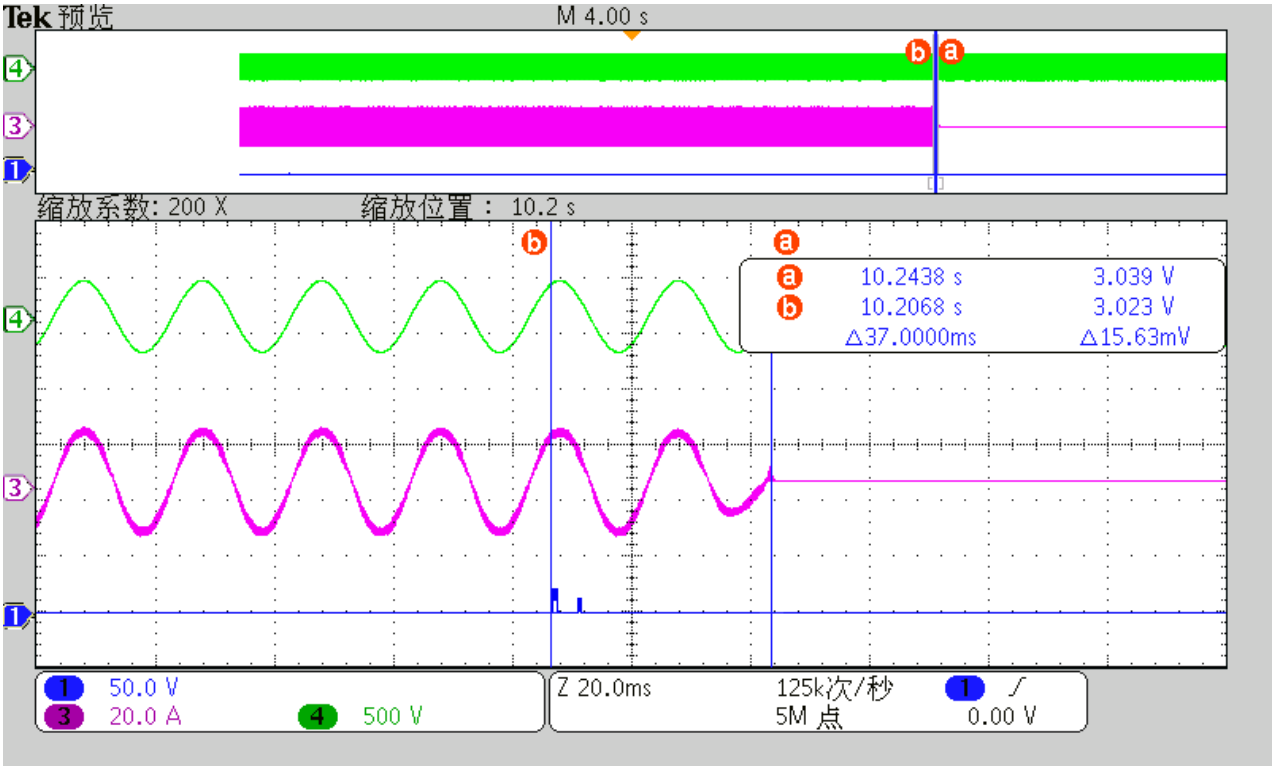
Screenshot of voltage waveform, distorted as required by CEI 0-21 Table 17 – Harmonics for the insensitivity of the frequency protection function.



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.3.2	TABLE: Remote trip signal	P
Model	HNS3000TL-1	
Test:	Remote tripping signal for the external disconnection	
Limit [ms]:	50	
Measurement time of the tripping value [ms]:	37.0	

Graph of remote trip signal:



Note:
The protection interface has to have a maximum delay of the remote tripping signal from receiving to transmitting to the DDI of 50ms.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.3.3	TABLE: Communication Signal		P
Model	HNS3000TL-1		
Enlargement of the frequency limits:		Yes	No
Enabled the trip of the functions 81<.S1 (49.8Hz) and 81>.S1 (50.2Hz) without communication signal		☒	☐
Enabled the trip of the functions 81<.S2 (47.5Hz) and 81>.S2 (51.5Hz) with communication signal		☒	☐

Note:

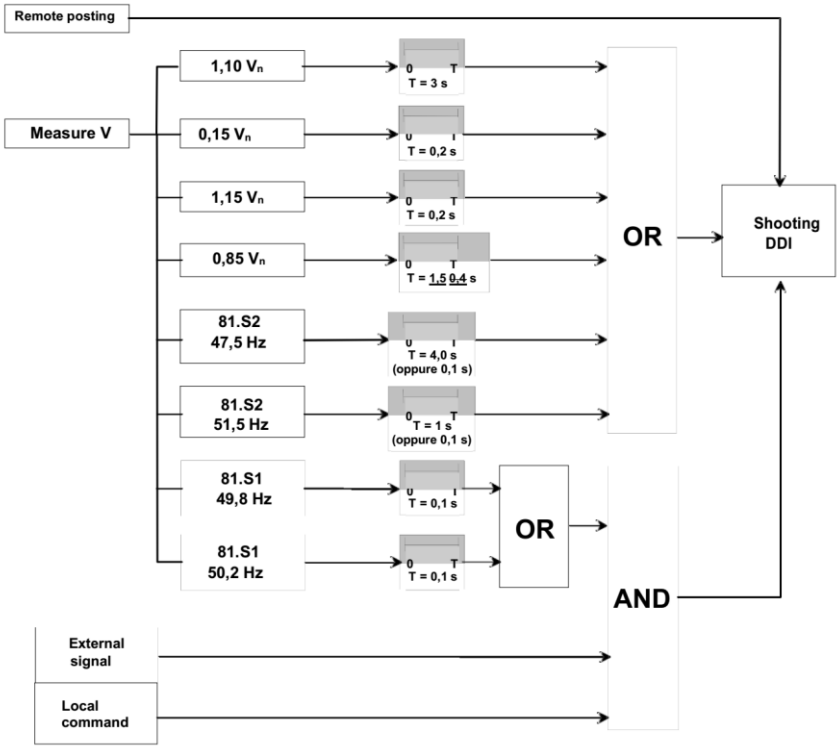


Figure 35 - Functional logic diagram of the SPI of the power park modules (the values in brackets refer to the transitory operating mode of the SPI)

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.3.4	**TABLE: Verification of insensitivity to the frequency derivative (ROCOF)**						**P**
Model	HNS3000TL-1						
Setting threshold (81 >)		Setting trip time		Setting threshold (81 <)		Setting trip time	
51.5 Hz		0.15 s		47.5 Hz		0.15 s	
Step	Frequency		Change time	Output power (W)	Result (Continuous operation or not)		Requirement
	Begin	End					
1)	47.55 Hz	47.55 Hz	10.0 s	3017	Continuous operation		Stay connected
2)	47.55 Hz	51.45 Hz	1.56 s	3019	Continuous operation		Stay connected
3)	51.45 Hz	47.55 Hz	1.56 s	3017	Continuous operation		Stay connected
2)	47.55 Hz	51.45 Hz	1.56 s	3018	Continuous operation		Stay connected
3)	51.45 Hz	47.55 Hz	1.56 s	3018	Continuous operation		Stay connected
2)	47.55 Hz	51.45 Hz	1.56 s	3020	Continuous operation		Stay connected
3)	51.45 Hz	47.55 Hz	1.56 s	3019	Continuous operation		Stay connected
2)	47.55 Hz	51.45 Hz	1.56 s	3019	Continuous operation		Stay connected
3)	51.45 Hz	47.55 Hz	1.56 s	3017	Continuous operation		Stay connected
2)	47.55 Hz	51.45 Hz	1.56 s	3019	Continuous operation		Stay connected
3)	51.45 Hz	47.55 Hz	1.56 s	3018	Continuous operation		Stay connected
5)	47.55 Hz	47.55 Hz	10.0 s	3018	Continuous operation		Stay connected

Test procedure:

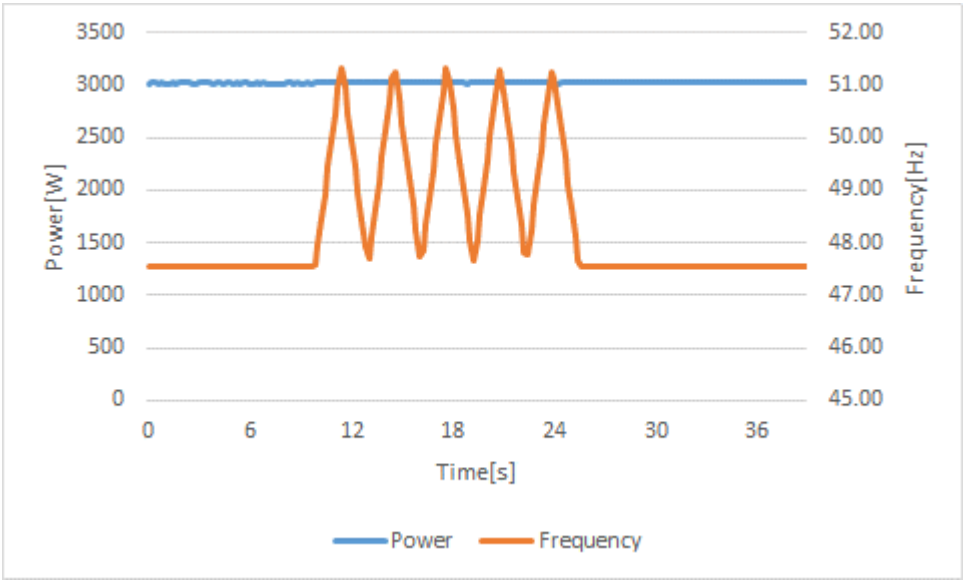
1) Apply a three-phase of symmetrical voltages of direct cyclic sequence having an amplitude of 100% of the rated voltage and a frequency of 47.550 Hz;
2) increase the frequency of the three-phase voltages, with ramp steps having an amplitude of 12.5 mHz and duration of 5 ms, until reaching the frequency value of 51.450 Hz;
3) decrease the frequency of the three-phase voltages, with ramp steps having an amplitude equal to 12.5 mHz and duration 5 ms until reaching the frequency value of 47.550 Hz;
4) repeat the tests referred to in points 2 and 3 above four times, for a total of 5 positive and negative ramps.
5) Apply a three-phase of symmetrical voltages of direct cyclic sequence having an amplitude of 100% of the rated voltage and a frequency of 47.550 Hz for 10 s.

Note:

When considering a sliding measurement window of 1.56 s, these profiles have a maximum RoCoF of 2.5 Hz/s.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Diagram:



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.4	**TABLE: Self-test**			**P**
Model	HNS3000TL-1			
Software version: Control board: V1.0, Display board: V1.0				
Can the self-test be activated from any user? (☒ YES; ☐ NO)				
Do the procedures be written / described in the user manual? (☒ YES; ☐ NO)				
Can the self-test results and the preset values be clearly readable / displayed? (☒ YES; ☐ NO)				
Accuracy		Threshold	Disconnection time	Tolerance
Overvoltage 59.S1	Reading	253.0V	601000ms	Is the voltage thresholds deviation within 1%? (☒ YES, ☐NO) Is the time deviation within 3% ± 20 ms? (☒ YES, ☐NO)
	Default	253.0 V	<603000 ms	
Overvoltage 59.S2	Reading	264.6V	198ms	
	Default	264.5 V	200 ms	
Undervoltage 27.S1	Reading	195.4V	1490ms	
	Default	195.5 V	1500 ms	
Undervoltage 27.S2	Reading	34.4V	196ms	
	Default	34.5 V	200 ms	
Overfrequency 81>.S1	Reading	50.2 Hz	95 ms	Is the frequency thresholds deviation within ± 20 mHz? (☒ YES, ☐NO) Is the time deviation within 3% ± 20 ms? (☒ YES, ☐NO)
	Default	50.2 Hz	100 ms	
Overfrequency 81>.S2	Reading	51.5 Hz	98 ms	
	Default	51.5 Hz	100 ms	
Underfrequency 81<.S2	Reading	49.8 Hz	99 ms	
	Default	49.8 Hz	100 ms	
Underfrequency 81<.S2	Reading	47.5 Hz	97 ms	
	Default	47.5 Hz	100 ms	

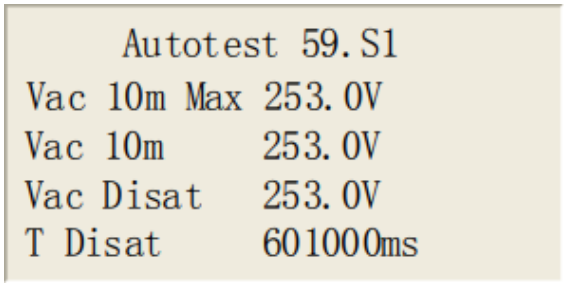
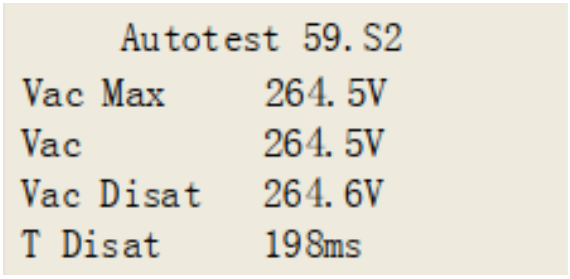
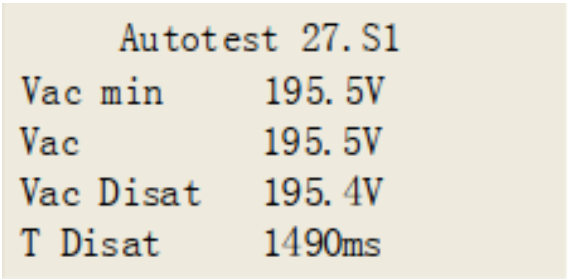
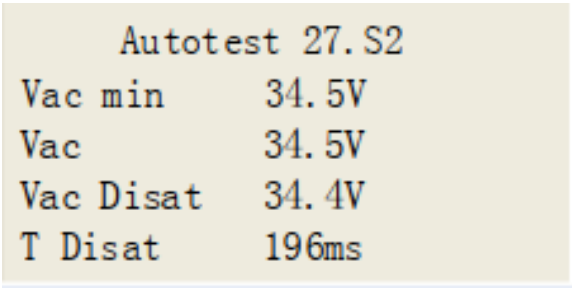
Note:

In the event that the interface protection functions are integrated into the inverter, at least one self-test system must be provided to check the maximum / minimum frequency and maximum / minimum voltage functions provided for in the SPI as described below:

- for each frequency and voltage protection function, the rise or fall intervention threshold shall be linearly varied with a ramp ≤ 0,05 Hz/s or ≤ 0,05 Vn/s for frequency and voltage protection respectively;
- this determines, at a certain point of the test, the coincidence between the threshold and the current value of the controlled magnitude (frequency or voltage) and therefore the intervention of the protection and the consequent opening of the interface device.

For each test the values of the quantities and the intervention times shall be viewable by the tester as well as the current value of the voltage and frequency detected by the converter.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Diagram of auto-test:
Overvoltage 59.S1 
Overvoltage 59.S2 
Undervoltage 27.S1 
Undervoltage 27.S2 

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Overfrequency 81>S1

Autotest 81>.S1	
F max	50.20Hz
Freq	50.20Hz
F Disat	50.20Hz
T Disat	95ms

Overfrequency 81>S2

Autotest 81>.S2	
F max	51.50Hz
Freq	51.50Hz
F Disat	51.50Hz
T Disat	98ms

Underfrequency 81<S1

Autotest 81<.S1	
F min	49.80Hz
Freq	49.80Hz
F Disat	49.80Hz
T Disat	99ms

Underfrequency 81<S2

Autotest 81<.S2	
F min	47.50Hz
Freq	47.50Hz
F Disat	47.50Hz
T Disat	97ms

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.5	**TABLE: Single fault tolerance**				**P**
Model	HNS3000TL-1				
Ambient temperature (°C) ……..……:					25°C
No.	component No.	fault	test voltage (V)	test time	result
1	ISO Relay(ALFG1)	Short circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Iso Fault. No danger ,no hazard ,no fires
2	Monitoring Relay - L(ALFG2)	Pin1 to Pin2 short circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
3	Monitoring Relay - L(ALFG2)	Pin1 to Pin2 open circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
4	Monitoring Relay - L(ALFG2)	Pin3 to Pin4 short circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
5	Monitoring Relay - L(ALFG2)	Pin3 to Pin4 open circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
6	Monitoring Relay - N(ALFG3)	Pin1 to Pin2 short circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
7	Monitoring Relay - N(ALFG3)	Pin1 to Pin2 open circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
8	Monitoring Relay - N(ALFG3)	Pin3 to Pin4 short circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
9	Monitoring Relay - N(ALFG3)	Pin3 to Pin4 open circuit before start up inverter	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
10	AC voltage measure (R113)	Pin1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
11	AC voltage measure (C34)	Pin1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires
12	AC current measure(C208)	Pin1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit can't operating, error message: Inv Over Current.No damage ,no hazard ,no fire.
13	AC frequency measure(C20)	Pin1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit shut down, error message: Grid Freq Fault.No damage ,no hazard ,no fire
14	DC current measure(C249)	Pin1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit shut down,error message: PV1 Over Current.no danger ,no hazard ,no fire

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Clause	Requirement - Test	Result - Remark	Verdict

15	Bus cap(C1)	Pin1-Pin2 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start-up, No damage, no hazard, no fire.
16	COM-of CPU1-CPU2(U15)	Pin 58 Open circuit	360Vdc-230Vac	3min	Unit shut down. error message: Communication lose.No damage, no hazard, no fire.
17	CPU1 Failure - Power(C105)	Pin 1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit shut down. No damage ,no hazard ,no fire
18	CPU1 Failure - Reset (C141)	Pin 1-Pin2 Short circuit	360Vdc-230Vac	3min	Unit can't operating,No damage ,no hazard ,no fire
19	EEPROM(U20)	Pin 5 Open circuit	360Vdc-230Vac	3min	EEPROM read and write function is abnormal. No damage, no hazards.
20	EEPROM(U20)	Pin 6 Open circuit	360Vdc-230Vac	3min	EEPROM read and write function is abnormal. No damage, no hazards.
21	Drive optocoupler(U10)	Pin1-Pin2 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start-up, No damage, no hazard, no fire.
22	power tube Boost(Q2)	Pin2-Pin3 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start-up, No damage, no hazard, no fire.
23	Diode(D54)	Short circuit	360Vdc-230Vac	3min	Unit normal operation, No danger ,no hazard ,no fire
24	power tube IGBT(QA1)	Pin1-Pin3 Short circuit	360Vdc-230Vac	3min	Unit shut down, error massage: Self Lock.No danger ,no hazard ,no fire
25	power tube IGBT(QA1)	Pin2-Pin3 Short circuit	360Vdc-230Vac	3min	Unit shut down, error message: Inv Over Current.No damage ,no hazard ,no fire
26	power tube IGBT(QA2)	Pin2-Pin3 Short circuit	360Vdc-230Vac	3min	Unit shut down, error message: Inv Over Current.No damage ,no hazard ,no fire
27	GFCI check(--)	Short circuit	360Vdc-230Vac	3min	Unit shut down, error message: GFCI Fault.No damage ,no hazard ,no fire
28	Transformer short circuit tests +20V(AF-SPS-H1)	Pin12-Pin13 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
29	Transformer short circuit tests +8V(AF-SPS-H1)	Pin15-Pin16 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
30	Transformer short circuit tests +12V(AF-SPS-H1)	Pin15-Pin18 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
31	Transformer short circuit tests +5V(AF-SPS-H1)	Pin19-Pin20 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
32	Transformer short circuit tests +5.1V(AF-SPS-H1)	Pin22-Pin24 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.

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Clause	Requirement - Test	Result - Remark	Verdict

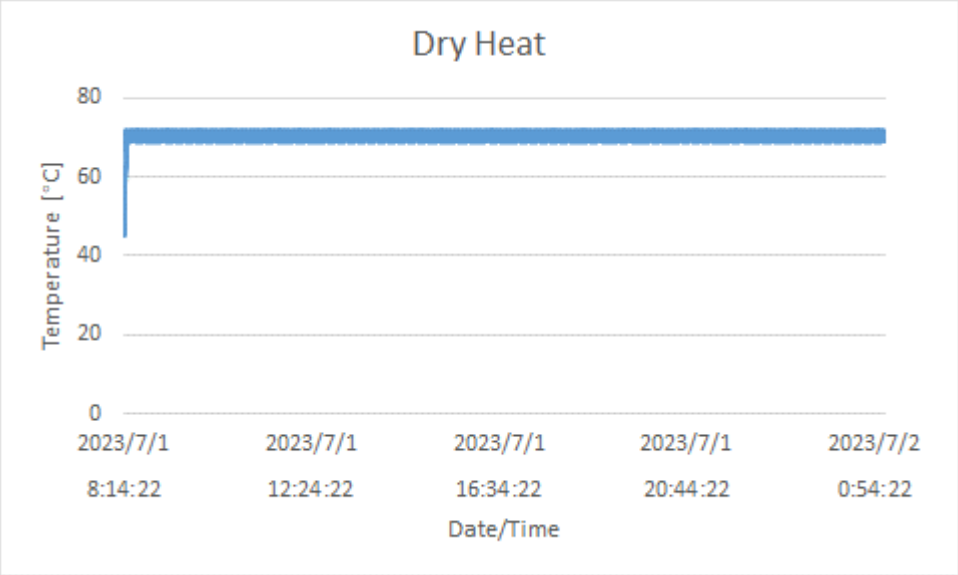
33	Transformer short circuit tests -5V(AF-SPS-H1)	Pin25-Pin26 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
34	Transformer short circuit tests +15V(AF-SPS-H1)	Pin28-Pin29 Short circuit before start up	360Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
35	power tube MOS-SPS(Q2)	G-DShort circuit	360Vdc-230Vac	3min	SPS no output,no danger ,no hazard ,no fire
36	Output L to N(--)	short circuit	360Vdc-230Vac	3min	Unit shut down ,error message:Inv Over Current.No damage ,no hazard ,no fire
37	Output L to PE(--)	short circuit	360Vdc-230Vac	3min	Unit shut down ,error message:Grid Volt Fault.No damage ,no hazard ,no fire
38	Output N to PE(--)	short circuit	360Vdc-230Vac	3min	Unit shut down ,error message:Grid Volt Fault.No damage ,no hazard ,no fire
39	DC(--)	--	360Vdc-230Vac	3min	Vac=0
40	AC(--)	--	360Vdc-230Vac	3min	Vdc=0
41	Overload(--)	Output overload (110%)	360Vdc-230Vac	3min	Unit normal operation,No damage ,no hazard ,no fire
42	Cooling system failure – Blanketing test(--)	Put the unit to box	360Vdc-230Vac	3min	1 hour power run at 80%
43	PV+ to PV-(--)	Reverse polarity	360Vdc-230Vac	3min	Unit can not start up, no danger ,no hazard ,no fire
44	Output L - N(--)	Reverse polarity before start up	360Vdc-230Vac	3min	Unit normal operation.No damage, no hazard, no fire.
42	Power supply +12V(T1)	Pin27-Pin29 Short circuit before start up	620Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
43	Power supply +12V(T1)	Pin132-Pin34 Short circuit before start up	620Vdc-230Vac	3min	Unit can not start up, No damage, no hazard, no fire.
44	power tube MOS-SPS(Q2)	G-D Short circuit	620Vdc-230Vac	3min	SPS no output, no danger ,no hazard ,no fires
Supplementary information: Tests performed under abnormal or fault conditions shall be tested with a source capable of 1,25 to 1,5 times the PCE rated maximum input current (Isc PV) for that input.					

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

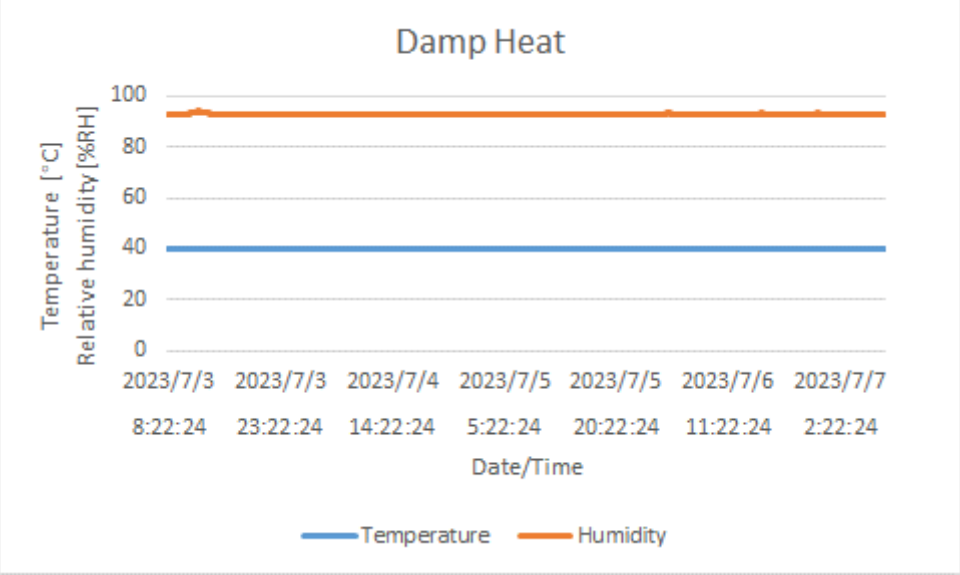
A.4.7	**TABLE: Climatic compatibility tests**			**P**
Model	HNS3000TL-1			
Climatic tests of unpowered equipment:				
Temperature	Relative humidity	Standards	Test time	
70°C ± 2°C	--	EN 60068-2-2	16h	
40°C ± 2°C	93% ± 3%	EN 60068-2-78	4 days	
-25°C ± 2°C	--	EN 60068-2-1	16h	
-25°C -> +70°C ± 2°C	--	EN 60068-2-14	3h @ -25°C, 3h @ +70°C	
Climatic tests of powered equipment:				
Temperature	Relative humidity	Standards	Test time	
60°C± 2°C*	--	EN 60068-2-2	16h	
40°C ± 2°C	93% ± 3%	EN 60068-2-78	4 days	
-25°C ± 2°C	--	EN 60068-2-1	16h	
-25°C -> +60°C ± 2°C*	--	EN 60068-2-14	3h @ -25°C, 3h @ +60°C	
Note: The unit is not allowed to be damaged while testing. *If the PV inverter max operating temperature above 55°C, please use the max operating temperature in the test.				

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Temperature diagram of unpowered equipment:

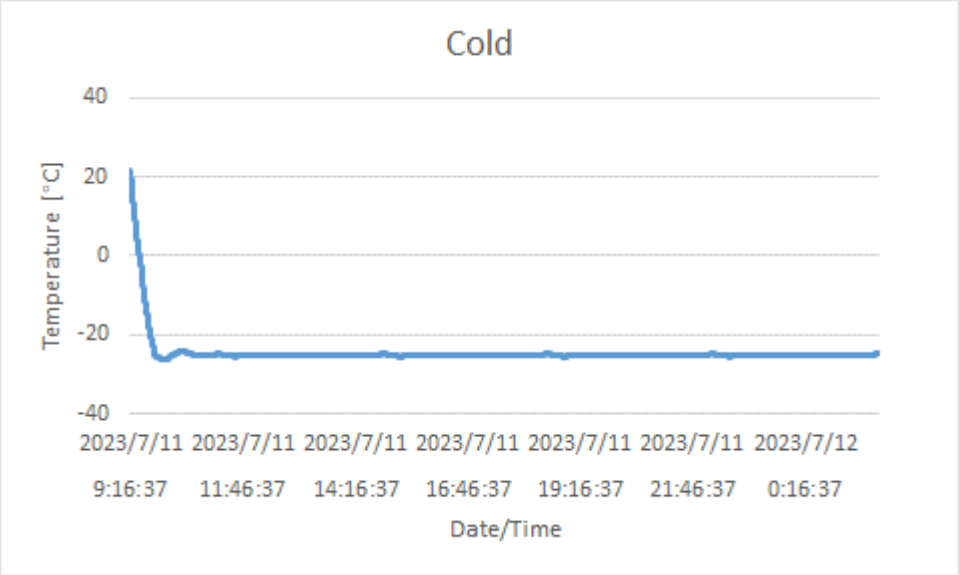


Temperature diagram of unpowered equipment:

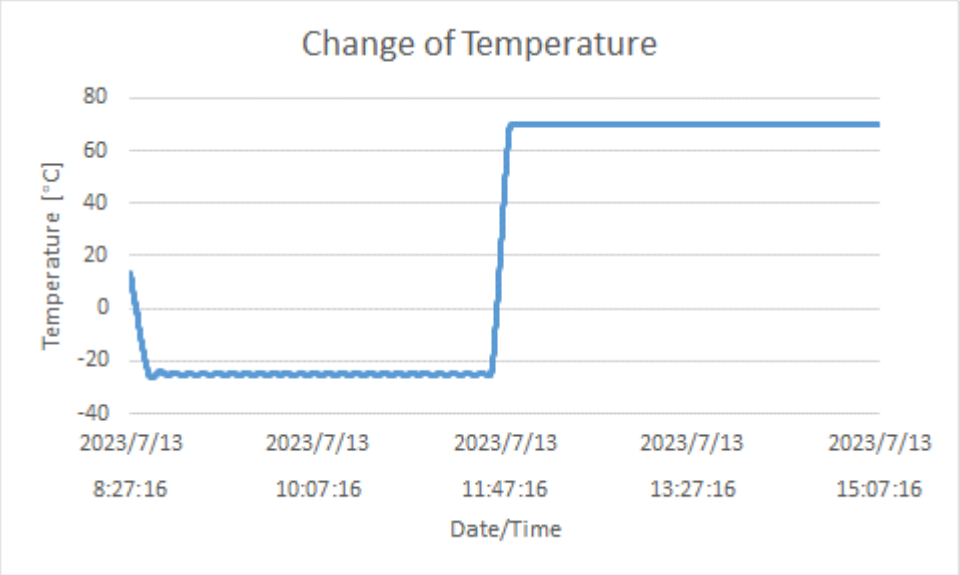


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Temperature diagram of unpowered equipment:

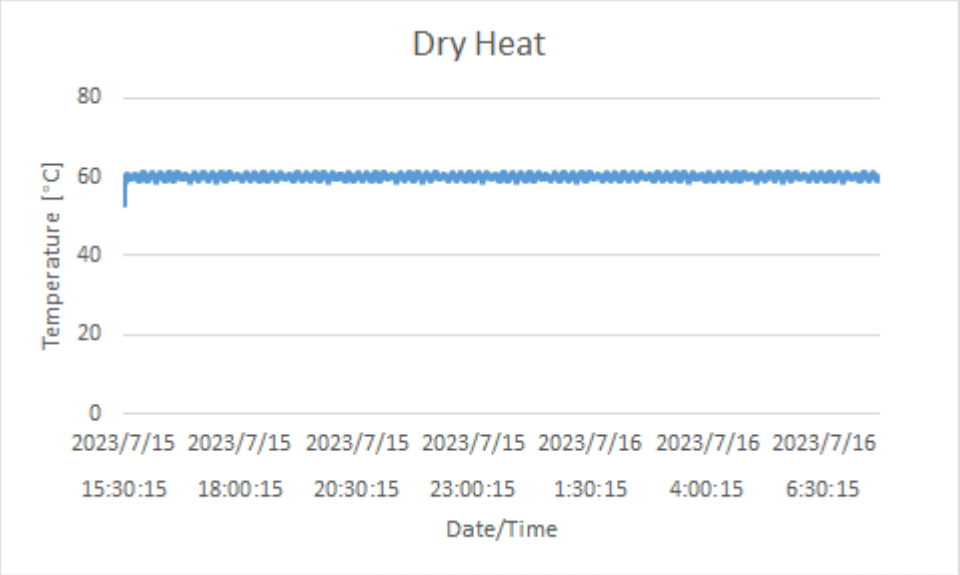


Temperature diagram of unpowered equipment:

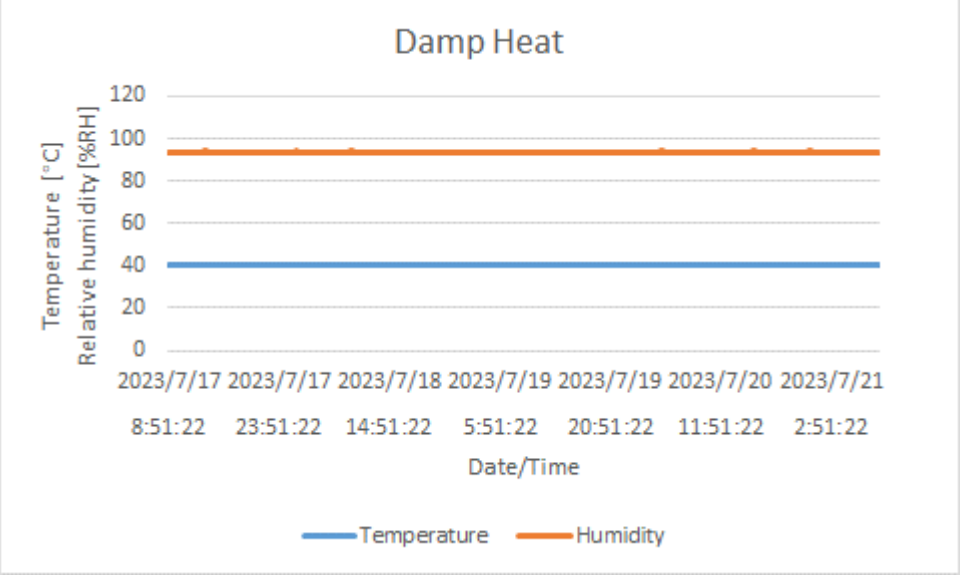


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Temperature diagram of powered equipment:

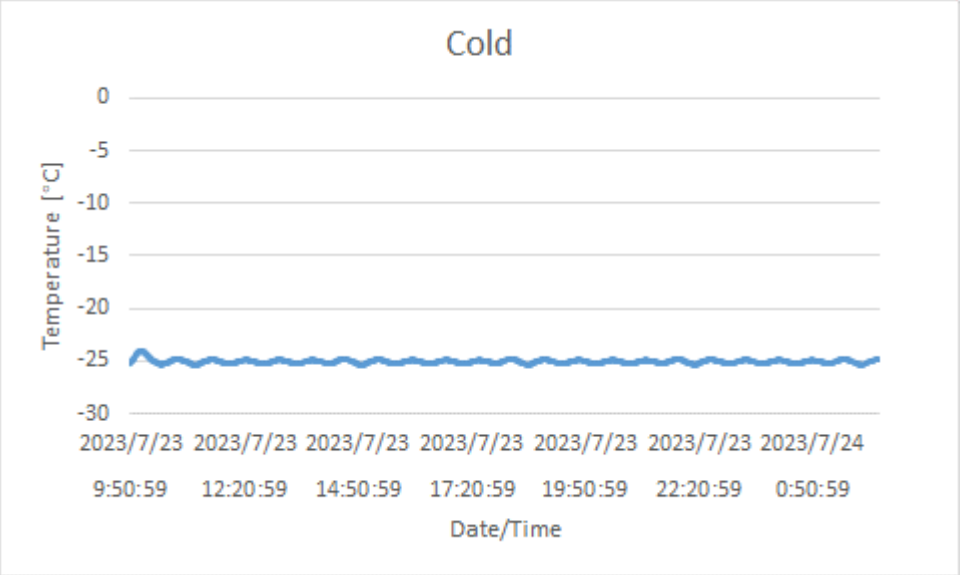


Temperature diagram of powered equipment:

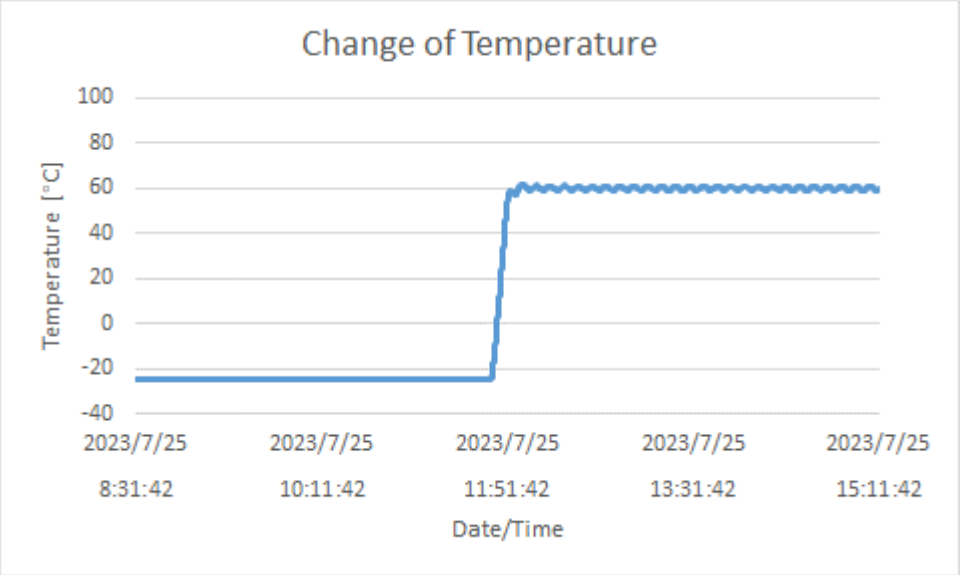


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Temperature diagram of powered equipment:



Temperature diagram of powered equipment:



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.8	**TABLE: Insulation tests (CEI EN 60255-5)**		**P**
Model	HNS3000TL-1		
Location		Test voltage	Result
Rigidity of electricity:			
AC to PE		2 kVac / 2,8kVdc	P
DC to PE		2 kVac / 2,8kVdc	P
AC to communication port		2 kVac / 2,8kVdc	P
DC to communication port		2 kVac / 2,8kVdc	P
Impulse test:			
AC to PE		5 kV (1,2/50µs)	P
DC to PE		5 kV (1,2/50µs)	P
AC to communication port		5 kV (1,2/50µs)	P
DC to communication port		5 kV (1,2/50µs)	P
Measurement of the insulation resistance:			
AC to PE		>100 MΩ at 500 Vdc	P
DC to PE		>100 MΩ at 500 Vdc	P
AC to communication port		>100 MΩ at 500 Vdc	P
DC to communication port		>100 MΩ at 500 Vdc	P
Note:			

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.9	**TABLE: Test for the overload capacity of measuring circuits**		**P**
Model	HNS3000TL-1		
Voltage		Test time	Result:
≥130%U_N		permanent	P
≥150%U_N		1s	P
Note: The unit is not allowed to be damaged while testing. The measurement circuit must show after the test the same values like befor the test.			

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

A.4.11	**TABLE: Automatic mechanism to prevent current imbalance during production**		**P**
Model	HNS3000TL-1		
Test No. 1			
Imbalance of power:		Test time:	Limit:
6kW<P<10kW		30min	max. 30 min
Test No.2			
Imbalance of power:		Test time:	Limit:
P>10kW		1min	max. 1 min

Note:
Test No.1
- System operating at its nominal conditions;
- Creation of a permanent artificial imbalance greater than 6 kW and less than 10 kW ;
- Checking the disconnection of the entire production system using the interface device (DDI) within a maximum time of 30 min.

Test No.2:
- System operating at its nominal conditions;
- Creation of a permanent artificial imbalance greater than 10 kW ;
- Checking the disconnection of the entire production system using the interface device (DDI) within a maximum time of 1 min.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) / b)	**TABLE: Harmonic current emission**	**P**
Model	HNS3000TL-1	
☒ CEI EN 61000-3-2 ☒ CEI EN 61000-3-12		
☒ Ambient temperature ☒ -25°C temperature ☒ +60°C temperature		
☒ 100% P_n ☒ 66% P_n ☒ 33% P_n		
Note: *If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test (such as -25°C / +60°C).		

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2)
25°C, 100% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.054	--	--	1.080
3rd	0.102	--	--	2.300
4th	0.024	--	--	0.430
5th	0.075	--	--	1.140
6th	0.003	--	--	0.300
7th	0.025	--	--	0.770
8th	0.008	--	--	0.230
9th	0.017	--	--	0.400
10th	0.004	--	--	0.184
11th	0.014	--	--	0.330
12th	0.007	--	--	0.153
13th	0.013	--	--	0.210
14th	0.006	--	--	0.131
15th	0.009	--	--	0.150
16th	0.004	--	--	0.115
17th	0.011	--	--	0.132
18th	0.008	--	--	0.102
19th	0.010	--	--	0.118
20th	0.007	--	--	0.092
21th	0.011	--	--	0.107
22th	0.005	--	--	0.084
23th	0.012	--	--	0.098
24th	0.010	--	--	0.077
25th	0.008	--	--	0.090
26th	0.009	--	--	0.071
27th	0.012	--	--	0.083
28th	0.005	--	--	0.066
29th	0.009	--	--	0.078
30th	0.007	--	--	0.061
31th	0.011	--	--	0.073
32th	0.005	--	--	0.058
33th	0.009	--	--	0.068
34th	0.005	--	--	0.054
35th	0.010	--	--	0.064
36th	0.005	--	--	0.051
37th	0.011	--	--	0.061
38th	0.005	--	--	0.048
39th	0.009	--	--	0.058
40th	0.004	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 100% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.051	--	--	1.080
3rd	0.102	--	--	2.300
4th	0.022	--	--	0.430
5th	0.076	--	--	1.140
6th	0.004	--	--	0.300
7th	0.025	--	--	0.770
8th	0.007	--	--	0.230
9th	0.017	--	--	0.400
10th	0.004	--	--	0.184
11th	0.014	--	--	0.330
12th	0.007	--	--	0.153
13th	0.013	--	--	0.210
14th	0.006	--	--	0.131
15th	0.009	--	--	0.150
16th	0.005	--	--	0.115
17th	0.011	--	--	0.132
18th	0.008	--	--	0.102
19th	0.011	--	--	0.118
20th	0.007	--	--	0.092
21th	0.011	--	--	0.107
22th	0.005	--	--	0.084
23th	0.012	--	--	0.098
24th	0.010	--	--	0.077
25th	0.009	--	--	0.090
26th	0.009	--	--	0.071
27th	0.011	--	--	0.083
28th	0.006	--	--	0.066
29th	0.009	--	--	0.078
30th	0.007	--	--	0.061
31th	0.011	--	--	0.073
32th	0.005	--	--	0.058
33th	0.009	--	--	0.068
34th	0.005	--	--	0.054
35th	0.010	--	--	0.064
36th	0.005	--	--	0.051
37th	0.011	--	--	0.061
38th	0.005	--	--	0.048
39th	0.008	--	--	0.058
40th	0.005	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 100% P_n power condition:				
Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.052	--	--	1.080
3rd	0.101	--	--	2.300
4th	0.024	--	--	0.430
5th	0.075	--	--	1.140
6th	0.004	--	--	0.300
7th	0.024	--	--	0.770
8th	0.007	--	--	0.230
9th	0.018	--	--	0.400
10th	0.004	--	--	0.184
11th	0.013	--	--	0.330
12th	0.006	--	--	0.153
13th	0.013	--	--	0.210
14th	0.006	--	--	0.131
15th	0.009	--	--	0.150
16th	0.004	--	--	0.115
17th	0.011	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.007	--	--	0.092
21th	0.010	--	--	0.107
22th	0.005	--	--	0.084
23th	0.011	--	--	0.098
24th	0.010	--	--	0.077
25th	0.008	--	--	0.090
26th	0.009	--	--	0.071
27th	0.011	--	--	0.083
28th	0.005	--	--	0.066
29th	0.009	--	--	0.078
30th	0.006	--	--	0.061
31th	0.011	--	--	0.073
32th	0.005	--	--	0.058
33th	0.008	--	--	0.068
34th	0.005	--	--	0.054
35th	0.010	--	--	0.064
36th	0.005	--	--	0.051
37th	0.011	--	--	0.061
38th	0.005	--	--	0.048
39th	0.008	--	--	0.058
40th	0.005	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2)
25°C, 66% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.038	--	--	1.080
3rd	0.065	--	--	2.300
4th	0.022	--	--	0.430
5th	0.026	--	--	1.140
6th	0.004	--	--	0.300
7th	0.019	--	--	0.770
8th	0.007	--	--	0.230
9th	0.011	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.013	--	--	0.210
14th	0.006	--	--	0.131
15th	0.012	--	--	0.150
16th	0.004	--	--	0.115
17th	0.008	--	--	0.132
18th	0.007	--	--	0.102
19th	0.011	--	--	0.118
20th	0.007	--	--	0.092
21th	0.012	--	--	0.107
22th	0.005	--	--	0.084
23th	0.007	--	--	0.098
24th	0.006	--	--	0.077
25th	0.012	--	--	0.090
26th	0.006	--	--	0.071
27th	0.012	--	--	0.083
28th	0.003	--	--	0.066
29th	0.009	--	--	0.078
30th	0.004	--	--	0.061
31th	0.013	--	--	0.073
32th	0.005	--	--	0.058
33th	0.007	--	--	0.068
34th	0.003	--	--	0.054
35th	0.006	--	--	0.064
36th	0.003	--	--	0.051
37th	0.009	--	--	0.061
38th	0.003	--	--	0.048
39th	0.006	--	--	0.058
40th	0.003	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 66% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.039	--	--	1.080
3rd	0.064	--	--	2.300
4th	0.020	--	--	0.430
5th	0.027	--	--	1.140
6th	0.004	--	--	0.300
7th	0.019	--	--	0.770
8th	0.007	--	--	0.230
9th	0.011	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.013	--	--	0.210
14th	0.006	--	--	0.131
15th	0.012	--	--	0.150
16th	0.004	--	--	0.115
17th	0.008	--	--	0.132
18th	0.007	--	--	0.102
19th	0.011	--	--	0.118
20th	0.008	--	--	0.092
21th	0.012	--	--	0.107
22th	0.005	--	--	0.084
23th	0.007	--	--	0.098
24th	0.005	--	--	0.077
25th	0.012	--	--	0.090
26th	0.005	--	--	0.071
27th	0.011	--	--	0.083
28th	0.003	--	--	0.066
29th	0.009	--	--	0.078
30th	0.004	--	--	0.061
31th	0.012	--	--	0.073
32th	0.005	--	--	0.058
33th	0.007	--	--	0.068
34th	0.003	--	--	0.054
35th	0.006	--	--	0.064
36th	0.003	--	--	0.051
37th	0.009	--	--	0.061
38th	0.003	--	--	0.048
39th	0.006	--	--	0.058
40th	0.003	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 66% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.037	--	--	1.080
3rd	0.065	--	--	2.300
4th	0.021	--	--	0.430
5th	0.027	--	--	1.140
6th	0.004	--	--	0.300
7th	0.019	--	--	0.770
8th	0.007	--	--	0.230
9th	0.011	--	--	0.400
10th	0.004	--	--	0.184
11th	0.009	--	--	0.330
12th	0.007	--	--	0.153
13th	0.014	--	--	0.210
14th	0.007	--	--	0.131
15th	0.012	--	--	0.150
16th	0.004	--	--	0.115
17th	0.008	--	--	0.132
18th	0.007	--	--	0.102
19th	0.011	--	--	0.118
20th	0.008	--	--	0.092
21th	0.012	--	--	0.107
22th	0.006	--	--	0.084
23th	0.007	--	--	0.098
24th	0.005	--	--	0.077
25th	0.012	--	--	0.090
26th	0.006	--	--	0.071
27th	0.011	--	--	0.083
28th	0.003	--	--	0.066
29th	0.009	--	--	0.078
30th	0.004	--	--	0.061
31th	0.013	--	--	0.073
32th	0.005	--	--	0.058
33th	0.007	--	--	0.068
34th	0.003	--	--	0.054
35th	0.006	--	--	0.064
36th	0.003	--	--	0.051
37th	0.009	--	--	0.061
38th	0.003	--	--	0.048
39th	0.006	--	--	0.058
40th	0.003	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 25°C, 33% P_n power condition:				
Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.034	--	--	1.080
3rd	0.093	--	--	2.300
4th	0.019	--	--	0.430
5th	0.014	--	--	1.140
6th	0.005	--	--	0.300
7th	0.008	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.007	--	--	0.210
14th	0.005	--	--	0.131
15th	0.013	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.002	--	--	0.084
23th	0.003	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.004	--	--	0.078
30th	0.004	--	--	0.061
31th	0.009	--	--	0.073
32th	0.004	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 33% P_n power condition:				
Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.035	--	--	1.080
3rd	0.093	--	--	2.300
4th	0.018	--	--	0.430
5th	0.014	--	--	1.140
6th	0.005	--	--	0.300
7th	0.008	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.007	--	--	0.210
14th	0.005	--	--	0.131
15th	0.013	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.002	--	--	0.084
23th	0.002	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.004	--	--	0.078
30th	0.004	--	--	0.061
31th	0.009	--	--	0.073
32th	0.004	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 33% P_n power condition:

Model	HNS3000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.035	--	--	1.080
3rd	0.095	--	--	2.300
4th	0.019	--	--	0.430
5th	0.014	--	--	1.140
6th	0.004	--	--	0.300
7th	0.009	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.008	--	--	0.153
13th	0.007	--	--	0.210
14th	0.006	--	--	0.131
15th	0.014	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.003	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.010	--	--	0.083
28th	0.002	--	--	0.066
29th	0.005	--	--	0.078
30th	0.004	--	--	0.061
31th	0.010	--	--	0.073
32th	0.004	--	--	0.058
33th	0.005	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2)
25°C, 100% P_n power condition:

Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.033	--	--	1.080
3rd	0.093	--	--	2.300
4th	0.019	--	--	0.430
5th	0.014	--	--	1.140
6th	0.005	--	--	0.300
7th	0.008	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.007	--	--	0.210
14th	0.005	--	--	0.131
15th	0.013	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.002	--	--	0.084
23th	0.003	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.004	--	--	0.078
30th	0.004	--	--	0.061
31th	0.009	--	--	0.073
32th	0.004	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 100% P_n power condition:

Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.035	--	--	1.080
3rd	0.094	--	--	2.300
4th	0.019	--	--	0.430
5th	0.014	--	--	1.140
6th	0.005	--	--	0.300
7th	0.009	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.010	--	--	0.330
12th	0.007	--	--	0.153
13th	0.007	--	--	0.210
14th	0.006	--	--	0.131
15th	0.013	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.003	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.004	--	--	0.078
30th	0.004	--	--	0.061
31th	0.009	--	--	0.073
32th	0.004	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 100% P_n power condition:				
Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.034	--	--	1.080
3rd	0.094	--	--	2.300
4th	0.018	--	--	0.430
5th	0.014	--	--	1.140
6th	0.005	--	--	0.300
7th	0.008	--	--	0.770
8th	0.005	--	--	0.230
9th	0.006	--	--	0.400
10th	0.004	--	--	0.184
11th	0.011	--	--	0.330
12th	0.007	--	--	0.153
13th	0.007	--	--	0.210
14th	0.006	--	--	0.131
15th	0.013	--	--	0.150
16th	0.003	--	--	0.115
17th	0.004	--	--	0.132
18th	0.007	--	--	0.102
19th	0.010	--	--	0.118
20th	0.005	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.003	--	--	0.098
24th	0.006	--	--	0.077
25th	0.011	--	--	0.090
26th	0.005	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.004	--	--	0.078
30th	0.004	--	--	0.061
31th	0.009	--	--	0.073
32th	0.004	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.005	--	--	0.064
36th	0.002	--	--	0.051
37th	0.007	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 25°C, 66% P_n power condition:				
Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.031	--	--	1.080
3rd	0.103	--	--	2.300
4th	0.016	--	--	0.430
5th	0.016	--	--	1.140
6th	0.005	--	--	0.300
7th	0.013	--	--	0.770
8th	0.005	--	--	0.230
9th	0.009	--	--	0.400
10th	0.005	--	--	0.184
11th	0.006	--	--	0.330
12th	0.006	--	--	0.153
13th	0.012	--	--	0.210
14th	0.007	--	--	0.131
15th	0.020	--	--	0.150
16th	0.003	--	--	0.115
17th	0.008	--	--	0.132
18th	0.005	--	--	0.102
19th	0.010	--	--	0.118
20th	0.004	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.006	--	--	0.098
24th	0.004	--	--	0.077
25th	0.010	--	--	0.090
26th	0.004	--	--	0.071
27th	0.008	--	--	0.083
28th	0.002	--	--	0.066
29th	0.006	--	--	0.078
30th	0.004	--	--	0.061
31th	0.007	--	--	0.073
32th	0.003	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.005	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 66% P_n power condition:

Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.034	--	--	1.080
3rd	0.102	--	--	2.300
4th	0.017	--	--	0.430
5th	0.016	--	--	1.140
6th	0.005	--	--	0.300
7th	0.013	--	--	0.770
8th	0.005	--	--	0.230
9th	0.009	--	--	0.400
10th	0.005	--	--	0.184
11th	0.007	--	--	0.330
12th	0.006	--	--	0.153
13th	0.012	--	--	0.210
14th	0.007	--	--	0.131
15th	0.020	--	--	0.150
16th	0.003	--	--	0.115
17th	0.008	--	--	0.132
18th	0.005	--	--	0.102
19th	0.010	--	--	0.118
20th	0.004	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.006	--	--	0.098
24th	0.004	--	--	0.077
25th	0.010	--	--	0.090
26th	0.004	--	--	0.071
27th	0.008	--	--	0.083
28th	0.002	--	--	0.066
29th	0.006	--	--	0.078
30th	0.004	--	--	0.061
31th	0.007	--	--	0.073
32th	0.003	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.005	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 66% P_n power condition:				
Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.031	--	--	1.080
3rd	0.103	--	--	2.300
4th	0.016	--	--	0.430
5th	0.017	--	--	1.140
6th	0.005	--	--	0.300
7th	0.013	--	--	0.770
8th	0.005	--	--	0.230
9th	0.009	--	--	0.400
10th	0.005	--	--	0.184
11th	0.006	--	--	0.330
12th	0.007	--	--	0.153
13th	0.012	--	--	0.210
14th	0.007	--	--	0.131
15th	0.020	--	--	0.150
16th	0.003	--	--	0.115
17th	0.007	--	--	0.132
18th	0.005	--	--	0.102
19th	0.010	--	--	0.118
20th	0.004	--	--	0.092
21th	0.014	--	--	0.107
22th	0.003	--	--	0.084
23th	0.006	--	--	0.098
24th	0.004	--	--	0.077
25th	0.010	--	--	0.090
26th	0.004	--	--	0.071
27th	0.008	--	--	0.083
28th	0.002	--	--	0.066
29th	0.006	--	--	0.078
30th	0.004	--	--	0.061
31th	0.007	--	--	0.073
32th	0.003	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.005	--	--	0.061
38th	0.002	--	--	0.048
39th	0.004	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 25°C, 33% P_n power condition:				
Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.028	--	--	1.080
3rd	0.071	--	--	2.300
4th	0.017	--	--	0.430
5th	0.044	--	--	1.140
6th	0.009	--	--	0.300
7th	0.037	--	--	0.770
8th	0.007	--	--	0.230
9th	0.028	--	--	0.400
10th	0.005	--	--	0.184
11th	0.014	--	--	0.330
12th	0.004	--	--	0.153
13th	0.010	--	--	0.210
14th	0.006	--	--	0.131
15th	0.019	--	--	0.150
16th	0.003	--	--	0.115
17th	0.015	--	--	0.132
18th	0.003	--	--	0.102
19th	0.015	--	--	0.118
20th	0.003	--	--	0.092
21th	0.011	--	--	0.107
22th	0.002	--	--	0.084
23th	0.007	--	--	0.098
24th	0.003	--	--	0.077
25th	0.010	--	--	0.090
26th	0.003	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.008	--	--	0.078
30th	0.003	--	--	0.061
31th	0.005	--	--	0.073
32th	0.002	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.004	--	--	0.061
38th	0.002	--	--	0.048
39th	0.005	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) -25°C, 33% P_n power condition:

Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.027	--	--	1.080
3rd	0.070	--	--	2.300
4th	0.017	--	--	0.430
5th	0.044	--	--	1.140
6th	0.009	--	--	0.300
7th	0.037	--	--	0.770
8th	0.006	--	--	0.230
9th	0.028	--	--	0.400
10th	0.005	--	--	0.184
11th	0.014	--	--	0.330
12th	0.004	--	--	0.153
13th	0.010	--	--	0.210
14th	0.006	--	--	0.131
15th	0.019	--	--	0.150
16th	0.003	--	--	0.115
17th	0.015	--	--	0.132
18th	0.003	--	--	0.102
19th	0.014	--	--	0.118
20th	0.003	--	--	0.092
21th	0.012	--	--	0.107
22th	0.002	--	--	0.084
23th	0.007	--	--	0.098
24th	0.003	--	--	0.077
25th	0.010	--	--	0.090
26th	0.003	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.008	--	--	0.078
30th	0.003	--	--	0.061
31th	0.005	--	--	0.073
32th	0.002	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.004	--	--	0.061
38th	0.002	--	--	0.048
39th	0.005	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1 a) Harmonics measurement under test condition 25°C /-25°C / 60°C (CEI EN 61000-3-2) 60°C, 33% P_n power condition:

Model	HNS1000TL-1			
Harmonic	L1 Phase (A)	L2 Phase (A)	L3 Phase (A)	Limit (A)
2nd	0.028	--	--	1.080
3rd	0.071	--	--	2.300
4th	0.018	--	--	0.430
5th	0.044	--	--	1.140
6th	0.009	--	--	0.300
7th	0.037	--	--	0.770
8th	0.006	--	--	0.230
9th	0.028	--	--	0.400
10th	0.005	--	--	0.184
11th	0.014	--	--	0.330
12th	0.004	--	--	0.153
13th	0.010	--	--	0.210
14th	0.006	--	--	0.131
15th	0.019	--	--	0.150
16th	0.003	--	--	0.115
17th	0.015	--	--	0.132
18th	0.003	--	--	0.102
19th	0.015	--	--	0.118
20th	0.003	--	--	0.092
21th	0.011	--	--	0.107
22th	0.002	--	--	0.084
23th	0.007	--	--	0.098
24th	0.003	--	--	0.077
25th	0.010	--	--	0.090
26th	0.003	--	--	0.071
27th	0.009	--	--	0.083
28th	0.002	--	--	0.066
29th	0.007	--	--	0.078
30th	0.003	--	--	0.061
31th	0.005	--	--	0.073
32th	0.002	--	--	0.058
33th	0.004	--	--	0.068
34th	0.002	--	--	0.054
35th	0.006	--	--	0.064
36th	0.002	--	--	0.051
37th	0.004	--	--	0.061
38th	0.002	--	--	0.048
39th	0.005	--	--	0.058
40th	0.002	--	--	0.046

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B1 c)	**TABLE: Flicker emission**	**P**
Model	HNS3000TL-1	

Normal ambient				
Output power:	Flicker limits according to*:	Result:		
		Plt	Pst	dc%
33%	EN61000-3-3 / EN61000-3-11	0.235	0.275	0.035
66%	EN61000-3-3 / EN61000-3-11	0.224	0.271	0.040
100%	EN61000-3-3 / EN61000-3-11	0.230	0.284	0.031
Minimum ambient rating or -25°C				
Output power:	Flicker limits according to*:	Result:		
		Plt	Pst	dc%
33%	EN61000-3-3 / EN61000-3-11	0.221	0.282	0.037
66%	EN61000-3-3 / EN61000-3-11	0.226	0.274	0.039
100%	EN61000-3-3 / EN61000-3-11	0.225	0.275	0.039
Maximum ambient rating or 60°C				
Output power:	Flicker limits according to*:	Result:		
		Plt	Pst	dc%
33%	EN61000-3-3 / EN61000-3-11	0.207	0.277	0.033
66%	EN61000-3-3 / EN61000-3-11	0.222	0.263	0.040
100%	EN61000-3-3 / EN61000-3-11	0.223	0.278	0.036

Note:
* Mains Impedance according EN61000-3-3 / EN61000-3-11: **R_{max} = Ω; jX_{max}= Ω @50Hz (|Z_{max}| = Ω)**

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:
$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$

The tests should be based on the limits of the EN61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.
If the EUT operating temperature out of -10°C to 55°C, please use the upper and lower operating temperature limit in the test (such as -25°C / +60°C).

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.019	Pass	0.386	Pass	0.0	Pass	0.268	Pass		
2	0.027	Pass	0.312	Pass	0.0	Pass	0.203	Pass		
3	0.021	Pass	0.382	Pass	0.0	Pass	0.203	Pass		
4	0.027	Pass	0.289	Pass	0.0	Pass	0.268	Pass		
5	0.020	Pass	0.356	Pass	0.0	Pass	0.258	Pass		
6	0.018	Pass	0.304	Pass	0.0	Pass	0.248	Pass		
7	0.025	Pass	0.397	Pass	0.0	Pass	0.236	Pass		
8	0.035	Pass	0.324	Pass	0.0	Pass	0.228	Pass		
9	0.020	Pass	0.306	Pass	0.0	Pass	0.275	Pass		
10	0.021	Pass	0.293	Pass	0.0	Pass	0.232	Pass		
11	0.018	Pass	0.346	Pass	0.0	Pass	0.207	Pass		
12	0.027	Pass	0.344	Pass	0.0	Pass	0.193	Pass		
Result		Pass		Pass		Pass		Pass	0.235	Pass

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

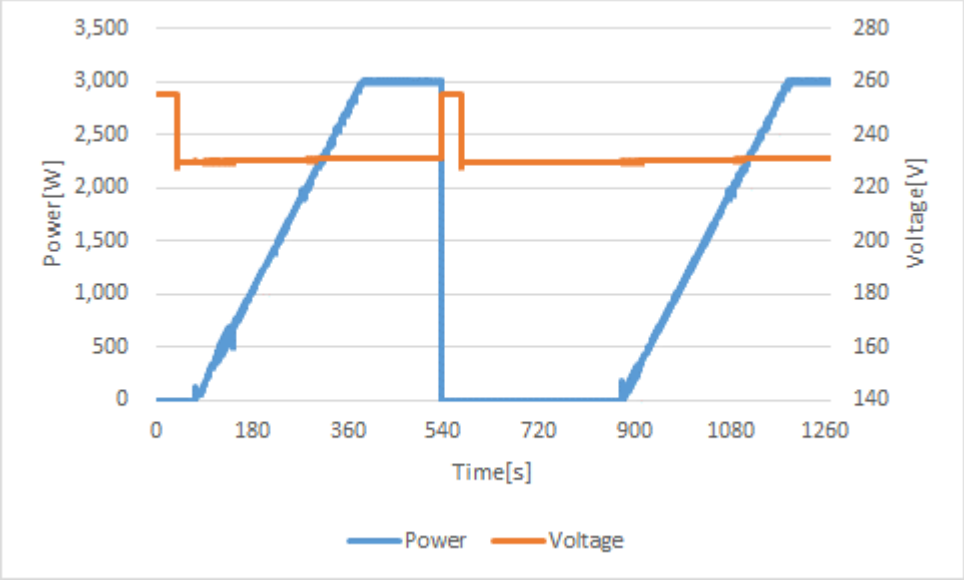
B.1.1	**TABLE: Conditions of connection, reconnection and gradual power supply**		**P**
Model	HNS3000TL-1		
Test:			
Power meter measurment-data:	Sample-Rate:	0.2 s	
	Sample time:	6400	
	Voltage conditons		
a) Out of voltage range	84% U_n for 30s	111% U_n for 30s	
Connection:	No connection	No connection	
Limit	No connection allowed		
b) In voltage range at start-up	85% U_n < U <110% U_n		
Reconnection time [s]	34.4	35.4	
Limit:	Reconnection after 30s		
Gradient:	Gradient schould be recorded for at least 300s until the inverter has the full output power. Max gradient: 20%Pn/min For recorded gradient see diagram underneath		
c) In voltage range after voltage failture	85% U_n < U <110% U_n		
Reconnection time [s]	304.4	304.2	
Limit:	Reconnection after 300s		
Gradient:	Gradient schould be recorded for at least 300s until the inverter has the full output power. Max gradient: 20%Pn/min For recorded gradient see diagram underneath		
	Frequency conditions		
d) Out of frequency range	49.88 ± 0.01	50.12 ± 0.01	
Connection:	No connection	No connection	
Limit	No connection allowed		
e) In frequency range at start-up	49,90 Hz < f < 50,10		
Reconnection time [s]	34.6	34.6	
Limit:	Reconnection after 30s		
Gradient:	Gradient schould be recorded for at least 300s until the inverter has the full output power. Max gradient: 20%Pn/min For recorded gradient see diagram underneath		
f) In frequency range after frequency failture	49.90 Hz < f < 50.10		
Reconnection time [s]	305.2	305.6	
Limit:	Reconnection after 300s		
Gradient:	Gradient schould be recorded for at least 300s until the inverter has the full output power. Max gradient: 20%Pn/min For recorded gradient see diagram underneath		

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

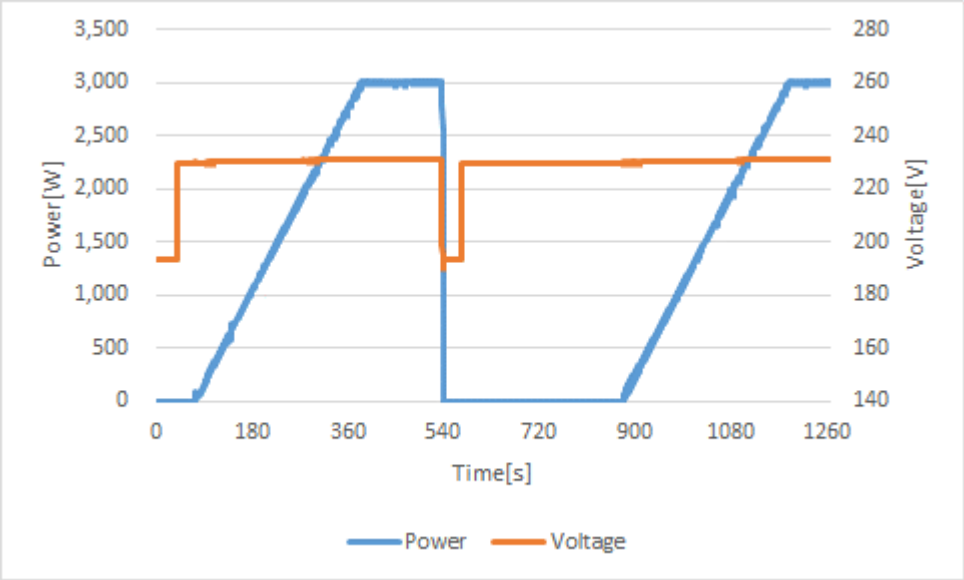
Changable reconnection conditions:	Frequency range: 49Hz-51Hz in 0.05Hz steps (default value: 49.90 and 50.10Hz)	Reconnection time range: 0-900s in steps of 5s (default value: 300s)

Test:
Test condition b) and c): voltage within the limits of 85% to 110%U_n
Test condition e) and f): frequency within the limits of 49.90Hz to 50.10Hz
Max deviation of the gradient: +2.5%P_n

Over Voltage

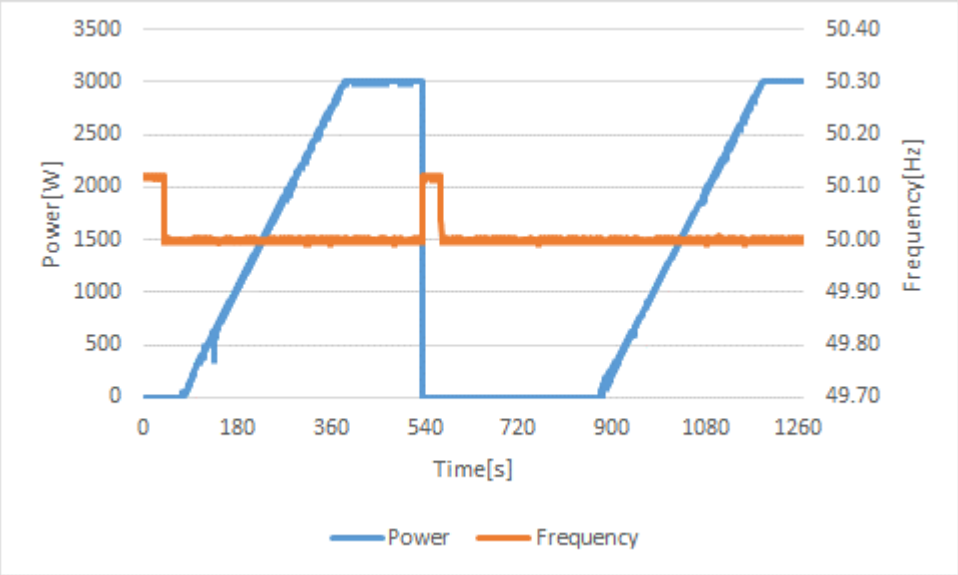


Under Voltage

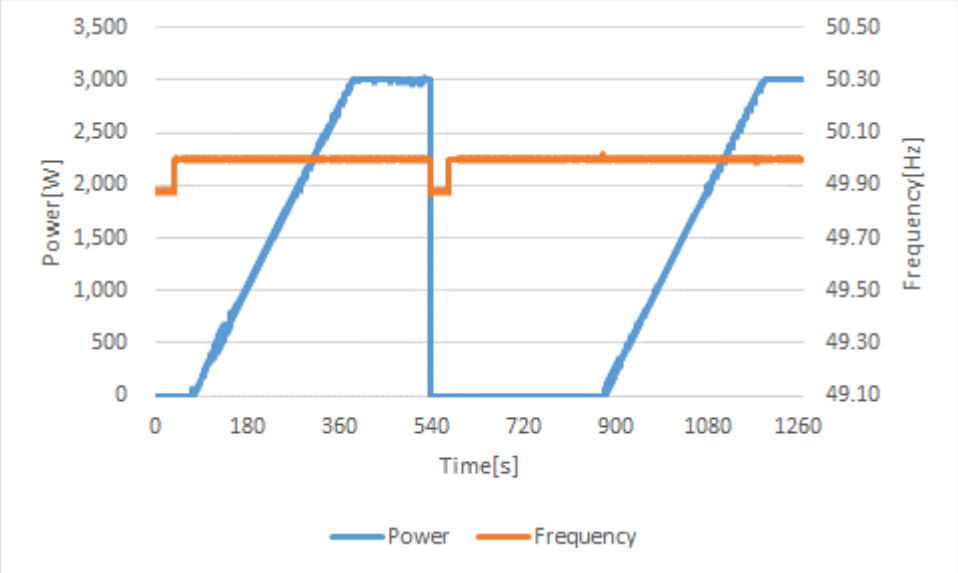


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Over Frequency



Under Frequency



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.2.2.2	**TABLE: Reactive power capability - Inverter in systems with total capacity greater than 11.08 kW**	**P**
Model	HNS3000TL-1	

TABLE: Reactive power production with set point Q = 0

Power-Bin	Active Power		Reactive Power		DC Power		Power Factor
	W	p.u.	VAr	p.u.	W	p.u.	Cos φ
0% -10%(*)	237	7.90%	67	2.23%	248	8.27%	0.9627
10% -20%(**)	545	18.17%	67	2.23%	569	18.97%	0.9925
20% -30%	843	28.10%	66	2.20%	877	29.23%	0.9969
30% -40%	1157	38.57%	69	2.30%	1201	40.03%	0.9982
40% -50%	1461	48.70%	61	2.03%	1521	50.70%	0.9989
50% -60%	1765	58.83%	67	2.23%	1805	60.17%	0.9976
60% -70%	2064	68.80%	65	2.17%	2126	70.87%	0.9979
70% -80%	2367	78.90%	63	2.10%	2481	82.70%	0.9996
80% -90%	2667	88.90%	63	2.10%	2772	92.40%	0.9997
90% -100%(***)	3042	101.40%	62	2.07%	3174	105.80%	0.9998

TABLE: Reactive power production with set point Q = -Q_{max} (>11.08 kW) or cos φ = -0.9 (≤ 11.08 kW)

Power-Bin	Active Power		Reactive Power		DC Power		Power Factor
	W	p.u.	VAr	p.u.	W	p.u.	Cos φ
0% -10%(*)	237	7.90%	67	2.23%	246	8.20%	0.9623
10% -20%(**)	545	18.17%	68	2.27%	561	18.70%	0.9924
20% -30%	820	27.33%	-1481	-49.37%	843	28.10%	0.4844
30% -40%	1127	37.57%	-1483	-49.43%	1156	38.53%	0.6049
40% -50%	1432	47.73%	-1486	-49.53%	1482	49.40%	0.6940
50% -60%	1736	57.87%	-1488	-49.60%	1806	60.20%	0.7593
60% -70%	2038	67.93%	-1490	-49.67%	2128	70.93%	0.8073
70% -80%	2339	77.97%	-1492	-49.73%	2453	81.77%	0.8431
80% -90%	2629	87.63%	-1496	-49.87%	2771	92.37%	0.8692
90% -100%(***)	2638	87.93%	-1494	-49.80%	2774	92.47%	0.8702

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

TABLE: Reactive power production with set point Q =+Q_{max} (>11.08 kW) or cos φ = +0.9 (≤ 11.08 kW)

Power-Bin	Active Power		Reactive Power		DC Power		Power Factor
	W	p.u.	VAr	p.u.	W	p.u.	Cos φ
0% -10%(*)	237	7.90%	67	2.23%	248	8.27%	0.9620
10% -20%(**)	545	18.17%	67	2.23%	568	18.93%	0.9924
20% -30%	842	28.07%	1511	50.37%	878	29.27%	0.4869
30% -40%	1148	38.27%	1503	50.10%	1195	39.83%	0.6071
40% -50%	1453	48.43%	1495	49.83%	1503	50.10%	0.6970
50% -60%	1757	58.57%	1489	49.63%	1805	60.17%	0.7629
60% -70%	2059	68.63%	1482	49.40%	2127	70.90%	0.8116
70% -80%	2359	78.63%	1476	49.20%	2452	81.73%	0.8478
80% -90%	2659	88.63%	1470	49.00%	2773	92.43%	0.8752
90% -100%(***)	2660	88.67%	1465	48.83%	2783	92.77%	0.8759

Note:
The PV inverter maximum reactive power set point Q = 48.43%P_D.
(*) For power outputs less than 10% of the nominal power the generator must not exchange a reactive power higher than 10% of the nominal power.
(**) For power outputs less than 20% of the nominal power the generator must not exchange a reactive power higher than 10% of the nominal power.
(***)Ensure that the minimum requirement for cos is sustained steadily when thermal balance is achieved.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.2.3	**TABLE: Reactive power supply at an assigned level (greater 11.08 kW systems, but can requested for smaller systems as well)**			**P**
Model	HNS3000TL-1			
Power meter measurment data:		Sample-Rate:	0.2 s	
		Samples time:	3 min for each power point	
P_N in %		Qmin/cosφ min (180s)	Q=0/ cosφ=0 (180s)	Qmax/cosφ max (180s)

50% P_n	Reactive power Set point Q/P_n [%]	Reactive power measured Q/P_n [%]	Deviation from set point $\Delta Q/P_n$ [%]	Limit [%]
$-Q_{min}$	-48.43%	-49.46%	-1.03%	$\Delta Q \leq \pm 2.5\% P_n$
0	0.00%	2.03%	2.03%	$\Delta Q \leq \pm 2.5\% P_n$
$+Q_{max}$	48.43%	49.84%	1.41%	$\Delta Q \leq \pm 2.5\% P_n$

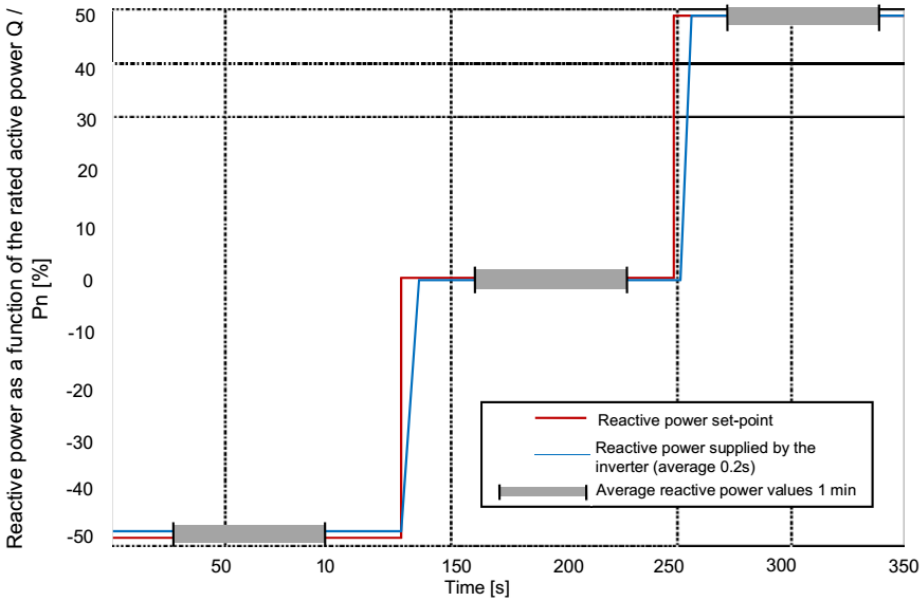


Figure 48 - Measurement of the reactive power delivered based on an external command, accuracy check

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test procedure:

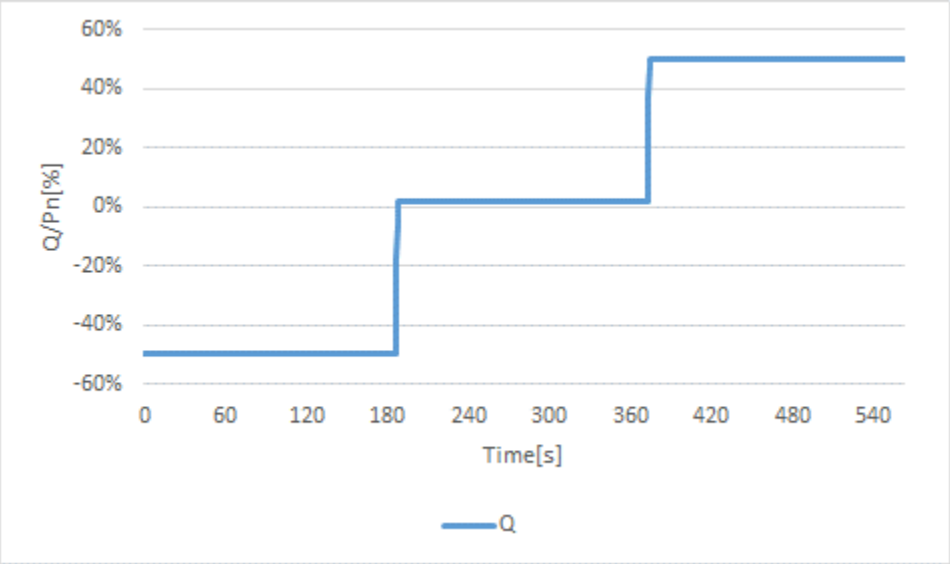
–Set the DC source so that the inverter delivers about 50% of the nominal active power Pn.

–Using the methods and the control parameter established by the manufacturer, vary the reactive power supplied by the converter passing from the maximum inductive value (at least equal to Qmin ≤ -0.4843 Pn) directly to zero (Q = 0), and then go from zero at the maximum capacitive value (equal to Qmax ≥ + 0.4843 Pn).

–Maintain each of the 3 limit set-points for 180 s.

–Calculate the average values of reactive power at 1 min on the basis of the values measured over a window of 200 ms at the fundamental frequency. The calculation of the value on an average of 1 min must start from the samples detected after 30 s from the instant in which the command of the new reactive power regulation set-point is sent, this is to ensure that the system has reached the steady state.

Diagram



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.2.4	**TABLE: Response time to an assigned step level change (greater 11.08 kW systems)**		**P**
Model	HNS3000TL-1		
Test:			
Power meter measurment data:	Sample-Rate:	0.2 s	
	Samples time:	at least 2 minutes for each power point	
file: 50% P_{Emax} Q=0→Qmin→Qmax→Q=0	0.06 s		
file: 100% P_{Emax} Q=0→Qmin→Qmax→Q=0	0.05 s		

Test:
DC source should be set to 50% (test1) and 100% (test 2) output power
Starting with Q=0 then Qmin≤ -0.4843 P_n to to Qmax≥ 0.4843 P_n, and then back to Q=0 in doing so each point must be kept for at least 2 minute.

The total tolerance is ΔQ ≤ ±5,0% of P_n or Δcosφ ≤ ±0.01
The maximum response time is 10s.

As for the requirements of the previous paragraph, also in this case the tests are required to inverters used in plants with a total power greater than 11.08 kW, which must also be able to implement a centralized control strategy via remote control signal, issued by the Distributor. However, the manufacturer has the right to voluntarily carry out tests even for smaller inverters.

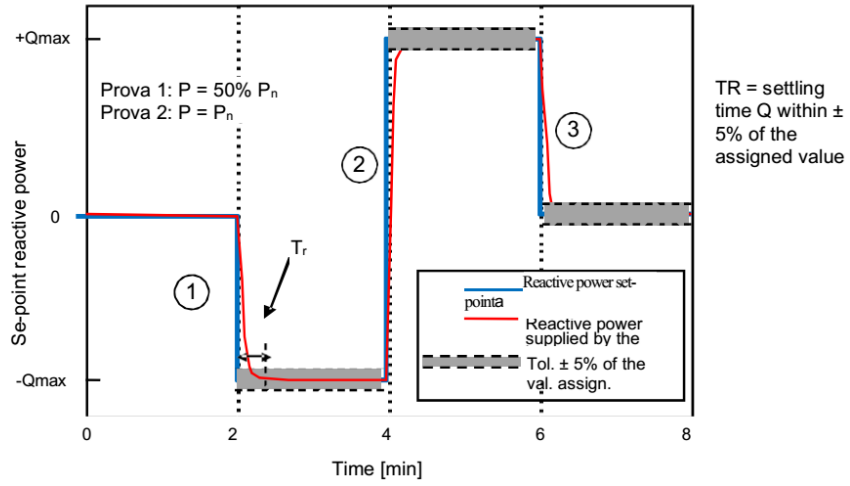
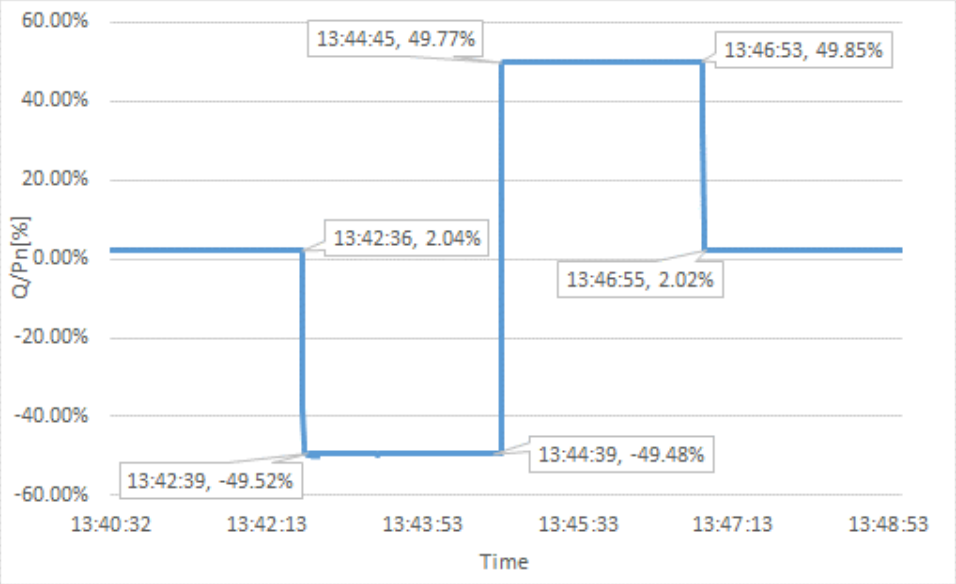


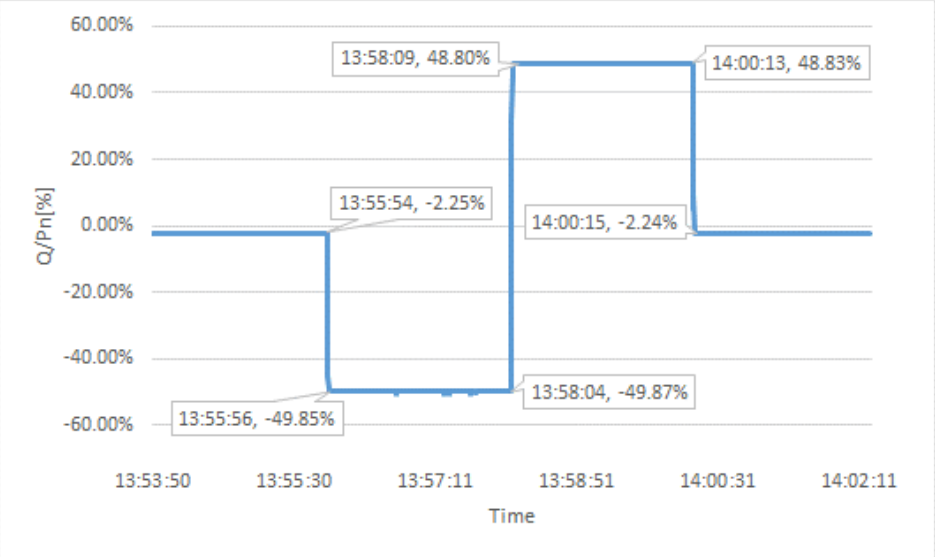
Figure 49 - Measurement of the response time to step changes of the set-point assigned for the reactive power

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test1



Test2



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.2.5	**TABLE: Automatic supply of reactive power according to the characteristic curve cos φ=f(P)**	**P**
Model	HNS3000TL-1	

Test:
Test points A-F: Set the system voltage to 1.04V_n (default lock-in value of the manufacture1.05V_n) and increases the active power from 20% P_{Emax} in increments of 10% P_E to 60%.
Test points G-H: Set the system voltage to 1,06V_n increases the active power from 60% P_E to 100% P_{Emax}.
Test points J: Set the system voltage back to V_n at 100% P_{Emax} and check that the inverter still remain in reactive power supply.
The total tolerance is Δcosφ ≤ ±0.01

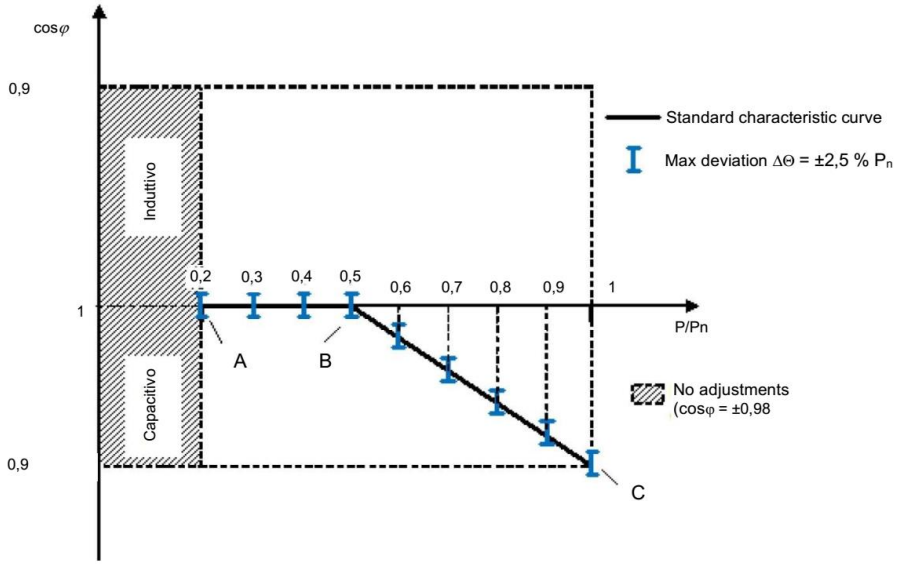


Figure 50 - Standard characteristic curve cosφ = f(P)

Assessment criterion:
Test 1: cos φ accuracy cos φ (±0.01)
Test 2: cos φ accuracy cos φ (±0.01)
For the test to be passed, the cos φ setpoint from the active power must be measured at the terminals of the PGU within a settling time of 10 s.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Model:	HNS3000TL-1							
P/P_{SMAX} [%]	P[W]	Vout[V]	Q[Var]	Cos φ Setpoint	Cos φ measured	ΔCosφ	Limit Δcosφ_max	Result
20	625	104.00	79	1.00	0.992	-0.008	≤ ± 0.01	P
30	919	104.05	81	1.00	0.996	-0.004	≤ ± 0.01	P
40	1212	104.09	81	1.00	0.998	-0.002	≤ ± 0.01	P
50	1512	104.15	83	1.00	0.998	-0.002	≤ ± 0.01	P
60	1807	104.20	85	1.00	0.999	-0.001	≤ ± 0.01	P
60	1811	106.20	-364	0.98	0.981	0.001	≤ ± 0.01	P
70	2108	106.23	-608	0.96	0.961	0.001	≤ ± 0.01	P
80	2402	106.28	-861	0.94	0.941	0.001	≤ ± 0.01	P
90	2703	106.34	-1143	0.92	0.921	0.001	≤ ± 0.01	P
100	2741	106.35	-1294	0.90	0.903	0.003	≤ ± 0.01	P
100	2744	102.40	-1305	0.90	0.904	0.004	≤ ± 0.01	P
100	3008	100.26	-104	1.00	0.999	-0.001	≤ ± 0.01	P

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B1.2.6	TABLE: Automatic supply of reactive power according to the characteristic curve Q= f(V) (greater 11.08kW systems)		P
Over voltage & Under voltage			
Power meter measurement data:	Sample-Rate:	0.2 s	
	Samples:	1000	

Test**:**

Test points A-I: Set the system voltage to 1.07 V_n / 0.93V_n (default lock-in value of the manufacture 1.08 V_n / 0.92V_n) and set up the active power to less than 20%. After stabilisation of this point increase the grid voltage from 0.93 to 0.91 and 1.08 to 1.10 V_n in 1V steps but hold the active power <20% $P_{E.}$ The active power should be now increase to 30% and and then from 30% P_{Emax} in increments of 10% P_E to 100%.

Test points J-K: Set the system voltage to 1.10V_n and 0.90V_n decreases the active power from 100% P_E to 10% P_{Emax} and after at least 30s smaller than 5% P_{Emax}.

The total tolerance is ΔQ ≤ ±2.5% of P_n

The inverter must be able to delay the activation of the curve from 0s - 30s (in 1s steps / default setting: 3s)

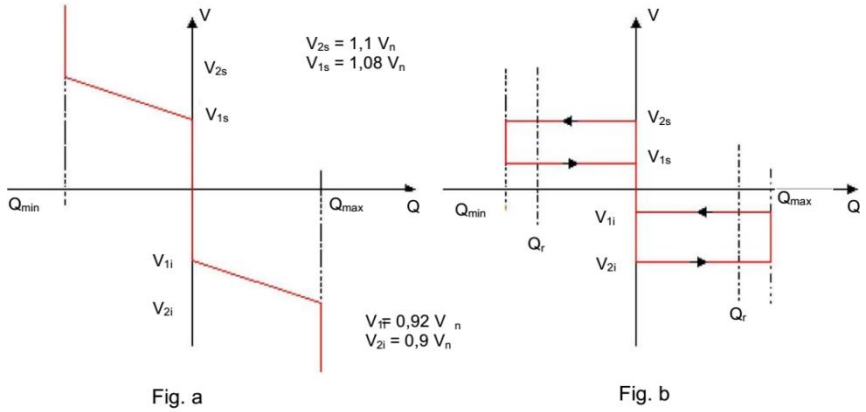


Figure 51 - Standard characteristic curves Q = f (V)

Curve settings:

V_{1s} =1.08V_n; V_{2s} = 1.1V_n

V_{1i} =0.92V_n; V2i = 0.9V_n

(V_{1i}, V_{2i}, V_{1s} and V_{2s} must be programmable in a range 0.9-1.1V_n with steps 0.01V_n)

Assessment criterion:

Test 1: cos φ accuracy cos φ (±0.01)

Test 2: cos φ accuracy cos φ (±0.01)

For the test to be passed, the cos φ setpoint from the active power must be measured at the terminals of the PGU within a settling time of 10 s.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.2.6	TABLE: Automatic supply of reactive power according to the characteristic curve Q= f(V) (greater 11.08kW systems)					P
Model	HNS3000TL-1					
Q_{min} reactive power in accordance to standard characteristic curve Q=f(V)						
P/P_n [%] Set-point	Vac [V] Set-point	P/P_n [%] measured	Vac [V] measured	Q [Var] measured	Q [Var] expected	ΔQ [≤±2.5%P_n]
< 20%	1.07Vn	18.86%	246.05	65	≈0(<±2.5%Pn)	2.17%
< 20%	1.09Vn	18.90%	250.67	66	≈0(<±2.5%P)	2.20%
< 20%-> 30%	1.09Vn	30.52%	250.79	-701	-0.5 Q_{min} (within 10s)	0.85%
40%	1.09V_n	40.33%	250.80	-696	-0.5 Q_{min}	1.02%
50%	1.09V_n	50.37%	250.81	-710	-0.5 Q_{min}	0.55%
60%	1.09V_n	60.27%	250.83	-728	-0.5 Q_{min}	-0.05%
70%	1.09V_n	70.24%	250.82	-732	-0.5 Q_{min}	-0.18%
80%	1.09V_n	80.21%	250.72	-734	-0.5 Q_{min}	-0.25%
90%	1.09V_n	90.20%	250.64	-753	-0.5 Q_{min}	-0.88%
100%	1.09V_n	97.78%	250.59	-770	-0.5 Q_{min}	-1.49%
100%	1.1 V_n	88.78%	253.85	-1449	- Q_{min}	0.13%
100%->10%	1.1 V_n	9.15%	253.51	-1504	- Q_{min}	-1.70%
10%-> ≤5%	1.1 V_n	3.63%	252.48	62	≈0 (<±5%P_n)	2.07%
Q_{max} reactive power in accordance to standard characteristic curve Q=f(V)						
P/P_n [%] Set-point	Vac [V] Set-point	P/P_n [%] measured	Vac [V] measured	Q [Var] measured	Q [Var] expected	ΔQ [≤±2.5%P_n]
< 20%	0.93V_n	18.42%	214.02	-62	≈0 (<±2.5%P_n)	-2.07%
< 20%	0.91V_n	18.70%	209.42	-61	≈0 (<±2.5%P_n)	-2.03%
< 20%-30%	0.91V_n	30.58%	209.31	736	-0.5 Q_{max} (within 10s)	0.32%
40%	0.91V_n	40.48%	209.35	727	-0.5 Q_{max}	0.02%
50%	0.91V_n	50.18%	209.27	725	-0.5 Q_{max}	-0.05%
60%	0.91V_n	60.37%	209.21	711	-0.5 Q_{max}	-0.52%
70%	0.91V_n	70.25%	209.17	709	-0.5 Q_{max}	-0.58%
80%	0.91V_n	80.19%	209.08	694	-0.5 Q_{max}	-1.08%
90%	0.91V_n	90.64%	209.52	671	-0.5 Q_{max}	-1.85%
100%	0.91V_n	98.43%	209.38	682	-0.5 Q_{max}	-1.48%
100%	0.90V_n	88.93%	206.21	1442	- Q_{max}	-0.36%
100%-10%	0.90V_n	8.84%	206.56	1445	- Q_{max}	-0.26%
10%-5%	0.90V_n	4.00%	206.46	-62	≈0(<±5%P_n)	-2.07%

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Note:

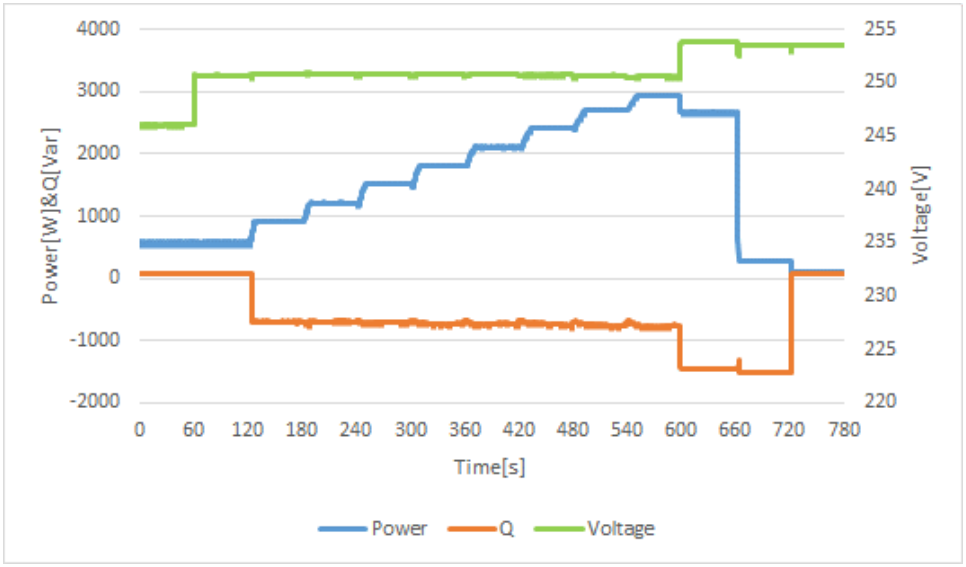
The lock-in value is adjustable between V_n and $1.1V_n$ and the lock-out value between V_n and $0.9V_n$ in 0.01V steps.

The inverter voltage on the AC side of the (inverter) is rated to 400V line to line.

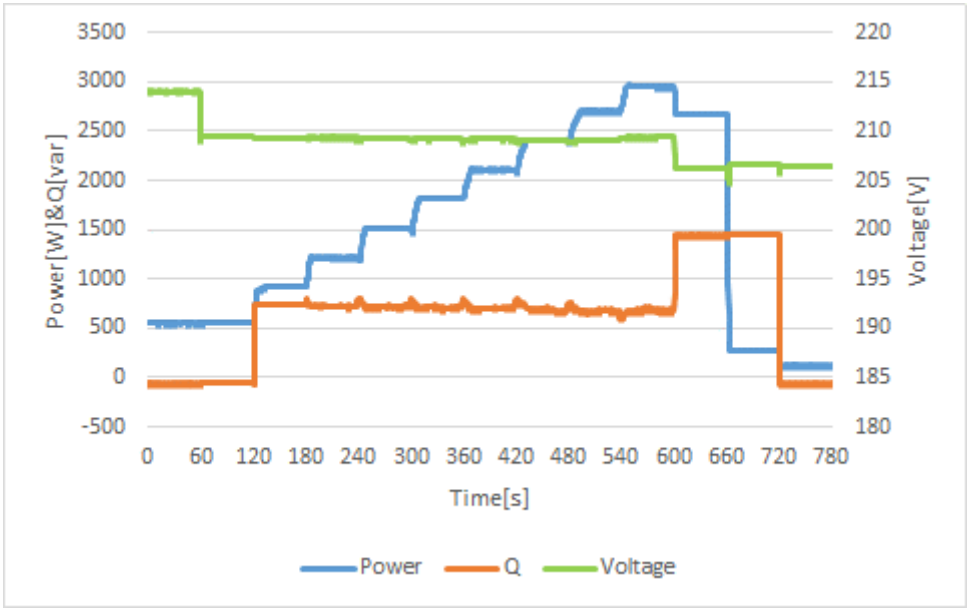
In reference to the circular characteristic, the inverter reduces the active output power to maintain the reactive output power.

The under voltage measurement effects the active output power in reference to the reactive output power since the reactive output power has always priority. Therefore the inverter must lower the active output power.

Over Voltage



Under Voltage

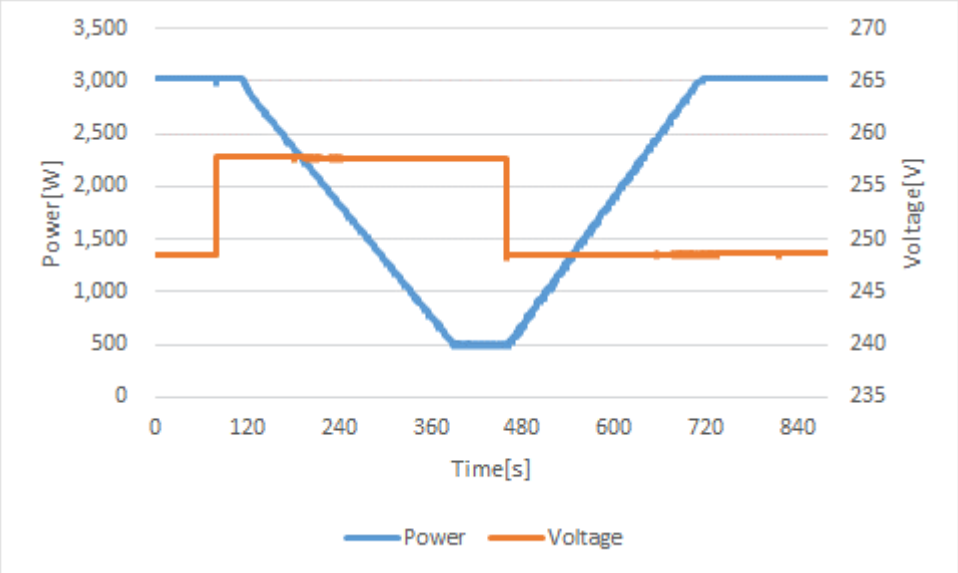


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.3.1	**TABLE: Automatic limitation of active power for voltage values close to 110% of the rated voltage**					**P**
Model	HNS3000TL-1					
Set point		Activation threshold U_1			Deactivation threshold U_2	
U/U_n		110%			112%	
P/P_n		100%			20%	
Step	Set voltage [V/Vn]	Voltage [V]	Measured power [W]	Measured power [%]	Limit	Result
1	1.08	248.56	3026	100.87	--	P
2	1.12	257.71	500	16.67	P <20%P_n	P
3	1.08	248.55	3025	100.83	--	P

The purpose of the test is to verify the automatic reduction function of the active power delivered when the voltage read at the generator terminals has a value close to 110% of V_n.
Proceed as follows:

- enable the active power reduction function P(U), according to the methods indicated by the manufacturer (which must be reported in the test report);
- adjust the voltage read at the output terminals of the converter to -2% of the activation threshold declared by the manufacturer and the DC source, so that the active power delivered at the output is equal to the maximum power available for injection;
- adjust the voltage read at the output terminals of the converter to + 2% of the activation threshold declared by the manufacturer;
- the active power is measured as averages at 1 s, plotting the values obtained as a function of time;
- within 5 minutes from the instant of application of the voltage + 2% of the activation threshold declared by the manufacturer, it is verified that the active power supplied by the inverter has been reduced to a value not exceeding 20% of P_n
- adjust the voltage read at the output terminals of the converter to -2% of the activation threshold declared by the manufacturer;
- the active power is measured as averages at 1 s, plotting the values obtained as a function of time;
- verify that the active power delivered by the inverter returns to the value congruent with the power made available from the primary or simulated source.



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.3.2	**TABLE: Adjustment of active power in the presence of over-frequency transistors on the transmission network**						**P**
Model	HNS3000TL-1						
Test:							
Power meter measurement data:	Sample-Rate:	0.2 s					
	Samples:	60 per frequency Point					
f [Hz] (ramps)	1) 47.51	2) 50.15	3) 50.40	4) 50.60	5) 51.49	6) 50.11	7) 50.00

Test:

The test is conducted for two powers. First, the test must start at a power 100% P_{Emax} ("Measurement 1"), and in a second test, for a power of 50% P_{Emax} ("Measurement 2"). The inverter must reduce the power and stay in this condition, until the grid stays in the limits for more than 300s. In the second test, after freezing of the momentary output power, the available active power output must be increased to a value 100% P_{Emax}, and after the network frequency of 50,3 Hz is fallen below, the rise of the active power gradient must be recorded.

Perform the measurements on 7 points (the frequency value must have an uncertainty of maximum ± 10 mHz) temporally consequent to each other:

1) f = 47.51 Hz (t_1 for sequence A, t1 for sequence B)
2) f = 50 Hz + 0.15 Hz (t_2 for sequence A, t'_2 for sequence B)
3) f = 50 Hz + 0.40 Hz (t_3 for sequence A, t'_3 for sequence B)
4) f = 50 Hz + 0.60 Hz (t_4 for sequence A, t'_4 for sequence B)
5) f = 50 Hz + 1.49 Hz (t_5 for sequence A, t'_5 for sequence B)
6) f = 50 Hz + 0.11 Hz (t_6 for sequence A, t'_6 for sequence B)

Now carry out step 7). bringing the frequency back to the nominal value to verify the conditions of gradual restoration of the maximum supply (sequence A), or to 50% of the maximum power available (sequence B):

7) f = 50 Hz (t_7 for sequence A, t'_7 for sequence B).

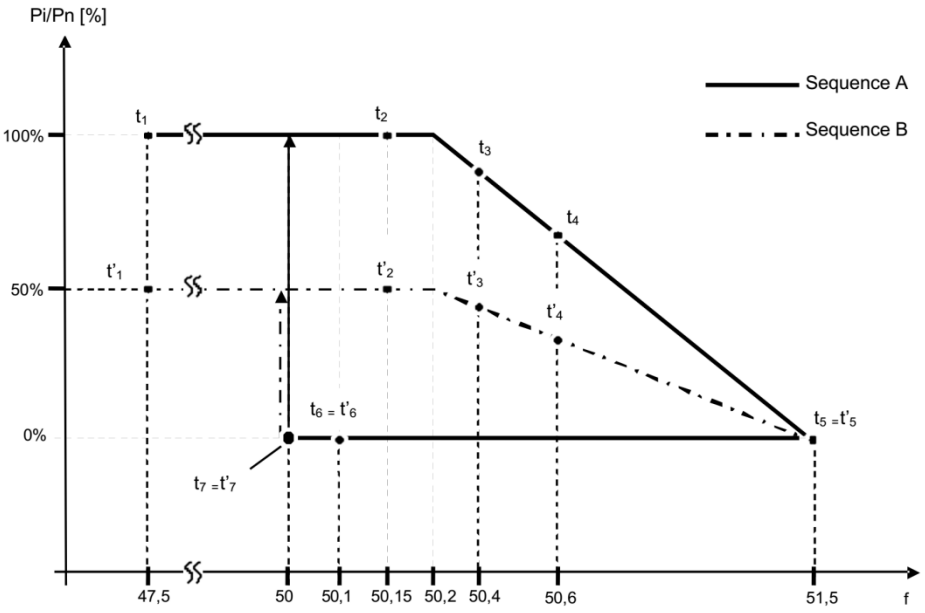
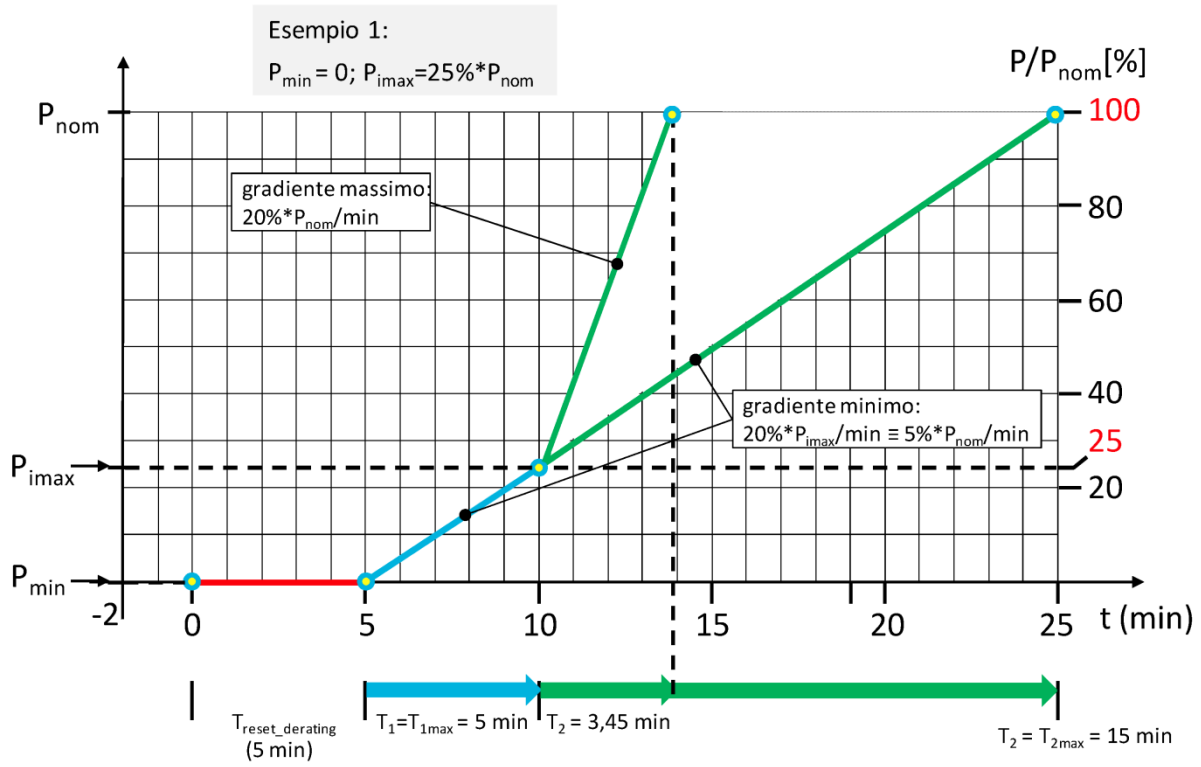


Figure 52 - Curves for limiting active power with respect to frequency

The total tolerance is ΔP ≤ ±2,5% of P_n

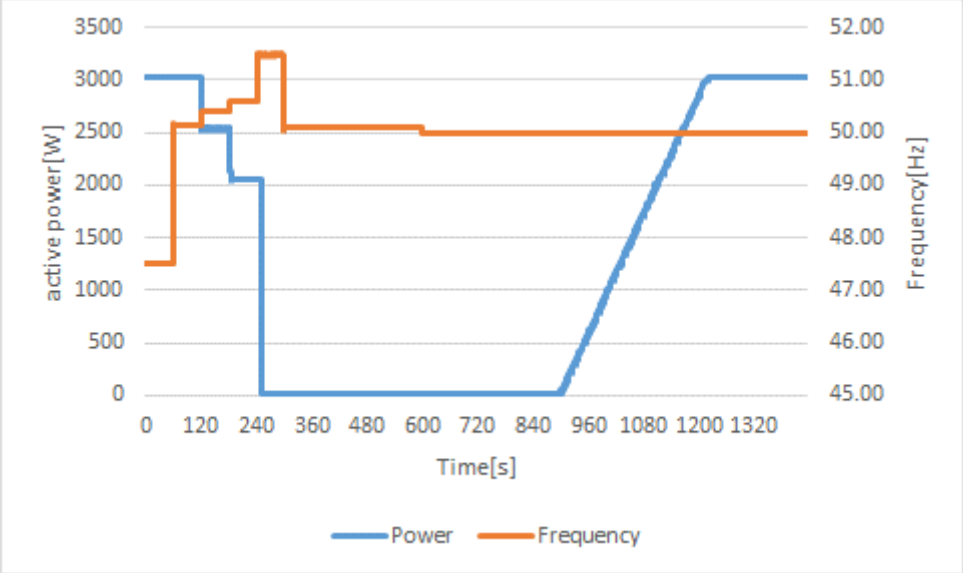
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Limits of the power-up gradient



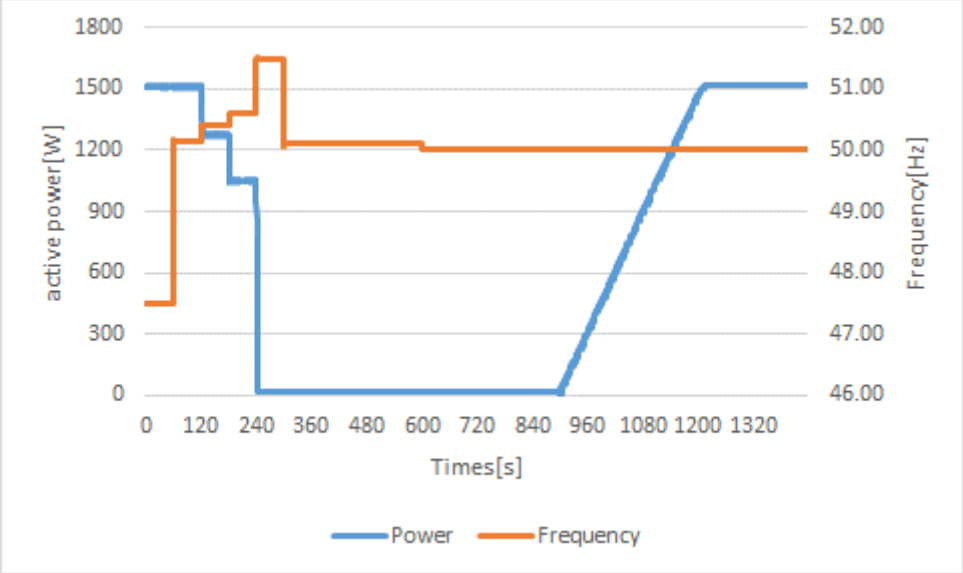
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Sequence A						
Step No.	Set output power [%]	Frequency[Hz]	Expected power value [W]	Actual power values [W]	Limits	Graph point
1	100	47.51	3000	3022	± 2.5% Pn	t_1
2	100	50.15	3000	3022	± 2.5% Pn	t_2
3	100	50.40	2539	2541	± 2.5% Pn	t_3
4	100	50.60	2077	2064	± 2.5% Pn	t_4
5	100	51.49	23	15	± 2.5% Pn	t_5
6	100	50.10	23	16	± 2.5% Pn	t_6
7	100	50.00	3000	3021	Pn	t_7



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Sequence B						
Step No.	Set output power [%]	Frequency[Hz]	Expected power value [W]	Actual power values [W]	Limits	Graph point
1	50	47.51	1500	1511	± 2.5% Pn	t'_1
2	50	50.15	1500	1511	± 2.5% Pn	t'_2
3	50	50.40	1269	1282	± 2.5% Pn	t'_3
4	50	50.60	1039	1054	± 2.5% Pn	t'_4
5	50	51.49	12	21	± 2.5% Pn	t'_5
6	50	50.10	12	20	± 2.5% Pn	t'_6
7	50	50.00	1500	1518	50% Pn	t'_7



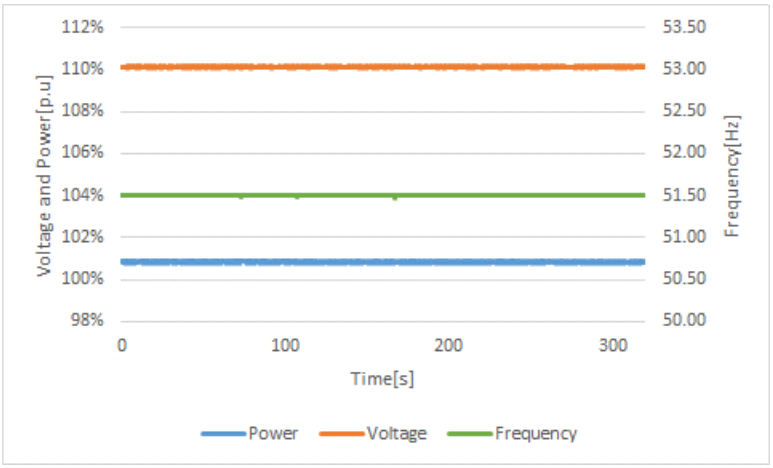
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.3.3	**TABLE: Verification of the operating range in voltage and frequency**					**P**
Model	HNS3000TL-1					
Test No.	Voltage (V)	Frequency (Hz)	P (W)	Cos φ	Time (s)	Limit (%P_n)
Test 1	253.32	51.50	3026	0.9983	>5min	± 5
Test 2	195.66	50.00	2995	0.9985	>5min	± 15

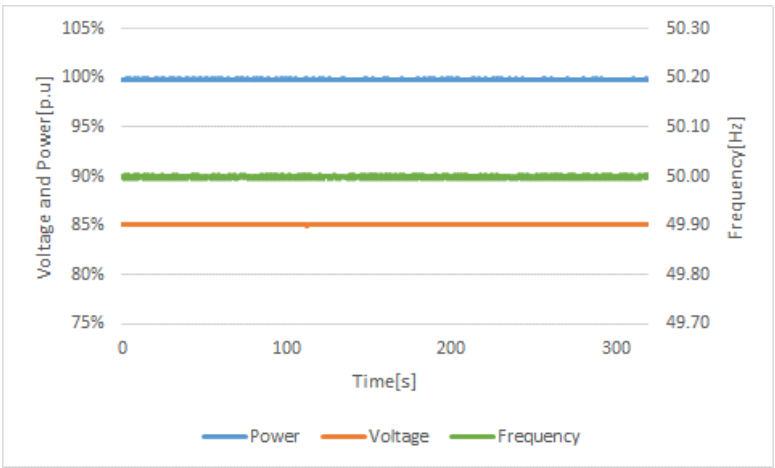
Test 1: V = 110 % * V_n; f = 51,5 Hz; P = 100 %P_n; Cos φ= 1 (Duration: at least 5 minutes)
Test 2: V = 85 % * V_n; f = 50,0 Hz; P = 100 %P_n; Cos φ= 1

Test 1 and 2 have a duration of at least 5 minutes. In Test 2, operation at reduced power is allowed, equal to the maximum deliverable when the maximum output current limit has been reached (P≥85% P_n).
To allow the tests to be carried out, the restrictive frequency thresholds must be disabled.
During the tests it is necessary to disable the automatic regulation in power reduction in case of over-frequency.
The frequency, voltage and active power measured at the generator output terminals must be recorded at a rate of at least 1 sample per second. The delivered power must remain stable within a limit of ± 5%P_n.

Test 1



Test 2

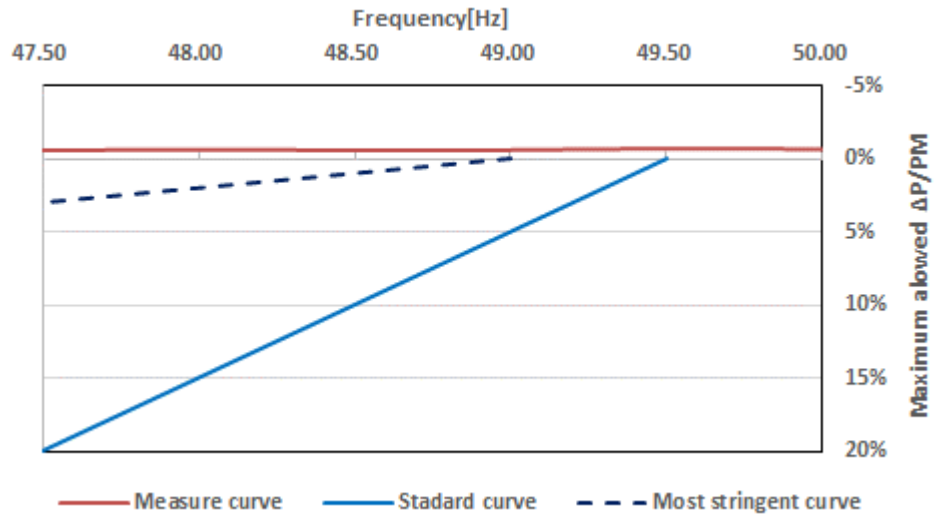


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.3.3.1	**TABLE: Reduction of active power in the presence of transient under-frequency on transmission network**					**P**
Model:	HNS3000TL-1					
5-min mean value	50.0 Hz	49.5 Hz	49.0 Hz	48.5 Hz	48.0 Hz	47.5 Hz
Frequency [Hz]:	50.0	49.5	49.0	48.5	48.0	47.5
Active power [kW]:	3024.06	3023.91	3023.82	3023.76	3023.73	3023.72

Test:
The test must be carried out at 100% P_n.
Measurements are carried out at the following operating points:
-Connect the object under test according to the instructions provided by the manufacturer.
-Set all the parameters of the simulated network to the respective values of normal exercise.
-Bring all the parameters of the object under test to the respective values of normal performance, such that the out power of the inverter is equal to the maximum deliverable power.
-Implement measures of active power on 6 points of time from each other on the basis of 50 Hz, and by reducing the frequency of 0.5 Hz with a step up to the minimum value of 47.5 Hz.
The each operating point shall be maintained for at least 5 min.

Assessment criterion:
The test is regarded as passed if:
the results should be presented in a table, and on the basis they must extrapolate the trend on a graph that must be greater than the threshold identified by continuous tract of fig. 12a contained in the 8.4.4.
• the power reduction in point c) is less or equal to the allowed power reduction according to 8.4.4.
The power reduction in point c) is less or equal to the power reduction of 10 % P_M per 1 Hz drop.

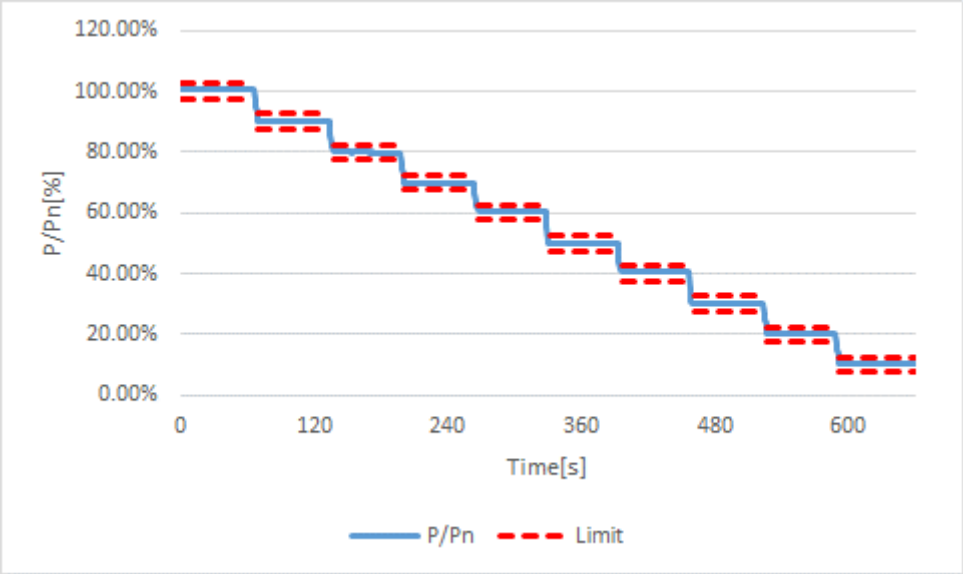


Maximum allowable power reduction in case of under-frequency

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.3.4	**TABLE: Limitation of active power by external control from the distributor**	**P**
Model	HNS3000TL-1	

Set point P [P/P_n]	Set point P [W]	P measured [W]	Deviation (%)	Limit (%P_n)
100	3000	3026	0.87%	--
90	2700	2704	0.13%	± 2.5
80	2400	2398	-0.07%	± 2.5
70	2100	2095	-0.17%	± 2.5
60	1800	1812	0.40%	± 2.5
50	1500	1499	-0.03%	± 2.5
40	1200	1223	0.77%	± 2.5
30	900	909	0.30%	± 2.5
20	600	609	0.30%	± 2.5
10	300	317	0.57%	± 2.5



Test:

The setpoint signal must be reduced from 100% to 10% P_{Emax}:
For adjustable PGUs in increments of 10% P_{Emax}. 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint. Then the active power of the PGU must be measured as a 1-min mean value.

Assessment criterion:

a) for adjustable PGUs:
- no network disconnection above 12,5% P_n
- the active power value does not exceed the setpoint by more than 2,5% P_n
- the setting time determined this way is ≤ 1min

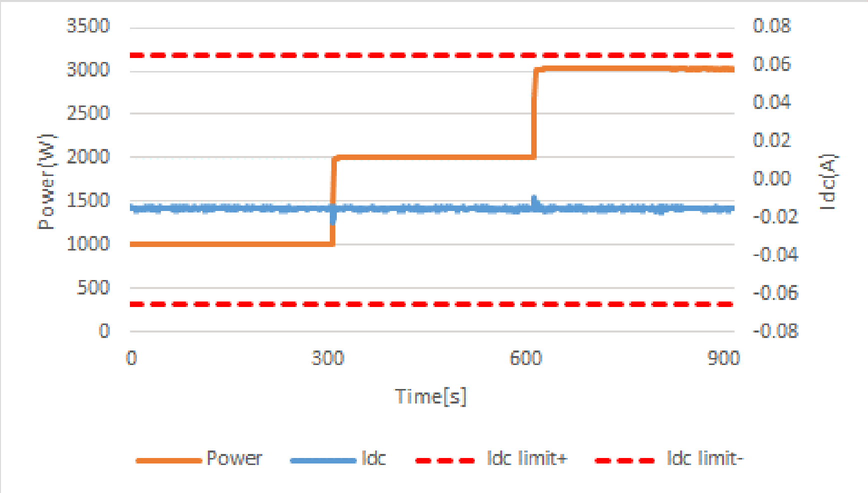
Note:

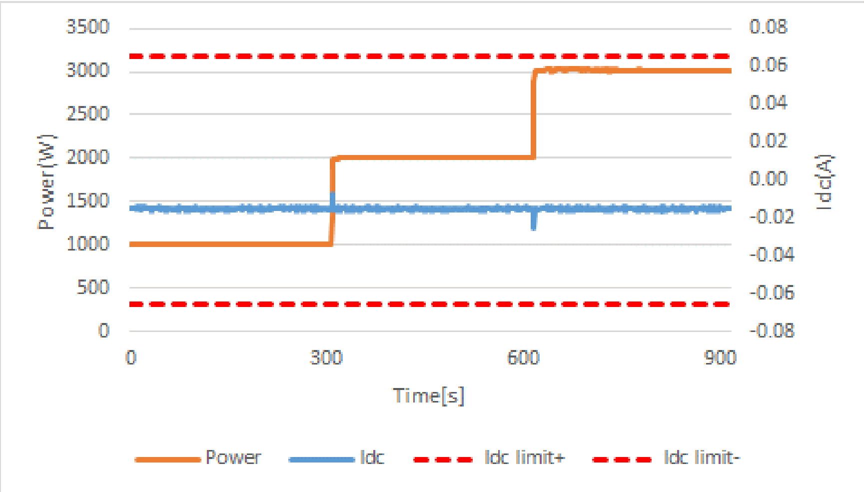
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

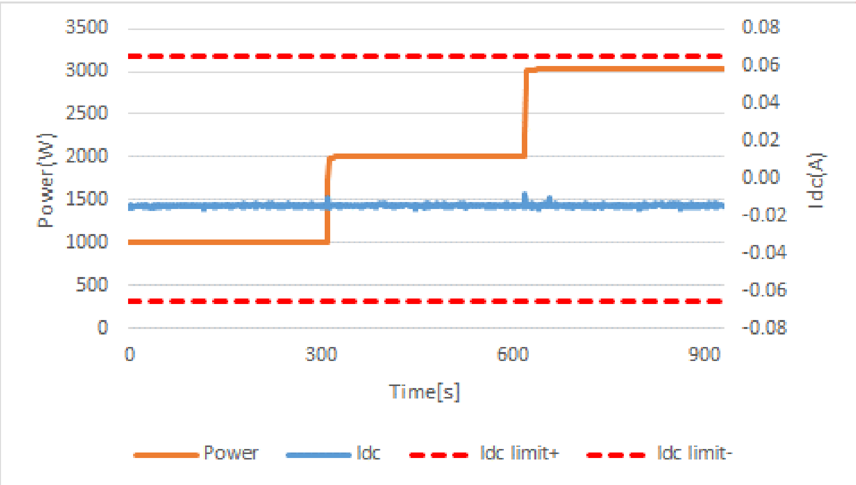
B.1.4.1	TABLE: Checking the DC component output		P
Model	HNS3000TL-1		

Power Level	(33 ± 5)%	(66 ± 5)%	(100 ± 5)%
Ambient			
Total output Power (W)	1006	2006	3021
Output Vrms	230.54	230.60	230.67
Output Arms	4.40	8.72	13.12
Cos φ	0.991	0.997	0.998
L1 DC Component (A)	0.015	0.015	0.015
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.115%	0.116%	0.115%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-
Minimum ambient rating or 20°C			
Total output Power (W)	1005	2006	3021
Output Vrms	230.54	230.61	230.68
Output Arms	4.40	8.72	13.12
Cos φ	0.991	0.997	0.998
L1 DC Component (A)	0.015	0.015	0.015
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.115%	0.116%	0.116%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-
Maximum ambient rating or 60°C			
Total output Power (W)	1005	2006	3022
Output Vrms	230.37	230.47	230.57
Output Arms	4.40	8.73	13.13
Cos φ	0.991	0.997	0.998
L1 DC Component (A)	0.014	0.014	0.014
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.110%	0.109%	0.109%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict





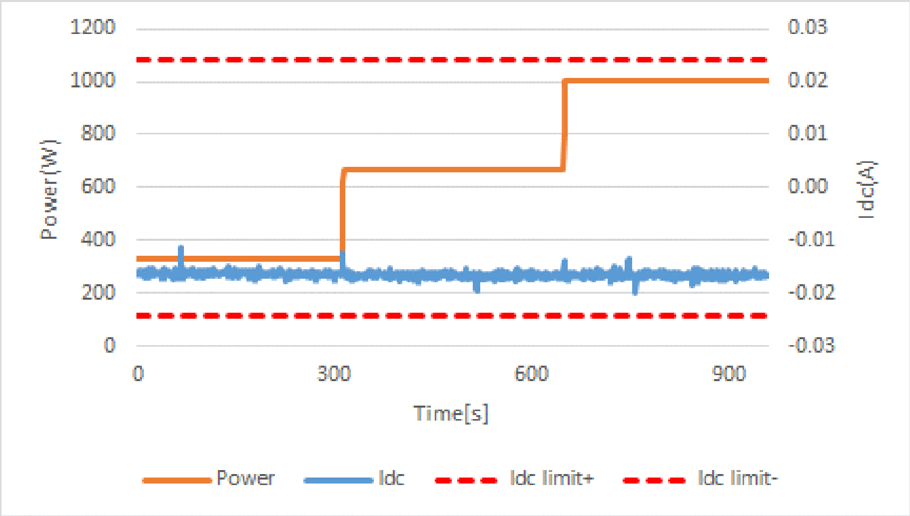


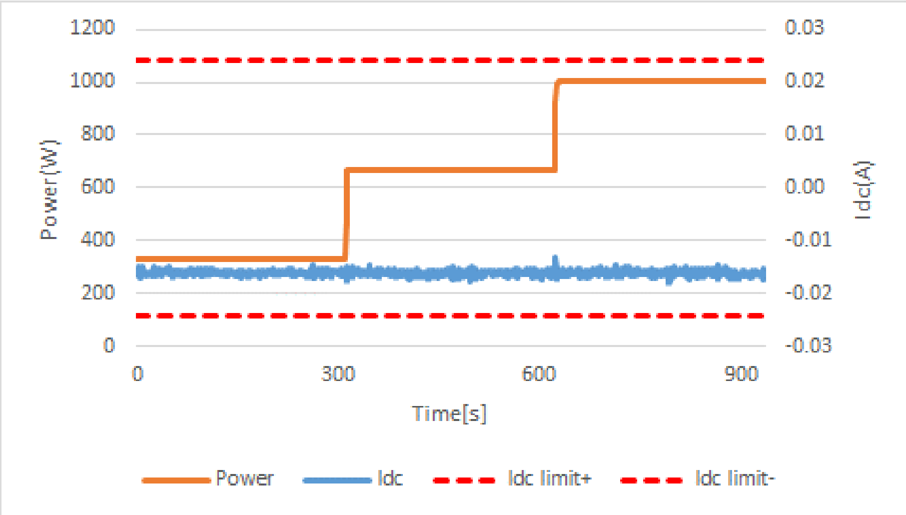
CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

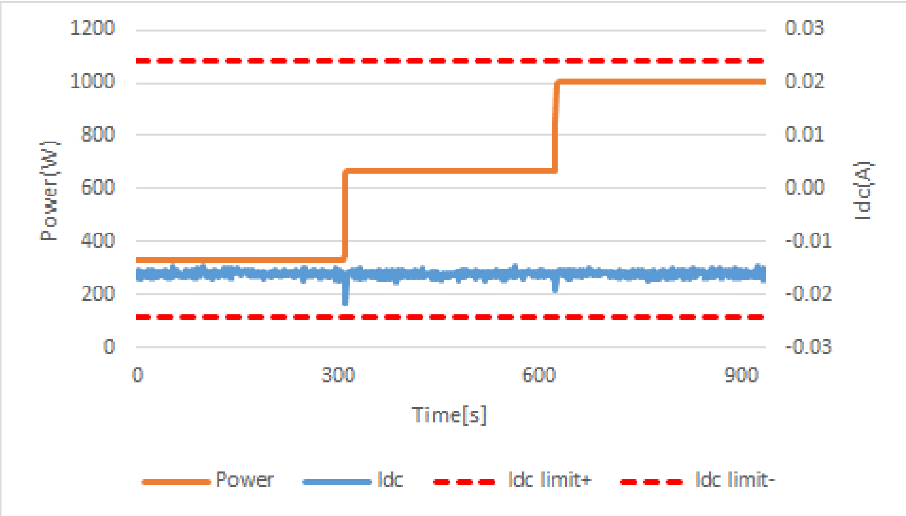
B.1.4.1	TABLE: Checking the DC component output		P
Model	HNS1000TL-1		

Power Level	(33 ± 5)%	(66 ± 5)%	(100 ± 5)%
Ambient			
Total output Power (W)	330	668	1004
Output Vrms	230.49	230.52	230.56
Output Arms	1.55	2.96	4.39
Cos φ	0.925	0.980	0.991
L1 DC Component (A)	0.015	0.015	0.015
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.336%	0.343%	0.342%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-
Minimum ambient rating or 20°C			
Total output Power (W)	330	668	1004
Output Vrms	230.54	230.56	230.59
Output Arms	1.55	2.96	4.40
Cos φ	0.925	0.980	0.991
L1 DC Component (A)	0.014	0.014	0.014
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.331%	0.333%	0.333%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-
Maximum ambient rating or 60°C			
Total output Power (W)	330	667	1004
Output Vrms	230.55	230.58	230.60
Output Arms	1.55	2.95	4.39
Cos φ	0.925	0.980	0.991
L1 DC Component (A)	0.014	0.015	0.014
L2 DC Component (A)	-	-	-
L3 DC Component (A)	-	-	-
L1 DC Component (% I_r)	0.331%	0.334%	0.332%
L2 DC Component (% I_r)	-	-	-
L3 DC Component (% I_r)	-	-	-

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict







CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.4.2	**TABLE: Checking the protection against DC injection**			P
Model	HNS3000TL-1			
Ambient				
Actual Power	Limits	Measurement:(mA)	Limiting value: (mA)	Disconnection time:(ms)
I_{dc} = 0.5% of I_{nom}				
33%	+0.5%I_{nom}/1s	65.83	65	998.8
66%	+0.5%I_{nom}/1s	65.89	65	990.8
100%	+0.5%I_{nom}/1s	65.78	65	998.0
I_{dc} = 1A				
33%	+1A Idc/200ms	1013	1000	194.8
66%	+1A Idc/200ms	1004	1000	198.8
100%	+1A Idc/200ms	1013	1000	195.2
Model	HNS1000TL-1			
Actual Power	Limits	Measurement:(mA)	Limiting value:(mA)	Disconnection time:(ms)
I_{dc} = 0.5% of I_{nom}				
33%	+0.5%I_{nom}/1s	23.16	21	996.0
66%	+0.5%I_{nom}/1s	23.17	21	994.0
100%	+0.5%I_{nom}/1s	23.24	21	994.0
I_{dc} = 1A				
33%	+1A Idc/200ms	1002	1000	198.8
66%	+1A Idc/200ms	1001	1000	192.4
100%	+1A Idc/200ms	1016	1000	199.2

Note:
The internal temperature of the EUT must be stabilized.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.4.2	**TABLE: Checking the protection against DC injection**			P
Model:	HNS3000TL-1			
Minimum ambient rating or 20°C				
Actual Power	Limits	Measurement:(mA)	Limiting value: (mA)	Disconnection time:(ms)
I_{dc} = 0.5% of I_{nom}				
33%	+0.5%I_{nom}/1s	65.85	65	998.8
66%	+0.5%I_{nom}/1s	66.05	65	998.8
100%	+0.5%I_{nom}/1s	65.44	65	998.8
I_{dc} = 1A				
33%	+1A Idc/200ms	1010	1000	197.6
66%	+1A Idc/200ms	1001	1000	193.6
100%	+1A Idc/200ms	1012	1000	198.8
Model:	HNS1000TL-1			
Actual Power	Limits	Measurement:(mA)	Limiting value: (mA)	Disconnection time:(ms)
I_{dc} = 0.5% of I_{nom}				
33%	+0.5%I_{nom}/1s	23.11	21	996.0
66%	+0.5%I_{nom}/1s	23.22	21	996.0
100%	+0.5%I_{nom}/1s	23.17	21	992.0
I_{dc} = 1A				
33%	+1A Idc/200ms	1001	1000	192.8
66%	+1A Idc/200ms	1016	1000	196.4
100%	+1A Idc/200ms	1014	1000	197.6
Note: The internal temperature of the EUT must be stabilized.				

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.4.2	**TABLE: Checking the protection against DC injection**				P
Model:	HNS3000TL-1				
Maximum ambient rating or 60°C					
Actual Power	Limits	Measurement:(mA)	Limiting value: (mA)	Disconnection time:(ms)	
I_{dc} = 0.5% of I_{nom}					
33%	+0.5%I_{nom} /1s	65.69	65	996.8	
66%	+0.5%I_{nom} /1s	65.70	65	994.8	
100%	+0.5%I_{nom} /1s	65.41	65	996.8	
I_{dc} = 1A					
33%	+1A Idc/200ms	1014	1000	199.2	
66%	+1A Idc/200ms	1003	1000	198.8	
100%	+1A Idc/200ms	1013	1000	198.0	
Model:	HNS1000TL-1				
Actual Power	Limits	Measurement:(mA)	Limiting value: (mA)	Disconnection time:(ms)	
I_{dc} = 0.5% of I_{nom}					
33%	+0.5%I_{nom} /1s	23.09	21	994.0	
66%	+0.5%I_{nom} /1s	23.13	21	998.0	
100%	+0.5%I_{nom} /1s	23.17	21	992.0	
I_{dc} = 1A					
33%	+1A Idc/200ms	1001	1000	195.2	
66%	+1A Idc/200ms	1017	1000	198.0	
100%	+1A Idc/200ms	1013	1000	198.4	
Note: The internal temperature of the EUT must be stabilized.					

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CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.5	TABLE: Verification of insensitivity to voltage dips (UVRT capability) [greater 11.08kW systems]	N/A
Model	HNS3000TL-1	

The purpose of these tests is to ensure that the converter, when used in systems with total capacity greater than 11.08 kW, is insensitive to voltage dips according to the time-amplitude profile shown in the diagram. In particular, the tests must verify that the following functional requirements are met:

- the generator must not disconnect from the grid in the white area above and along the points of the UVRT (V-t) characteristic indicated in Figure 29, where V is the phase-to-phase voltage at the connection point. Supply of active and reactive power prior to the occurrence of the fault can be temporarily interrupted in this area.
- in the area below (grey) the generator can disconnect from the grid.
- within 400 ms from restoring network voltage to within the range of +10% and -15% of nominal voltage, the generator must return to supplying active and reactive power to the network as before the fault, with a maximum tolerance of ±10% of the nominal voltage of the generator. If voltage returns but remains in the range between 85% and 90%, power distribution may be reduced in relation to the generator limits of output power.

Verification of compliance with the requirements of immunity to voltage sags are carried out according to the test sequences shown in Table 31, to be carried out with the generator running respectively:

a) between 10% and 30% of the rated power;
b) and above 90% of the rated power.

Table 12 - Parameters relating to Figure 29 for the fault-ride-through capability of power park modules over 11.08 kW

Uret	0,05 [p.u.]	Tclear	0,2 s
Uclear	0,15 [p.u.]	Trec1	0,2 s
Urec1	0,15 [p.u.]	Trec2	0,2 s
Urec2	0,85 [p.u.]	Trec3	1,5 s

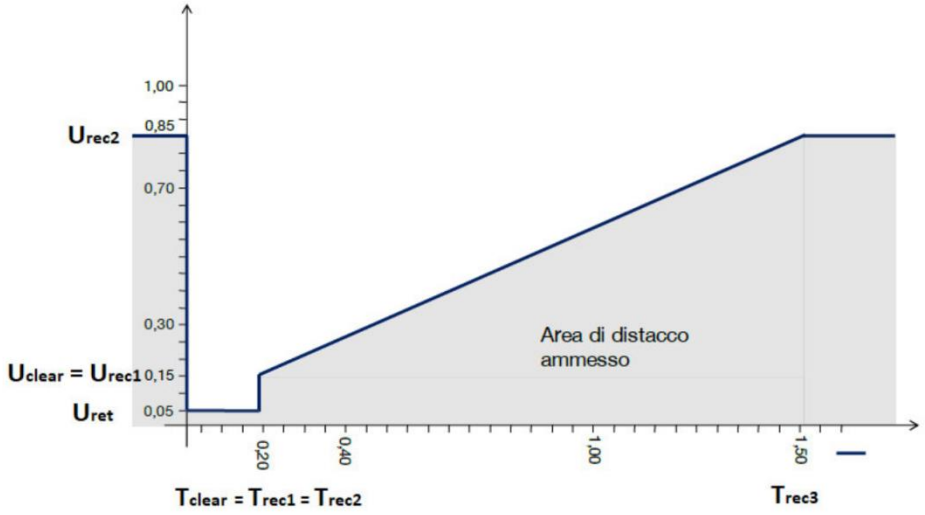
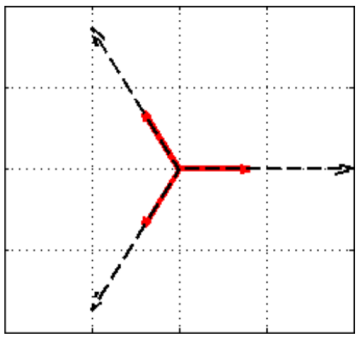


Figure 29 - Fault-ride-through profile of power park modules over 11.08 kW

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

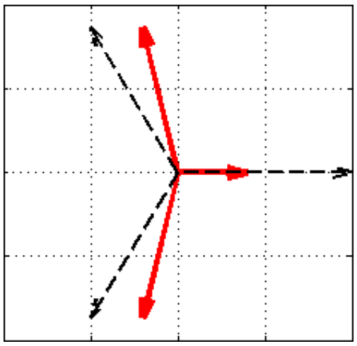
Test sequence:

1) three-phase symmetrical fault (Table 31, Tests N.1s, N.2s, N.3s and N4s)

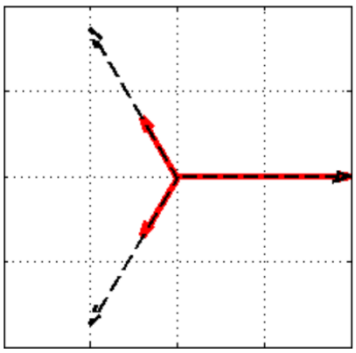


2) two-phase asymmetric fault (Table 31, Tests N.1a, N2a, N.3a and N.4a)

Failure in MV, which causes a variation in LV not only of amplitude but also of the phase relationship of the voltages (the case considered involves the presence of a transformer Dy in the secondary substation).



3) LV two-phase asymmetric fault (Table 31, Tests No. 5 and No. 6)



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Clause	Requirement - Test	Result - Remark	Verdict

Requirement of LVRT test:

Table 31 - Test sequences to verify immunity to temporary voltage dips. The amplitude, duration and shape relate to no-load test conditions

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Drop duration limit [ms]	Power re-supply time after restoring network [ms]	Shape (*)
1s – three-phase symmetrical fault	0.10 ± 0.05 (V_1/Vn)	200 ± 20	400	
1a – two-phase asymmetric failure	0.10 ± 0.05 (V_1/Vn)	200 ± 20	400	
2s – three-phase symmetrical fault	0.25 ± 0.05 (V_2/Vn)	400 ± 20	400	
2a – two-phase asymmetric failure	0.25 ± 0.05 (V_2/Vn)	400 ± 20	400	
3s – three-phase asymmetrical fault	0.50 ± 0.05 (V_3/Vn)	850 ± 20	400	
3a – two-phase asymmetric failure	0.50 ± 0.05 (V_3/Vn)	850 ± 20	400	
4s – three-phase asymmetrical fault	0.75 ± 0.05 (V_4/Vn)	1300 ± 20	400	
4a – two-phase asymmetric failure	0.75 ± 0.05 (V_4/Vn)	1300 ± 20	400	
5 – LV two-phase asymmetrical fault	0.10 ± 0.05 (V_5/Vn)	200 ± 20	400	
6 – LV two-phase asymmetrical fault	0.50 ± 0.05 (V_6/Vn)	850 ± 20	400	

Test No.	V/V_{nom}	Phase-to-earth voltages			Phase angles		
		$U_1/U_{1,nom}$	$U_2/U_{2,nom}$	$U_3/U_{3,nom}$	φ_{U1}	φ_{U2}	φ_{U3}
1s	0.10 ± 0.05	0.10 ± 0.05	0.10 ± 0.05	0.10 ± 0.05	0°	-120°	120°
1a	0.10 ± 0.05	0.87 ± 0.05	0.87 ± 0.05	0.10 ± 0.05	27°	-147°	120°
2s	0.25 ± 0.05	0.25 ± 0.05	0.25 ± 0.05	0.25 ± 0.05	0°	-120°	120°
2a	0.25 ± 0.05	0.88 ± 0.05	0.88 ± 0.05	0.25 ± 0.05	22°	-142°	120°
3s	0.50 ± 0.05	0.50 ± 0.05	0.50 ± 0.05	0.50 ± 0.05	0°	-120°	120°
3a	0.50 ± 0.05	0.90 ± 0.05	0.90 ± 0.05	0.50 ± 0.05	14°	-134°	120°
4s	0.75 ± 0.05	0.75 ± 0.05	0.75 ± 0.05	0.75 ± 0.05	0°	-120°	120°
4a	0.75 ± 0.05	0.94 ± 0.05	0.94 ± 0.05	0.75 ± 0.05	7°	-127°	120°
5	0.10 ± 0.05	1	0.10 ± 0.05	0.10 ± 0.05	0°	-120°	120°
6	0.50 ± 0.05	1	0.50 ± 0.05	0.50 ± 0.05	0°	-120°	120°
normal condition	1	1	1	1	0°	-120°	120°

(*) Regardless of the method used to simulate the transients (simulator or impedance network), the falling and rising edges of the voltage must have a duration of less than 10 ms.

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Clause	Requirement - Test	Result - Remark	Verdict

Graph of LVRT test:				
List of tests	**Residual amplitude of phase-to-phase voltage V/V_{nom}**	**Drop duration limit [ms]**	**Measured drop duration [ms]**	**Duration of restoring network [ms]**
1s – three-phase symmetrical fault (P = 0.1 - 0.3)	0.10 ± 0.05 (V_1/Vn)	200	210	164
1s – three-phase symmetrical fault (P > 0.9)	0.10 ± 0.05 (V_1/Vn)	200	210	168
1a – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.10 ± 0.05 (V_1/Vn)	200	211	155
1a – two-phase asymmetrical fault (P > 0.9)	0.10 ± 0.05 (V_1/Vn)	200	211	106
2s – three-phase symmetrical fault (P = 0.1 - 0.3)	0.25 ± 0.05 (V_2/Vn)	400	410	163
2s – three-phase symmetrical fault (P > 0.9)	0.25 ± 0.05 (V_2/Vn)	400	410	173
2a –two-phase asymmetrical fault (P = 0.1 - 0.3)	0.25 ± 0.05 (V_2/Vn)	400	411	155
2a –two-phase asymmetrical fault (P > 0.9)	0.25 ± 0.05 (V_2/Vn)	400	411	188
3s – three-phase symmetrical fault (P = 0.1 - 0.3)	0.50 ± 0.05 (V_3/Vn)	850	859	155
3s – three-phase symmetrical fault (P > 0.9)	0.50 ± 0.05 (V_3/Vn)	850	859	172
3a – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.50 ± 0.05 (V_3/Vn)	850	859	104
3a – two-phase asymmetrical fault (P > 0.9)	0.50 ± 0.05 (V_3/Vn)	850	859	106
4s – three-phase symmetrical fault (P = 0.1 - 0.3)	0.75 ± 0.05 (V_4/Vn)	1300	1311	151
4s – three-phase symmetrical fault (P > 0.9)	0.75 ± 0.05 (V_4/Vn)	1300	1311	176
4a – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.75 ± 0.05 (V_4/Vn)	1300	1309	92
4a – two-phase asymmetrical fault (P > 0.9)	0.75 ± 0.05 (V_4/Vn)	1300	1309	103
5 – LV two-phase asymmetrical fault (P = 0.1 - 0.3)	0.10 ± 0.05 (V_5/Vn)	200	209	0
5 – LV two-phase asymmetrical fault (P > 0.9)	0.10 ± 0.05 (V_5/Vn)	200	209	0
6 – LV two-phase asymmetrical fault (P = 0.1 - 0.3)	0.50 ± 0.05 (V_6/Vn)	850	858	0
6 – LV two-phase asymmetrical fault (P > 0.9)	0.50 ± 0.05 (V_6/Vn)	850	858	0

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Clause	Requirement - Test	Result - Remark	Verdict

7 – HV three-phase symmetrical fault (P = 0,1 - 0,3)	1,20 ± 0,05 (V_7/Vn)	500 ± 20	510	127
7 – HV three-phase symmetrical fault (P > 0,9)	1,20 ± 0,05 (V_7/Vn)	500 ± 20	510	162
8 – HV three-phase symmetrical fault (P = 0,1 - 0,3)	1,25 ± 0,05 (V_8/Vn)	100 ± 20	110	129
8 – HV three-phase symmetrical fault (P > 0,9)	1,25 ± 0,05 (V_8/Vn)	100 ± 20	110	160

Note:
(*) Regardless of the method used to simulate transients (simulator or impedance network), the rise and fall time of the voltage must be less than 10 ms
The interface protection shall be disabled or adjusted to avoid spurious tripping during testing.
The test conditions are performed as worst case conditions. The inverter feeds maximal active and reactive power during the complete test.

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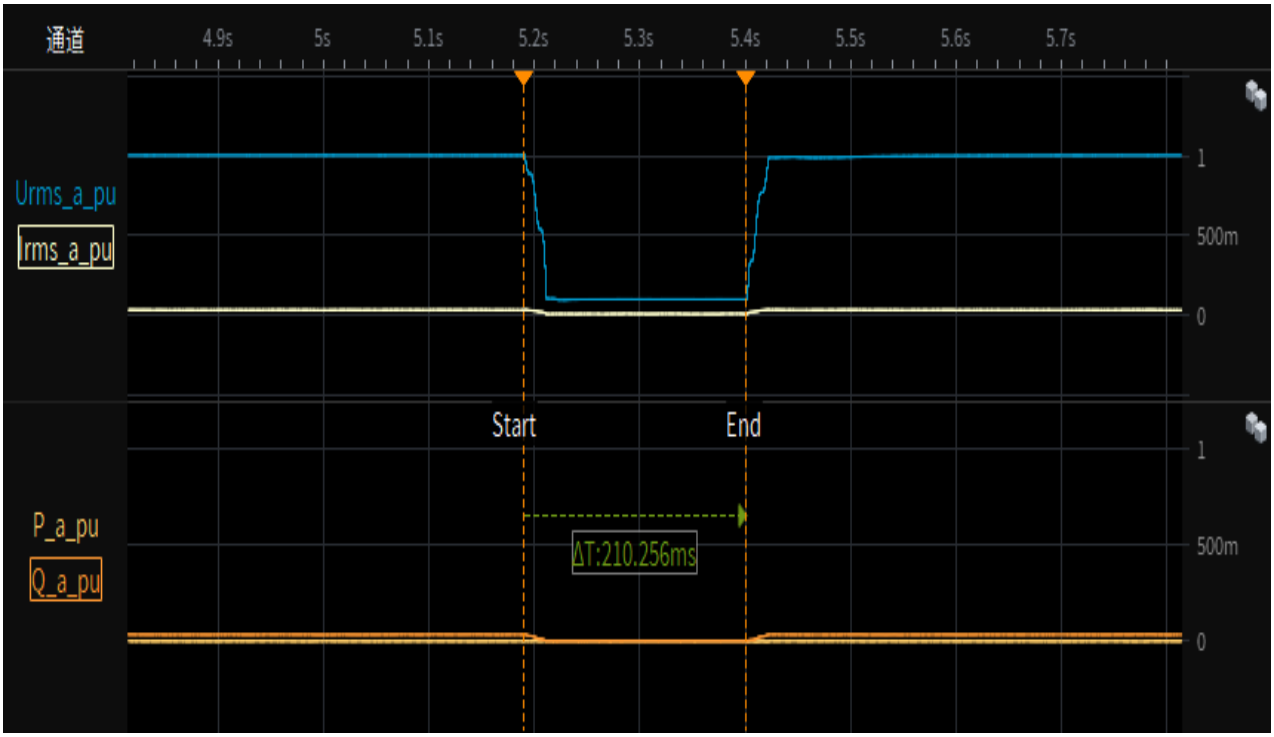
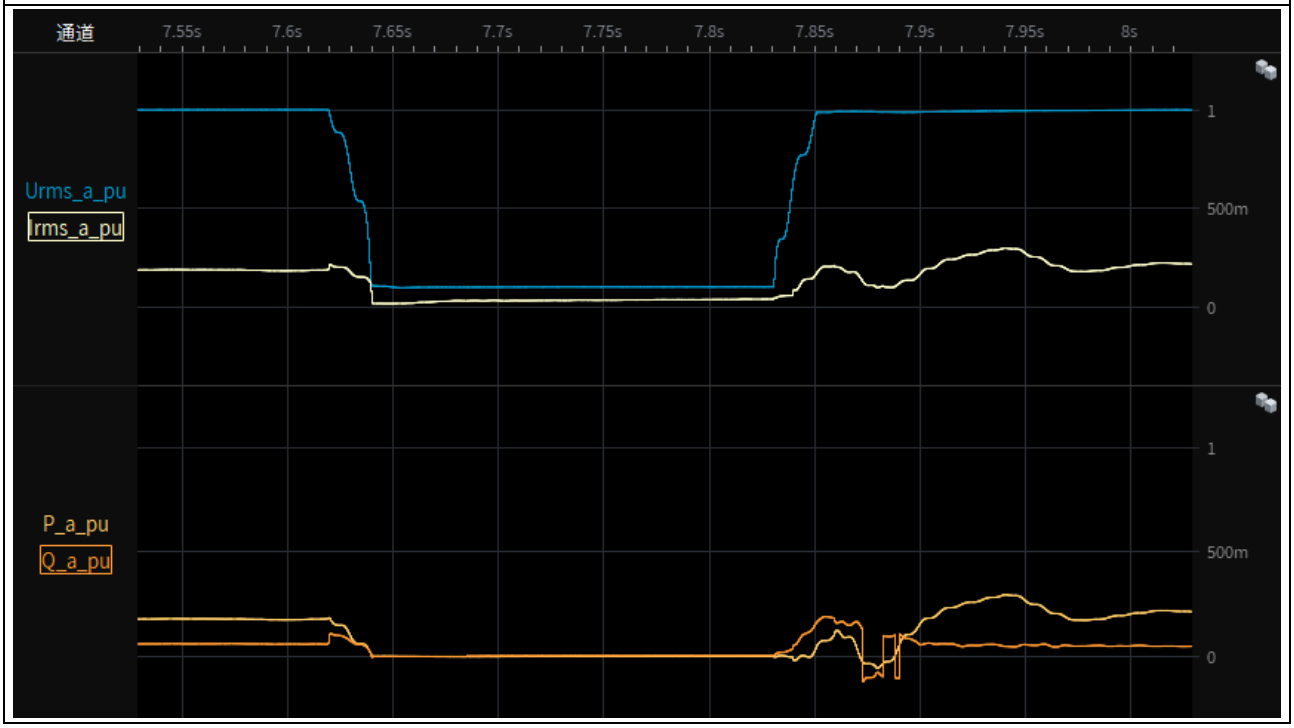
Clause	Requirement - Test	Result - Remark	Verdict

Test 1s-Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A), 0% load
Test overview(voltage,current,active and reactive power)



Test 1s-1.1 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)



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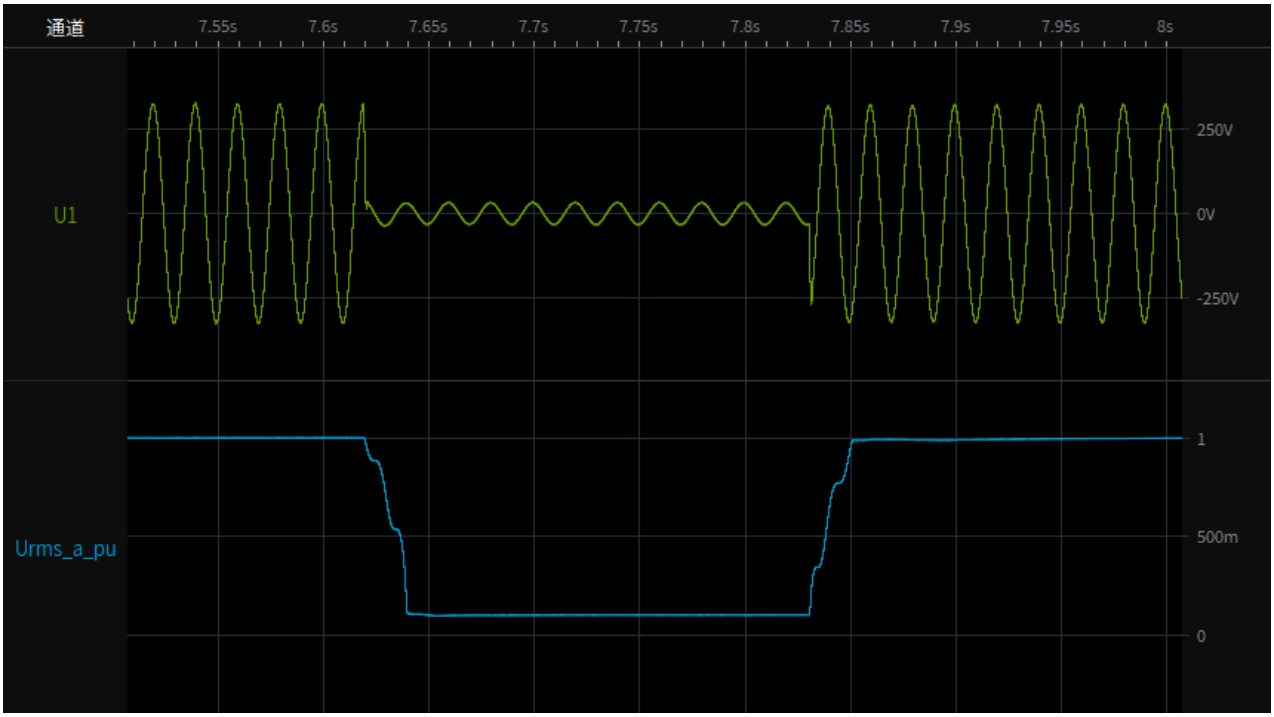
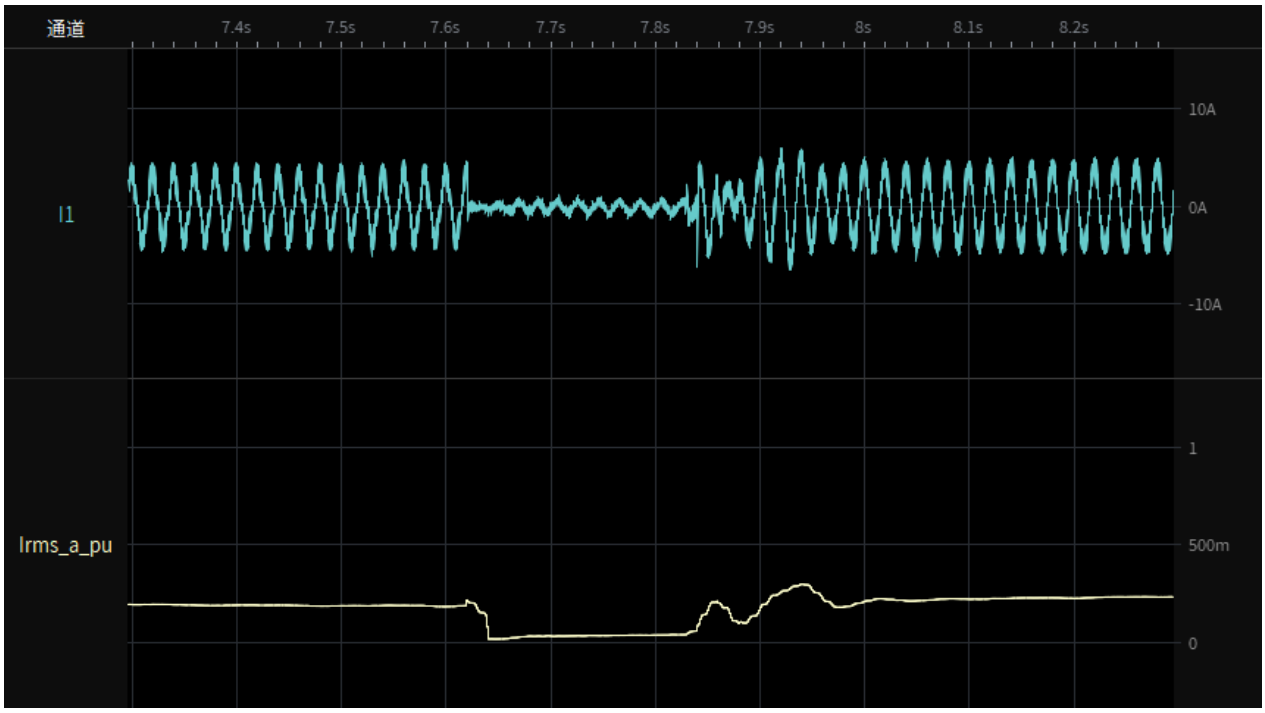
Clause	Requirement - Test	Result - Remark	Verdict

Test 1s-1.2 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages



Test 1s-1.3 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents



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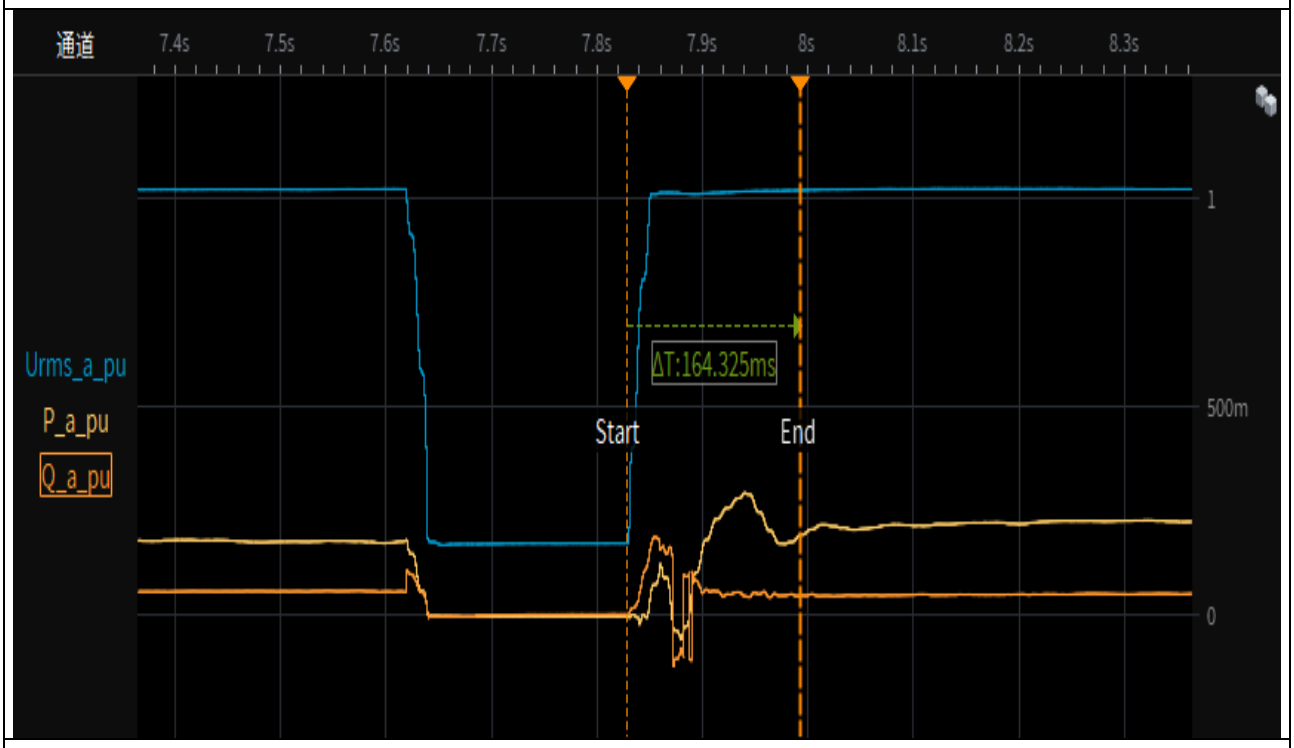
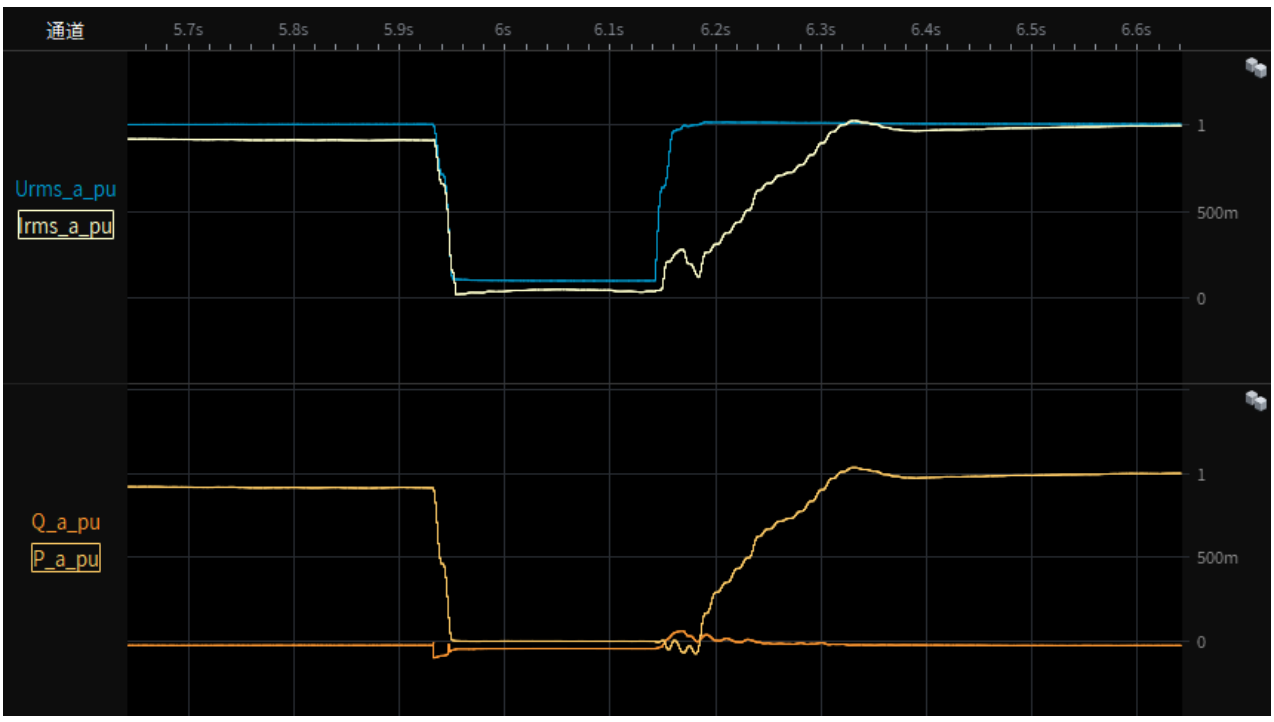
Clause	Requirement - Test	Result - Remark	Verdict

Test 1s-1.4 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),
20% load restoring time



Test 1s-2.1 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),95% load
Test overview(voltage,current,active and reactive power)



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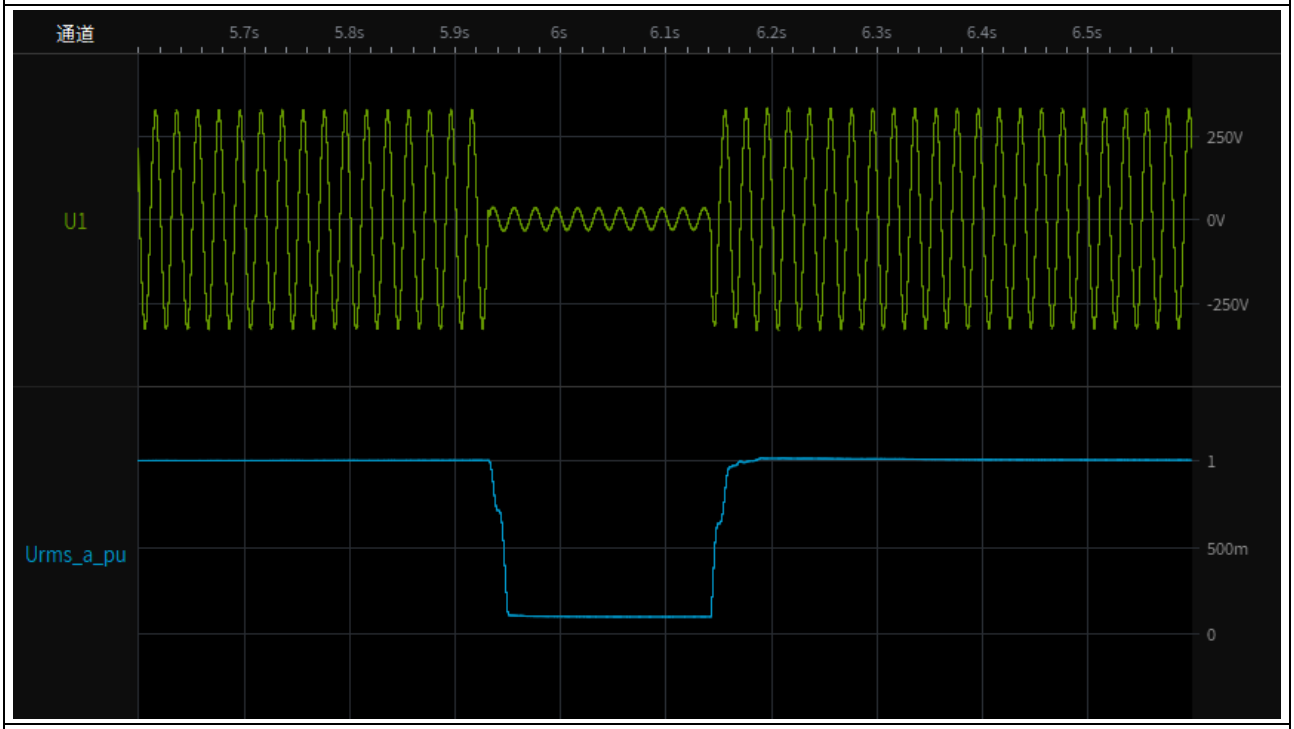
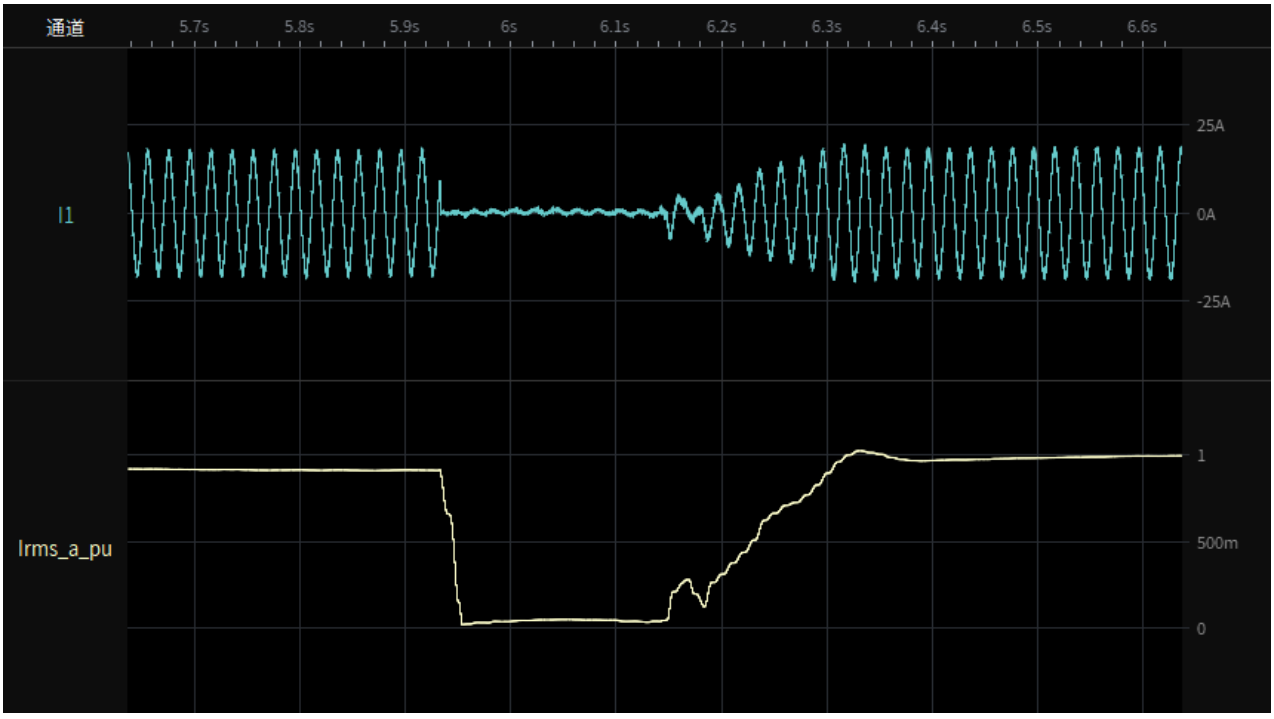
Clause	Requirement - Test	Result - Remark	Verdict

Test 1s-2.2 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

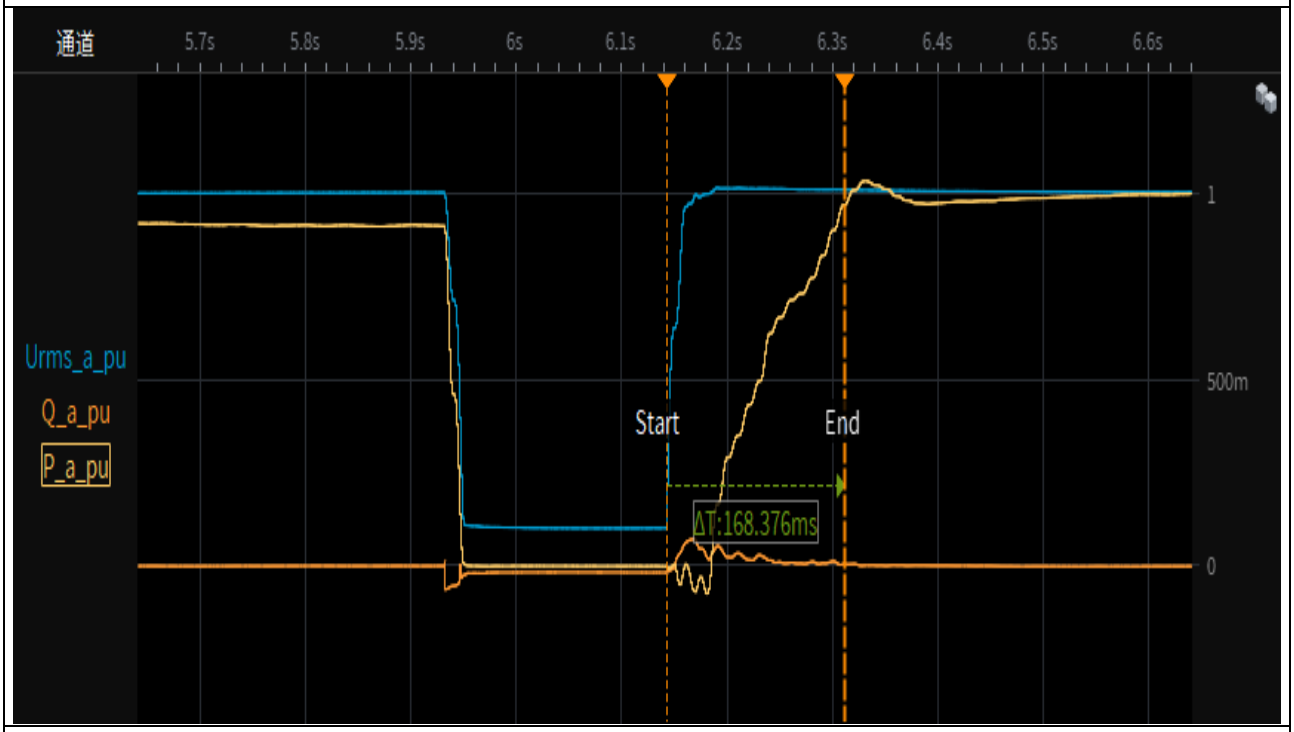


Test 1s-2.3 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents

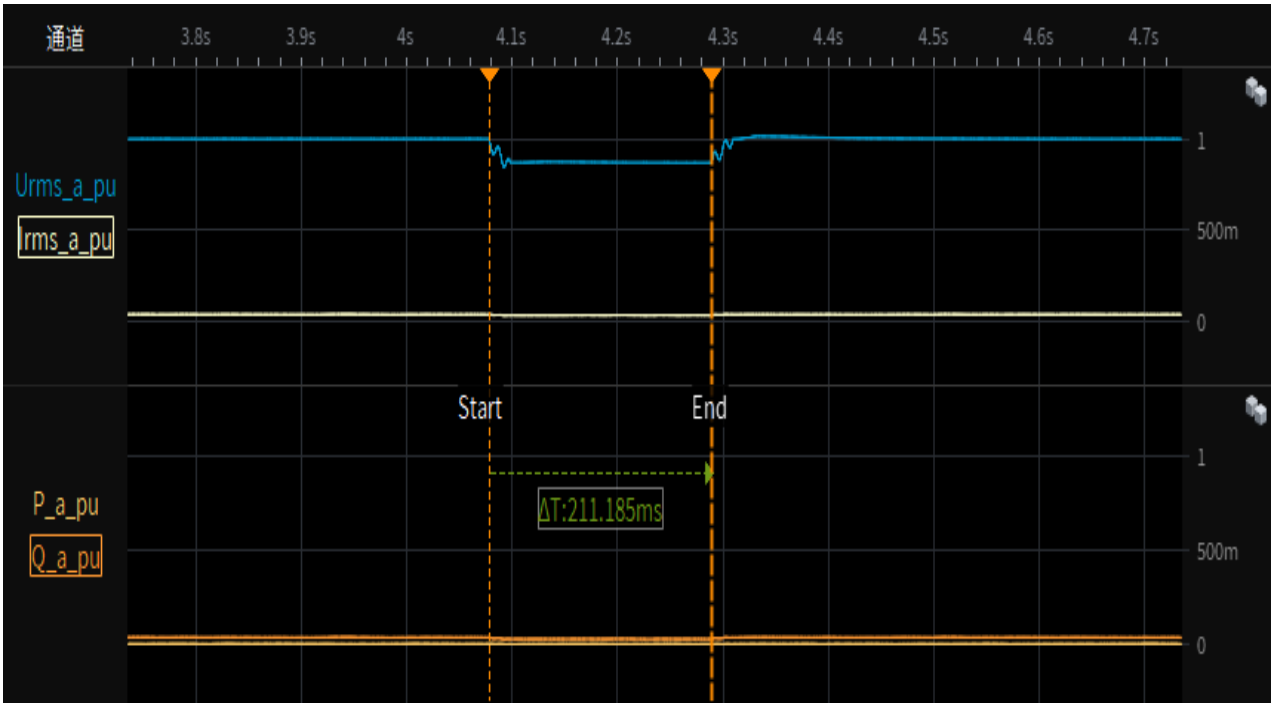


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 1s-2.4 Depth of fault phase: 0.1p.u.,three-phase-symmetrical (type A),
95% load restoring time

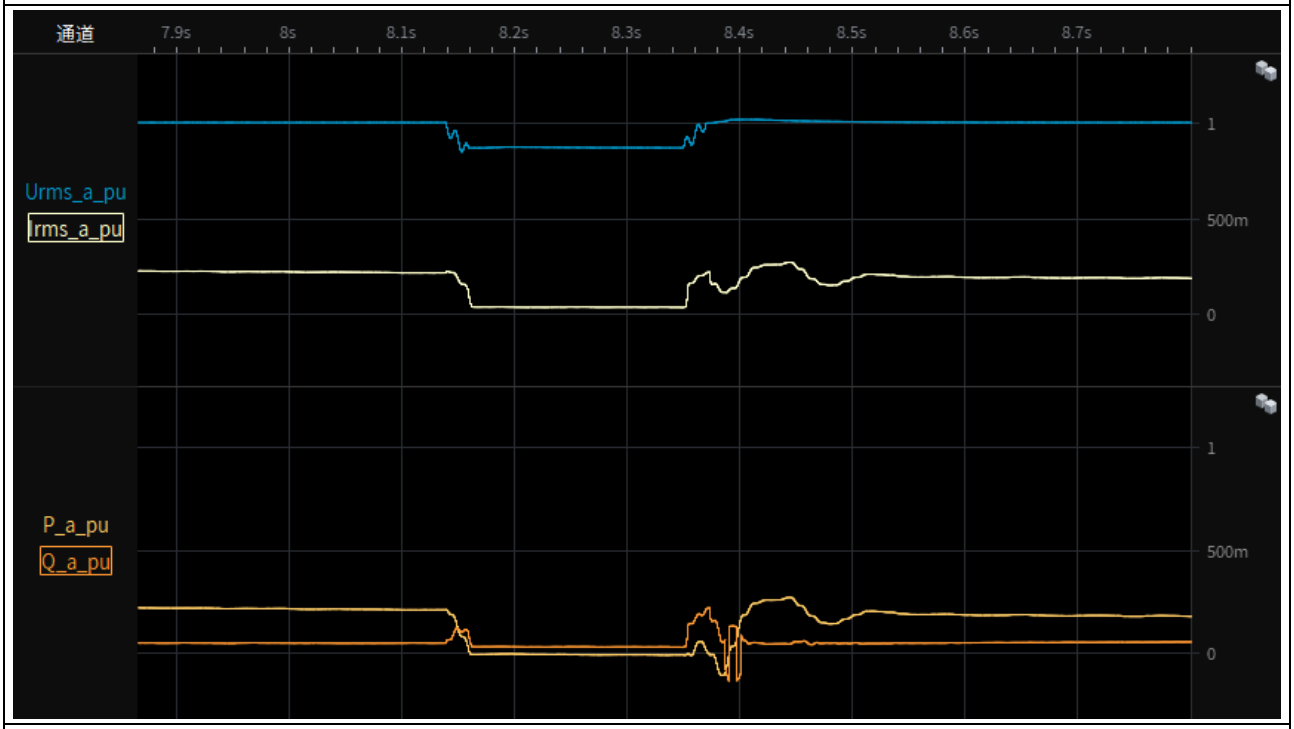


Test 1a- Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

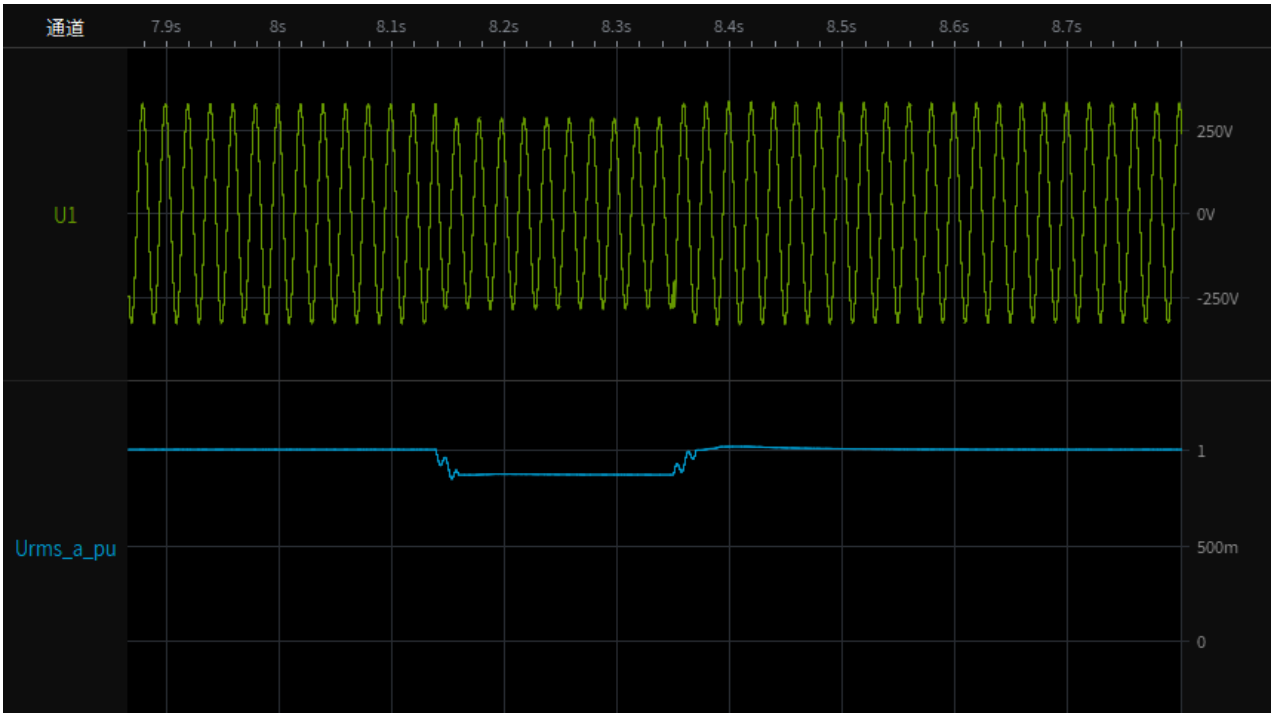


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 1a-1.1 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

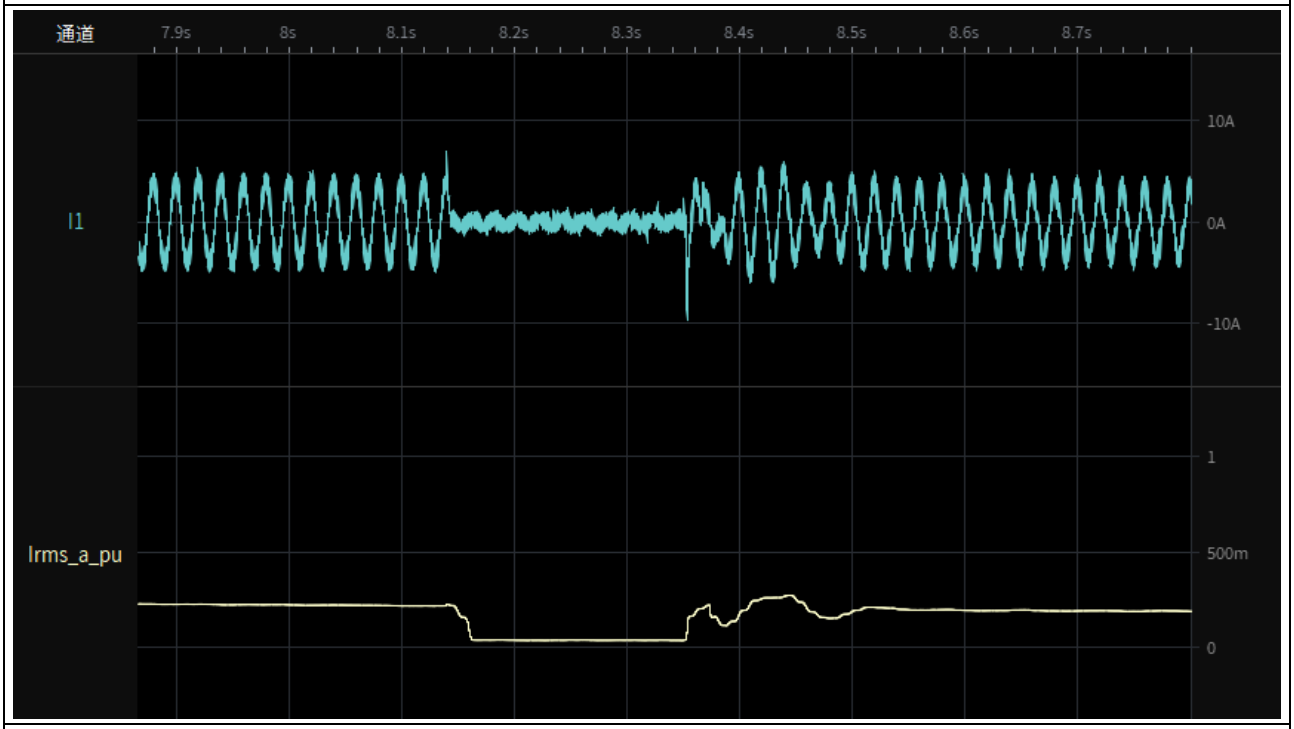


Test 1a-1.2 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

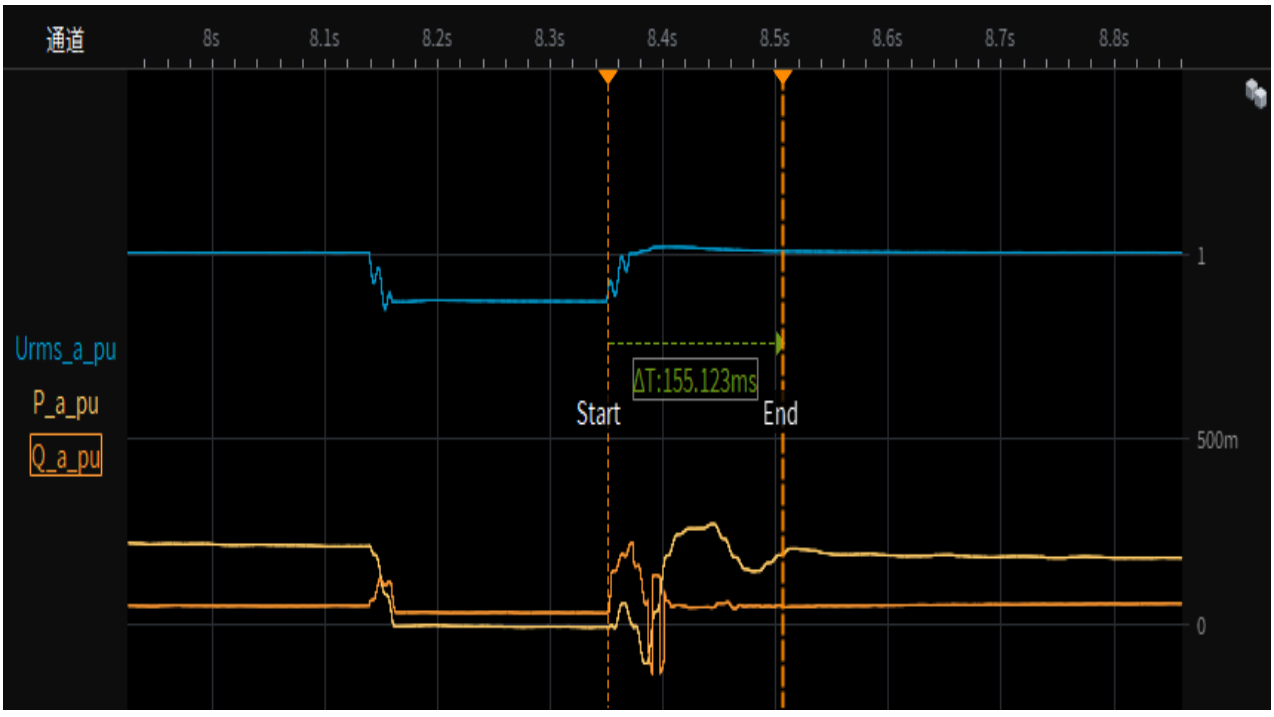


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 1a-1.3 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

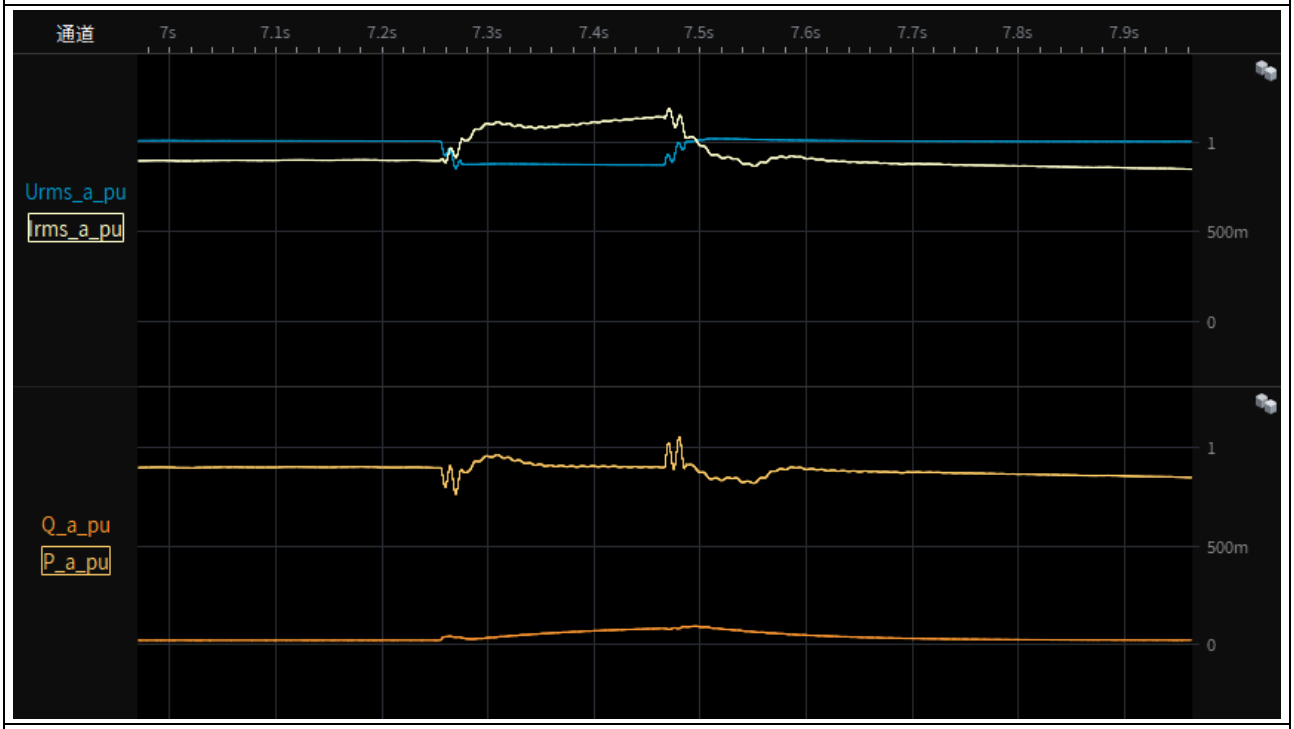


Test 1a-1.4 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),
20% load restoring time

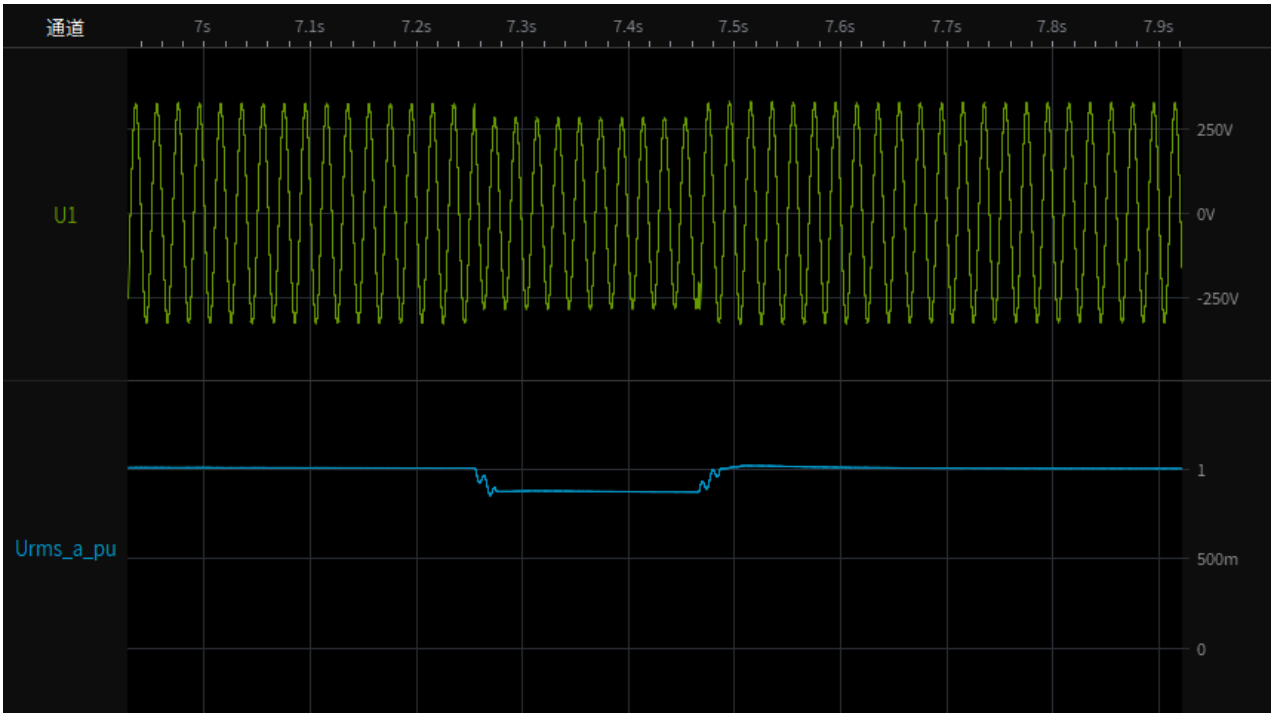


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 1a-2.1 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

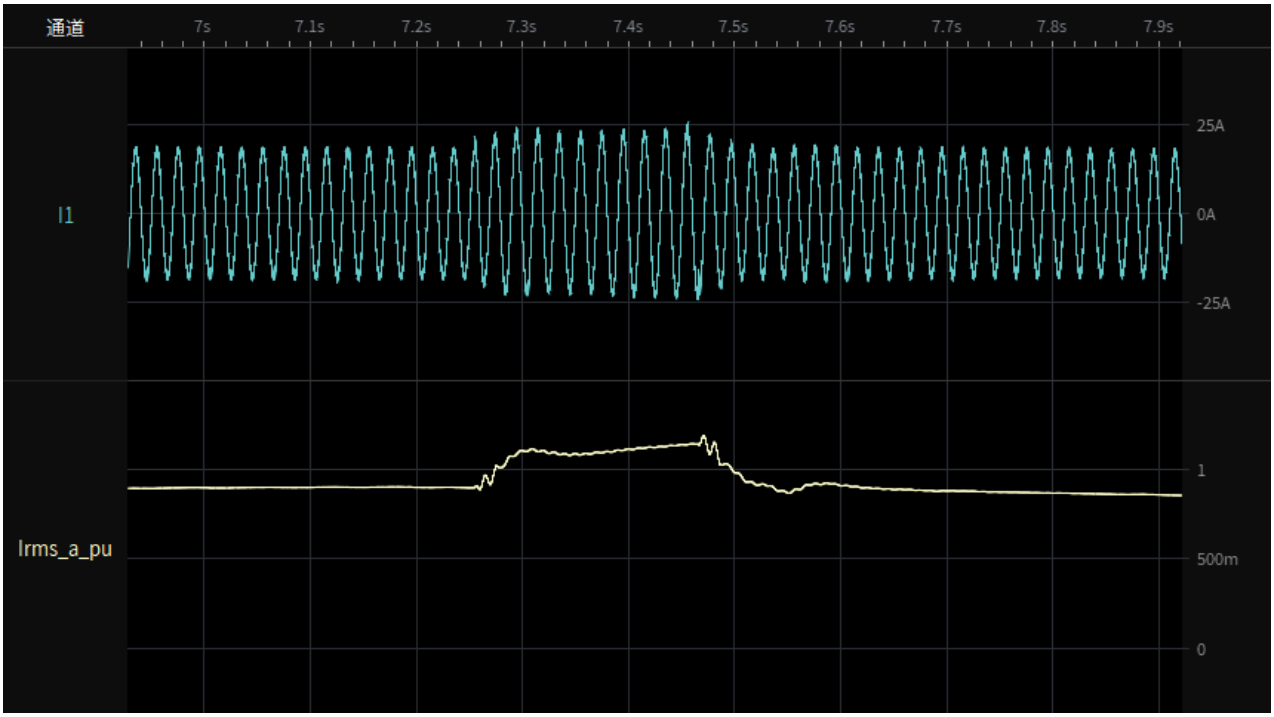


Test 1a-2.2 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

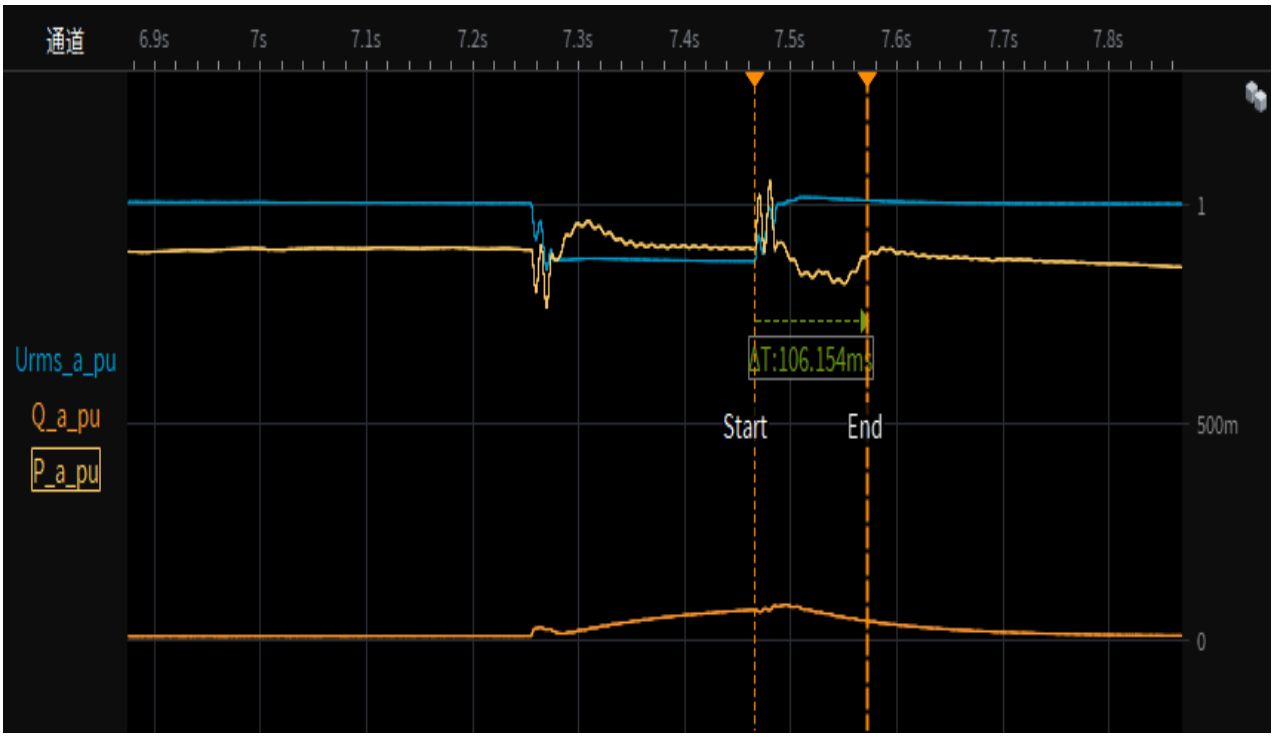


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 1a-2.3 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

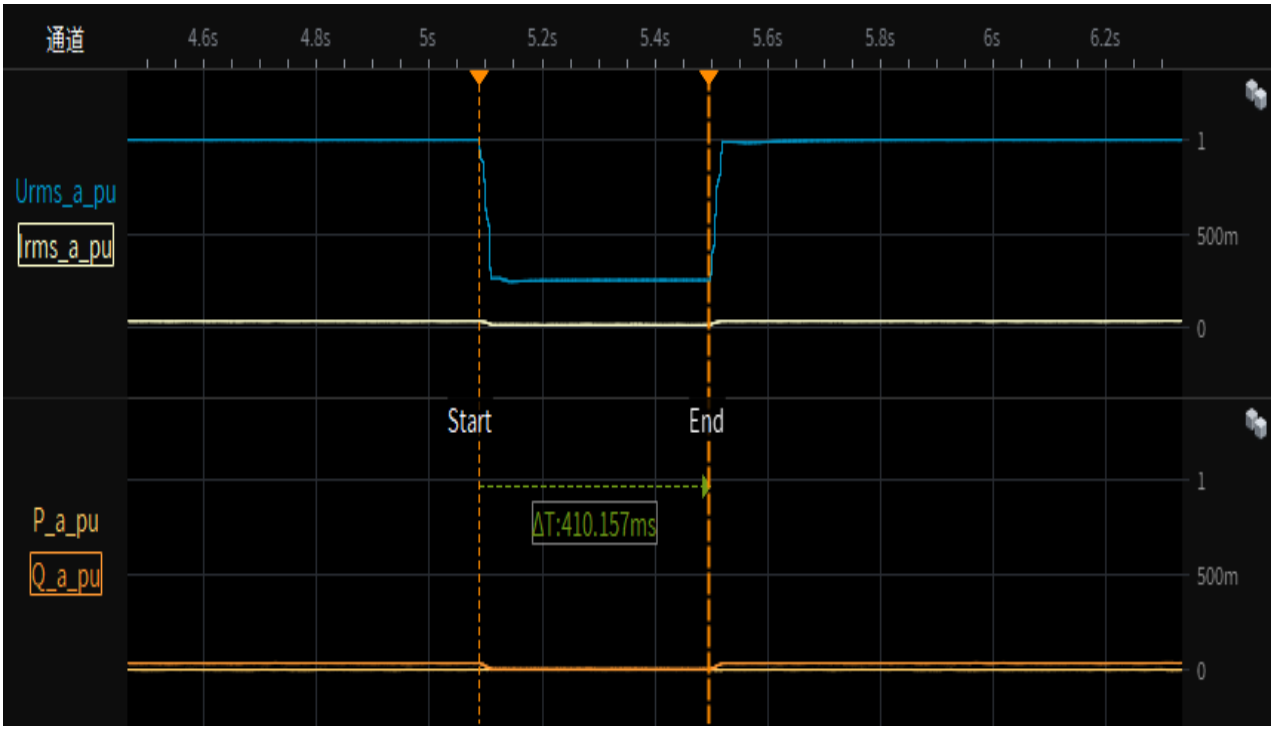


Test 1a-2.4 Depth of fault phase: 0.1p.u.,two-phase-asymmetrical (type D),
95% load restoring time

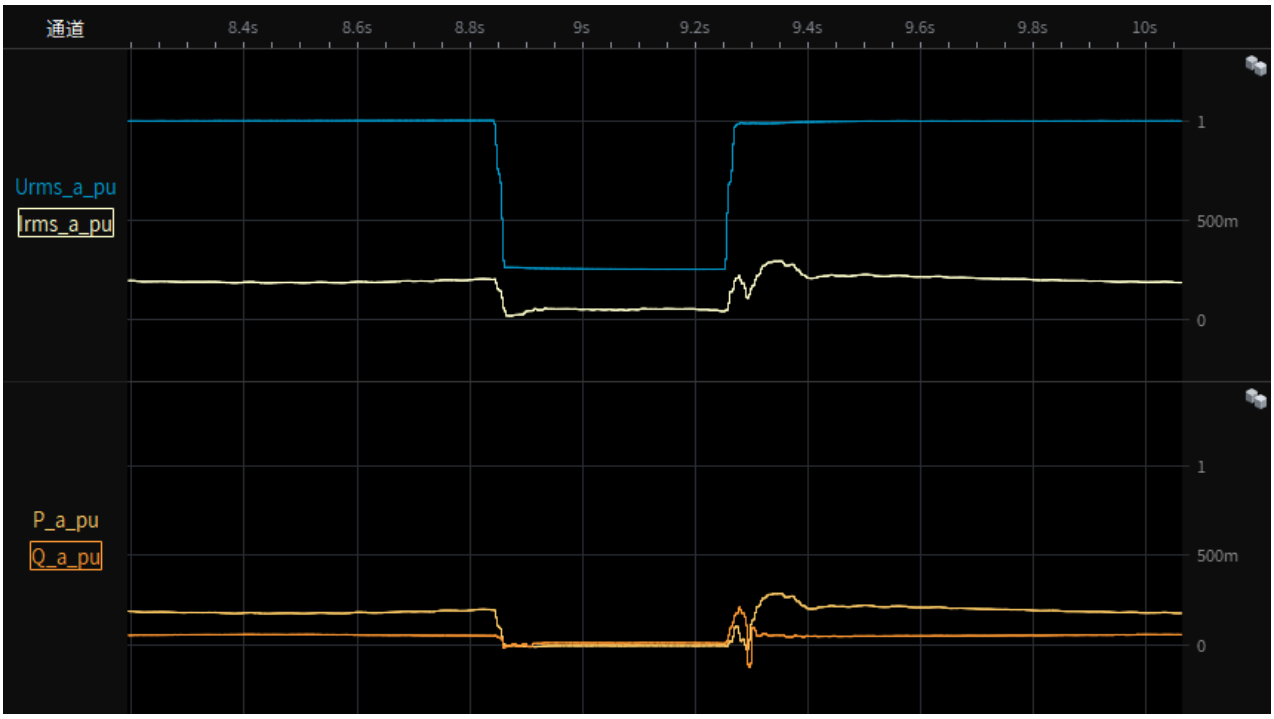


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2s- Depth of fault phase: 0.25p.u.,three-phase-symmetrical (type A),0% load
Test overview(voltage,current,active and reactive power)

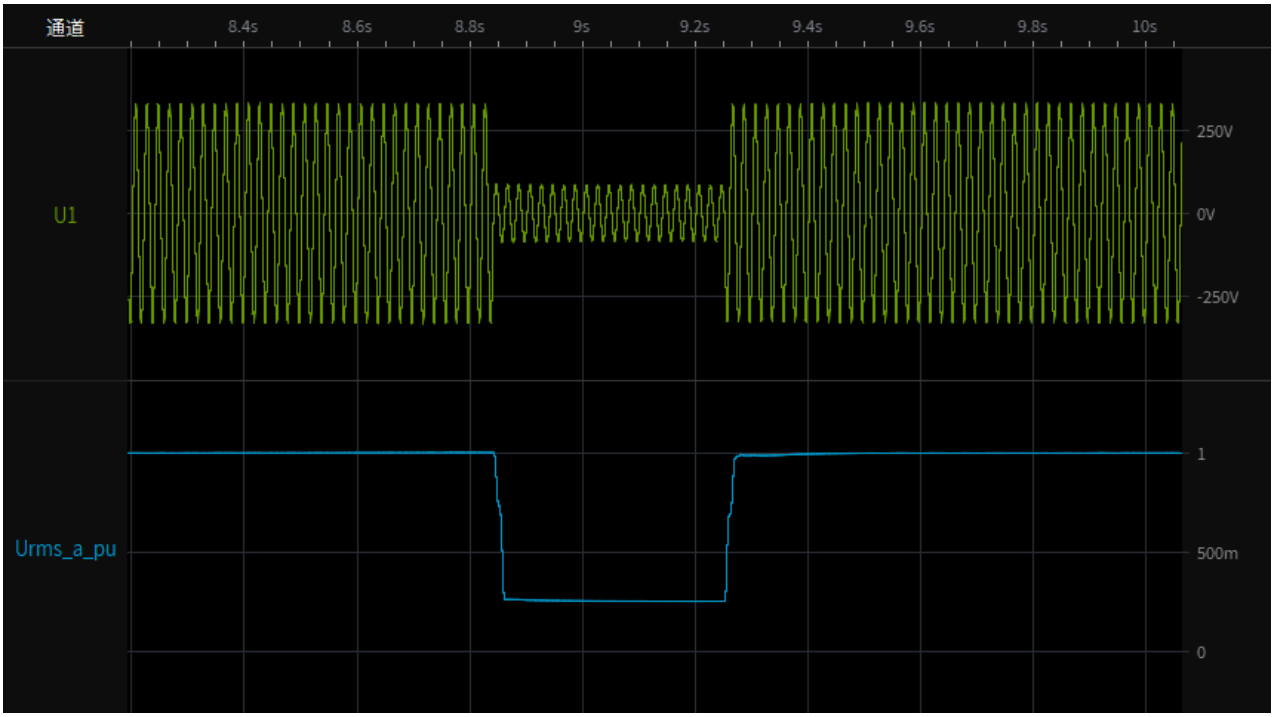


Test 2s-1.1 Depth of fault phase: 0.25p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)

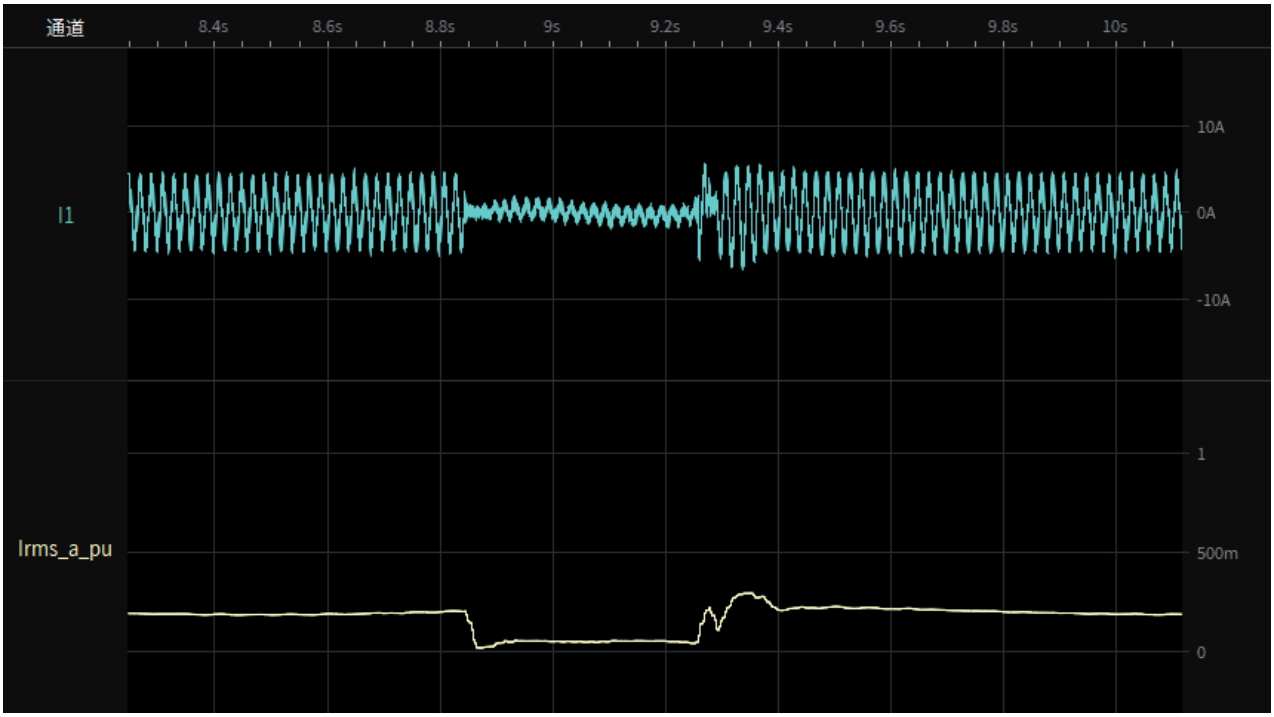


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2s-1.2 Depth of fault phase:0.25p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

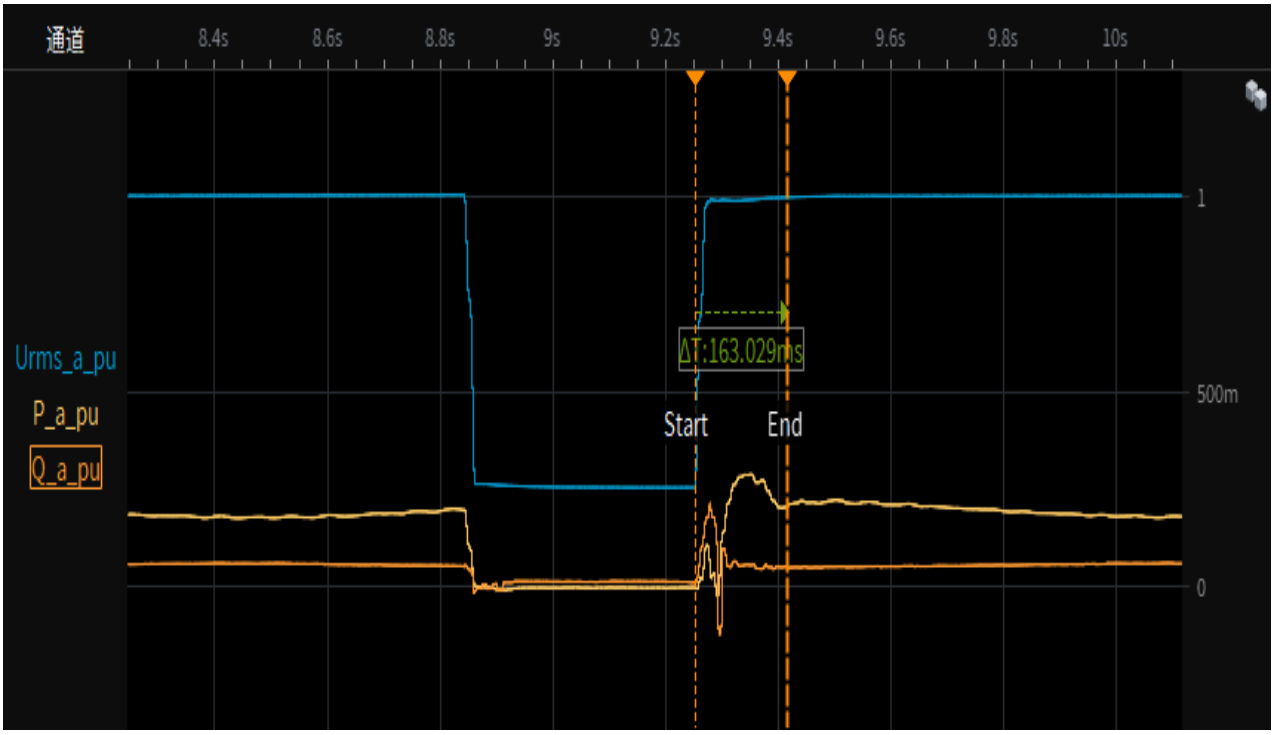


Test 2s-1.3 Depth of fault phase:0.25p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents

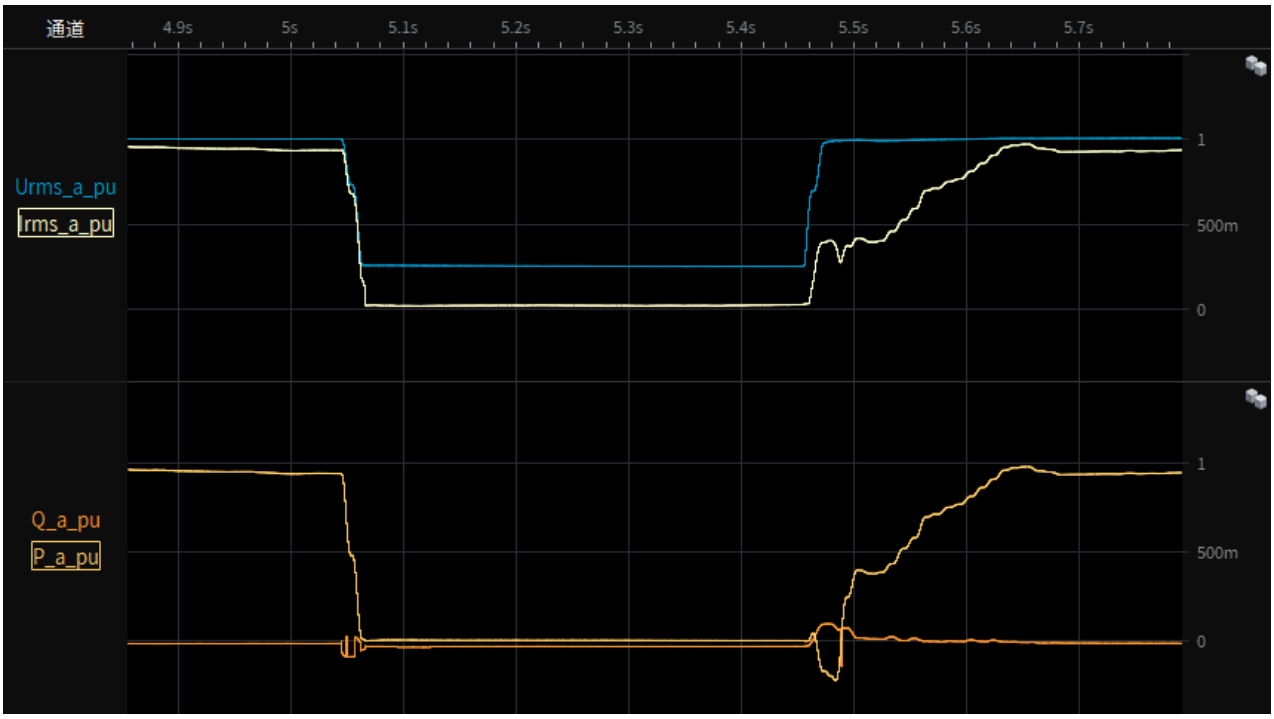


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2s-1.4 Depth of fault phase:0.25p.u.,three-phase-symmetrical (type A),
20% load restoring time

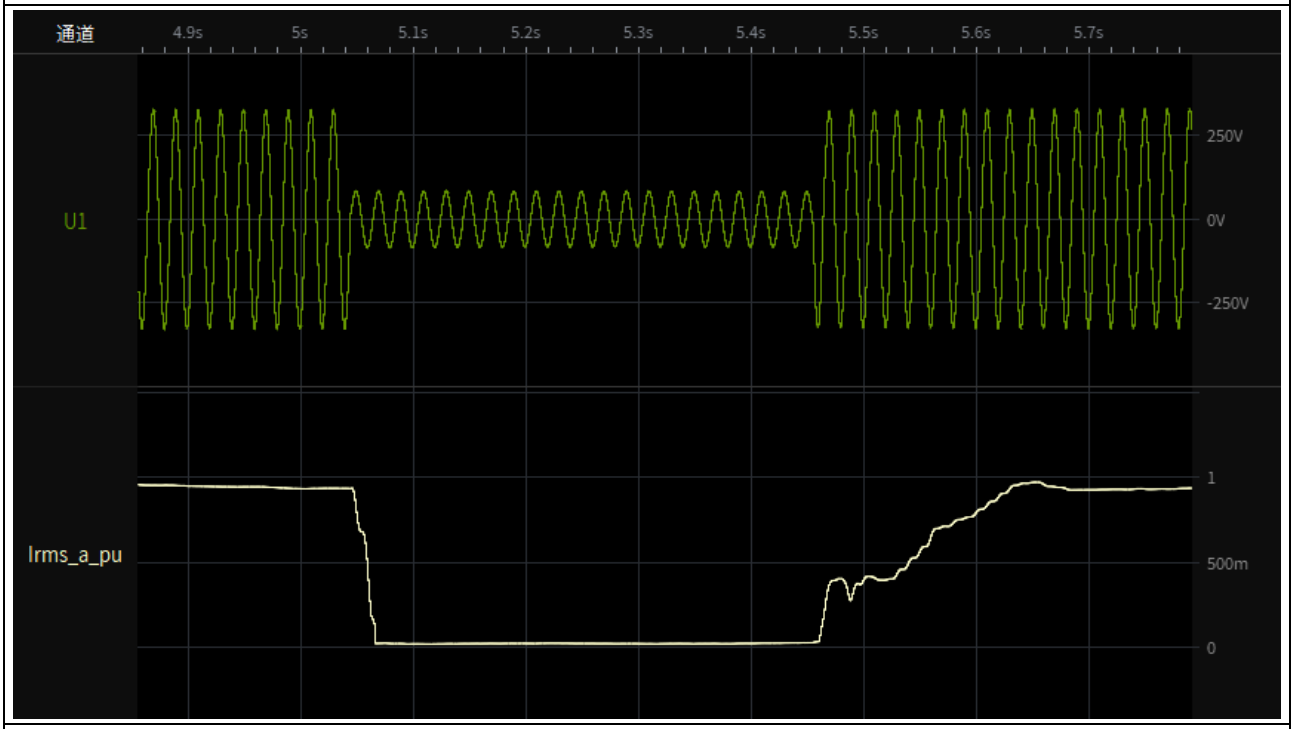


Test 2s-2.1 Depth of fault phase:0.25p.u.,three-phase-symmetrical (type A),95% load
Test overview(voltage,current,active and reactive power)

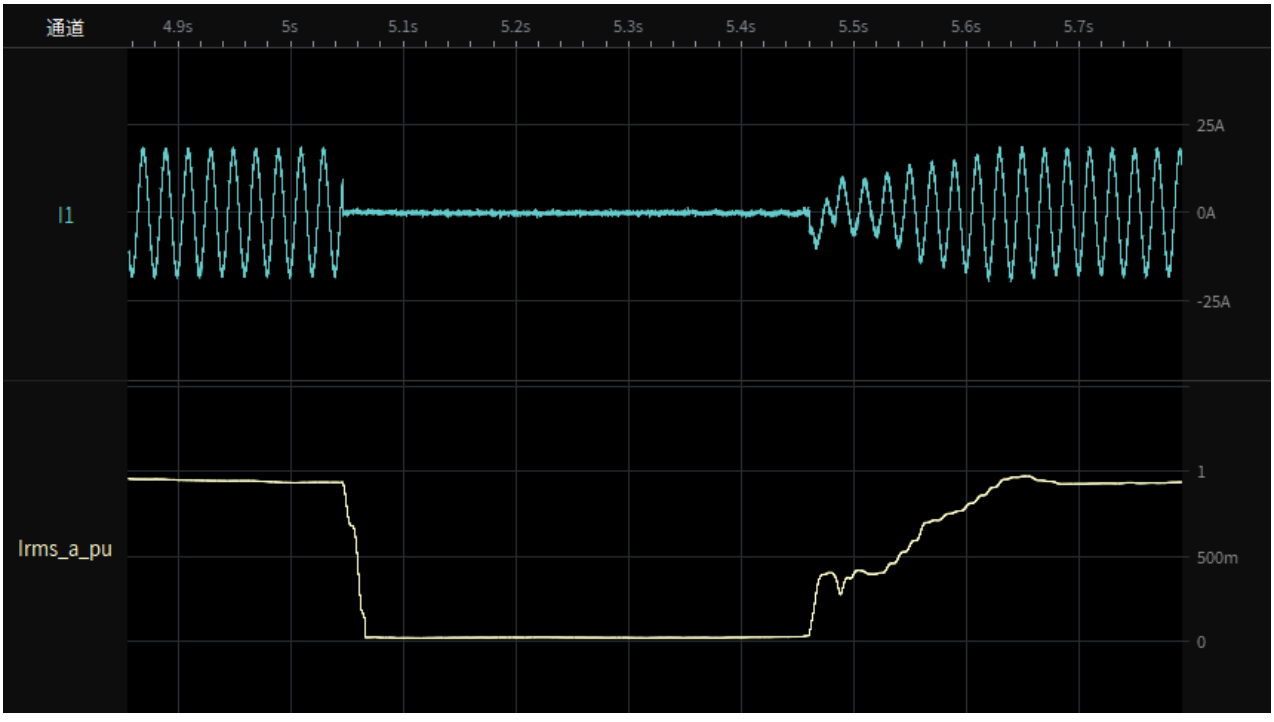


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2s-2.2 Depth of fault phase: 0.25p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

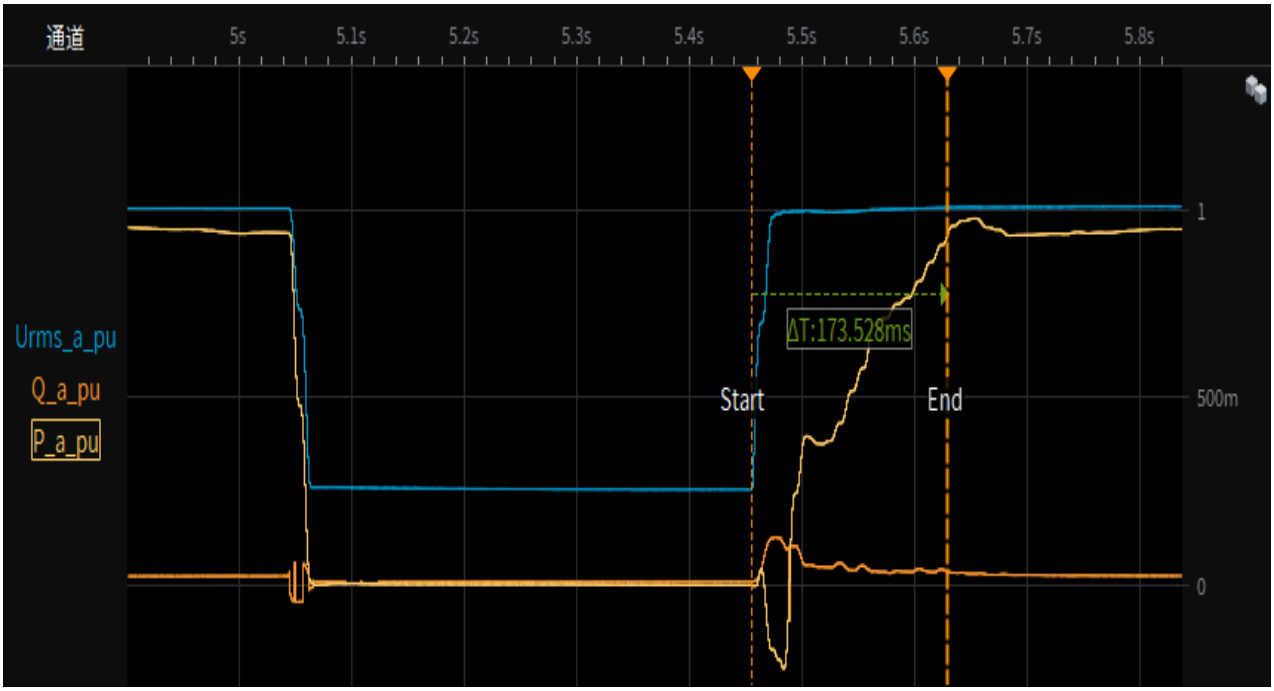


Test 2s-2.3 Depth of fault phase: 0.25p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents

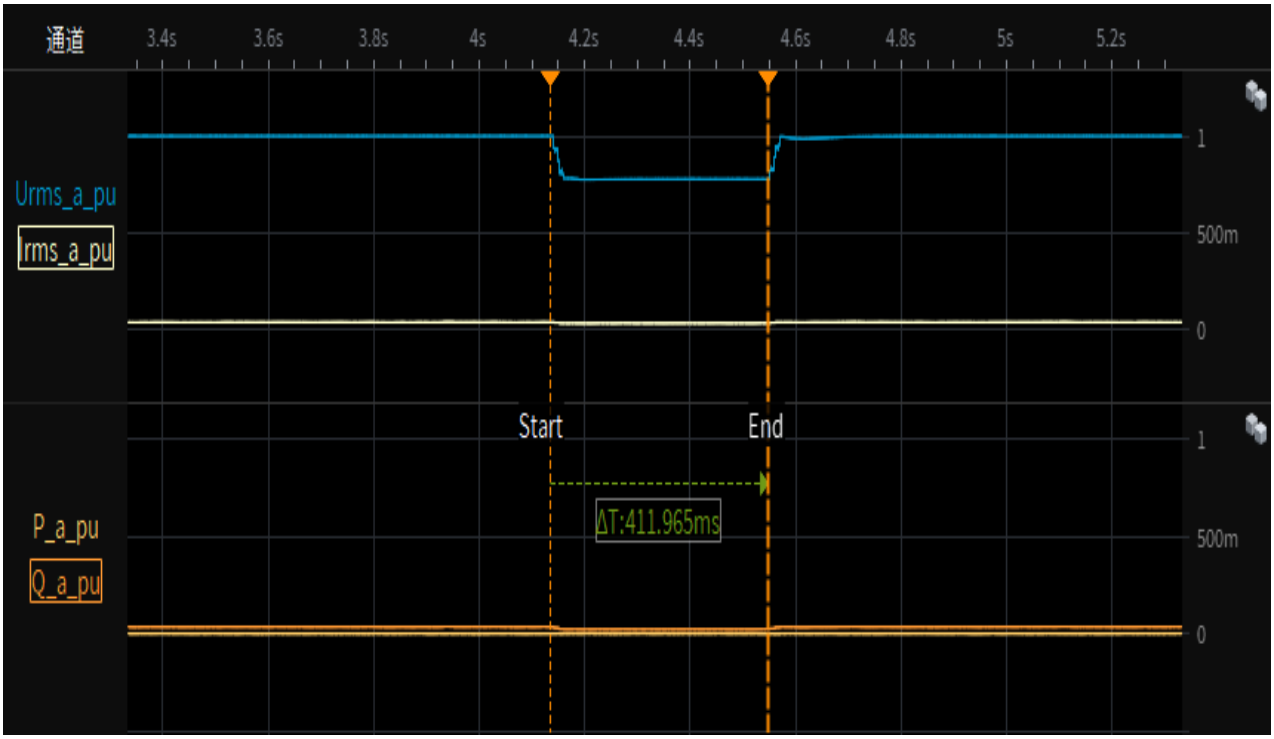


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2s-2.4 Depth of fault phase: 0.25p.u.,three-phase-symmetrical (type A),
95% load restoring time

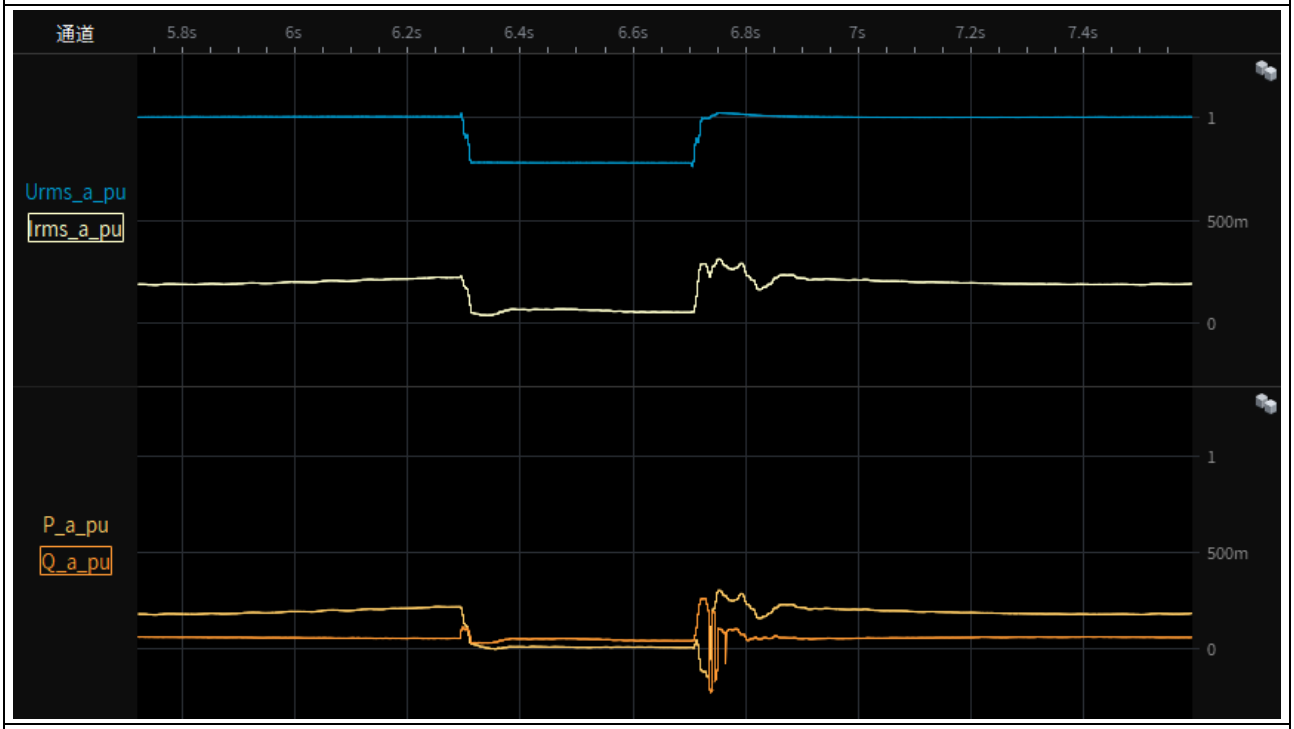


Test 2a- Depth of fault phase: 0.25p.u.,two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

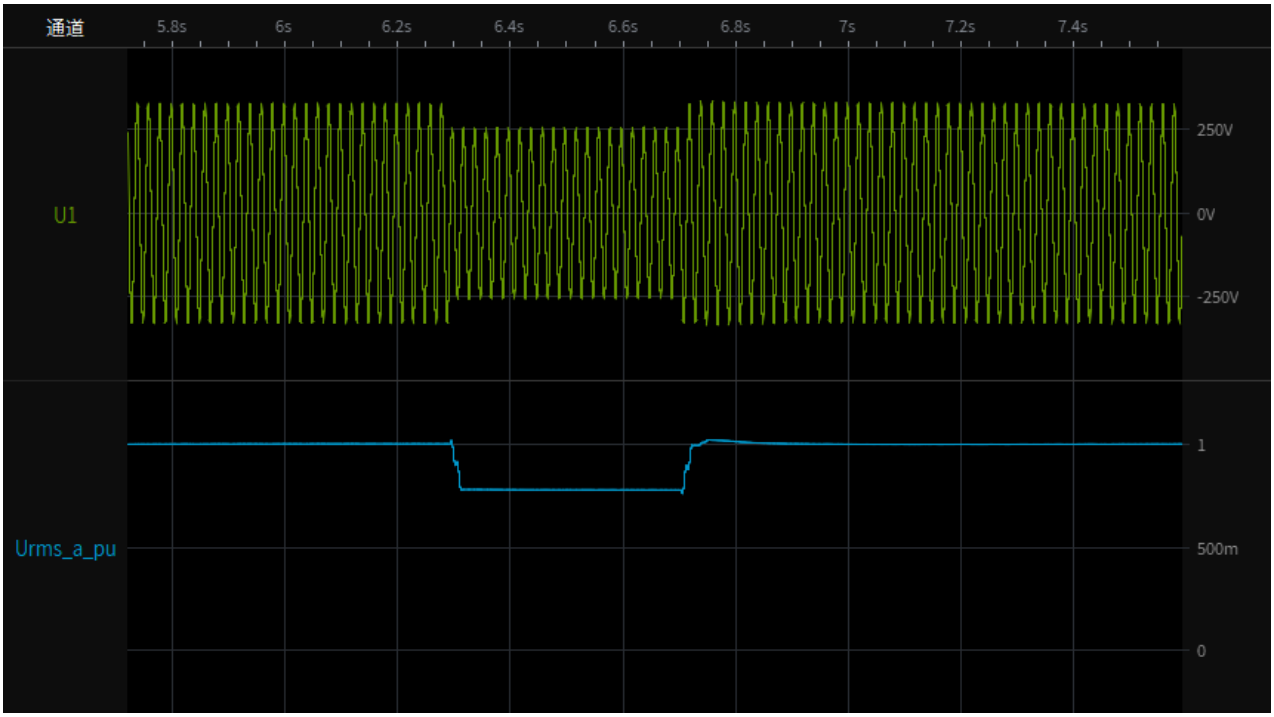


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2a-1.1 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

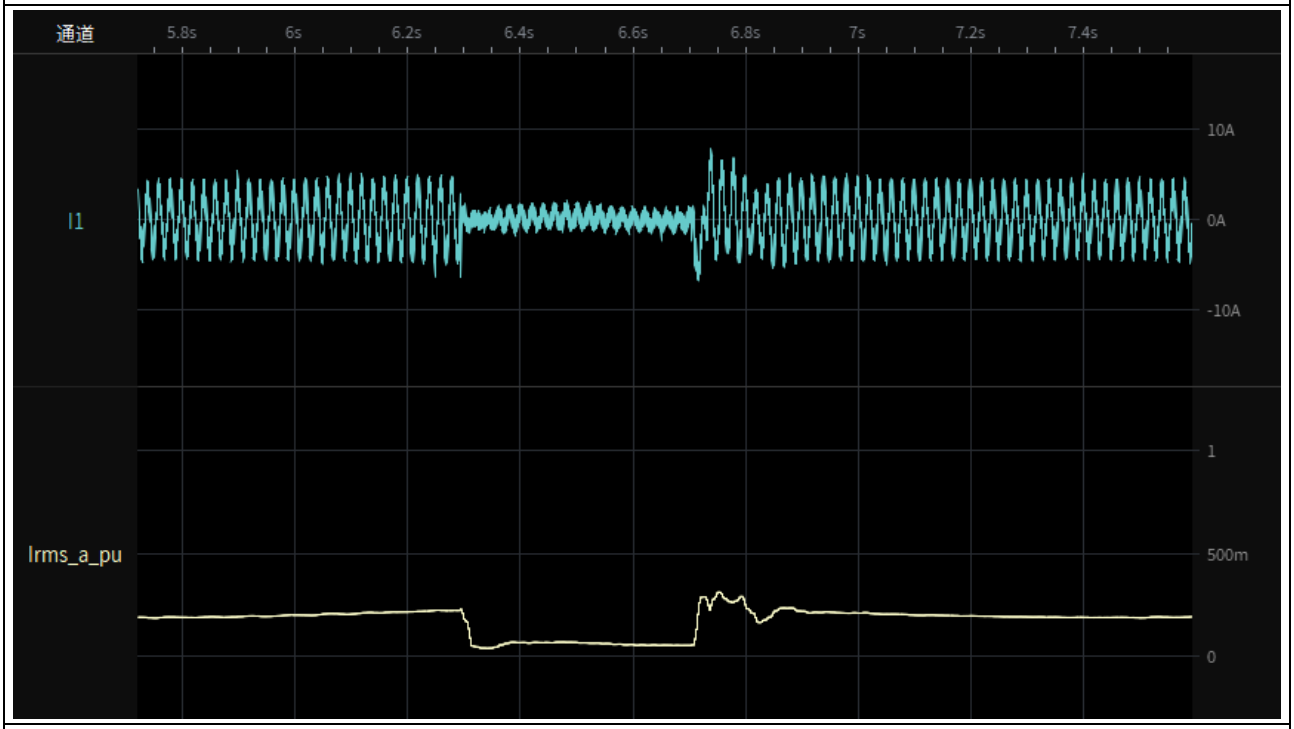


Test 2a-1.2 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

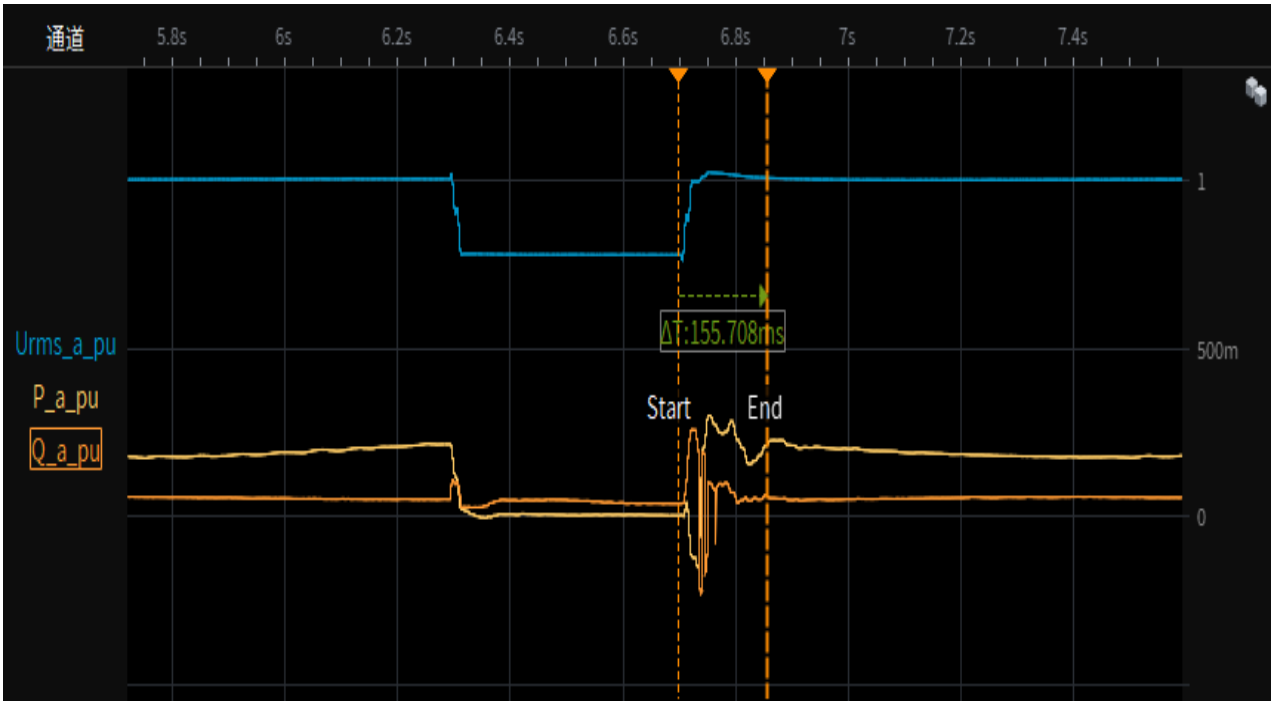


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2a-1.3 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

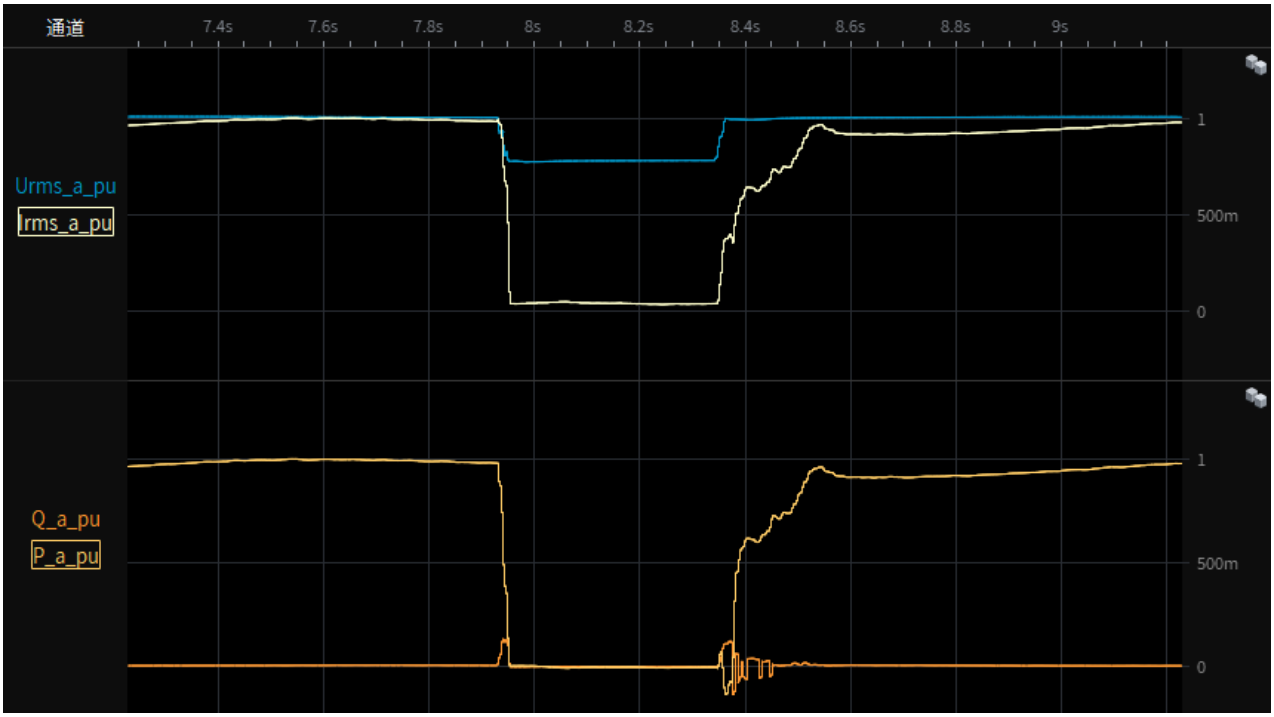


Test 2a-1.4 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),
20% load restoring time

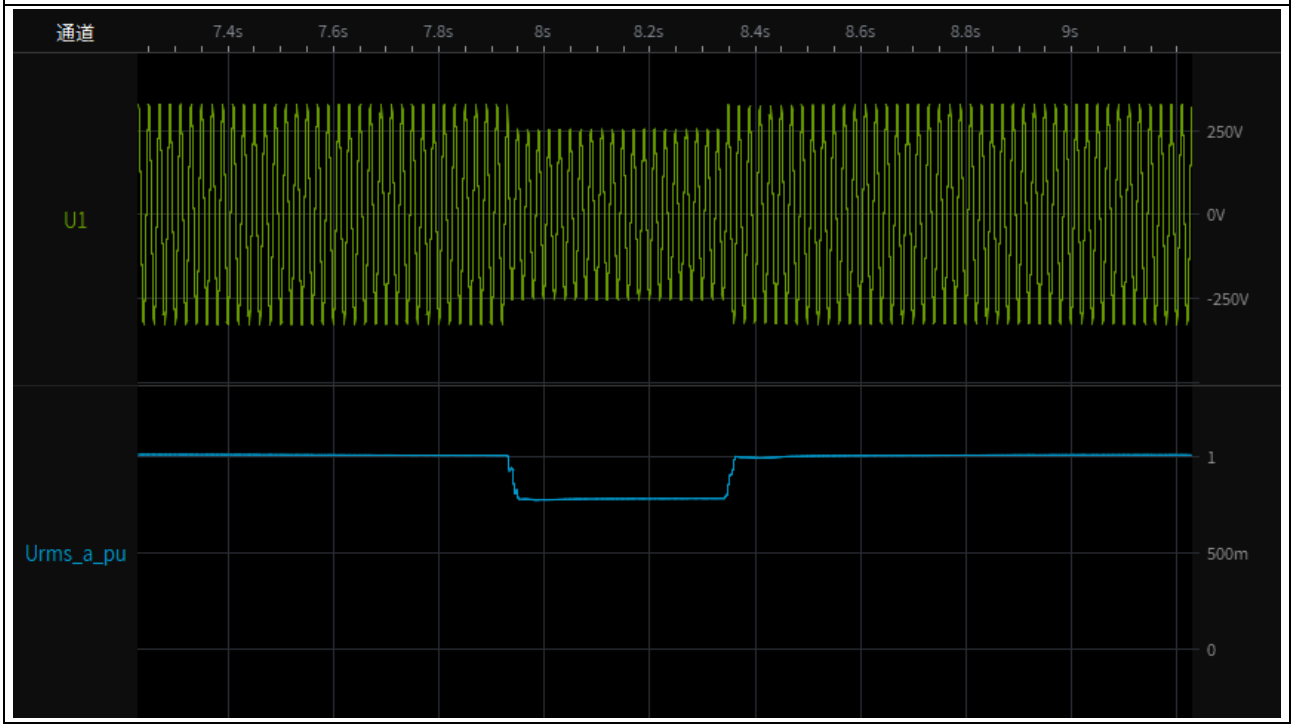


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2a-2.1 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

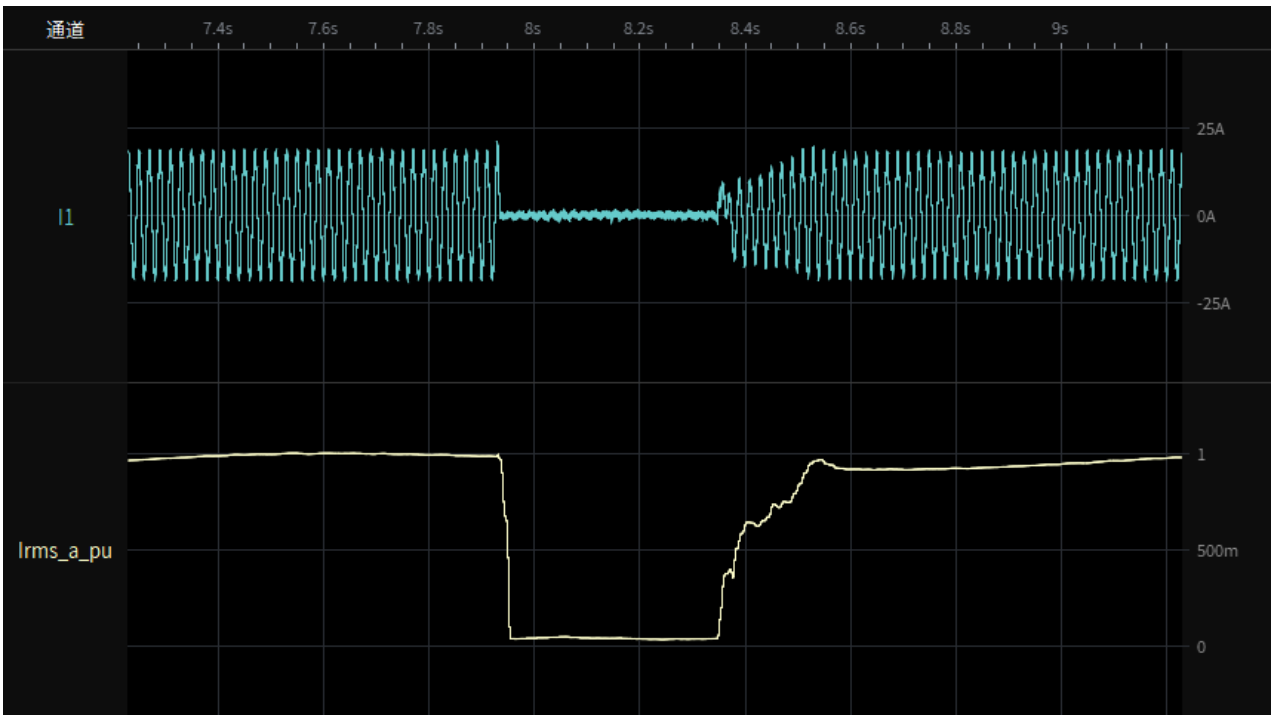


Test 2a-2.2 Depth of fault phase: 0.25p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

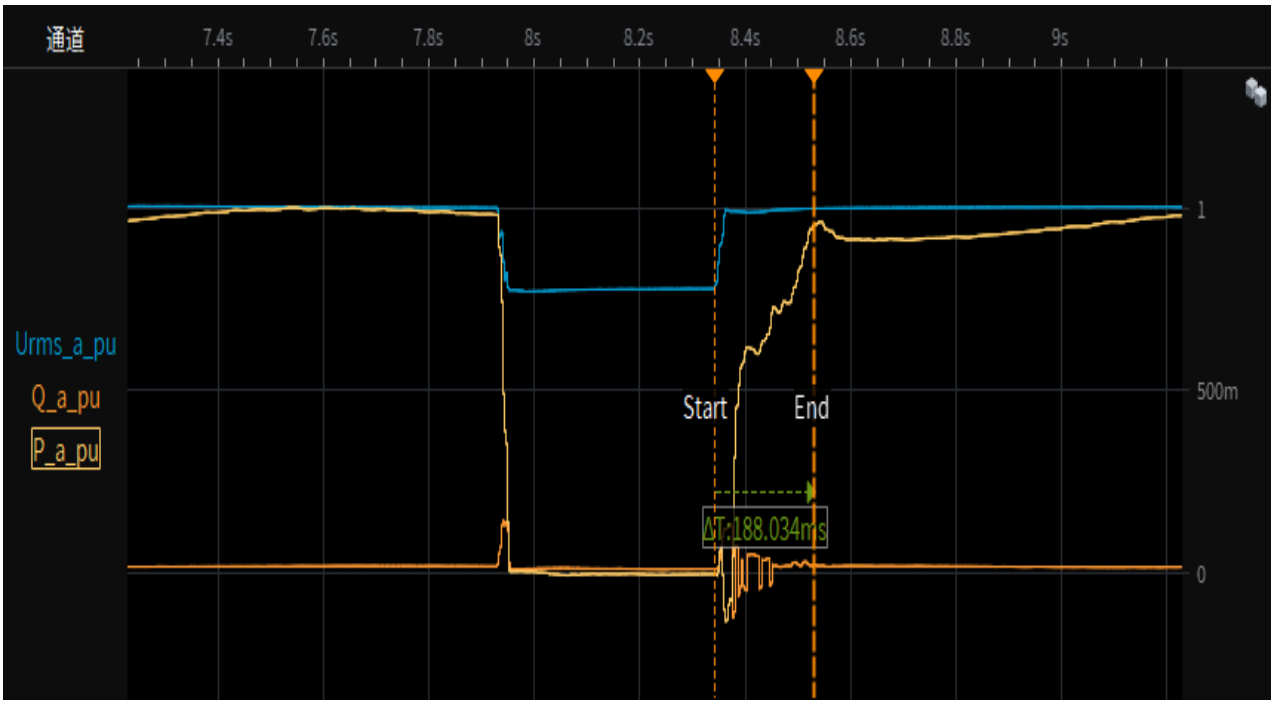


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2a-2.3 Depth of fault phase:0.25p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

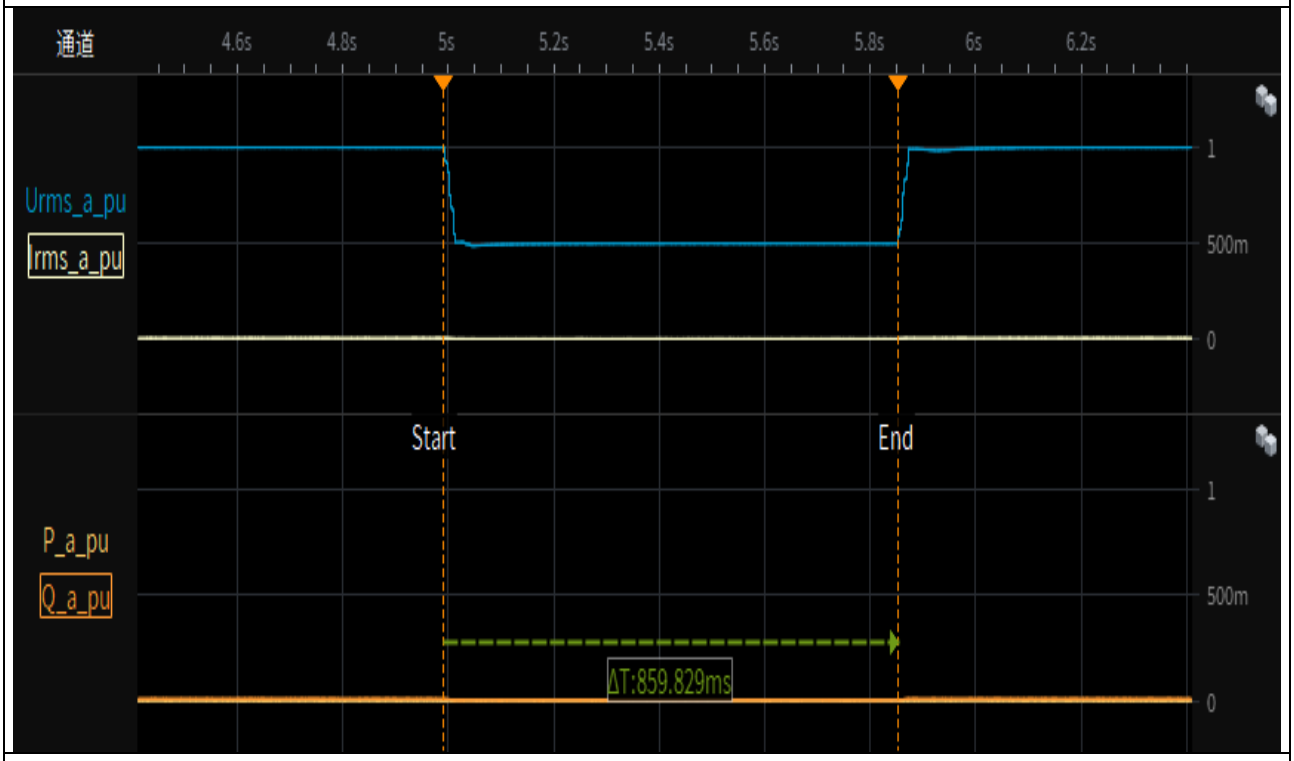


Test 2a-2.4 Depth of fault phase: 0.25p.u.,two-phase-asymmetrical (type D),
95% load restoring time

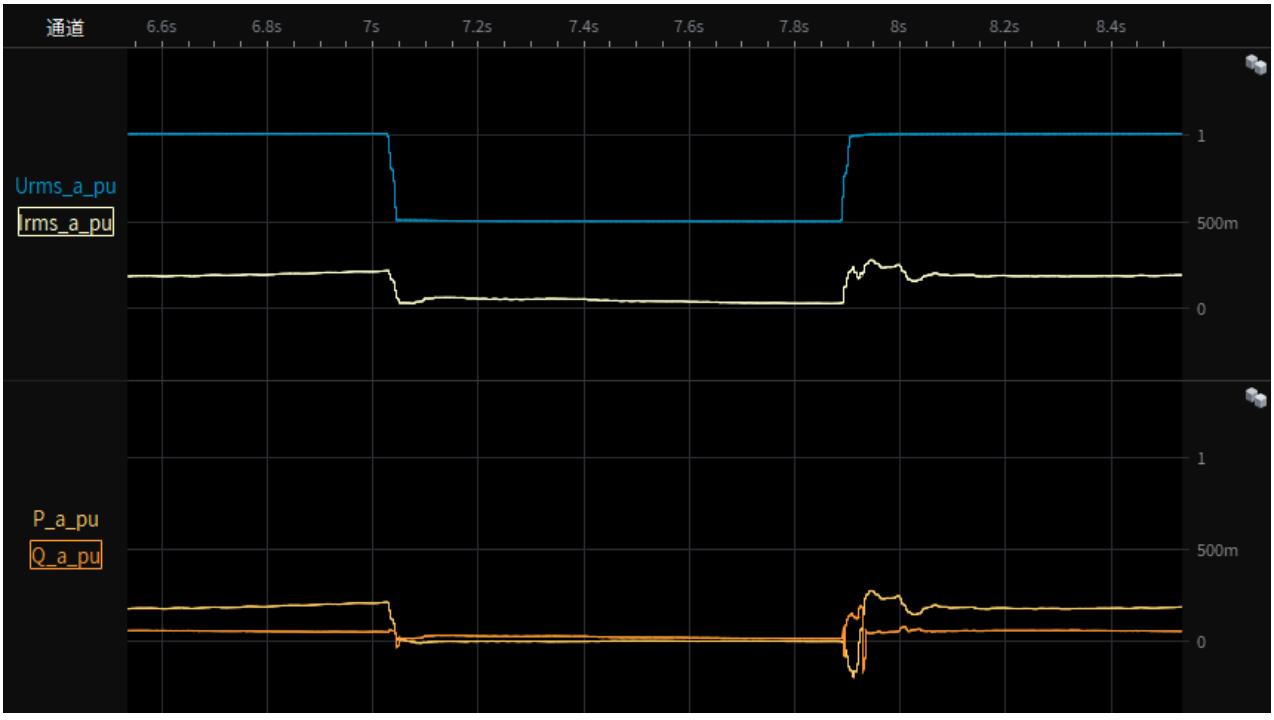


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3s- Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),0% load
Test overview(voltage,current,active and reactive power)

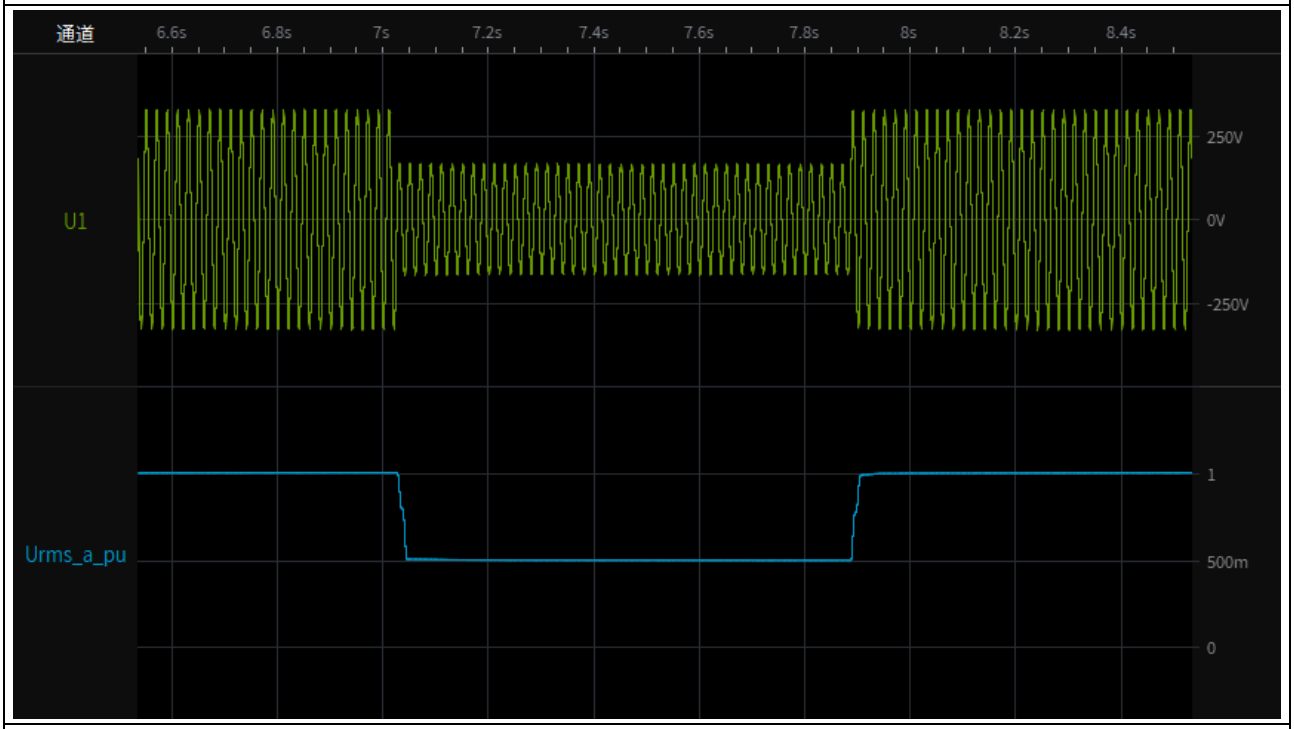


Test 3s-1.1 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)

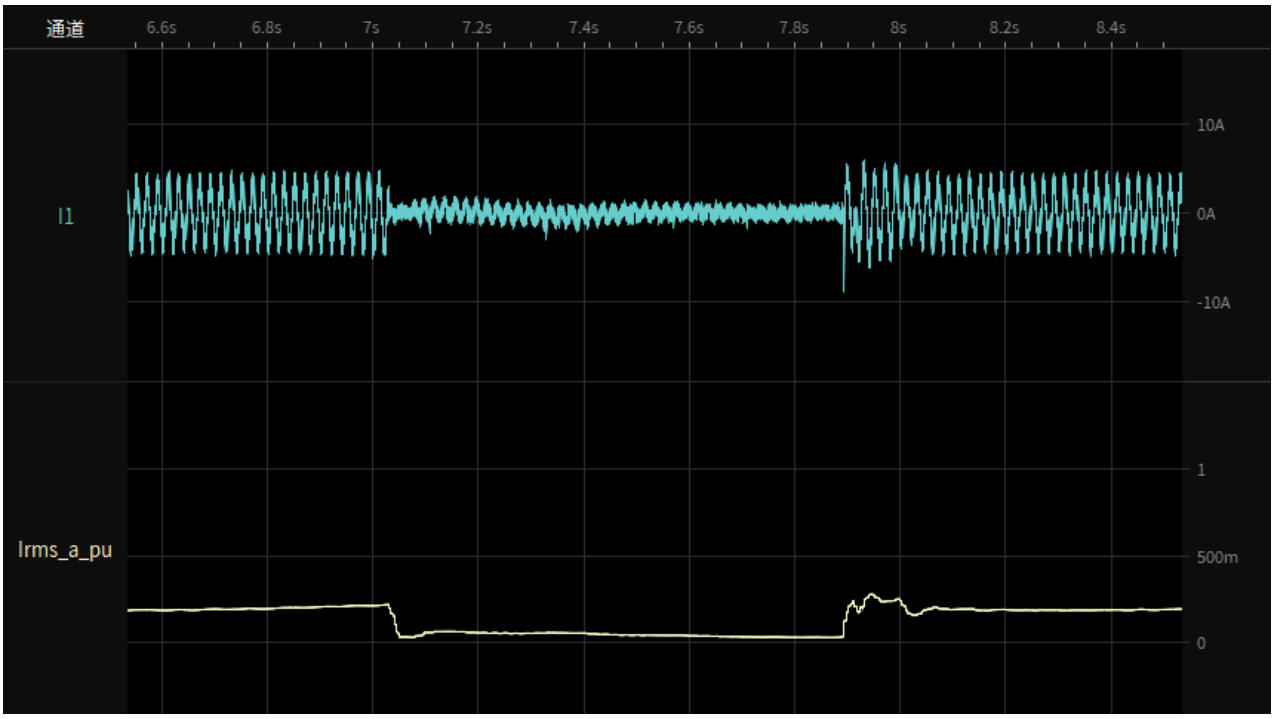


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3s-1.2 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

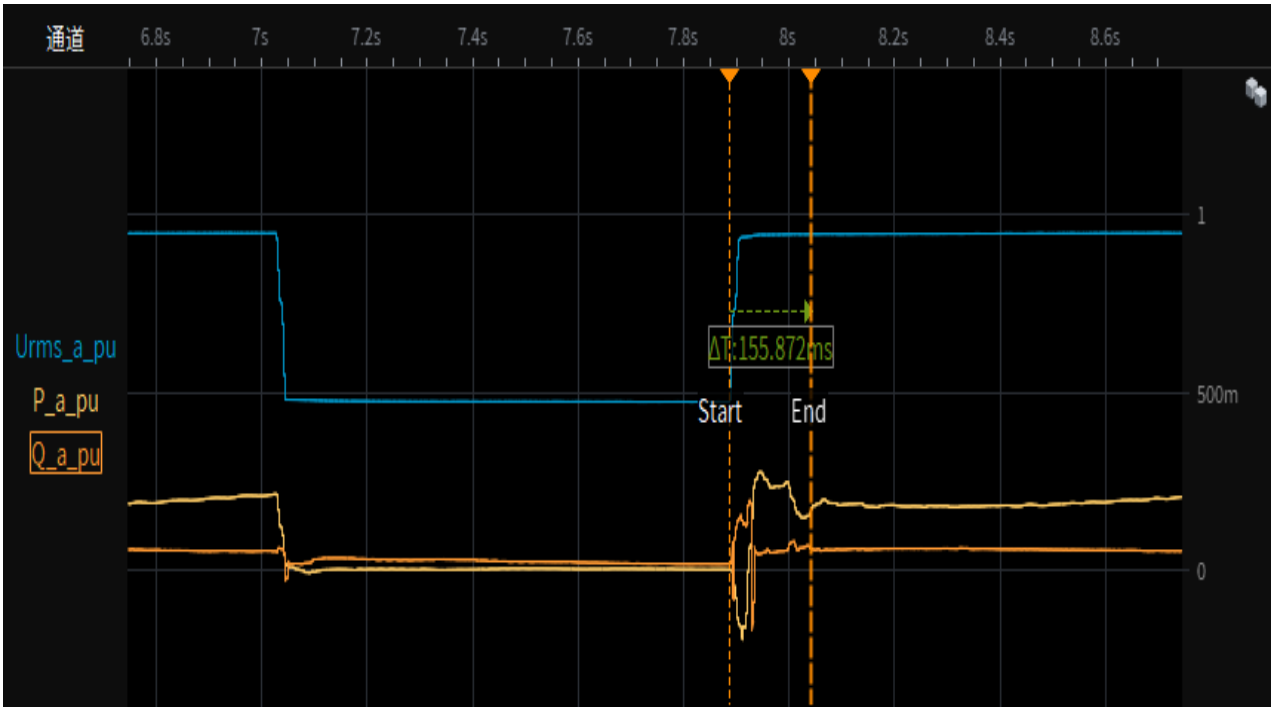


Test 3s-1.3 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents

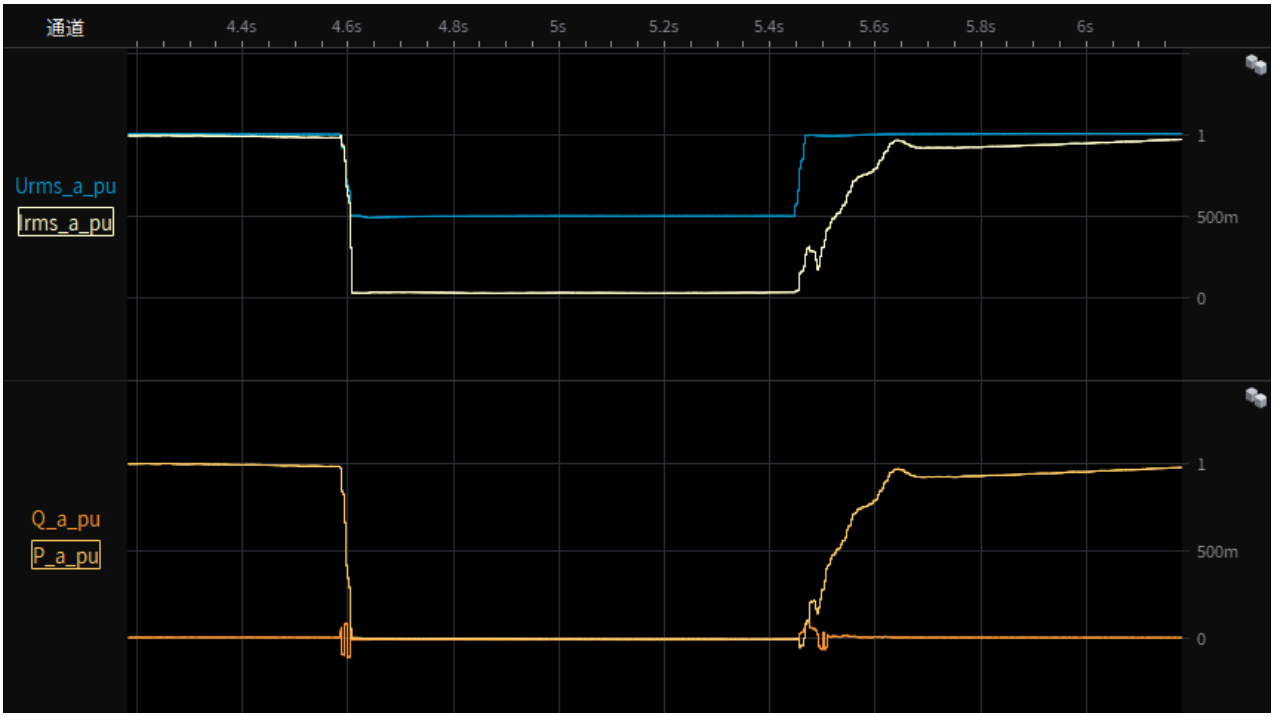


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3s-1.4 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),
20% load restoring time

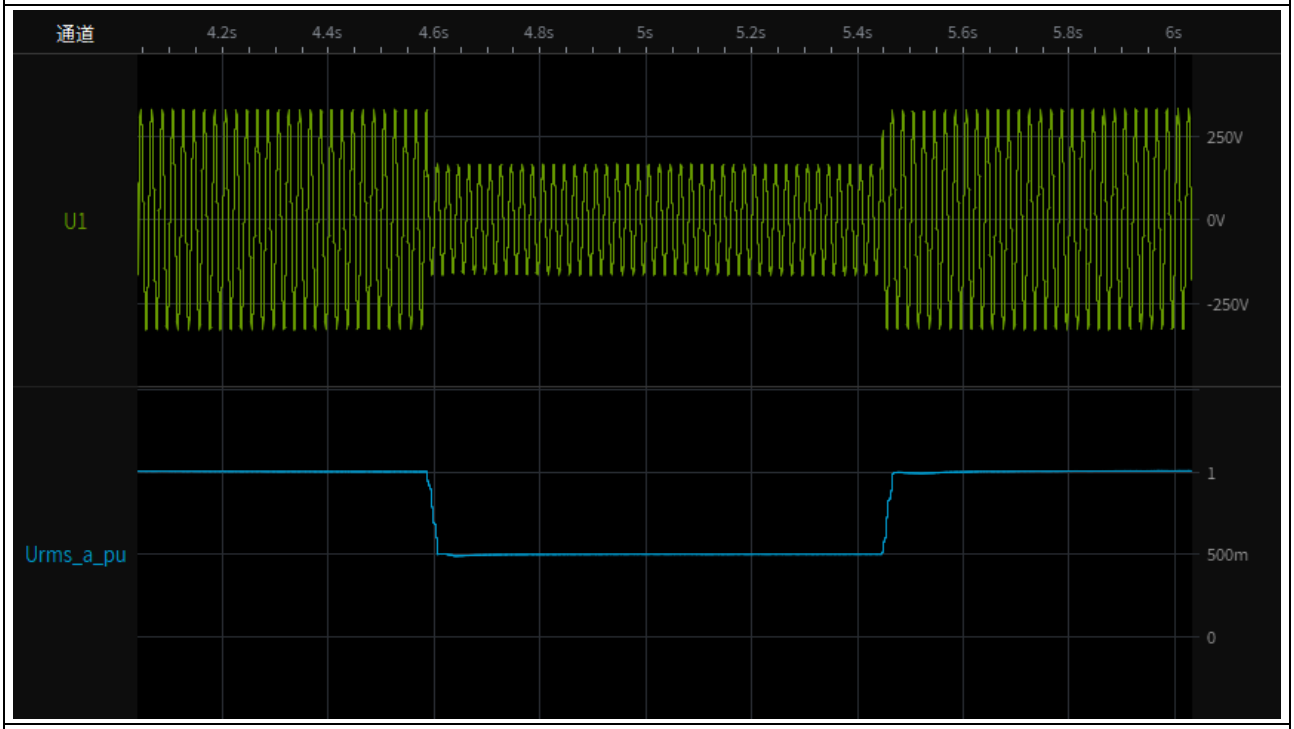


Test 3s-2.1 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),95% load
Test overview(voltage,current,active and reactive power)

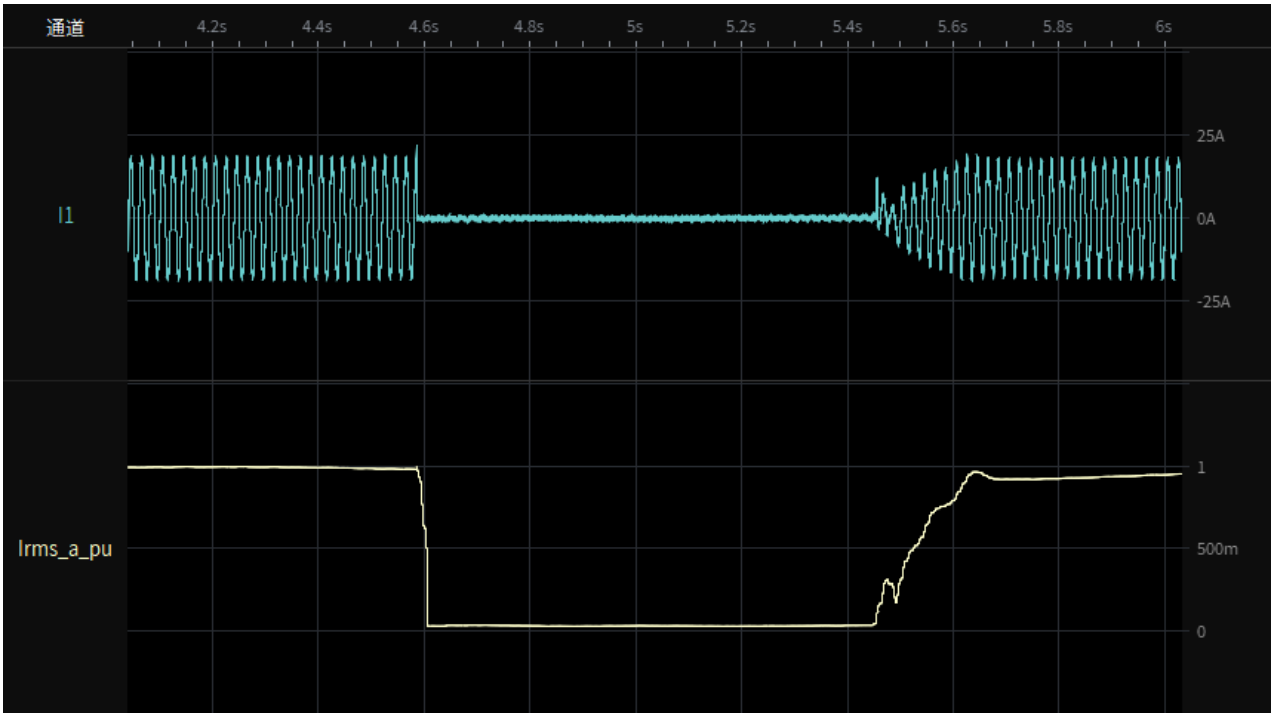


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3s-2.2 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

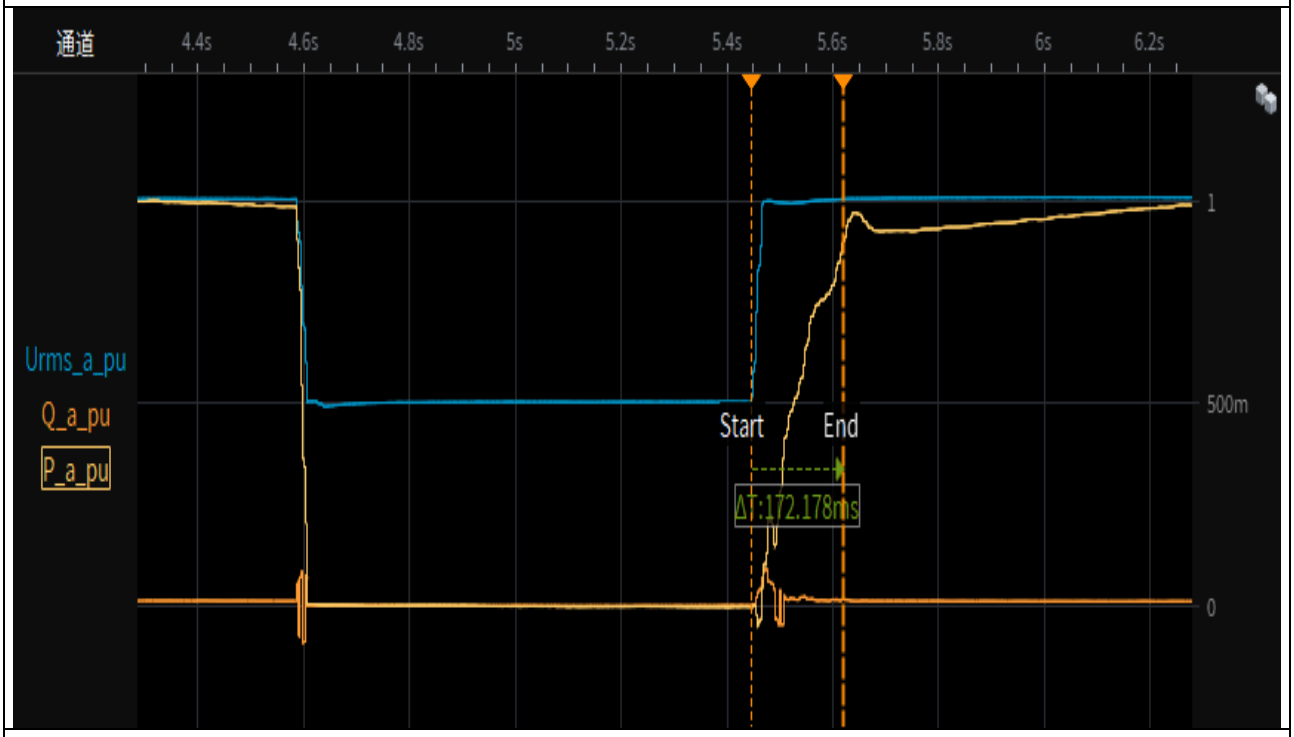


Test 3s-2.3 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents

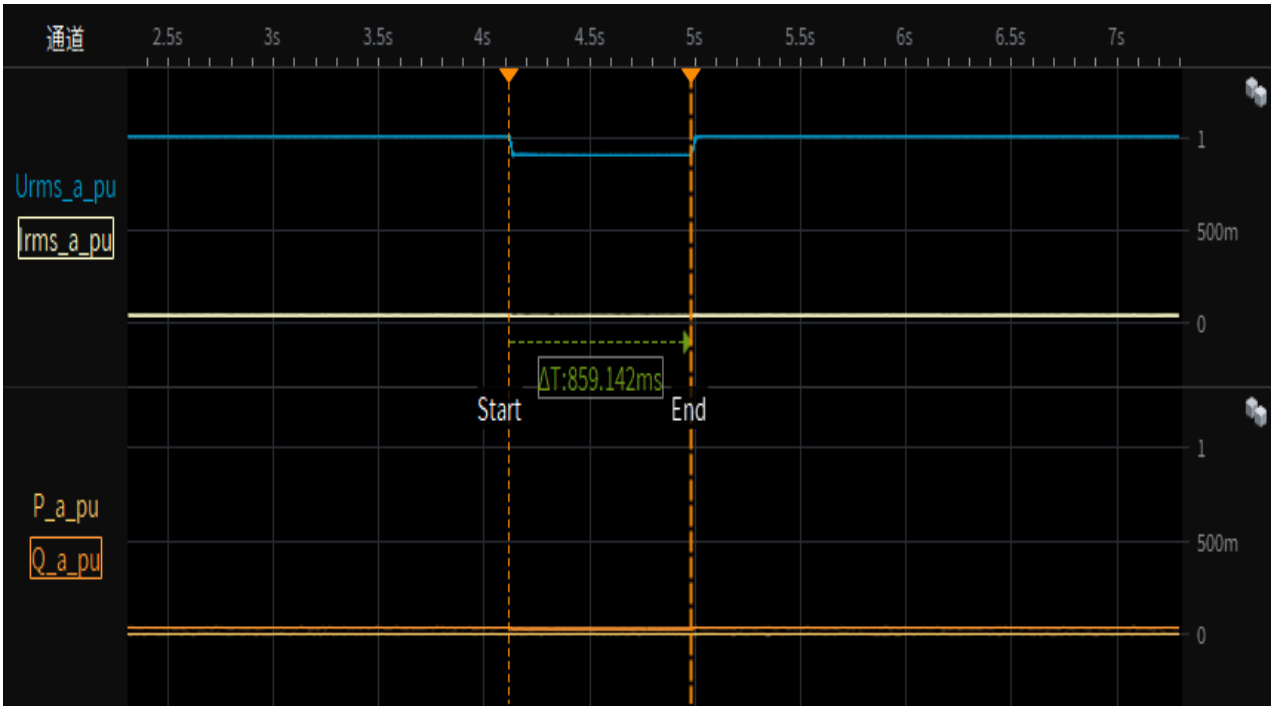


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3s-2.4 Depth of fault phase: 0.5p.u.,three-phase-symmetrical (type A),
95% load restoring time

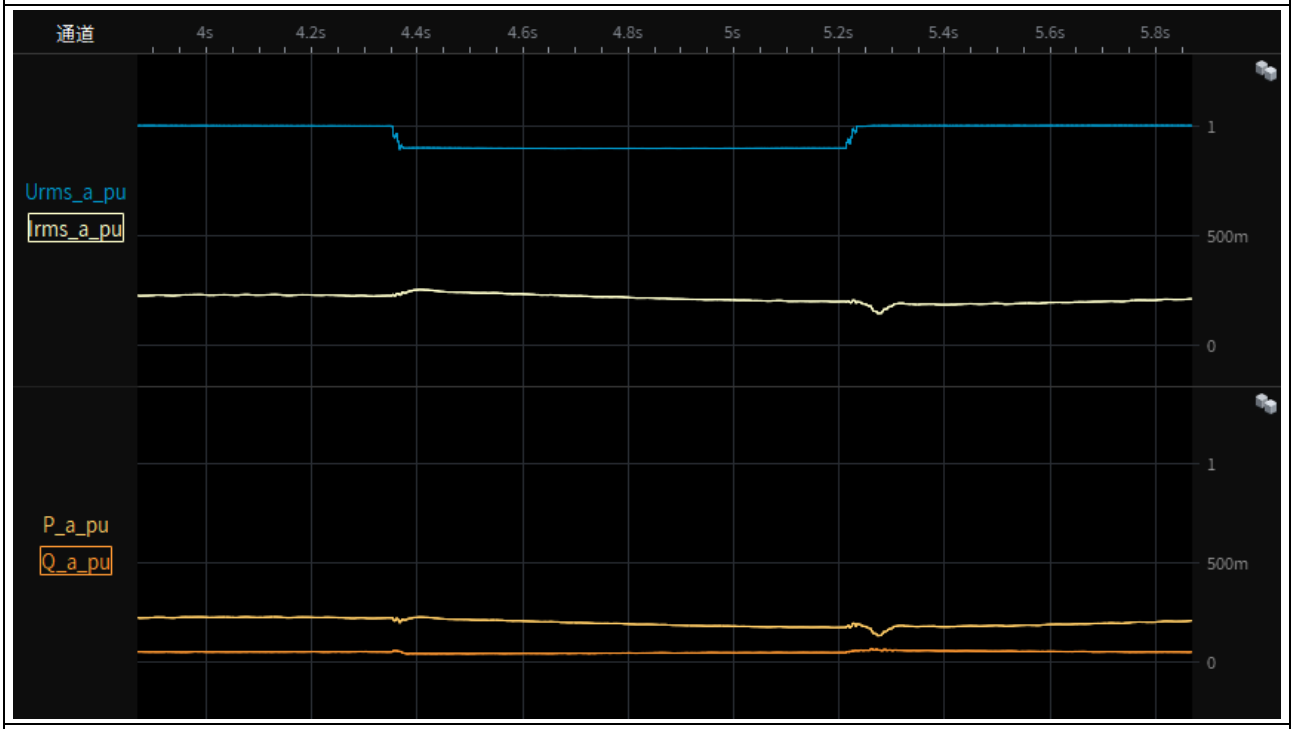


Test 3a- Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

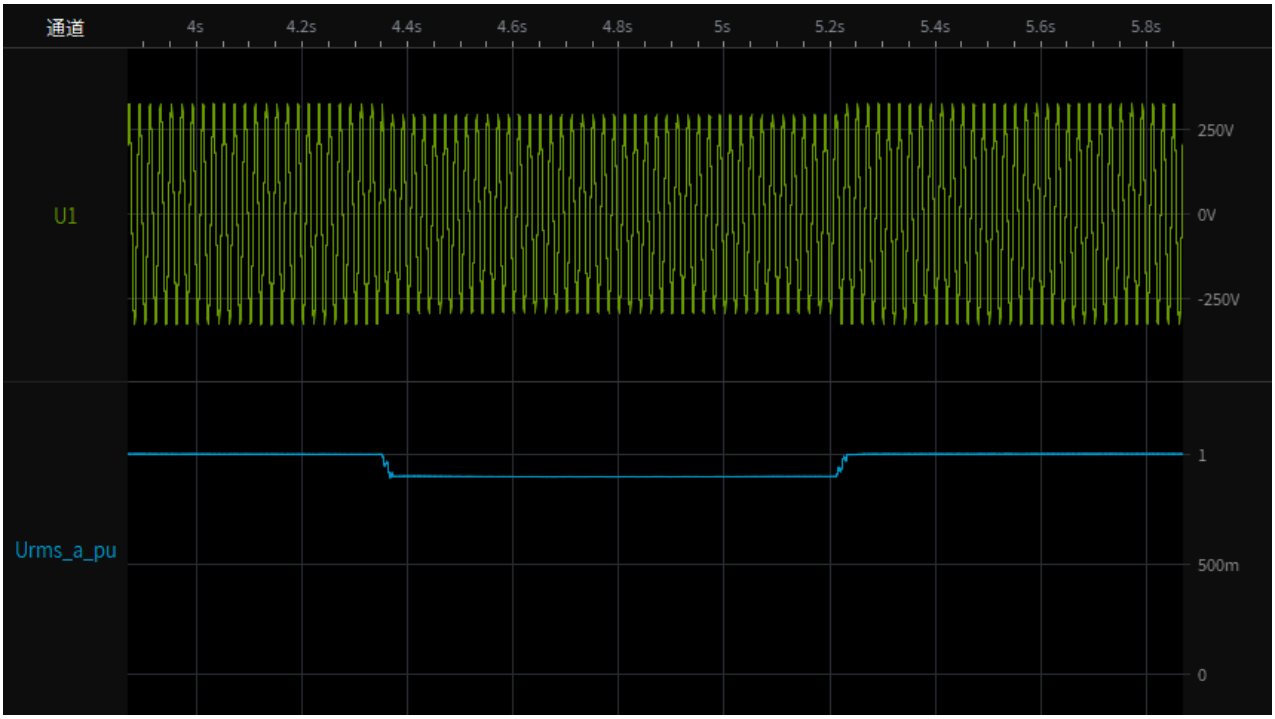


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3a-1.1 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

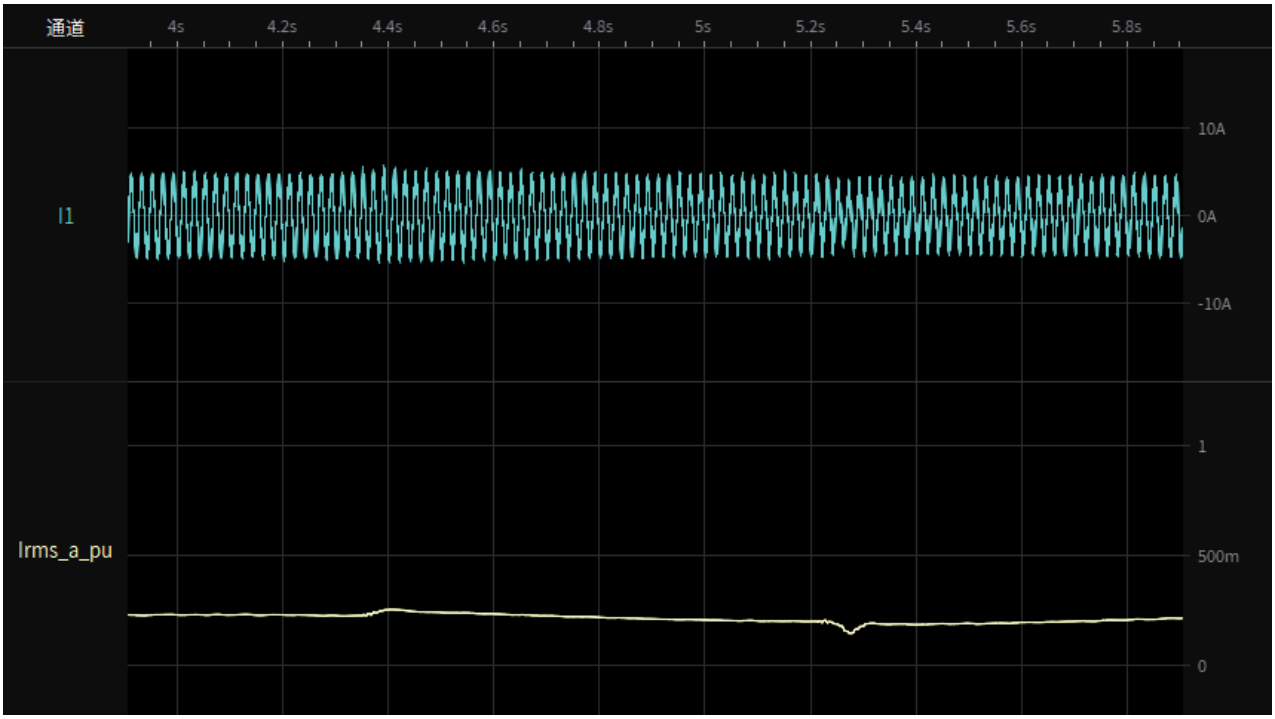


Test 3a-1.2 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

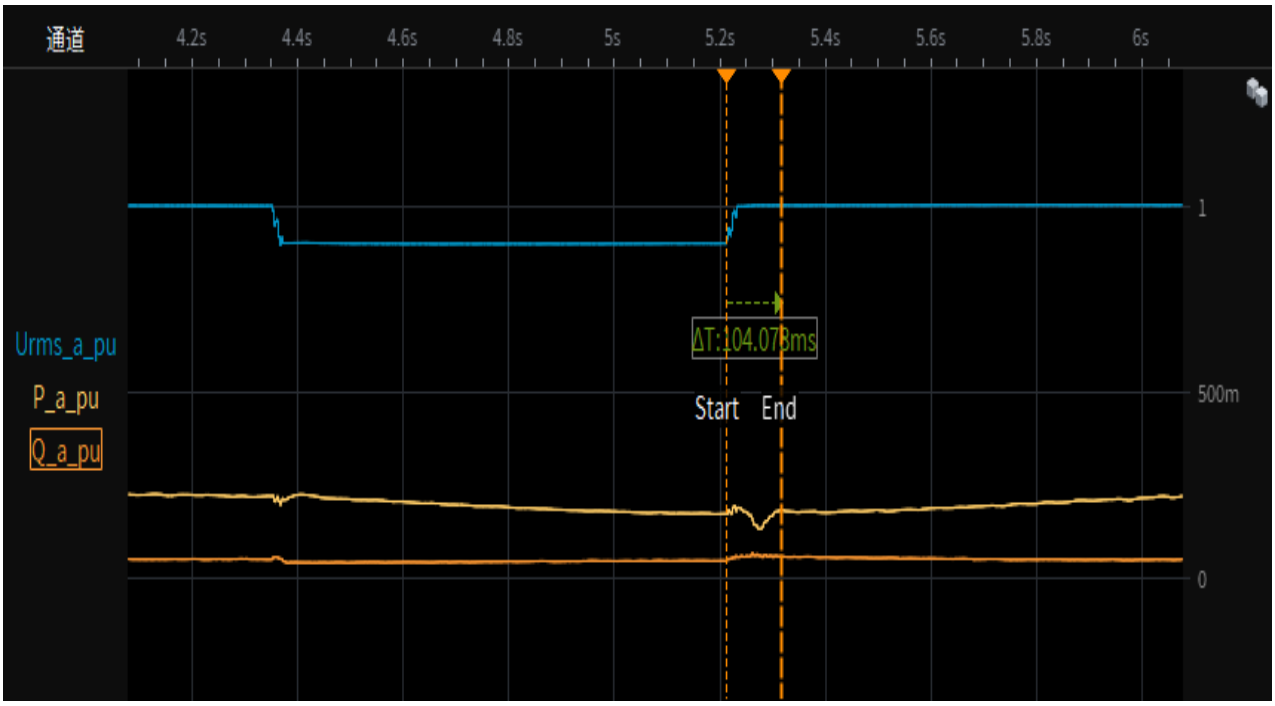


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3a-1.3 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

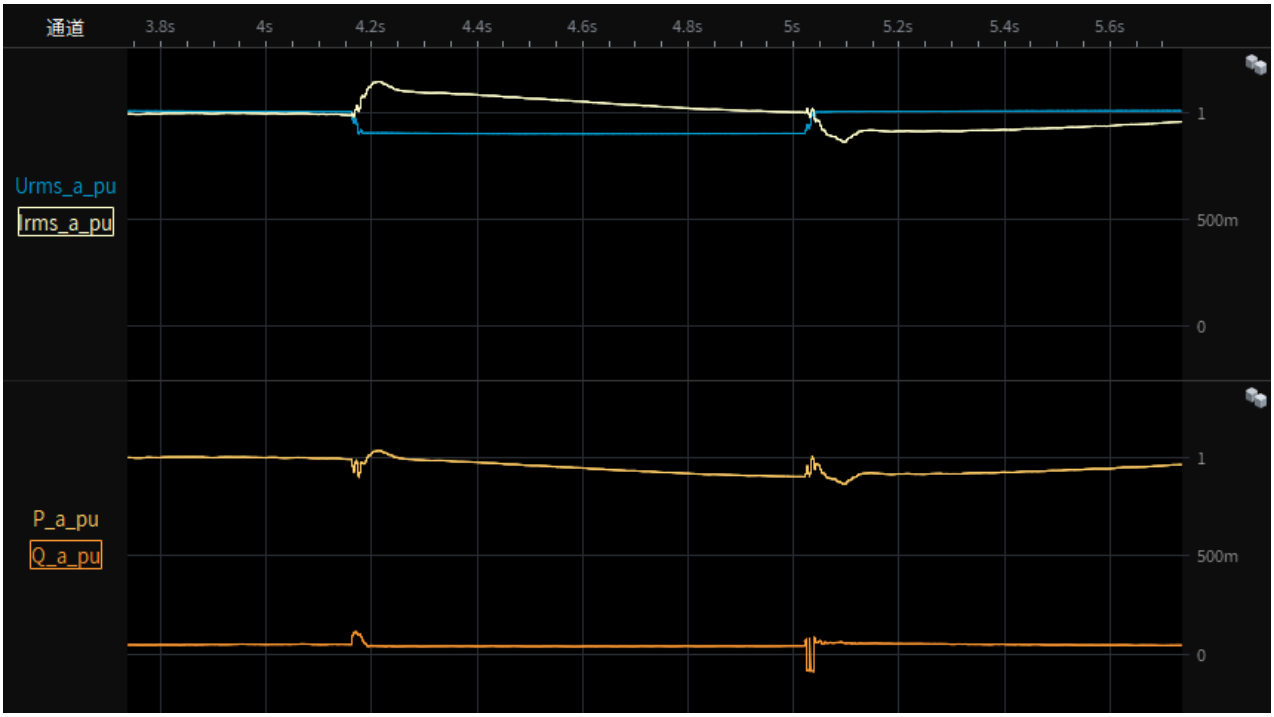


Test 3a-1.4 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),
20% load restoring time

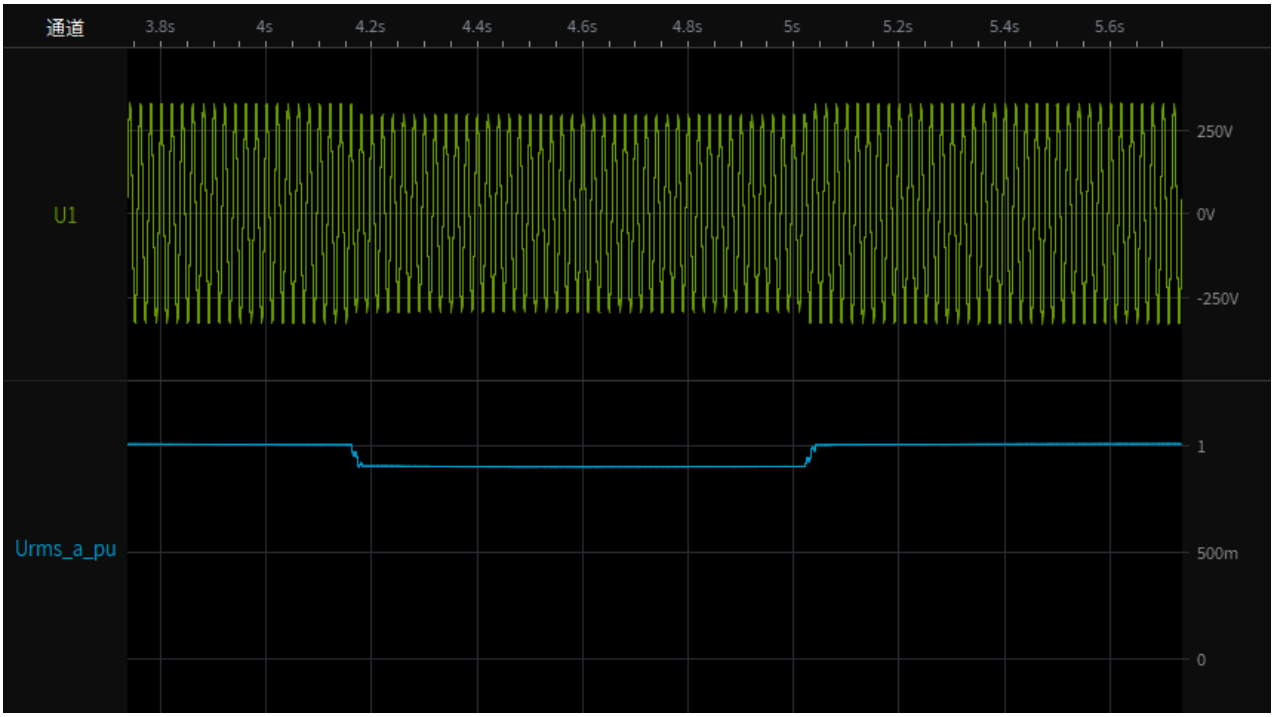


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3a-2.1 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

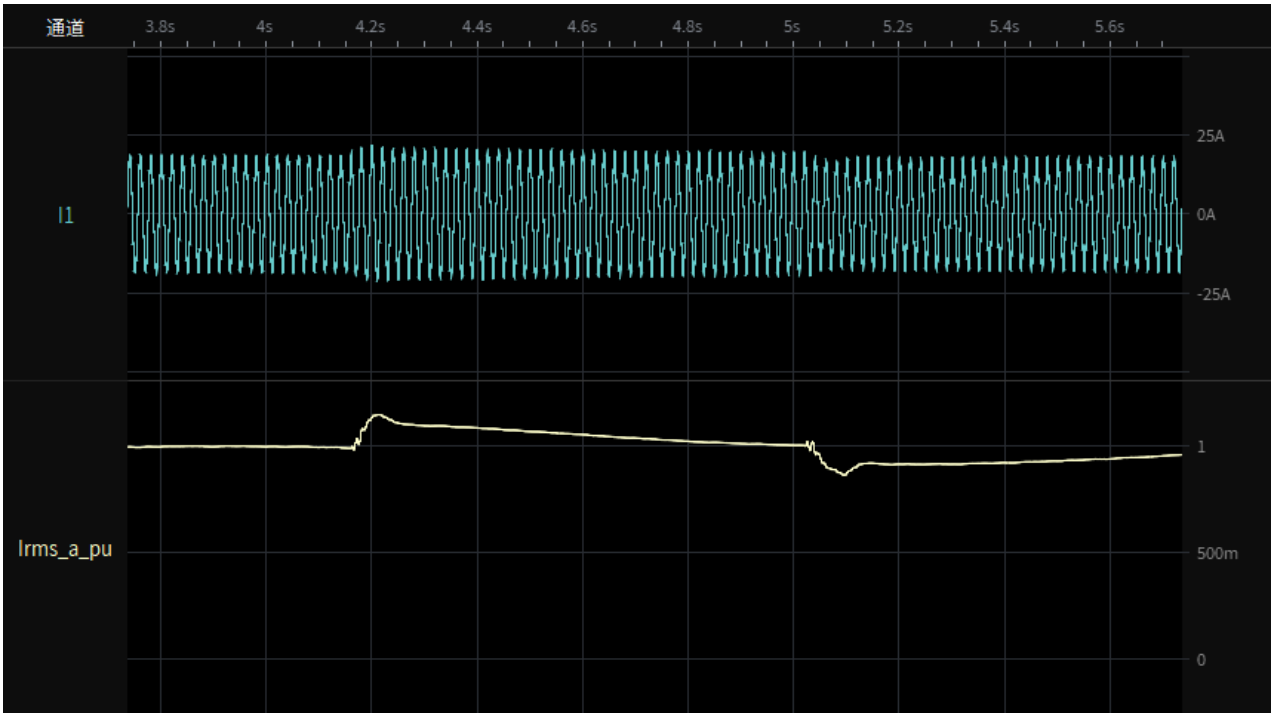


Test 3a-2.2 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

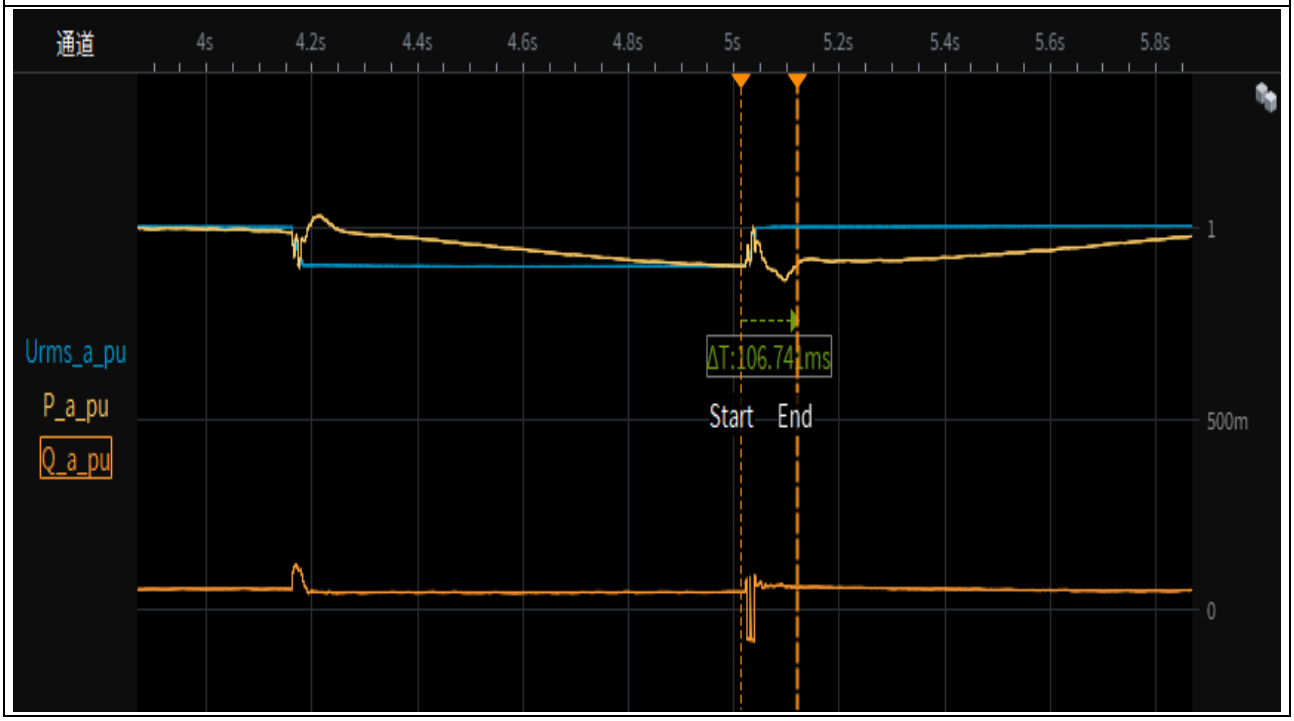


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3a-2.3 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

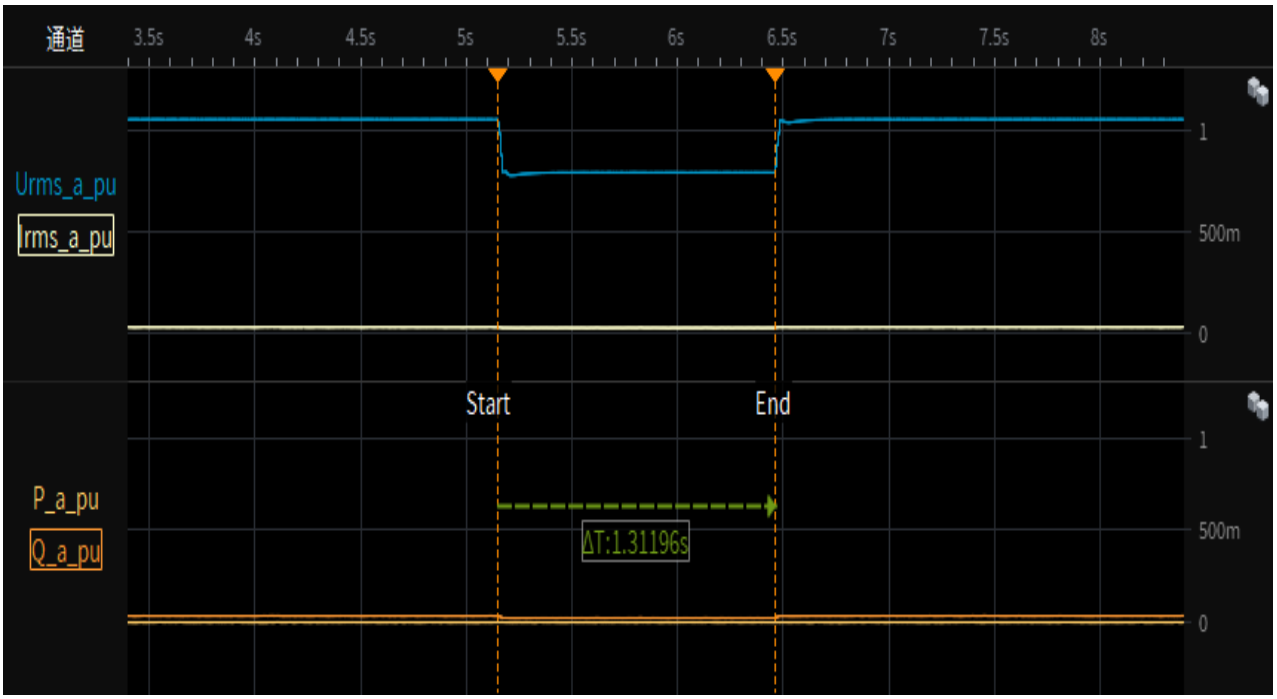


Test 3a-2.4 Depth of fault phase: 0.5p.u.,two-phase-asymmetrical (type D),
95% load restoring time

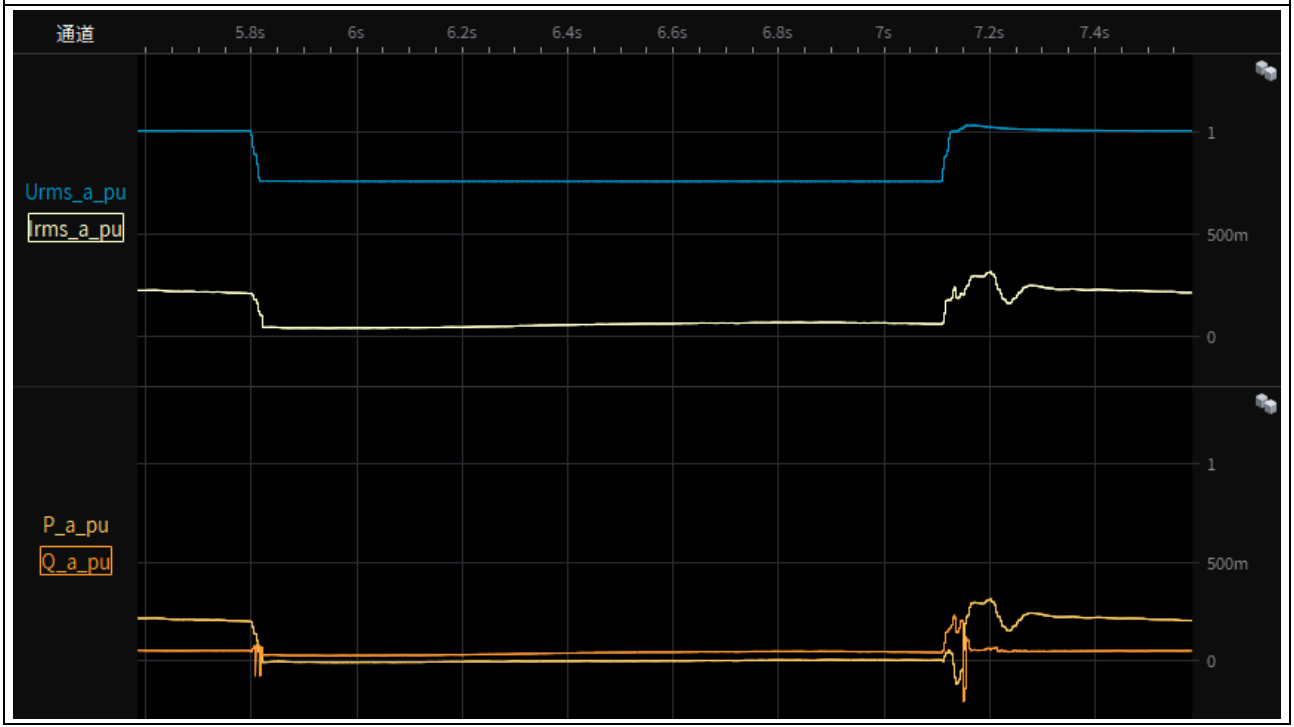


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4s- Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),0% load
Test overview(voltage,current,active and reactive power)

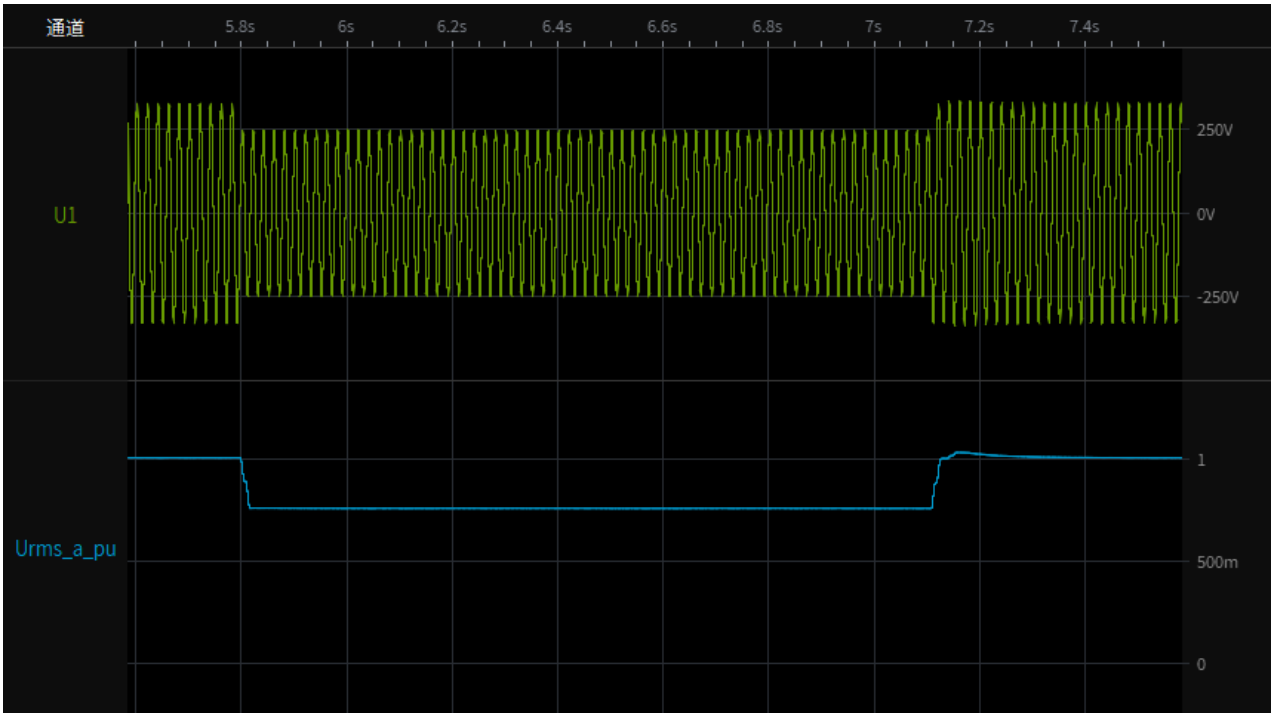


Test 4s-1.1 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)

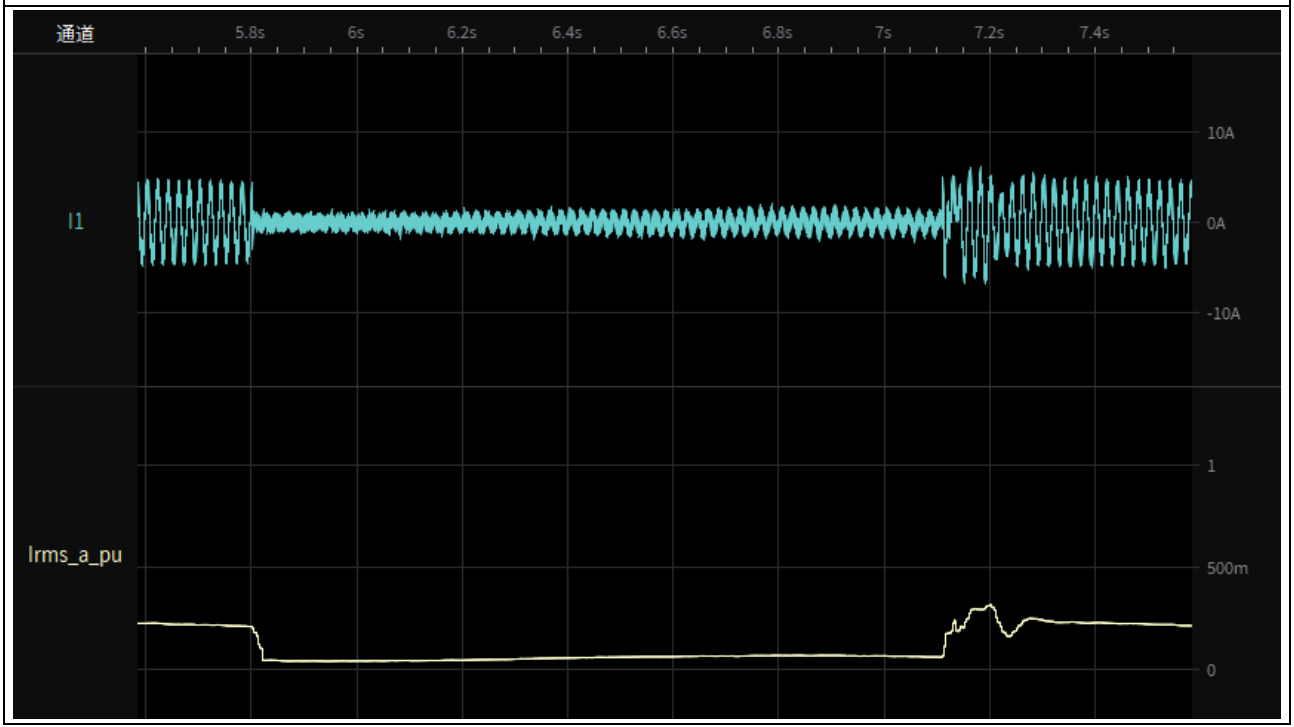


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4s-1.2 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

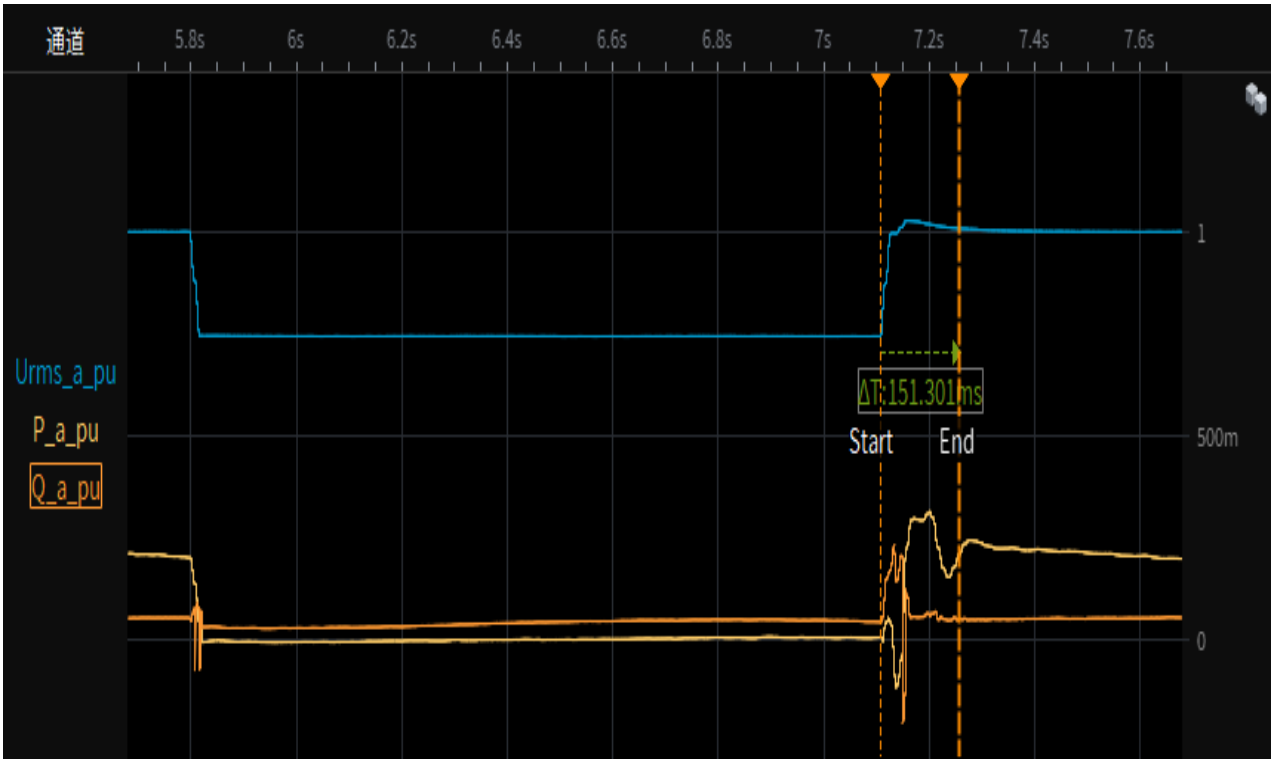


Test 4s-1.3 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents

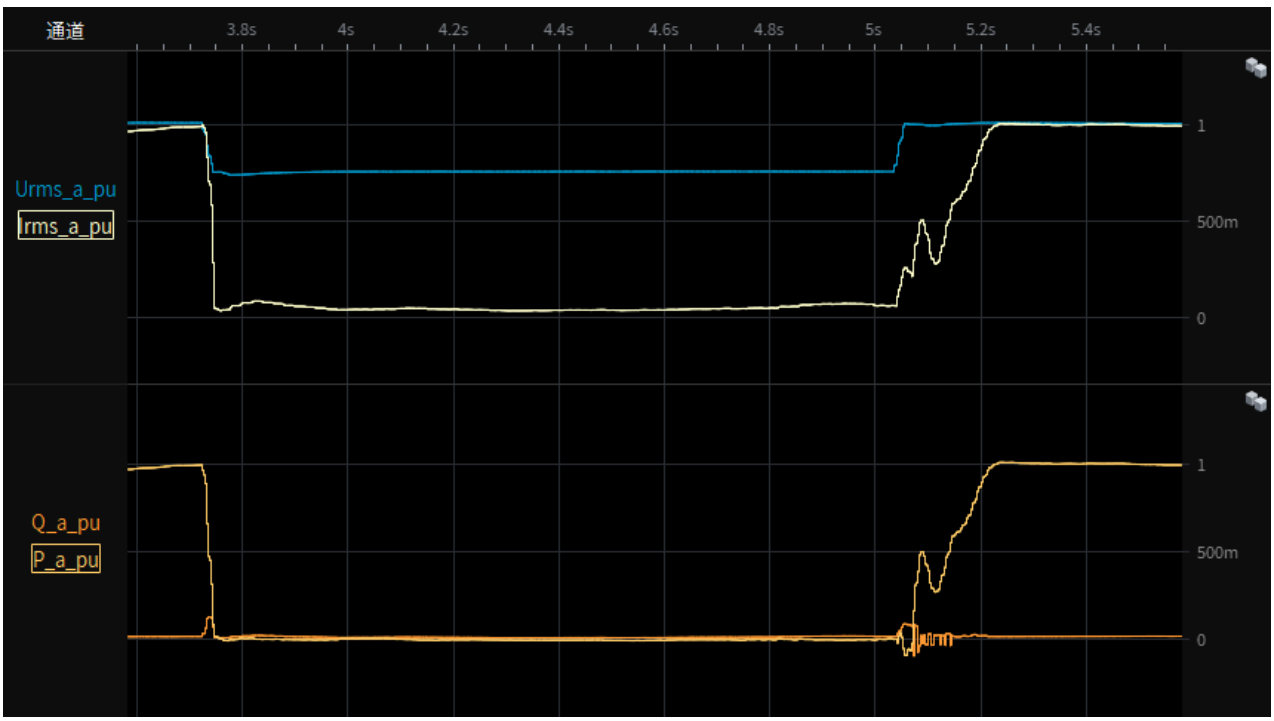


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4s-1.4 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),
20% load restoring time

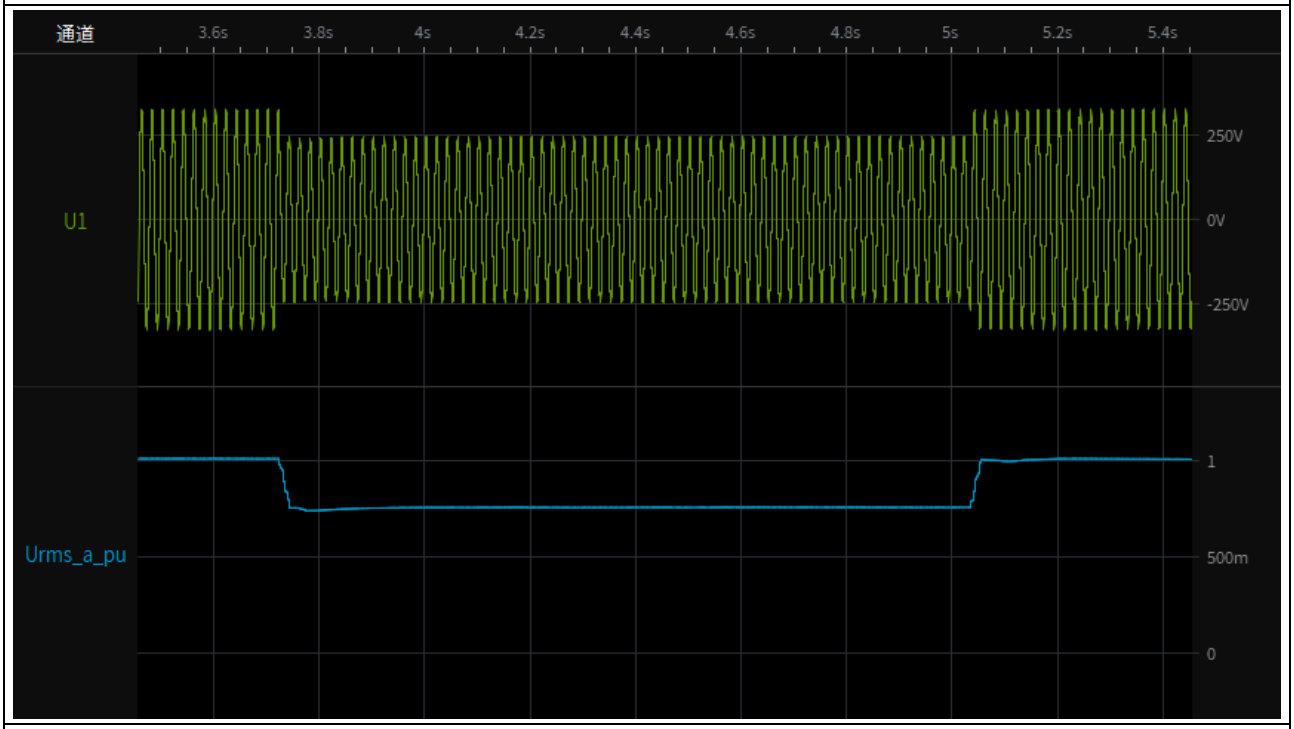


Test 4s-2.1 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),95% load
Test overview(voltage,current,active and reactive power)

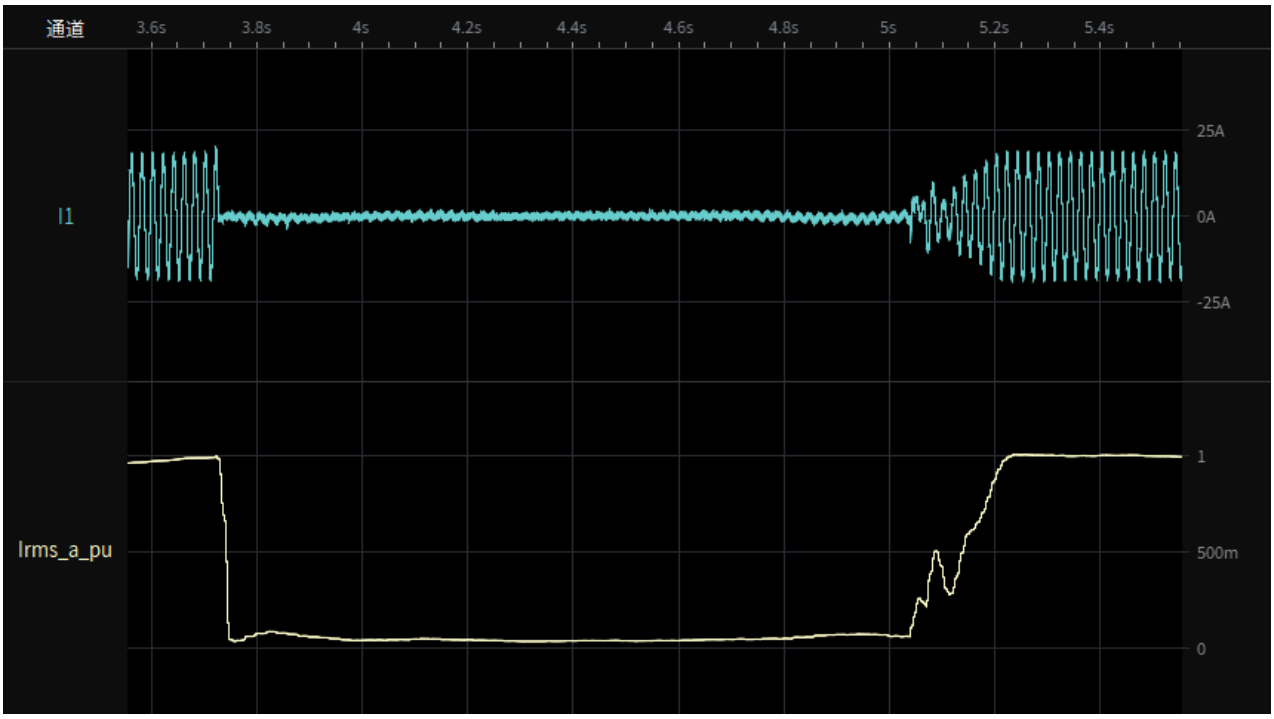


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4s-2.2 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

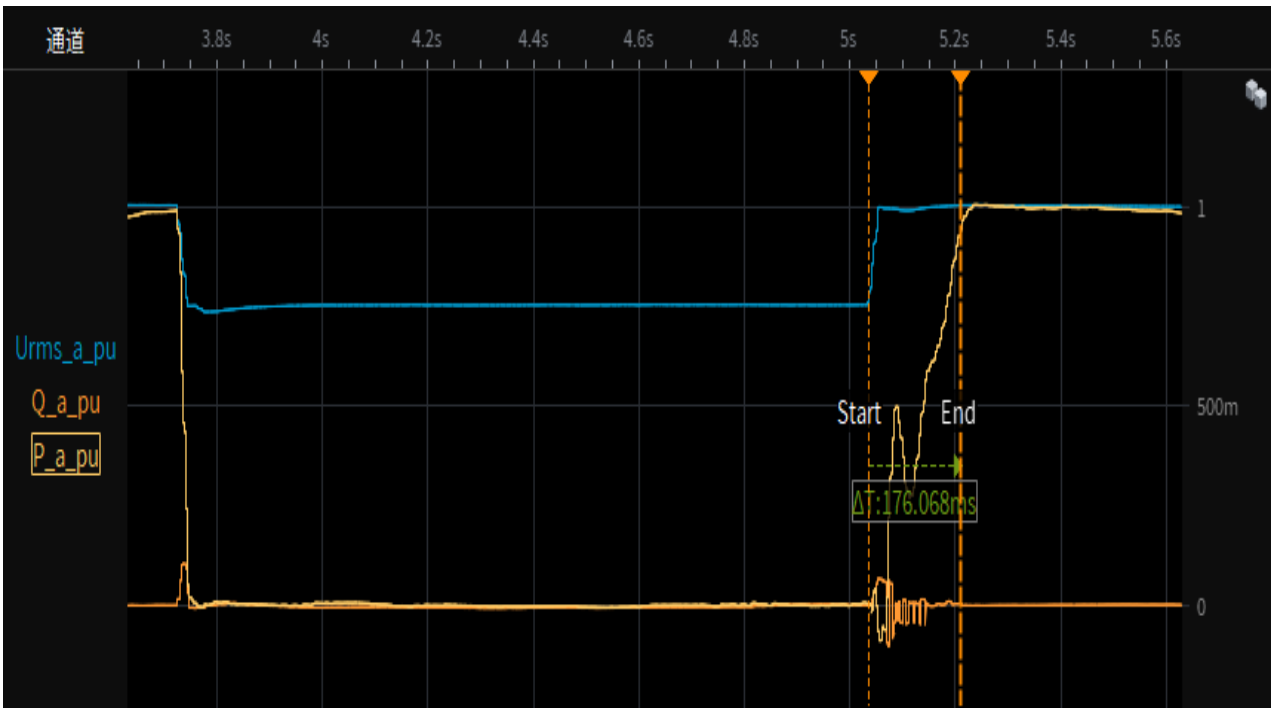


Test 4s-2.3 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents

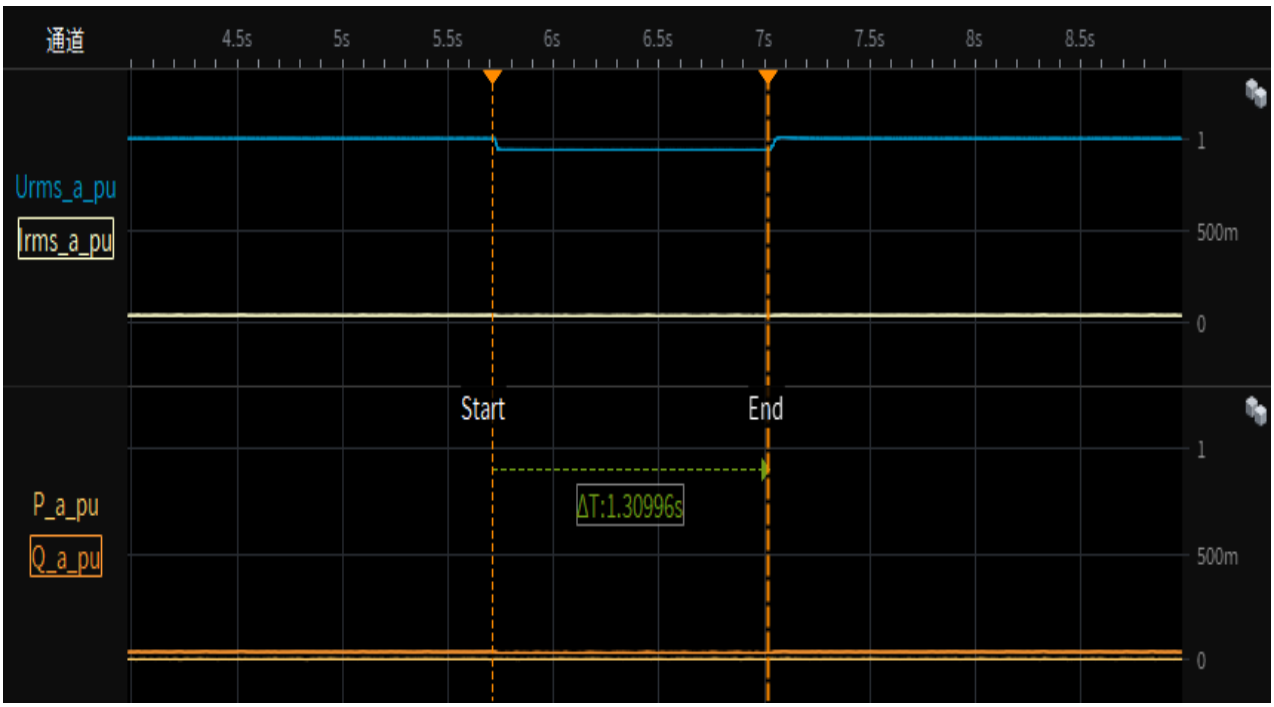


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4s-2.4 Depth of fault phase: 0.75p.u.,three-phase-symmetrical (type A),
95% load restoring time

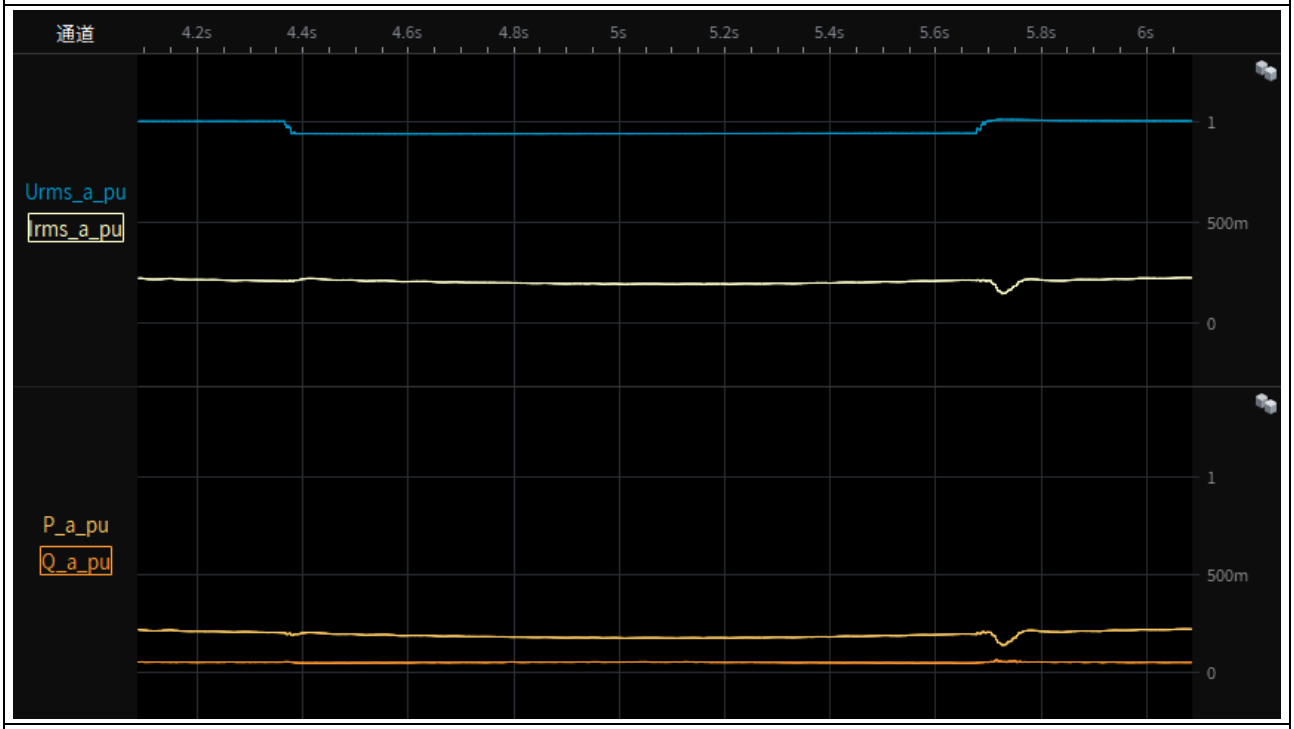


Test 4a- Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

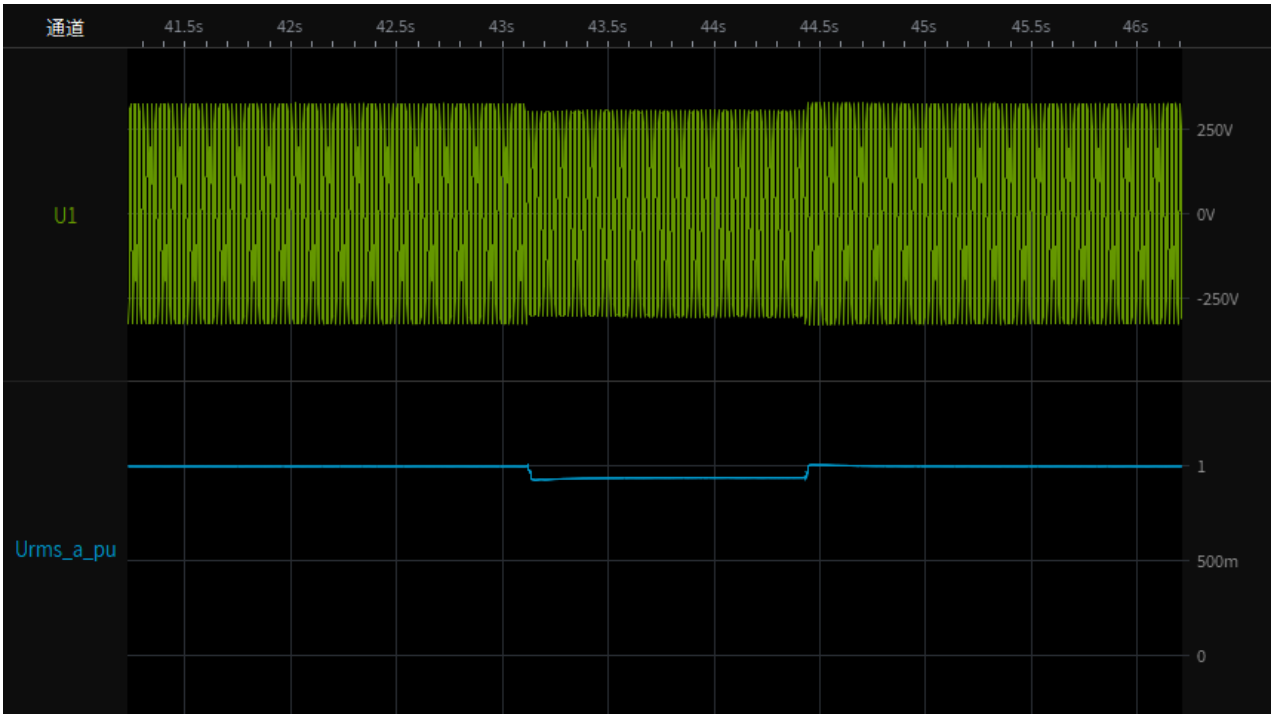


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4a-1.1 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

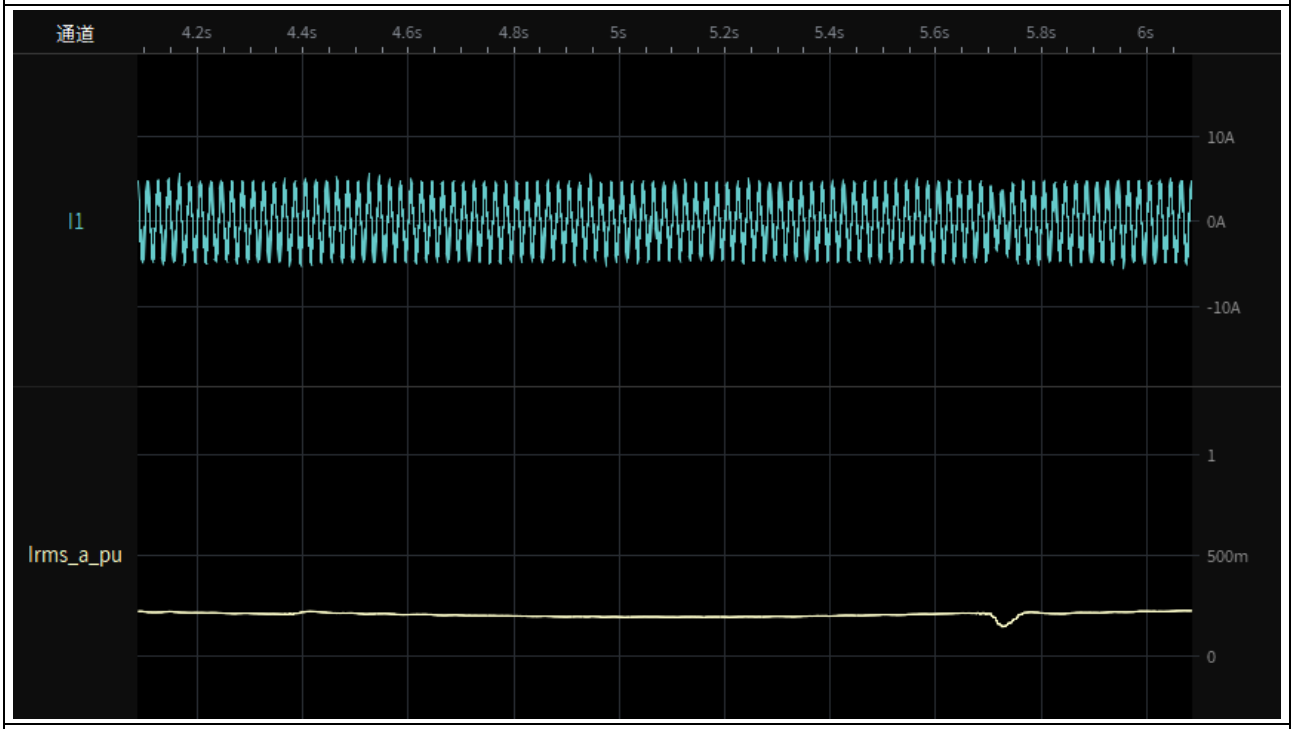


Test 4a-1.2 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

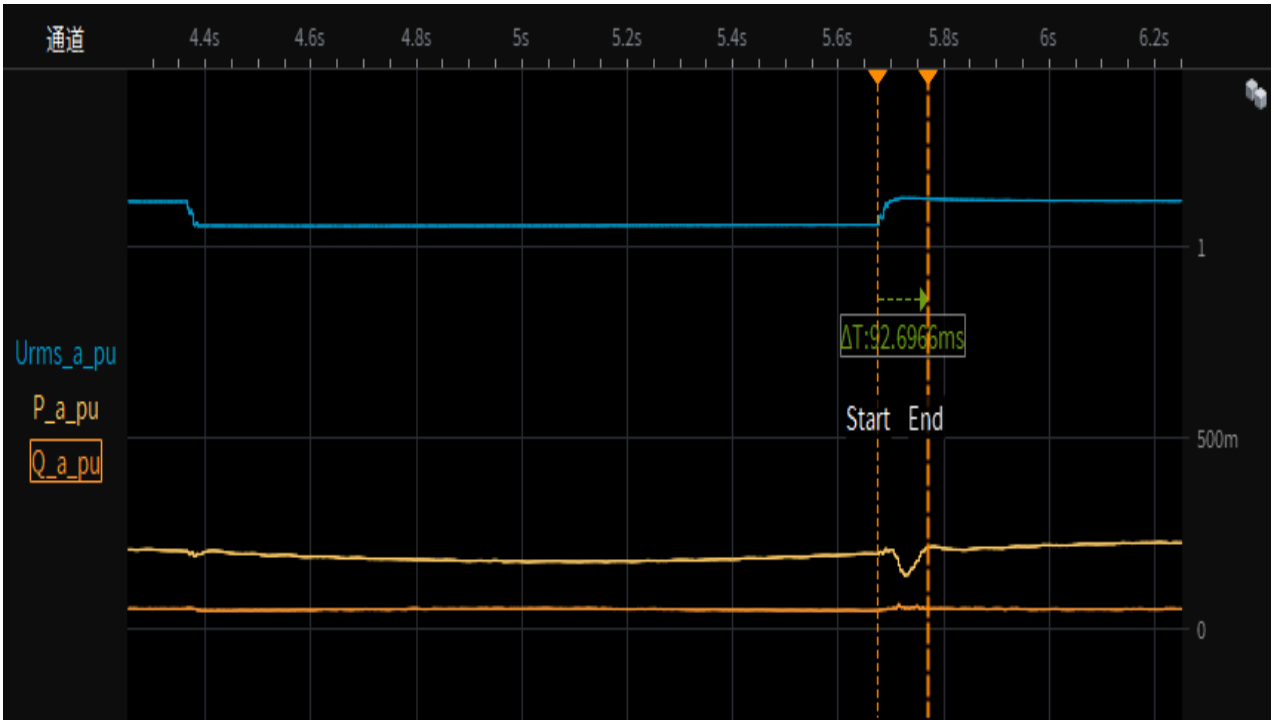


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4a-1.3 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

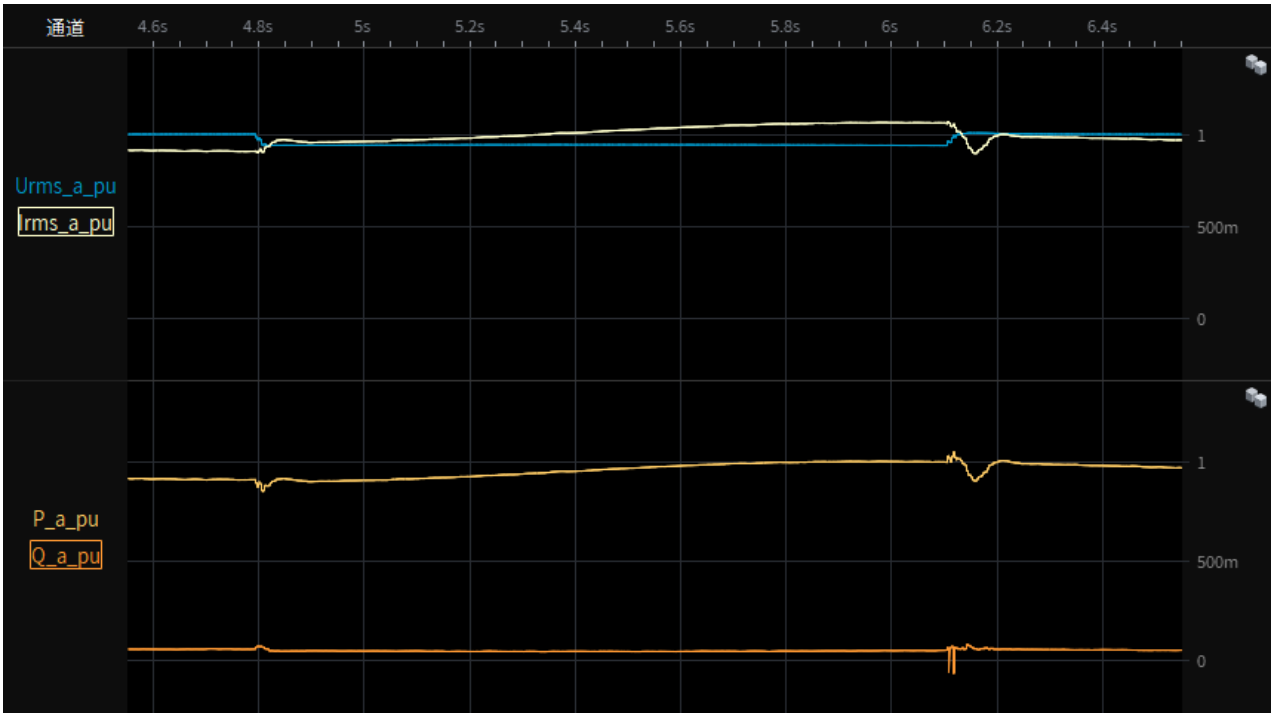


Test 4a-1.4 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),
20% load restoring time

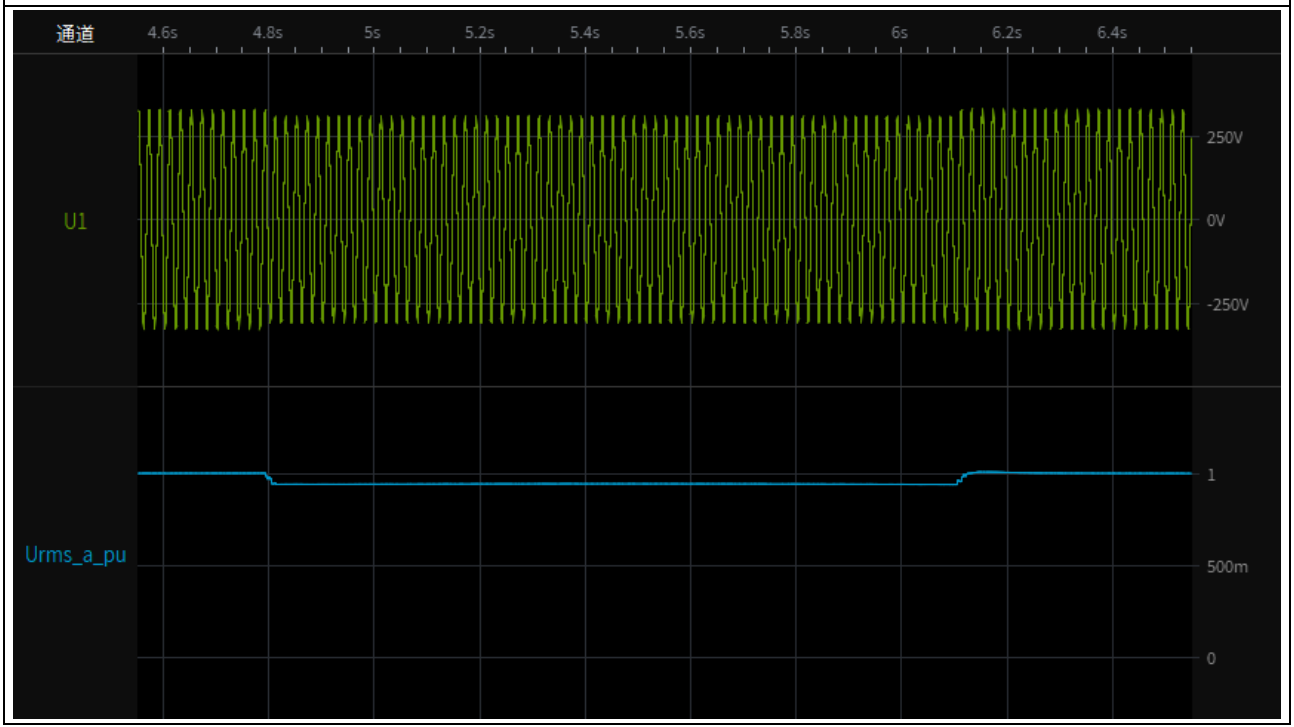


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4a-2.1 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

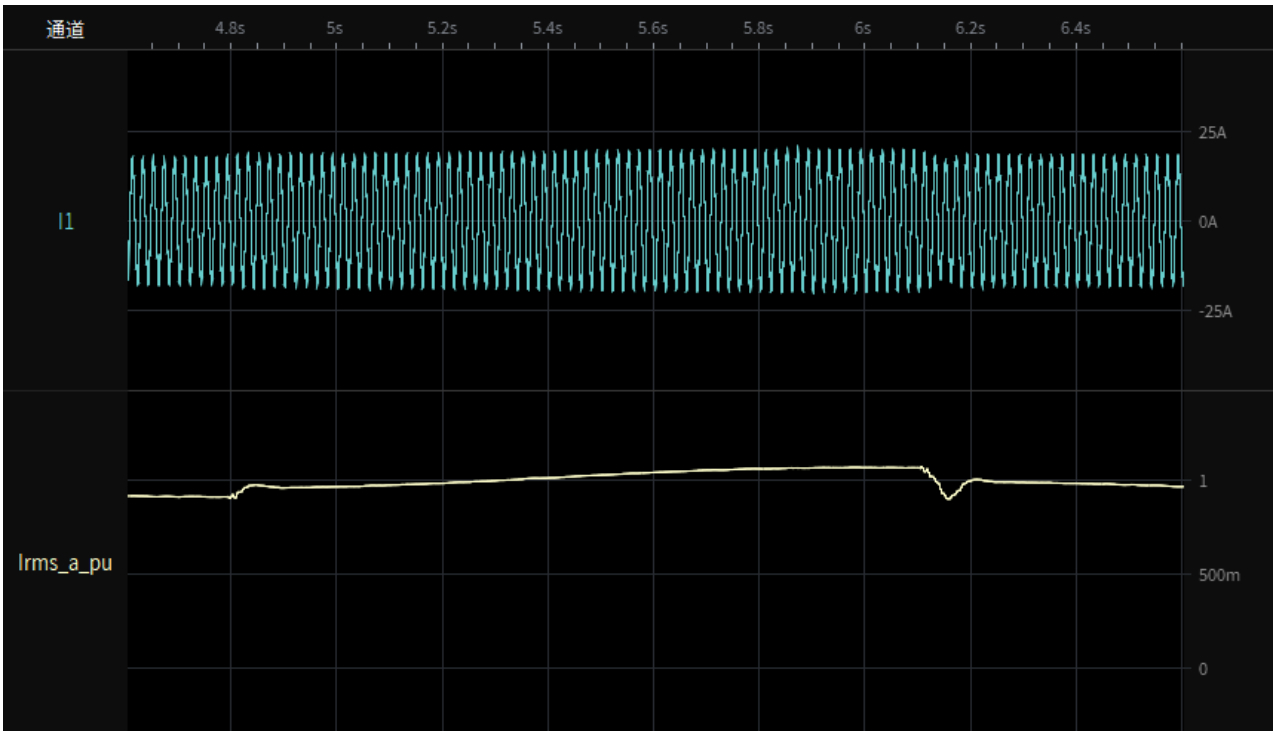


Test 4a-2.2 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

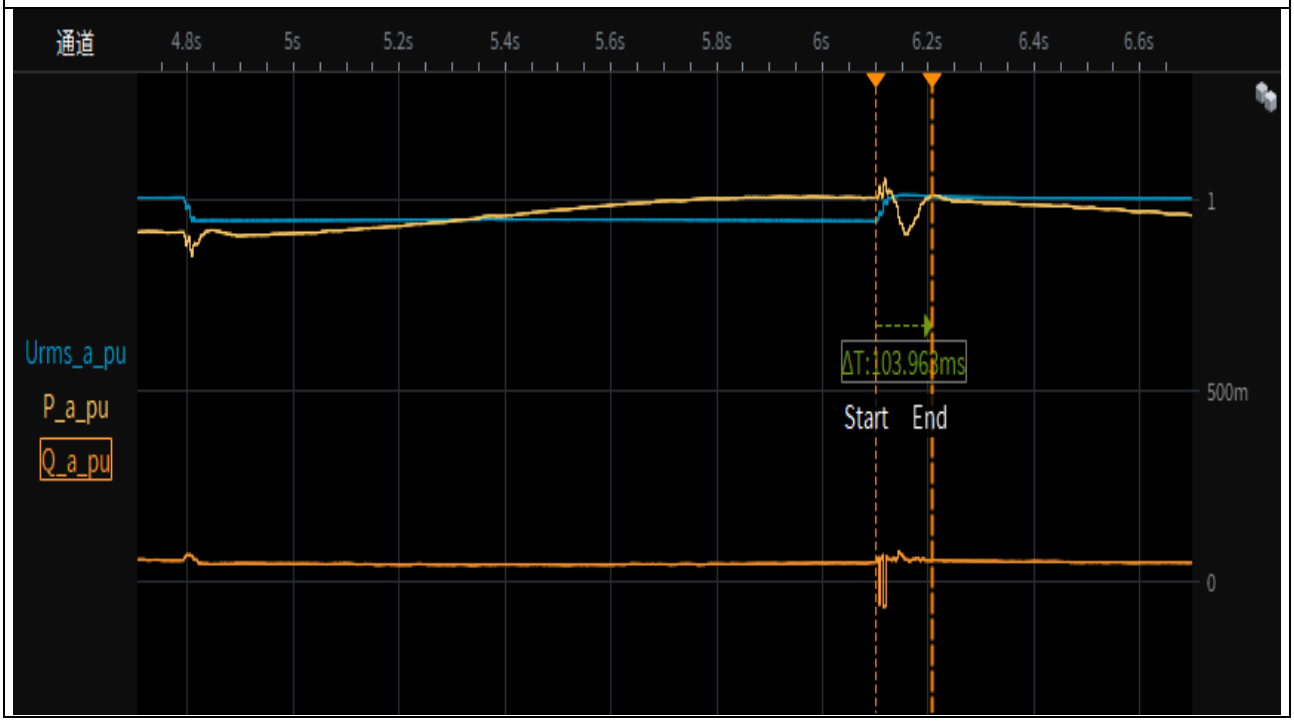


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 4a-2.3 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

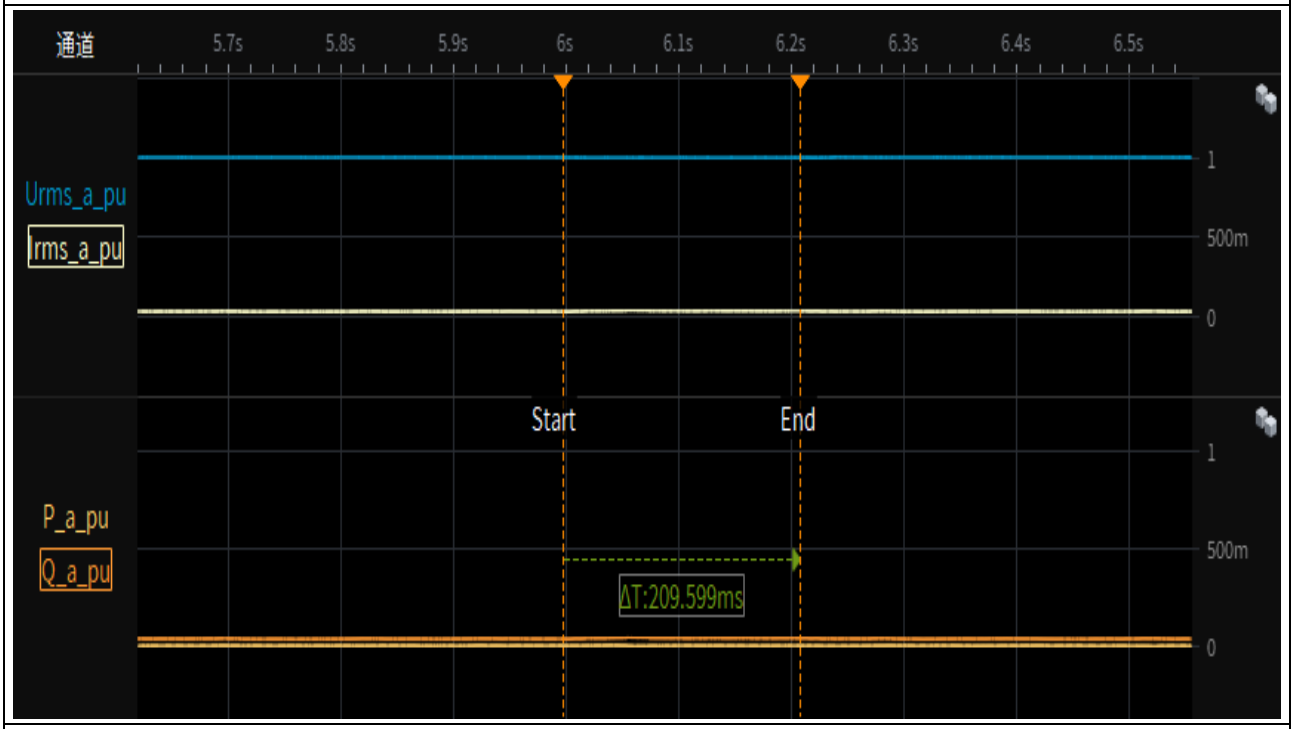


Test 4a-2.4 Depth of fault phase: 0.75p.u.,two-phase-asymmetrical (type D),
95% load restoring time

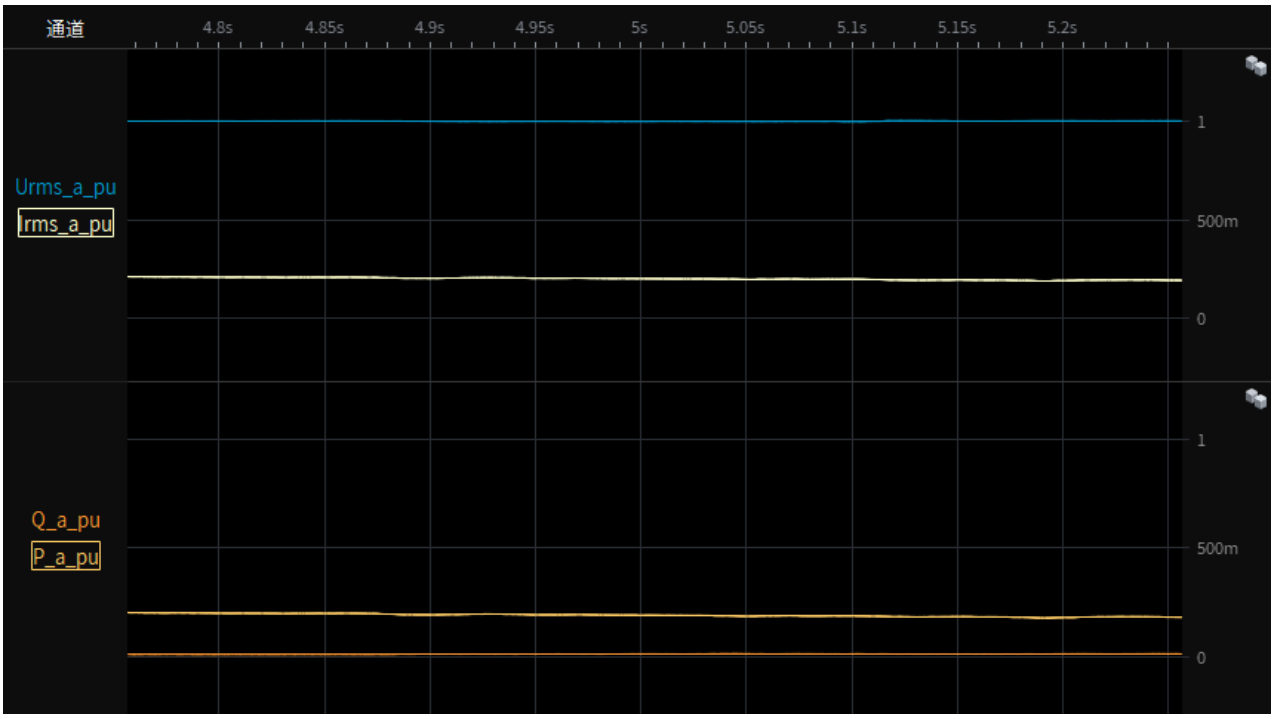


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 5- Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

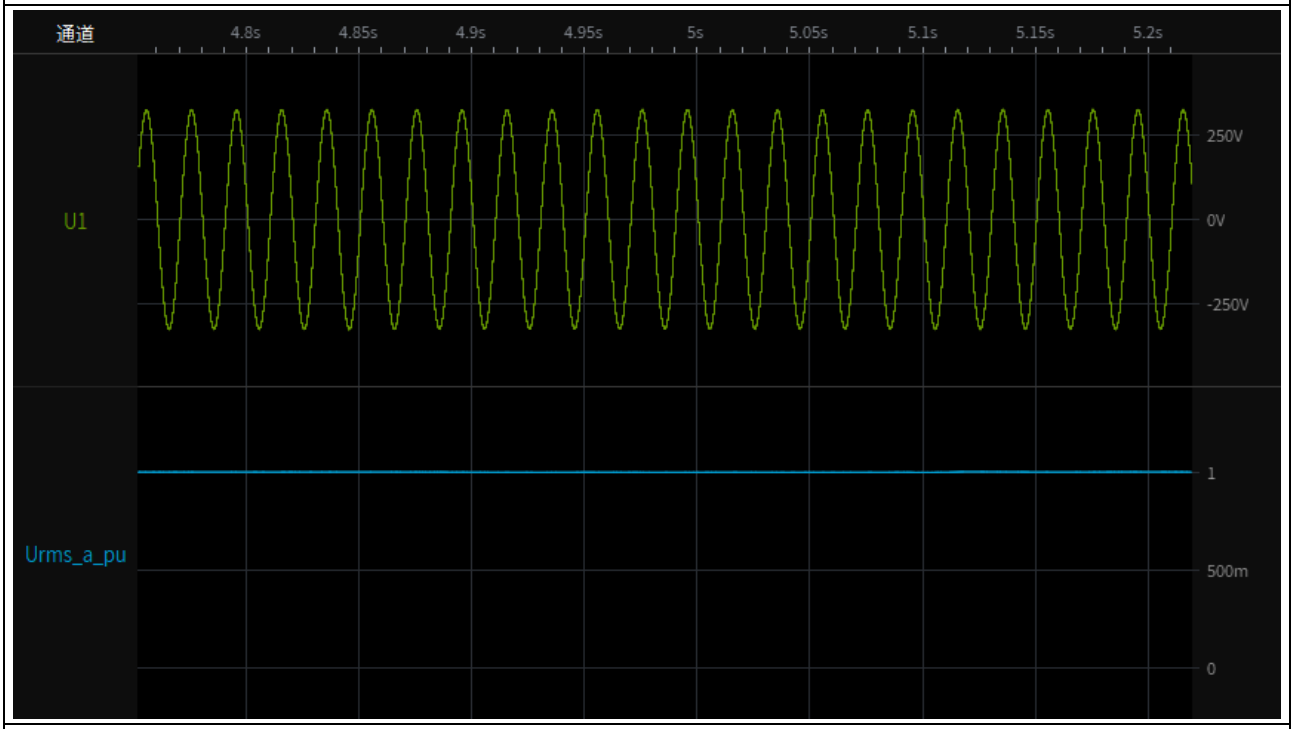


Test 5-1.1 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

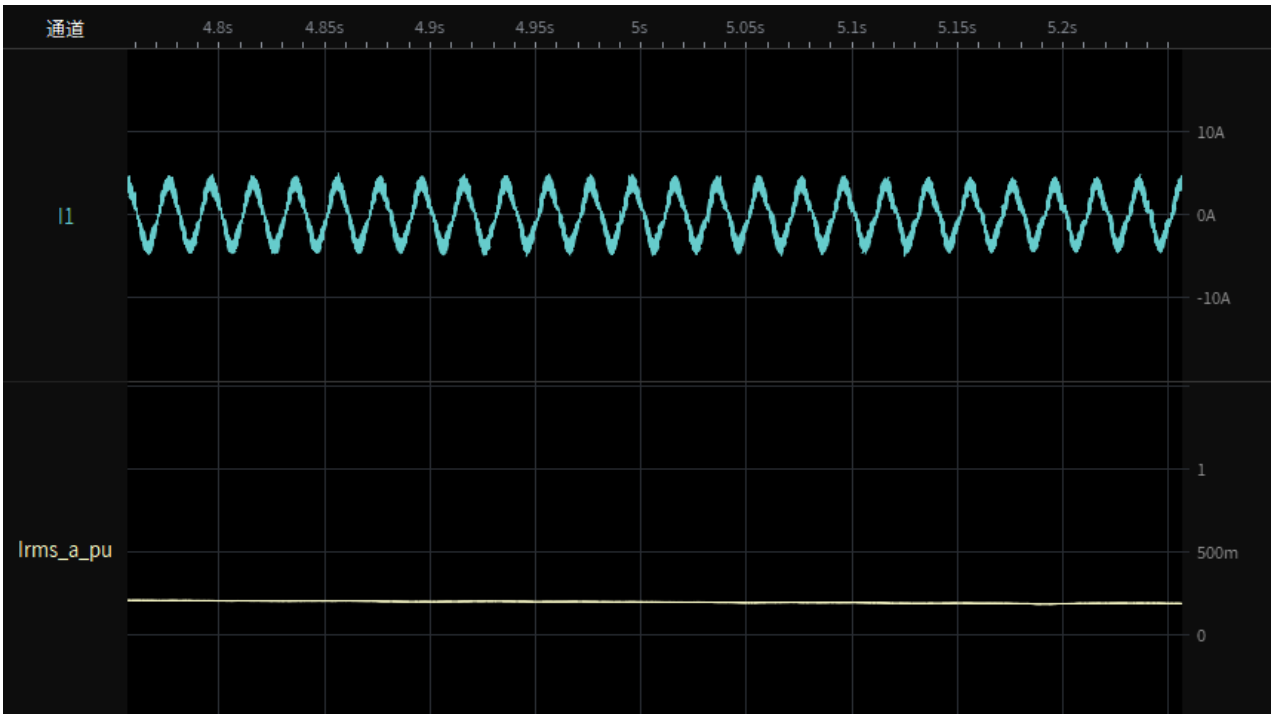


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 5-1.2 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

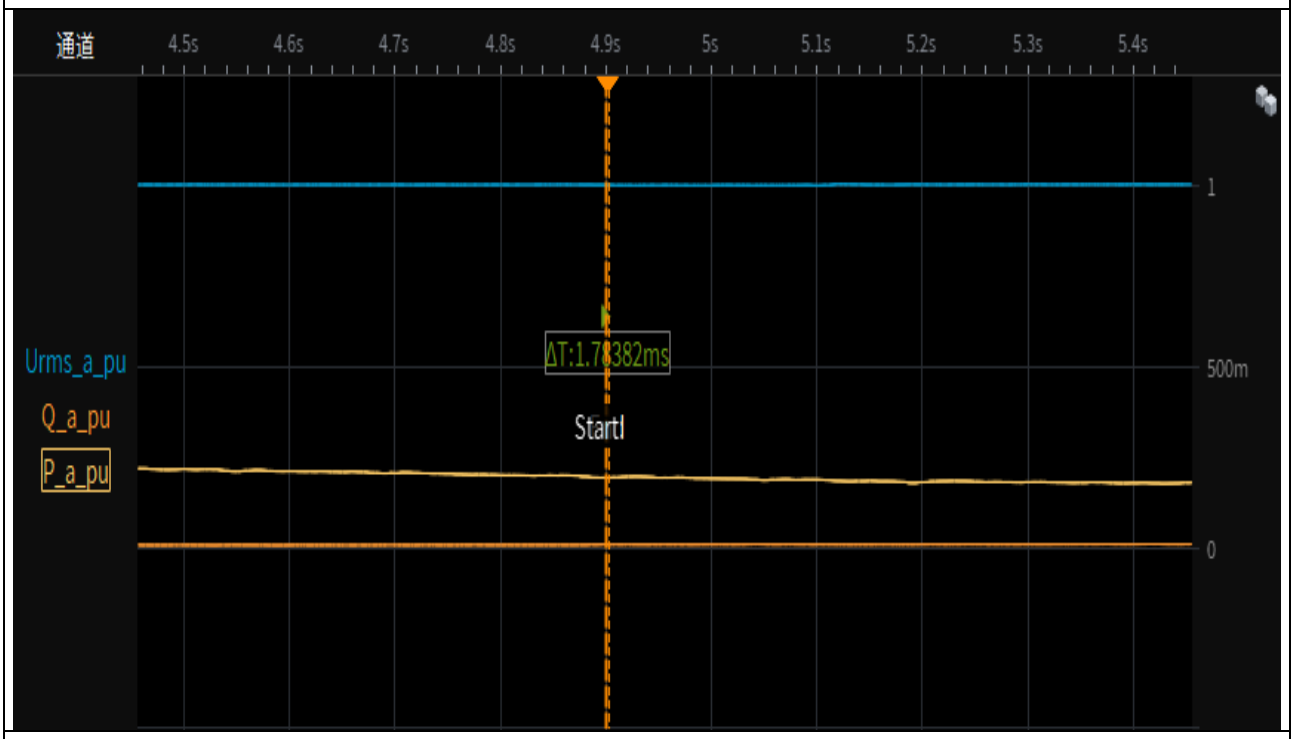


Test 5-1.3 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

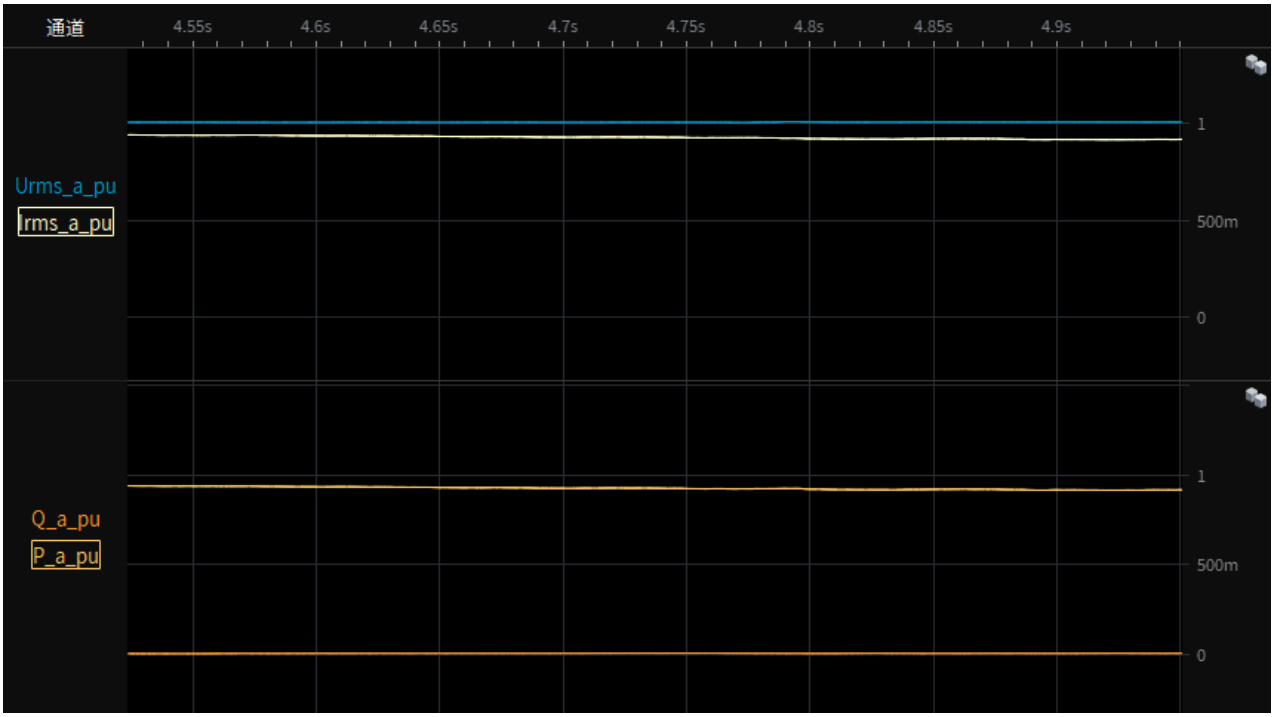


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 5-1.4 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D), 20% load restoring time

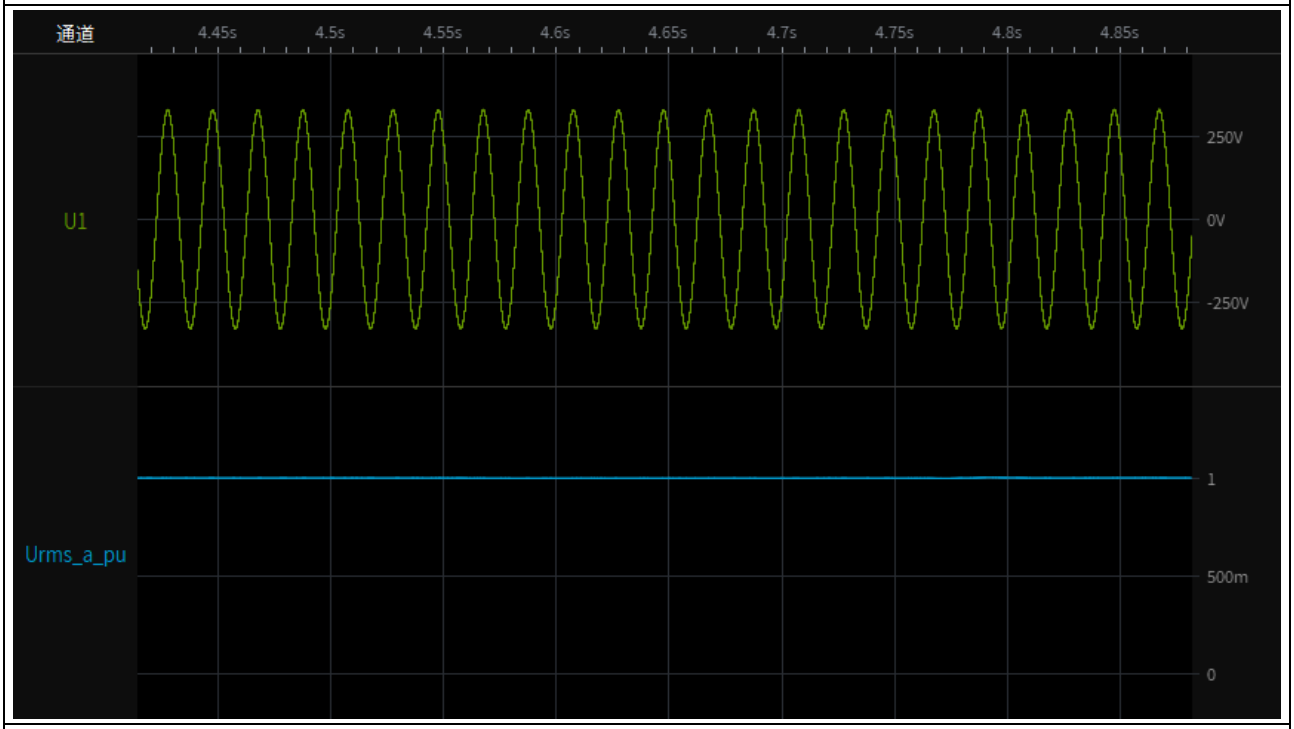


Test 5-2.1 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

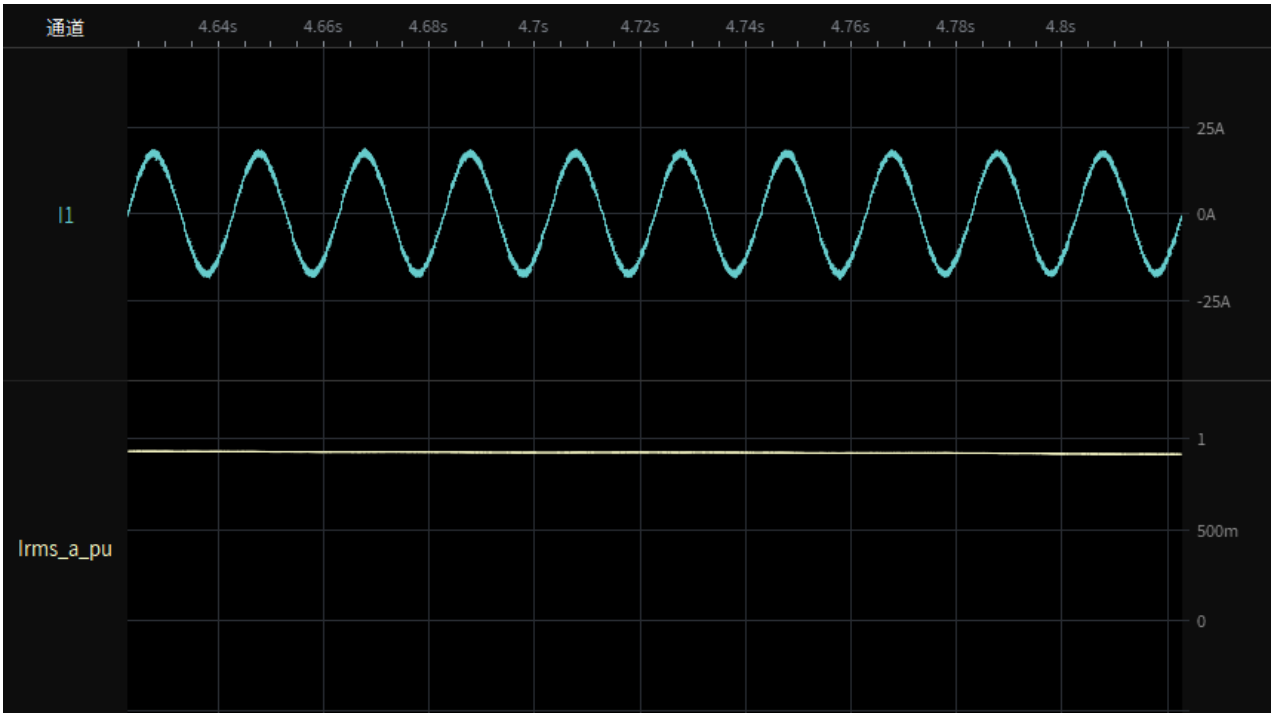


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 5-2.2 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

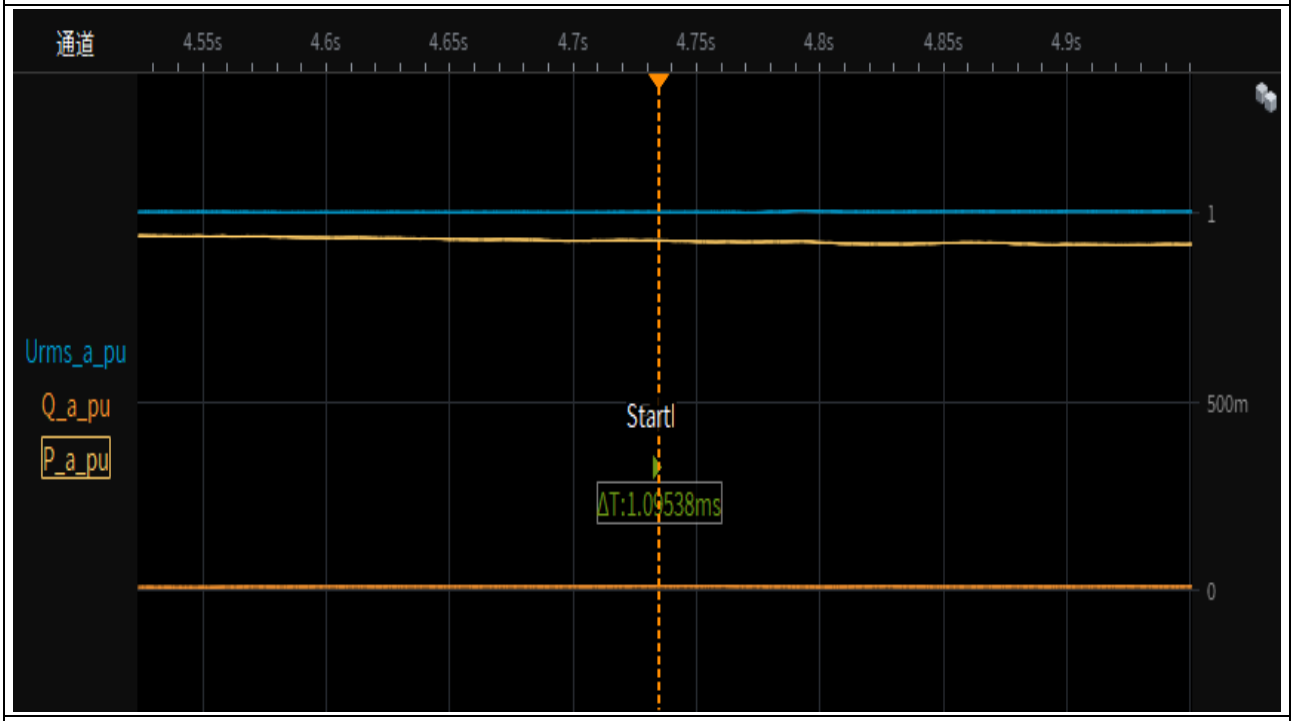


Test 5-2.3 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

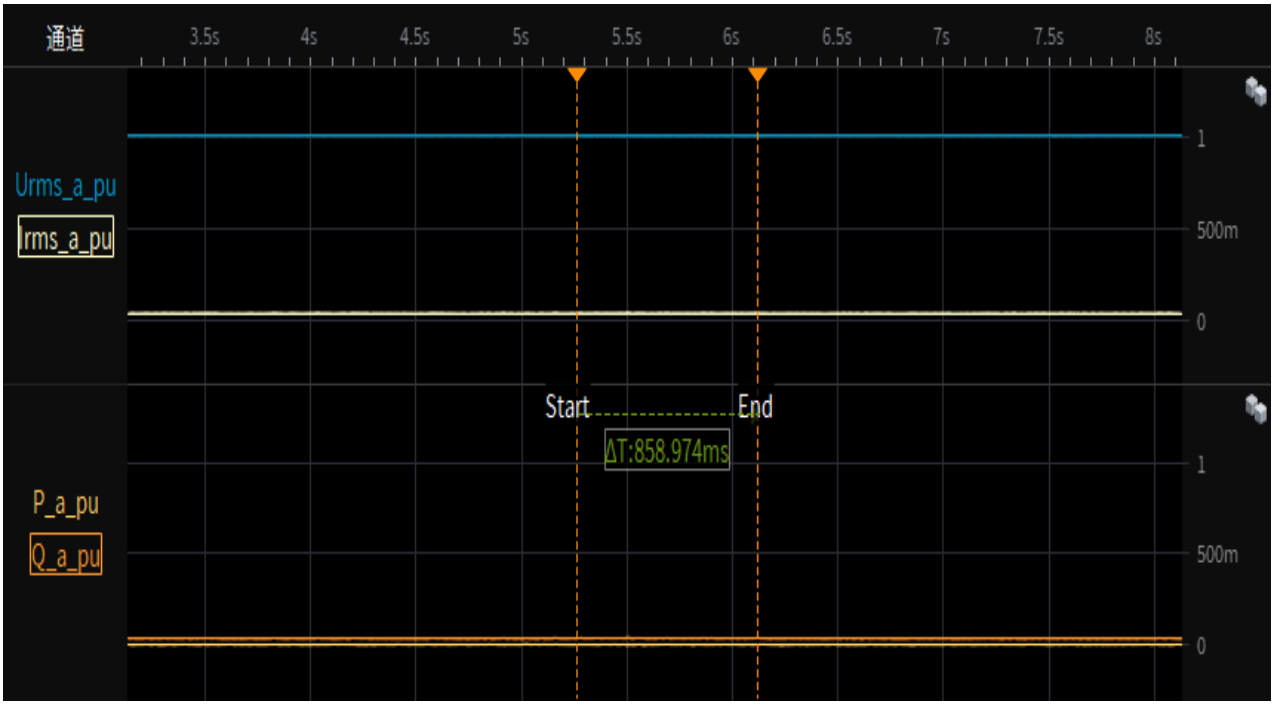


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 5-2.4 Depth of fault phase: 0.1p.u.,LV two-phase-asymmetrical (type D), 95% load restoring time

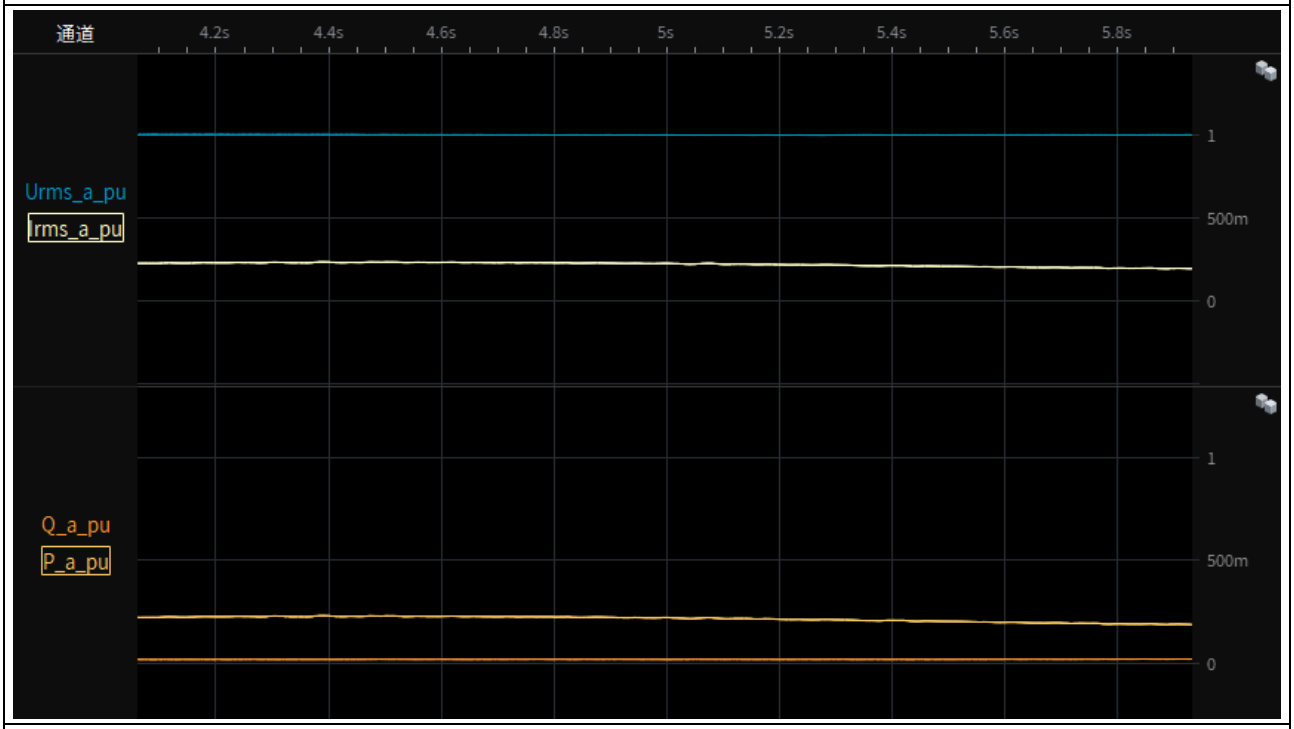


Test 6- Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),0% load
Test overview(voltage,current,active and reactive power)

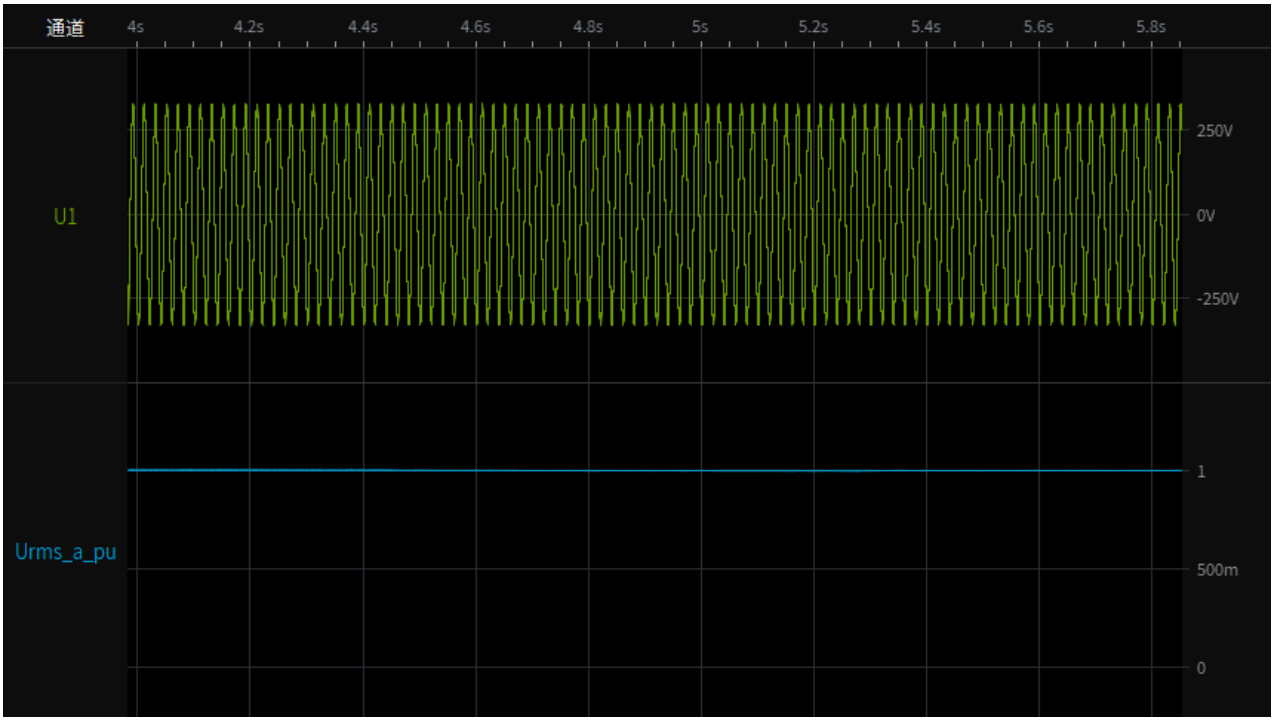


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 6-1.1 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),20% load
Test overview(voltage,current,active and reactive power)

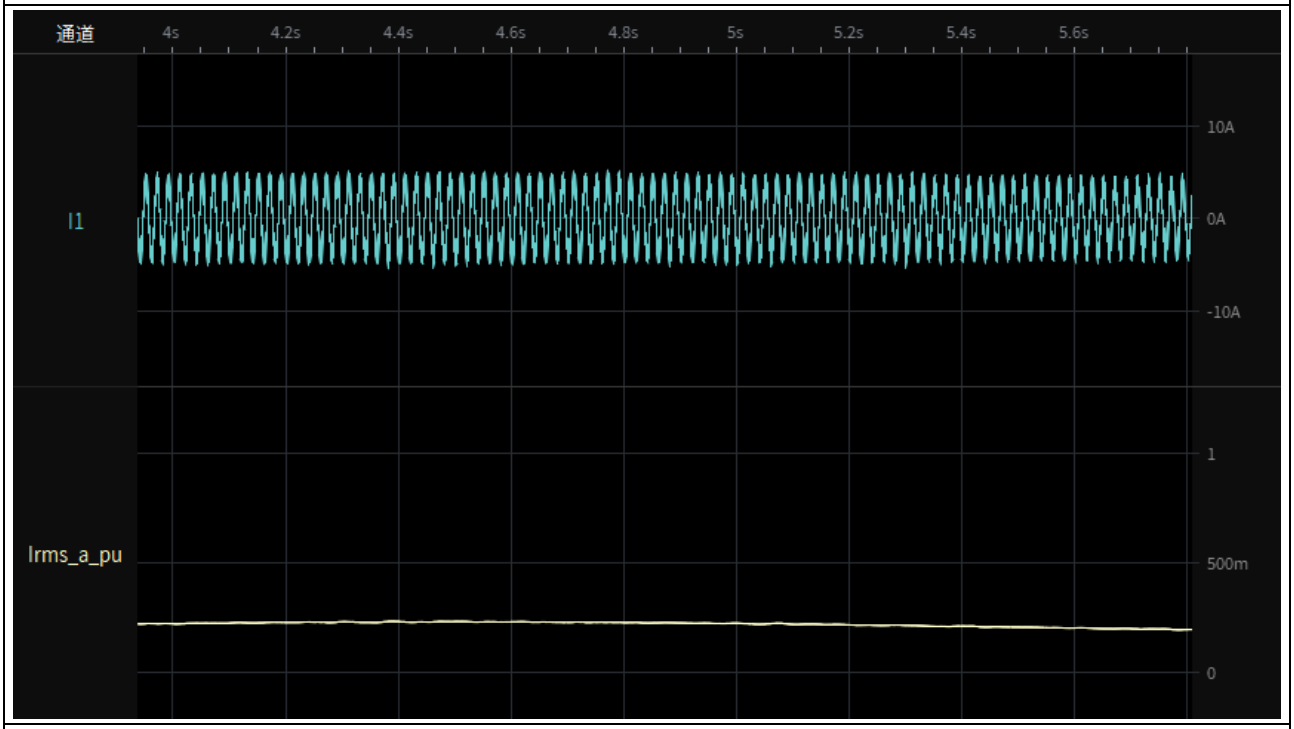


Test 6-1.2 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

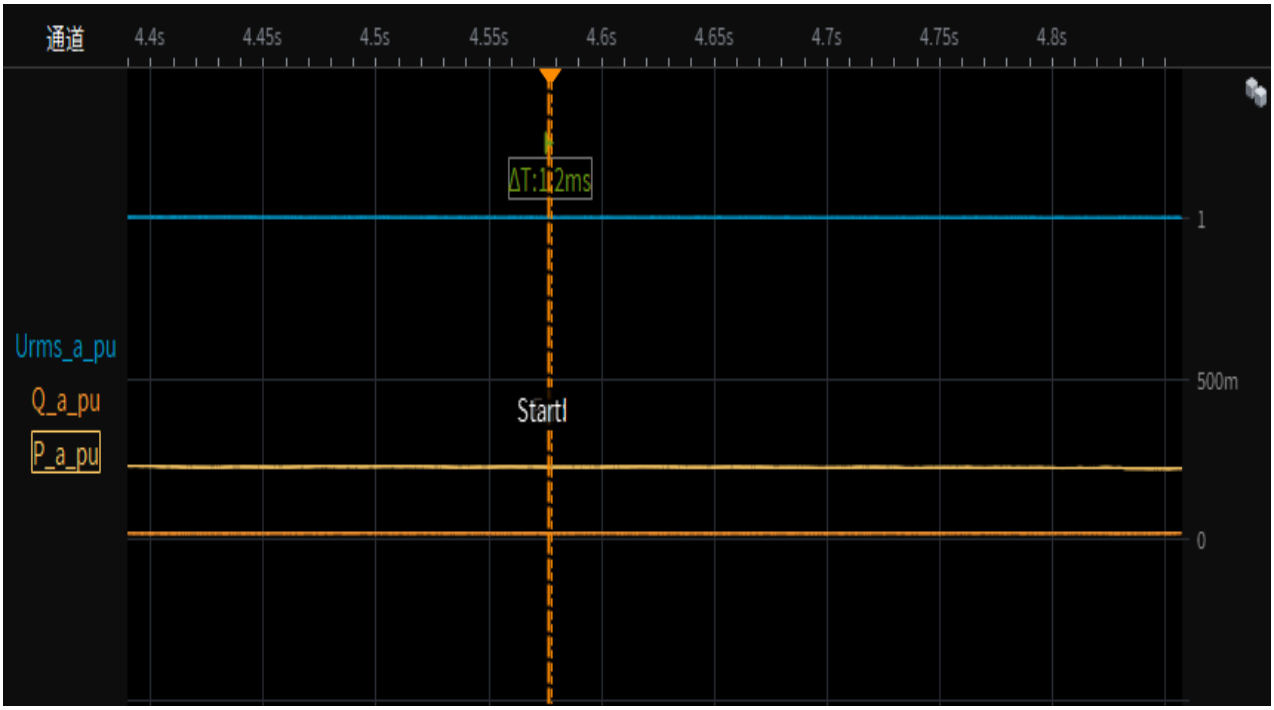


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 6-1.3 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),20% load
Instantaneous curve and RMS value of phase currents

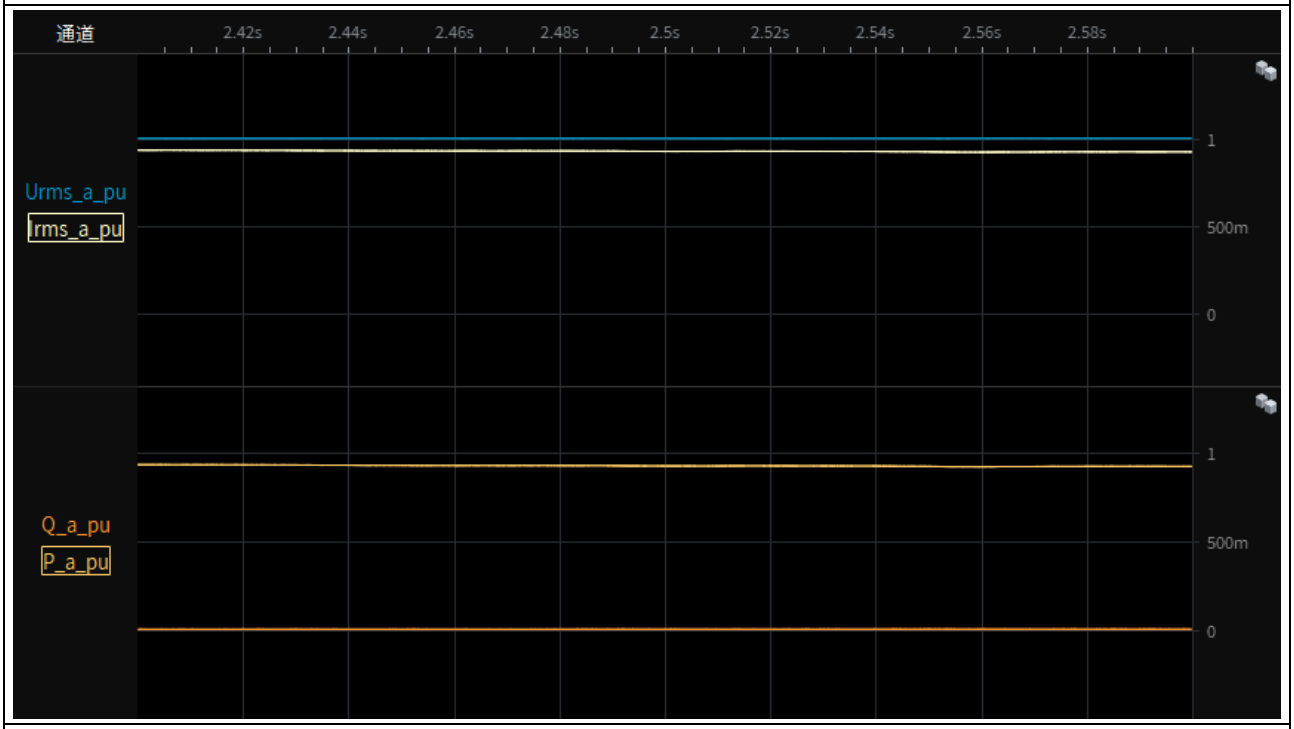


Test 6-1.4 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),
20% load restoring time

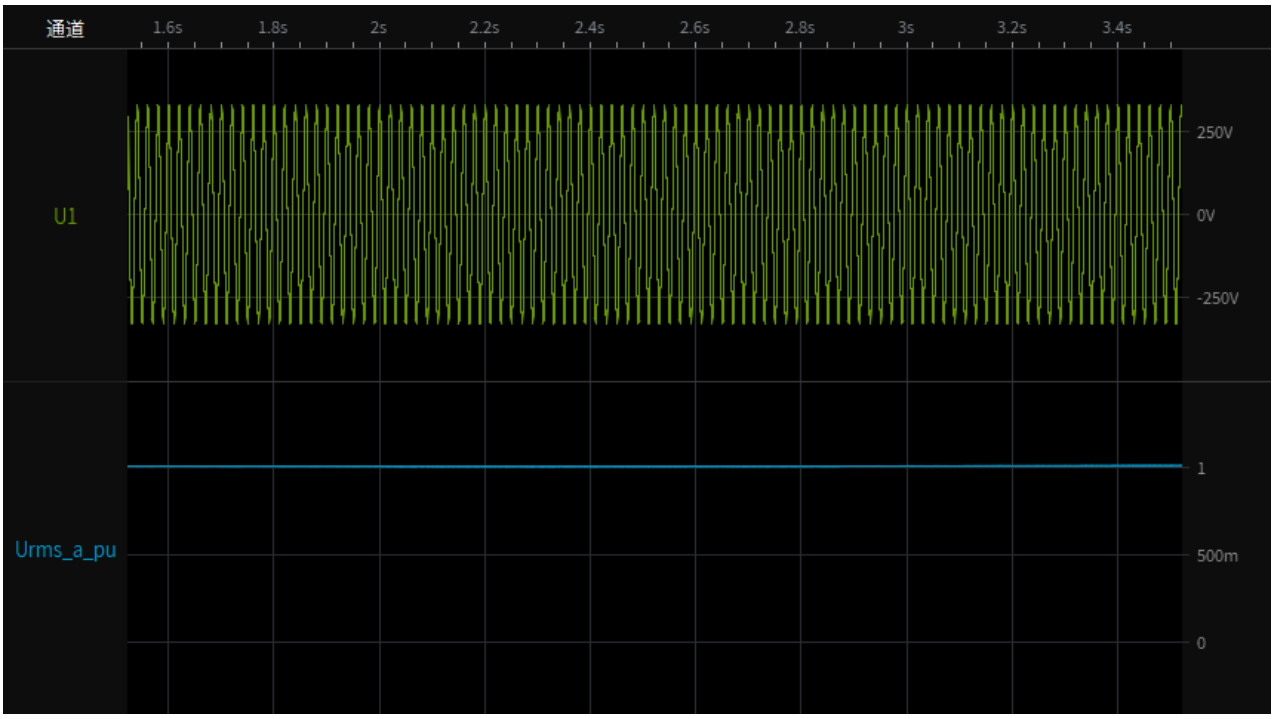


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 6-2.1 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),95% load
Test overview(voltage,current,active and reactive power)

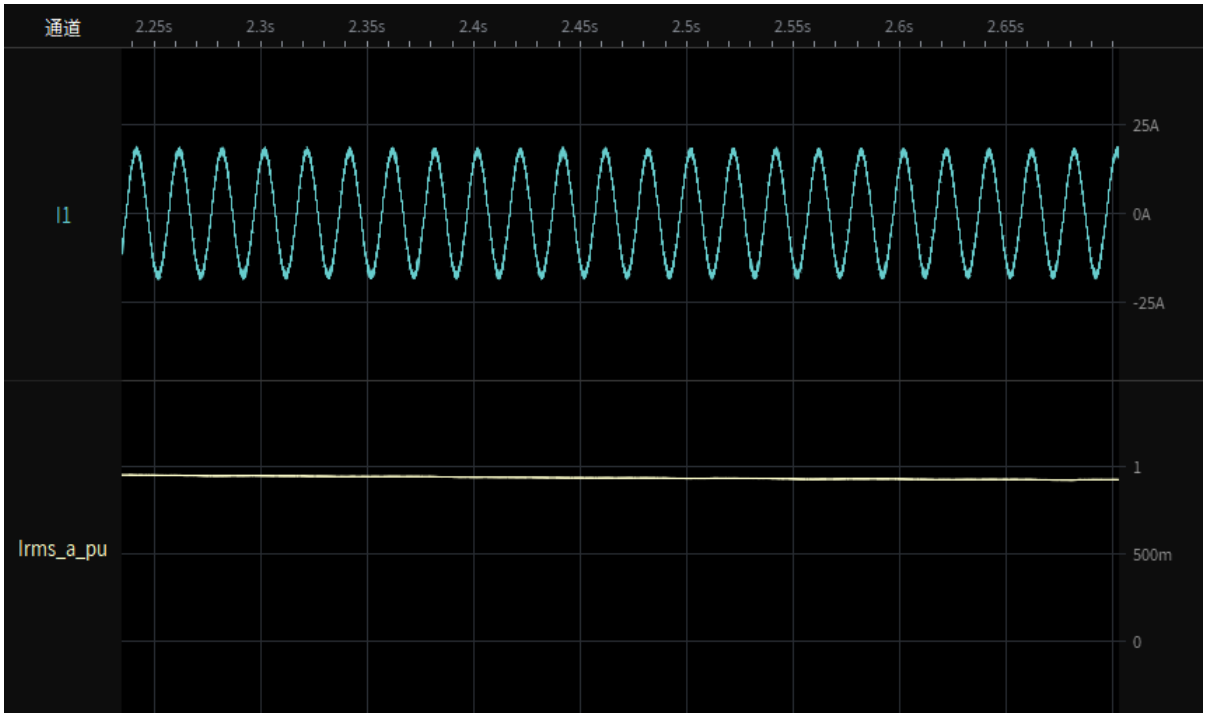


Test 6-2.2 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

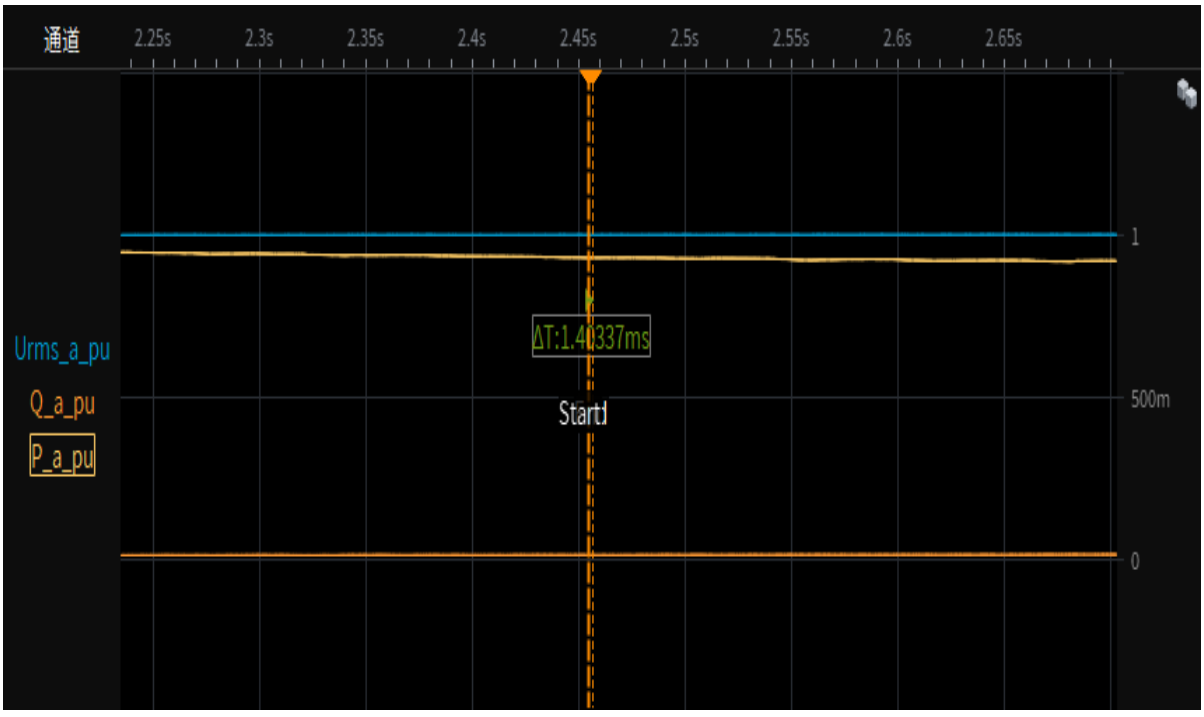


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 6-2.3 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),95% load
Instantaneous curve and RMS value of phase currents

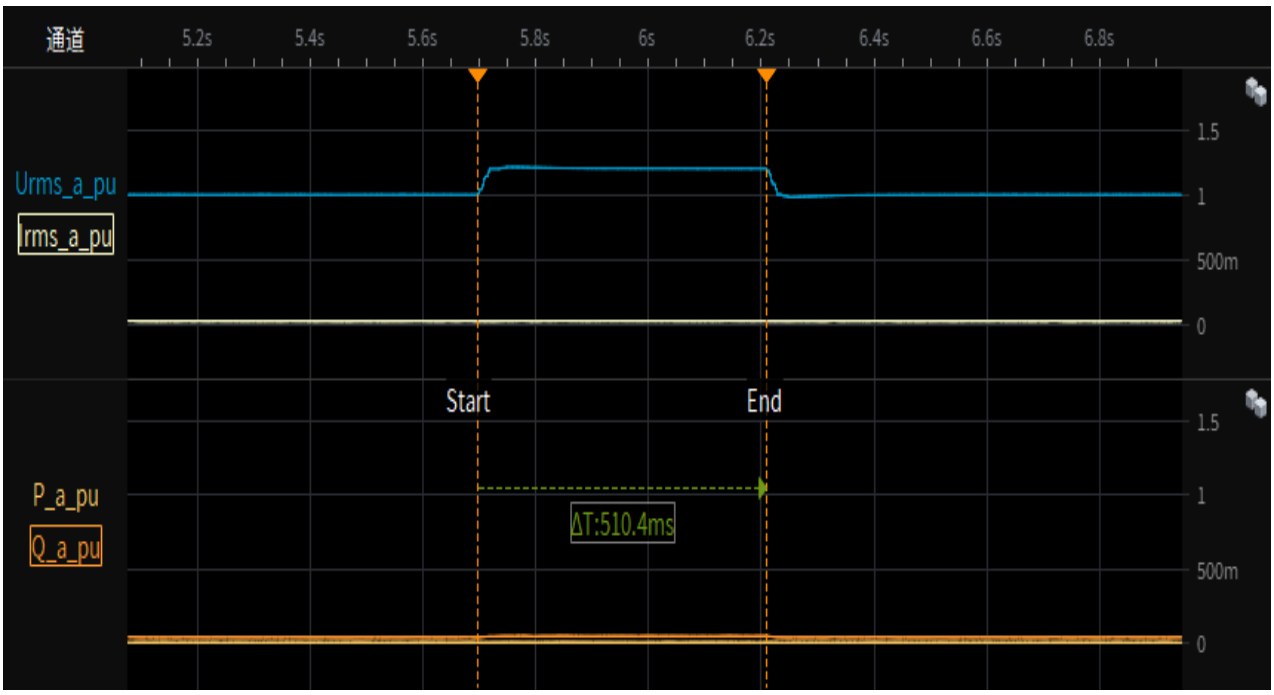


Test 6-2.4 Depth of fault phase: 0.5p.u.,LV two-phase-asymmetrical (type D),
95% load restoring time

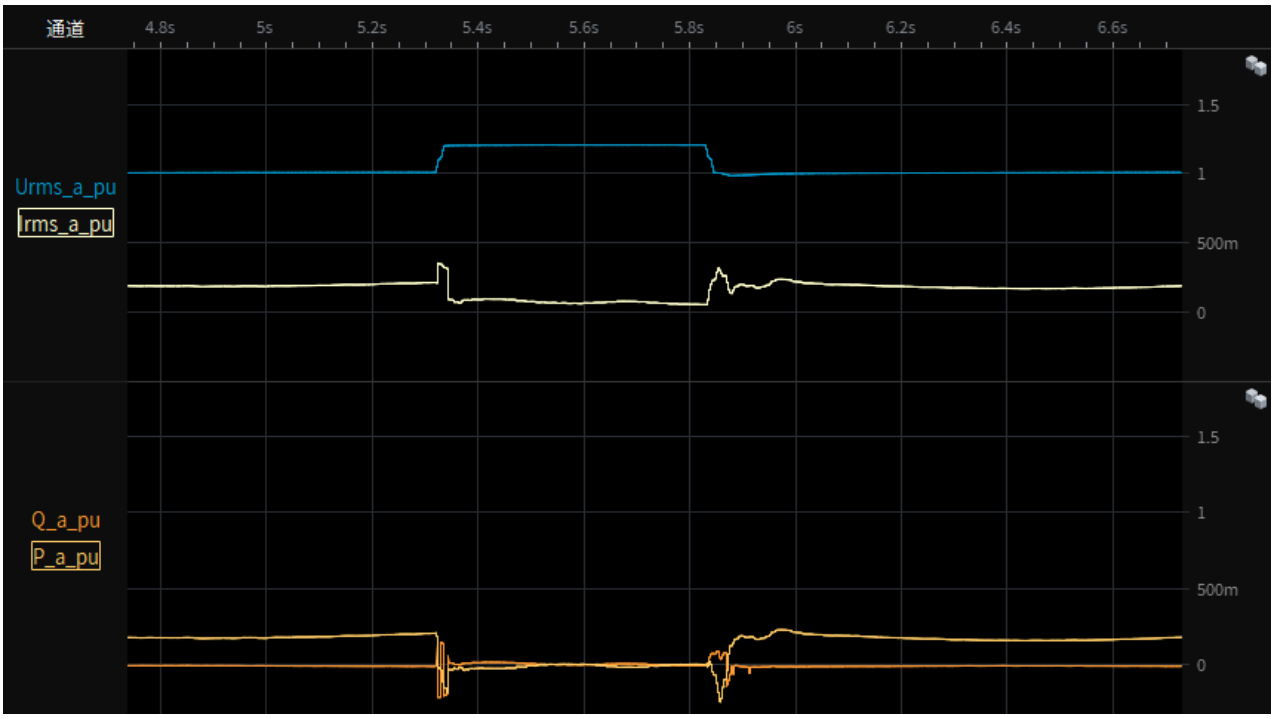


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 7-Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A), 0% load
Test overview(voltage,current,active and reactive power)

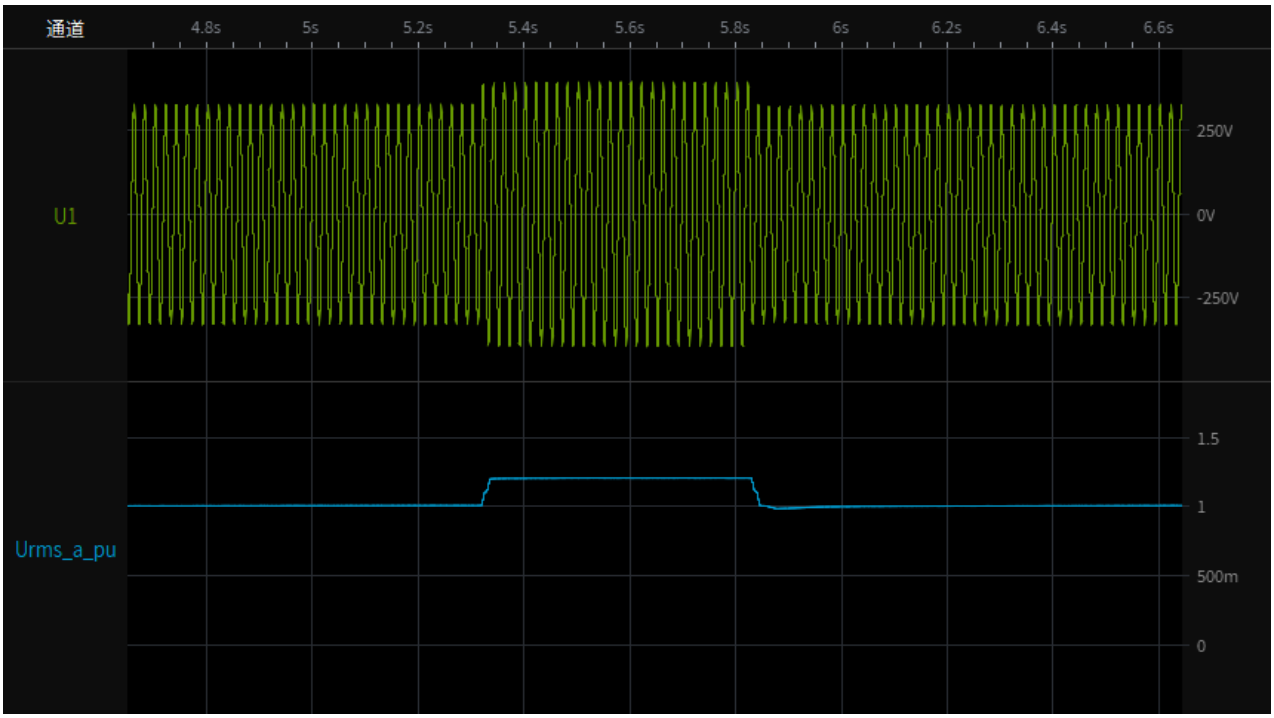


Test 7-1.1 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)

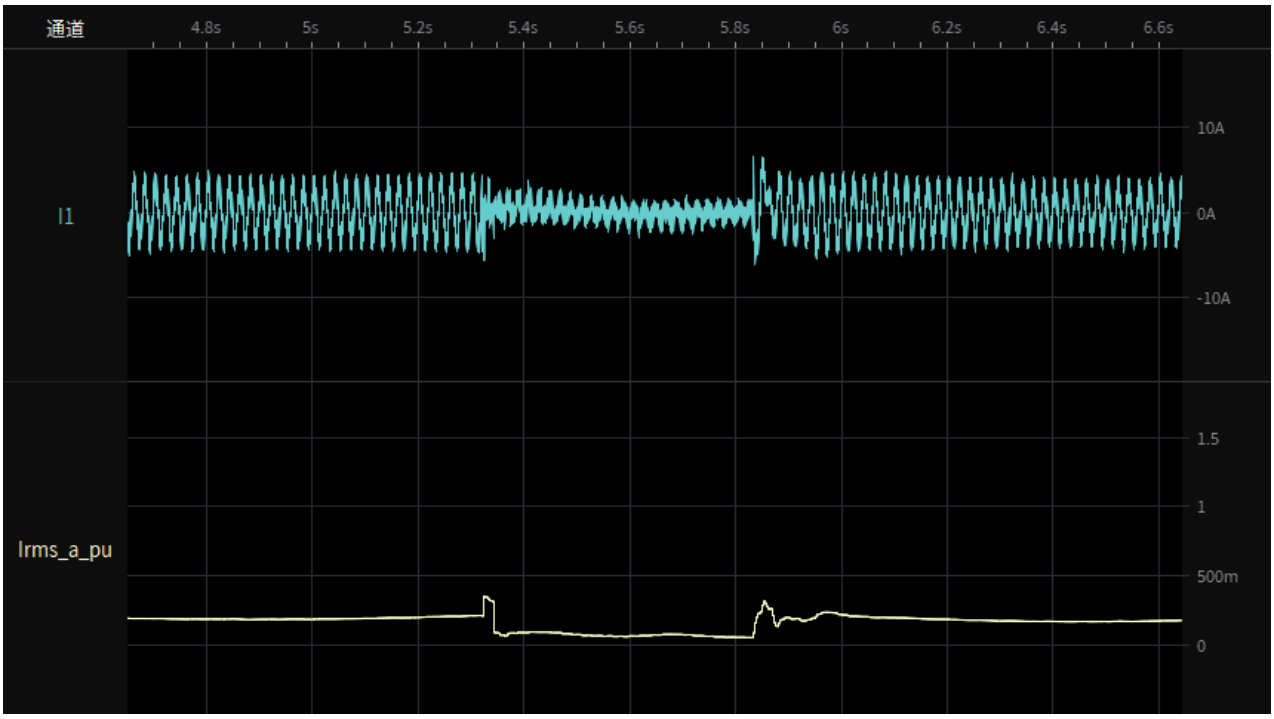


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 7-1.2 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

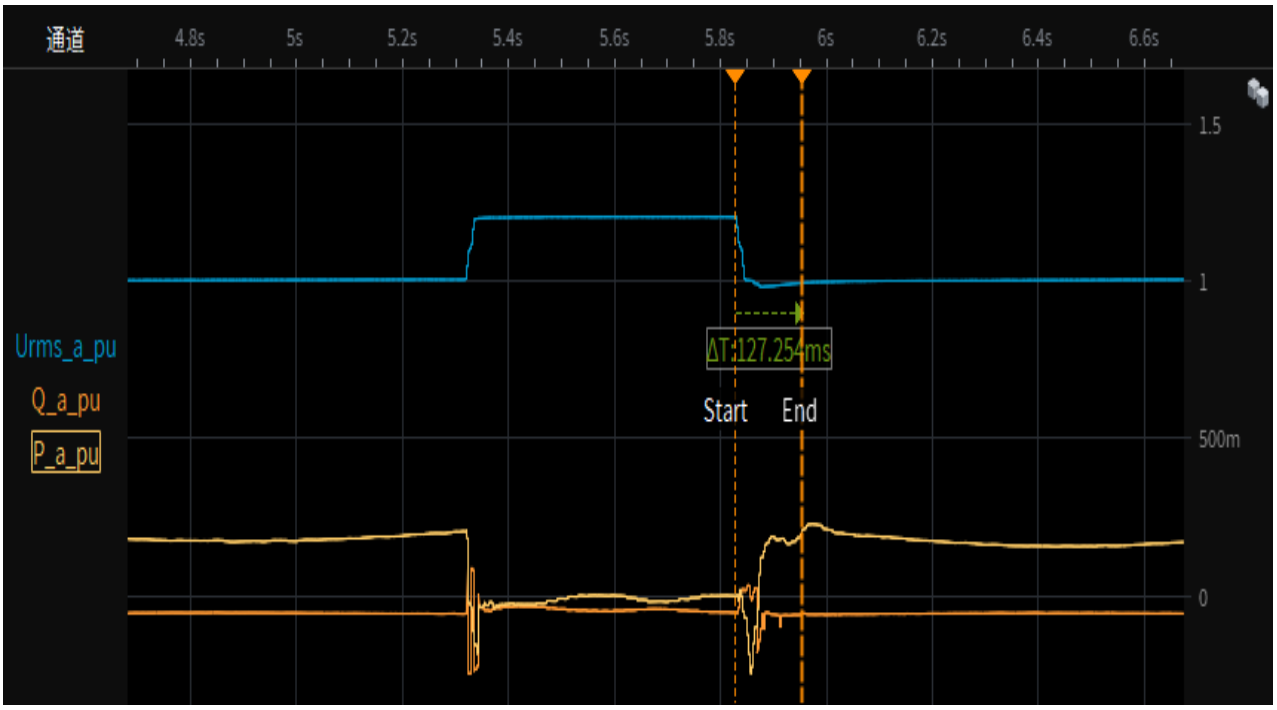


Test 7-1.3 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents

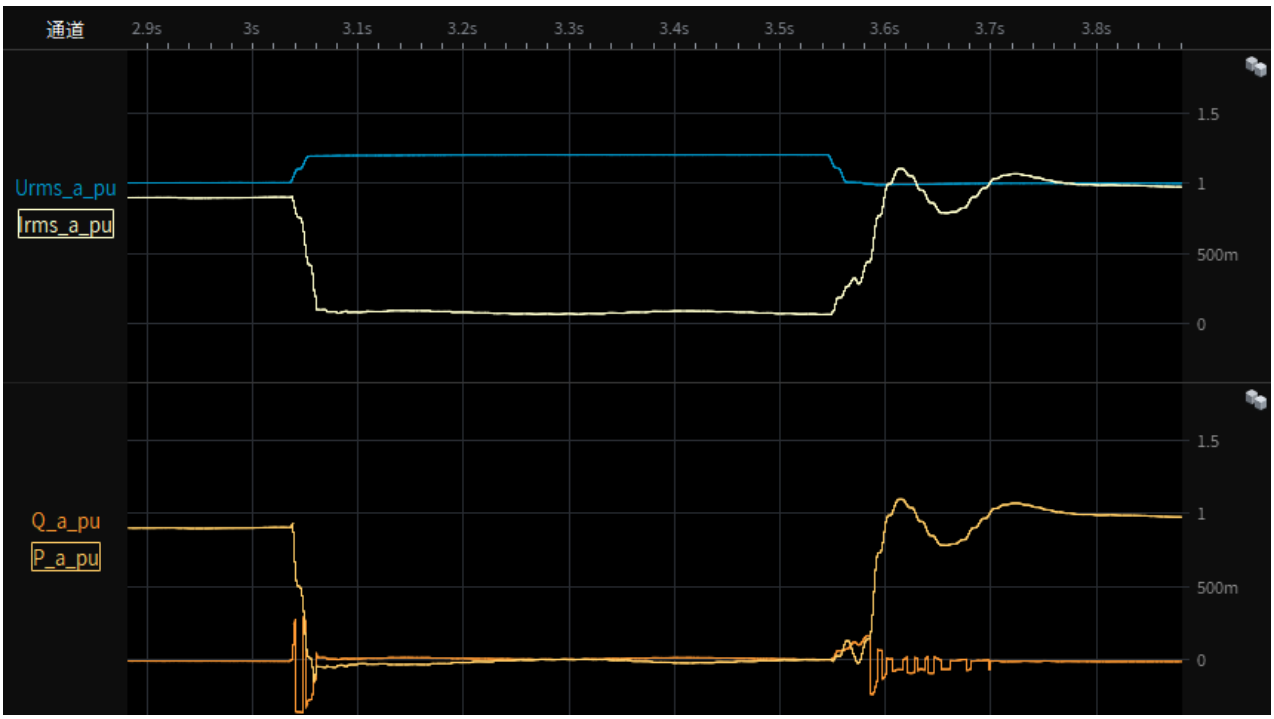


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 7-1.4 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),20% load restoring time

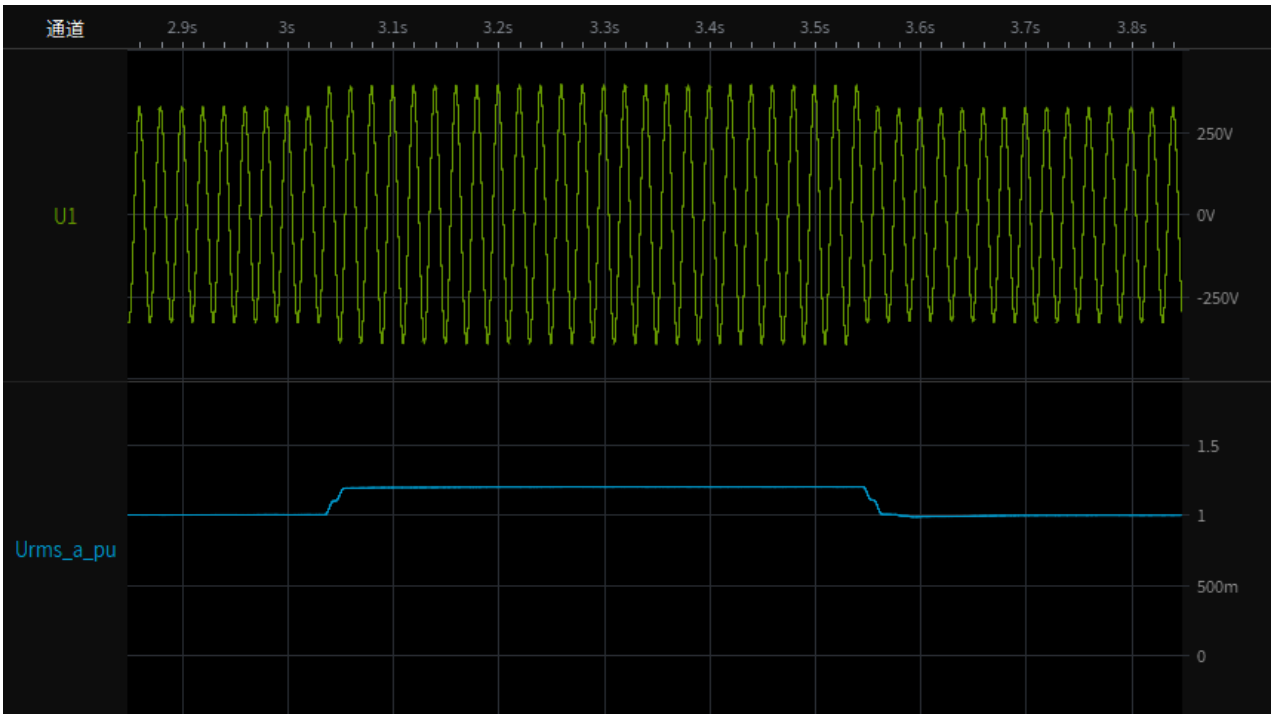


Test 7-2.1 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),95% load Test overview(voltage,current,active and reactive power)

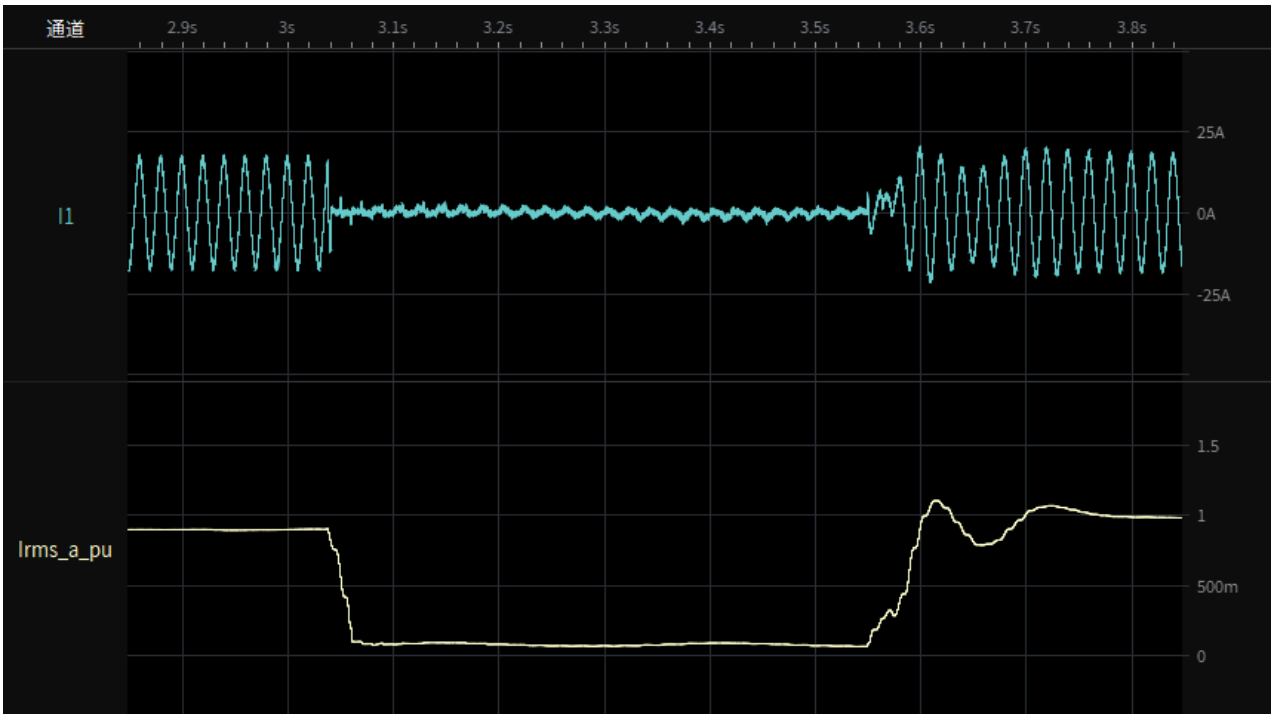


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 7-2.2 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages

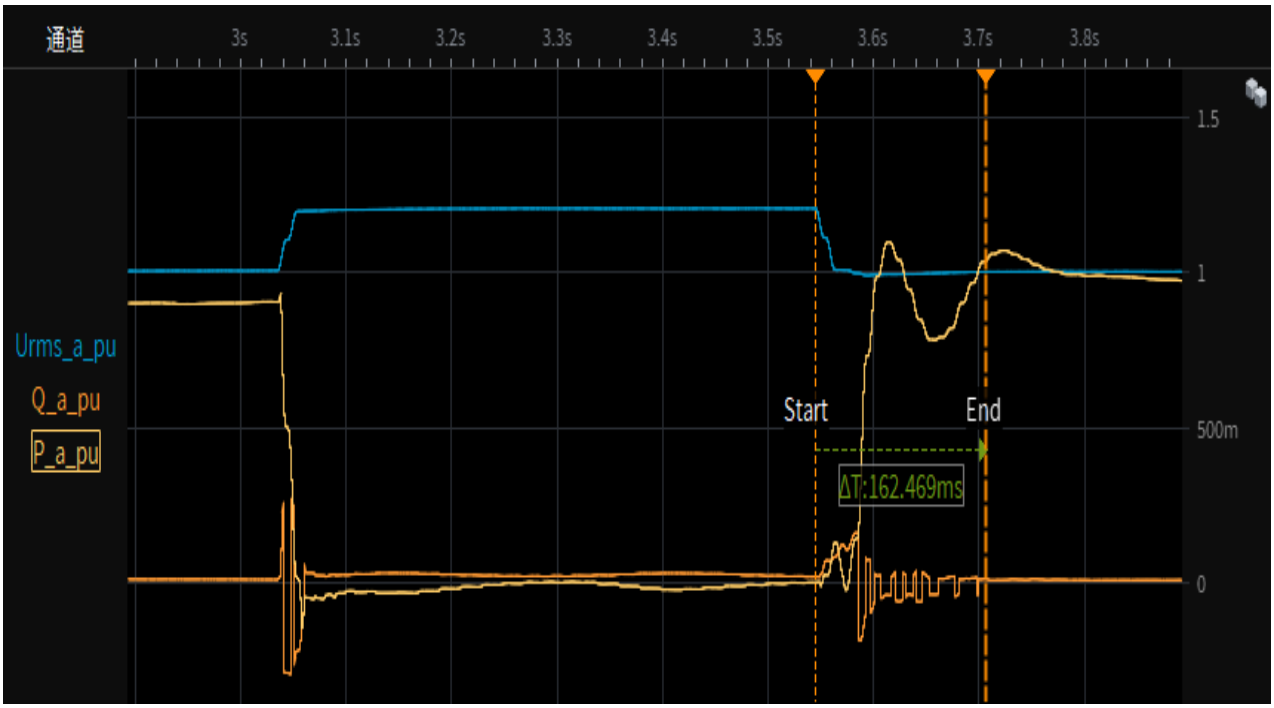


Test 7-2.3 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents

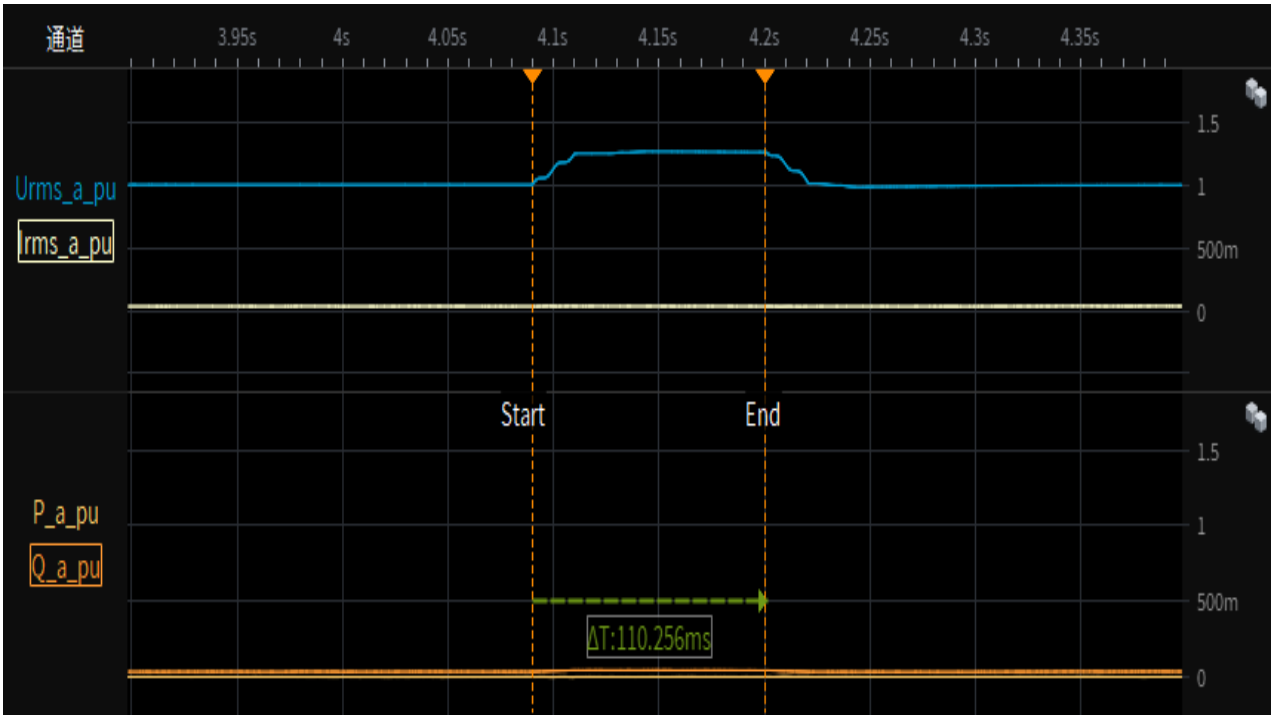


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 7-2.4 Depth of fault phase: 1.20p.u.,three-phase-symmetrical (type A), 95% load restoring time

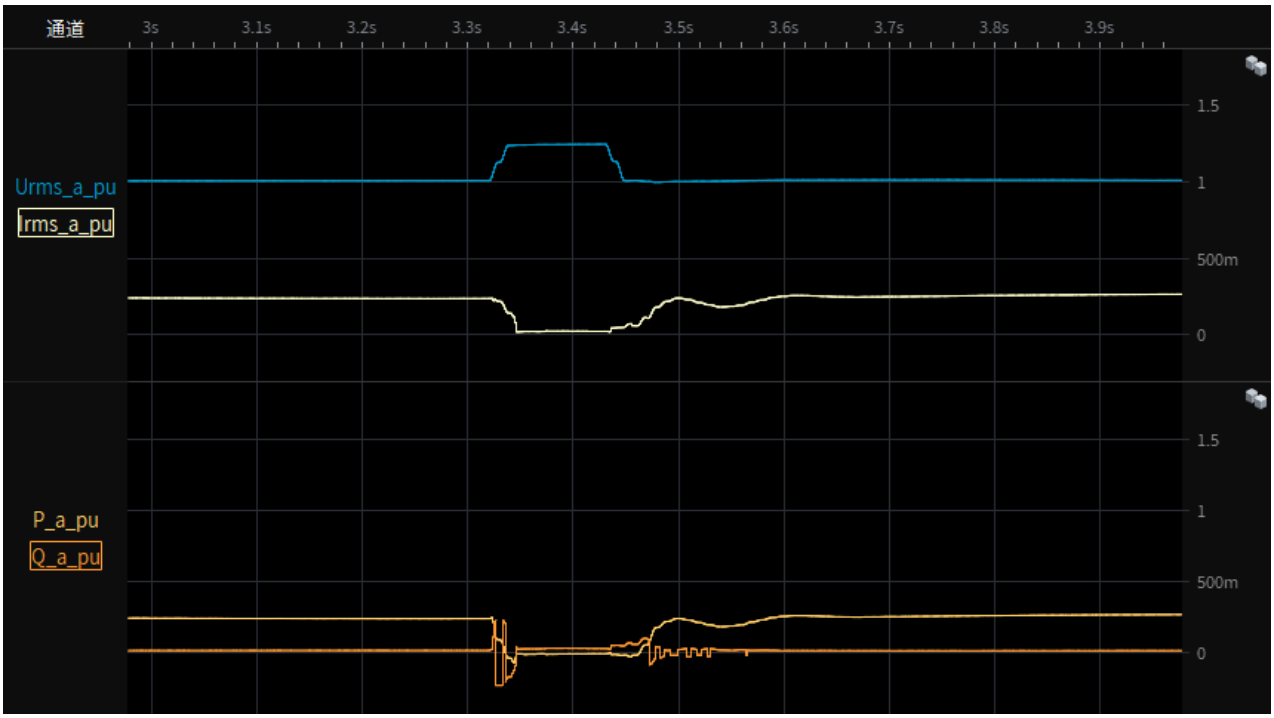


Test 8-Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A), 0% load
Test overview(voltage,current,active and reactive power)

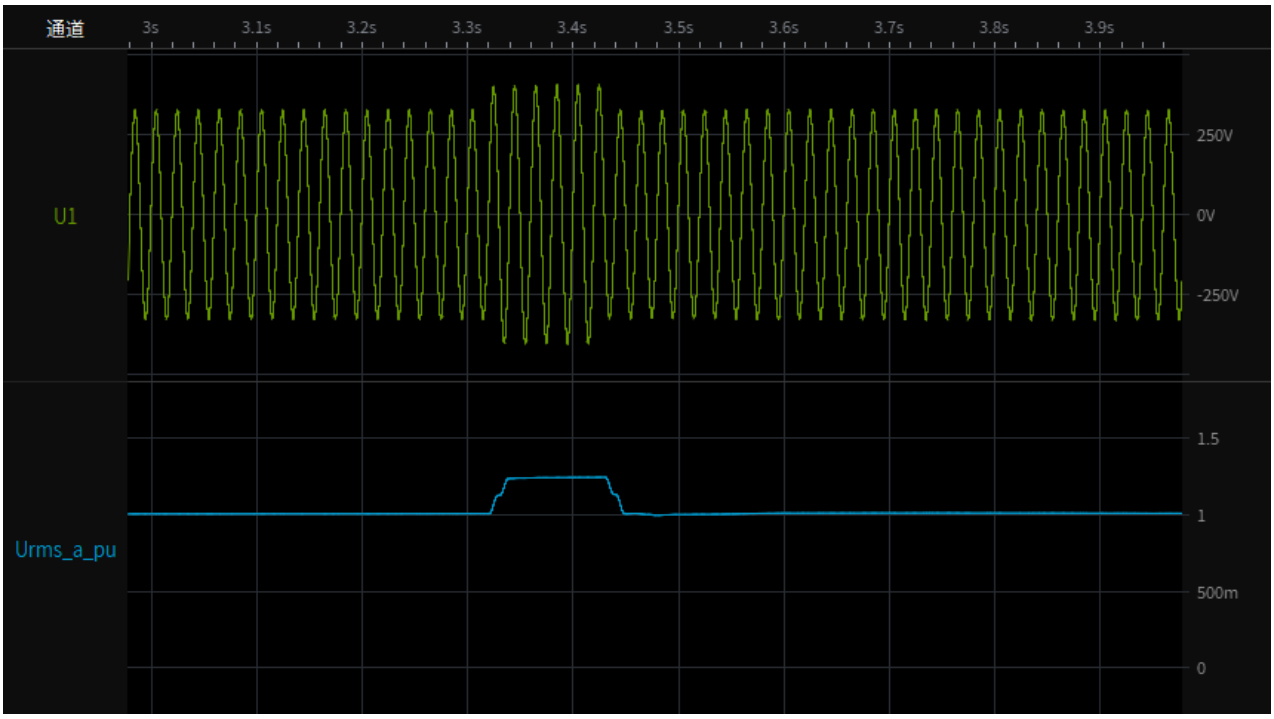


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 8-1.1 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),20% load
Test overview(voltage,current,active and reactive power)

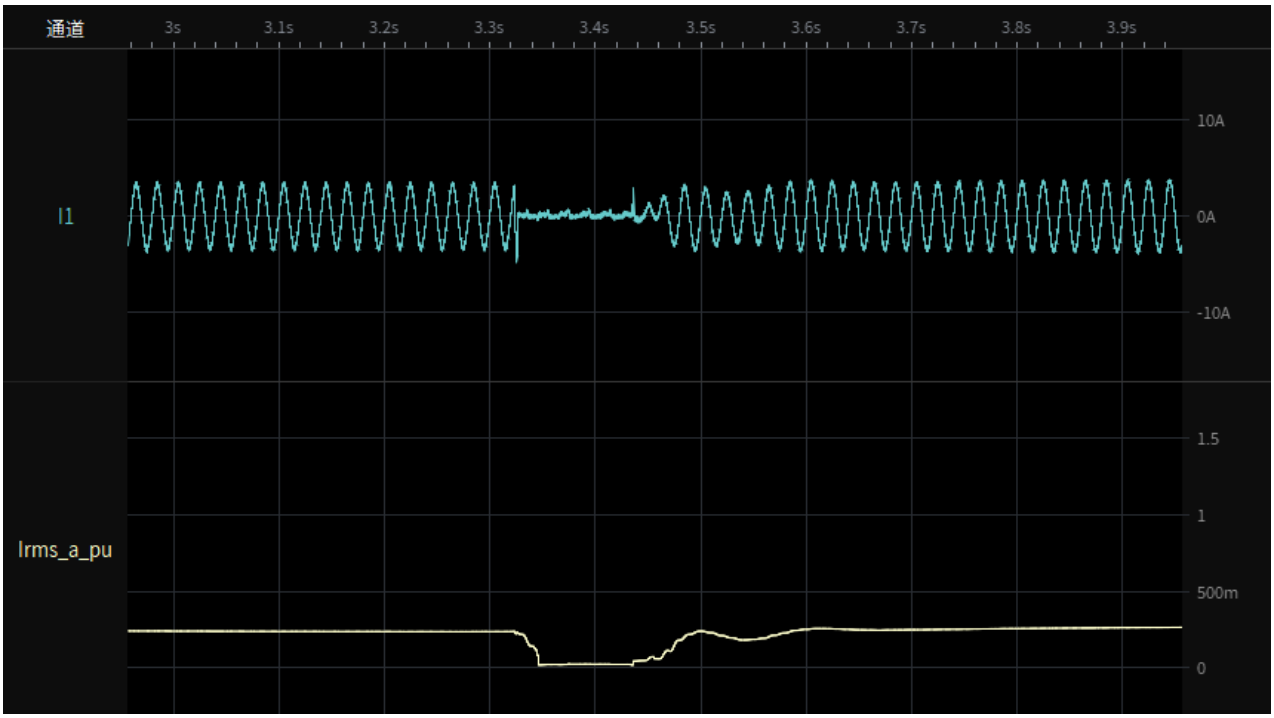


Test 8-1.2 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase-to-neutral voltages

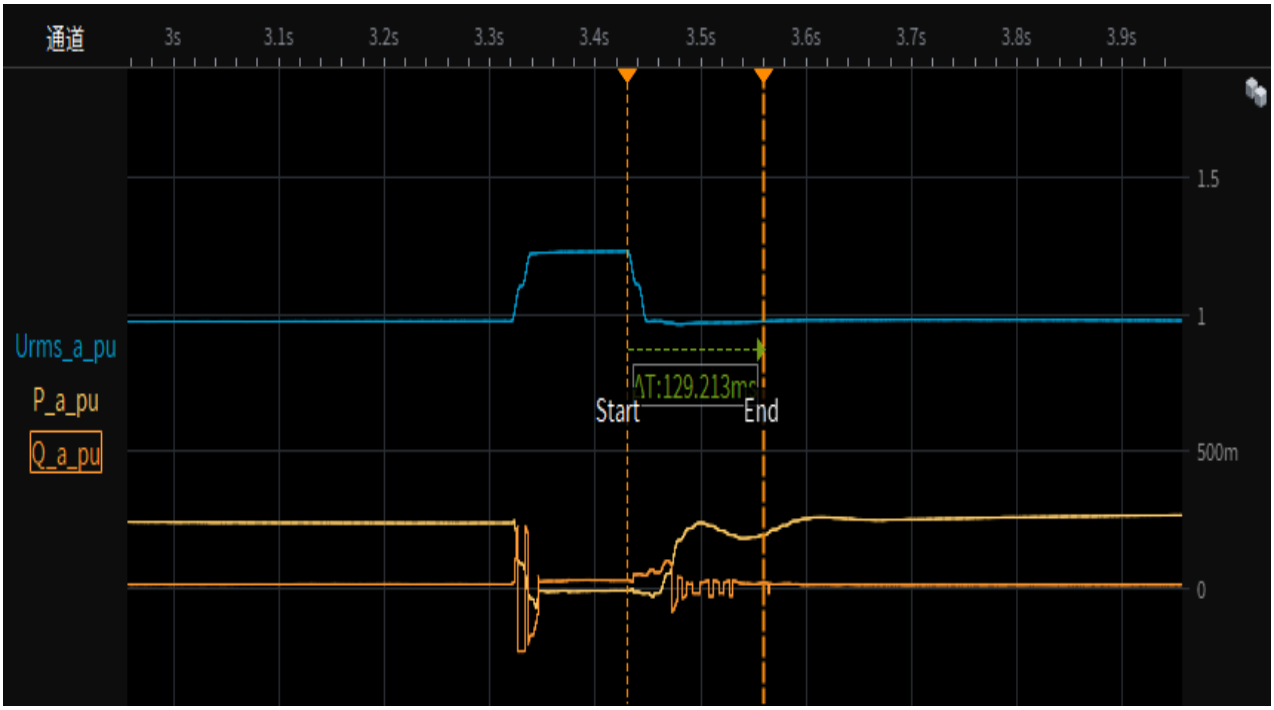


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 8-1.3 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),20% load
Instantaneous curve and RMS value of phase currents

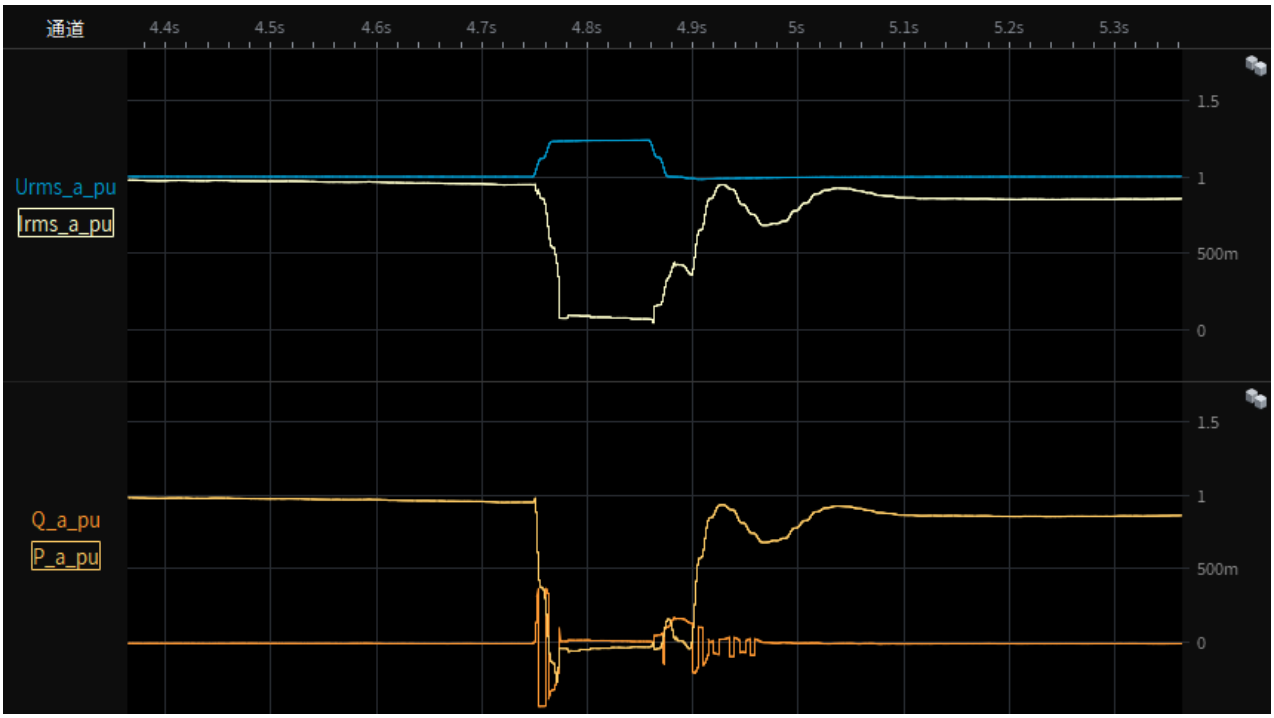


Test 8-1.4 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),20% load
restoring time

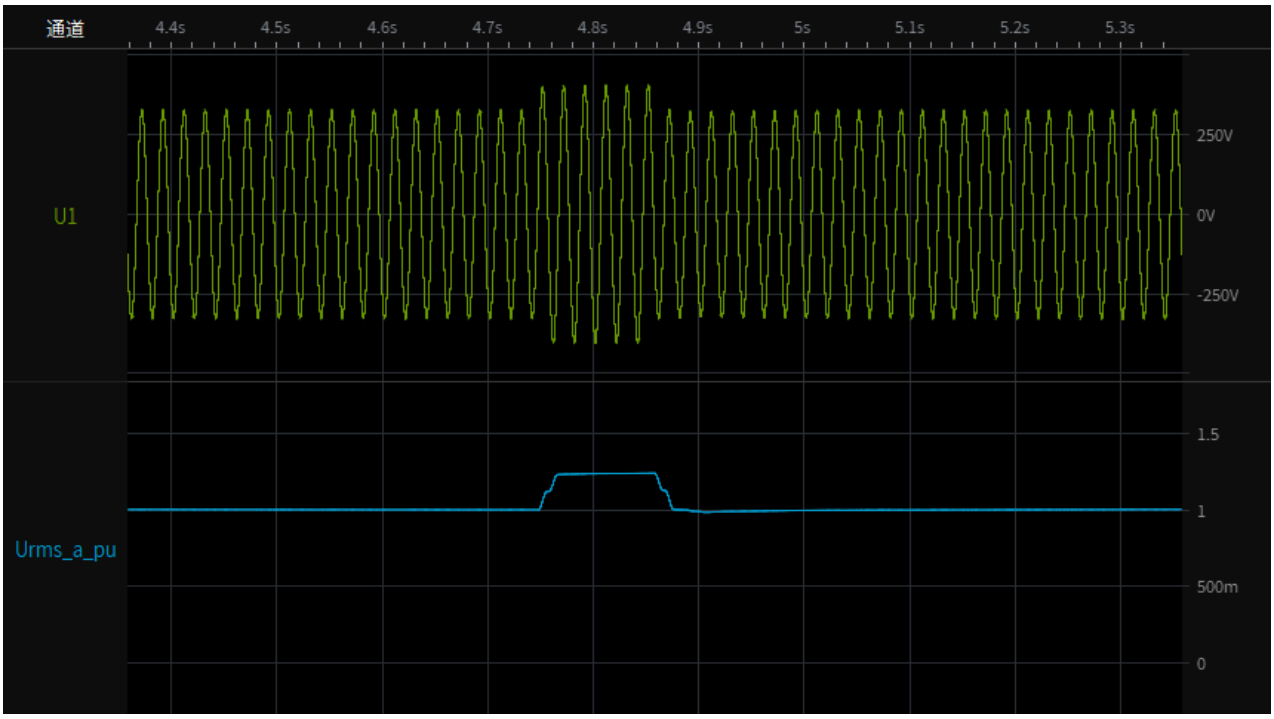


CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 8-2.1 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),95% load
Test overview(voltage,current,active and reactive power)

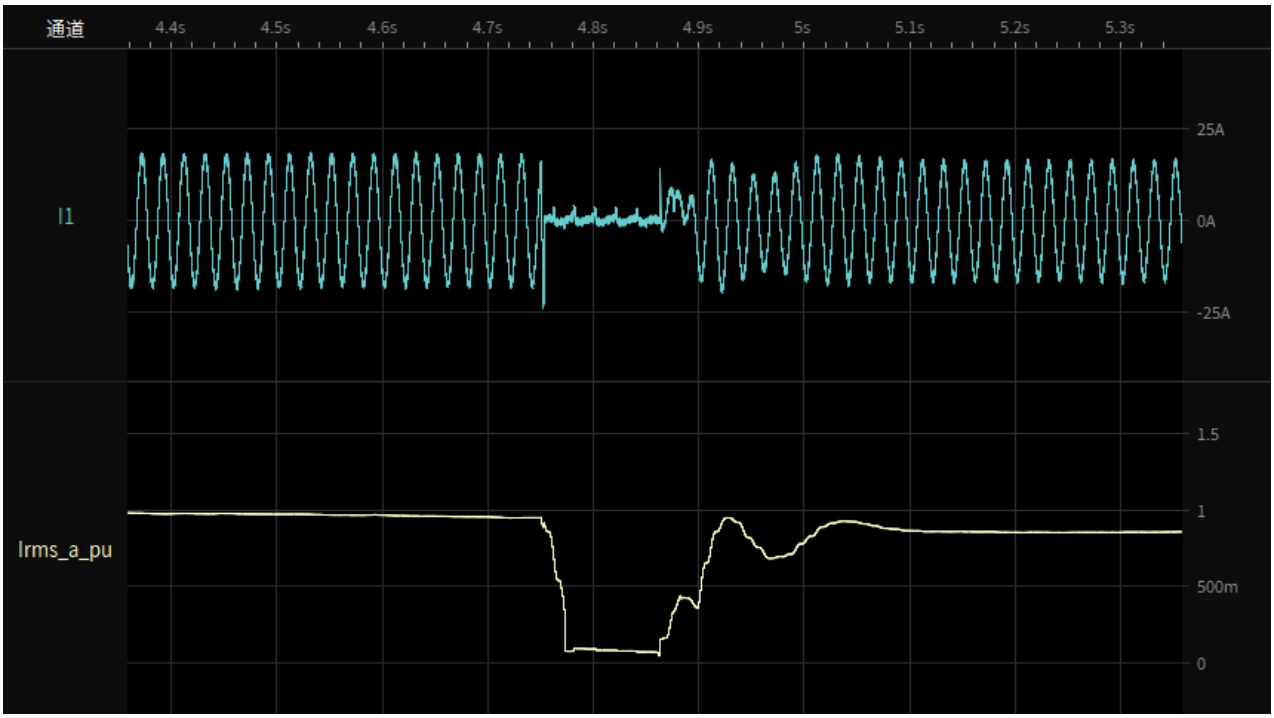


Test 8-2.2 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase-to-neutral voltages



CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 8-2.3 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A),95% load
Instantaneous curve and RMS value of phase currents



Test 8-2.4 Depth of fault phase: 1.25p.u.,three-phase-symmetrical (type A), 95% load
restoring time

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

B.1.6	**TABLE: Checking the insensitivity to automatic reclosing during phase discordance**				**P**
Model	HNS3000TL-1				
Test 1: Phase angle shift of 90°					
Power level	Cos φ	Phase shift angle (°)	Current 20 ms before phase shift (A)	Current 200ms after phase shif (A)	Result
100%	0.999	90	13.60	12.88	The PV inverter continue to feed power to grid after phase angle shift has been performed. No damage, no hazard.
Test 2: Phase angle shift of 180°					
Power level (%)	Cos φ	Phase shift angle (°)	Current 20 ms before phase shift (A)	Current 200ms after phase shif (A)	Result
100%	0.999	180	13.61	13.95	The PV inverter continue to feed power to grid after phase angle shift has been performed. No damage, no hazard.

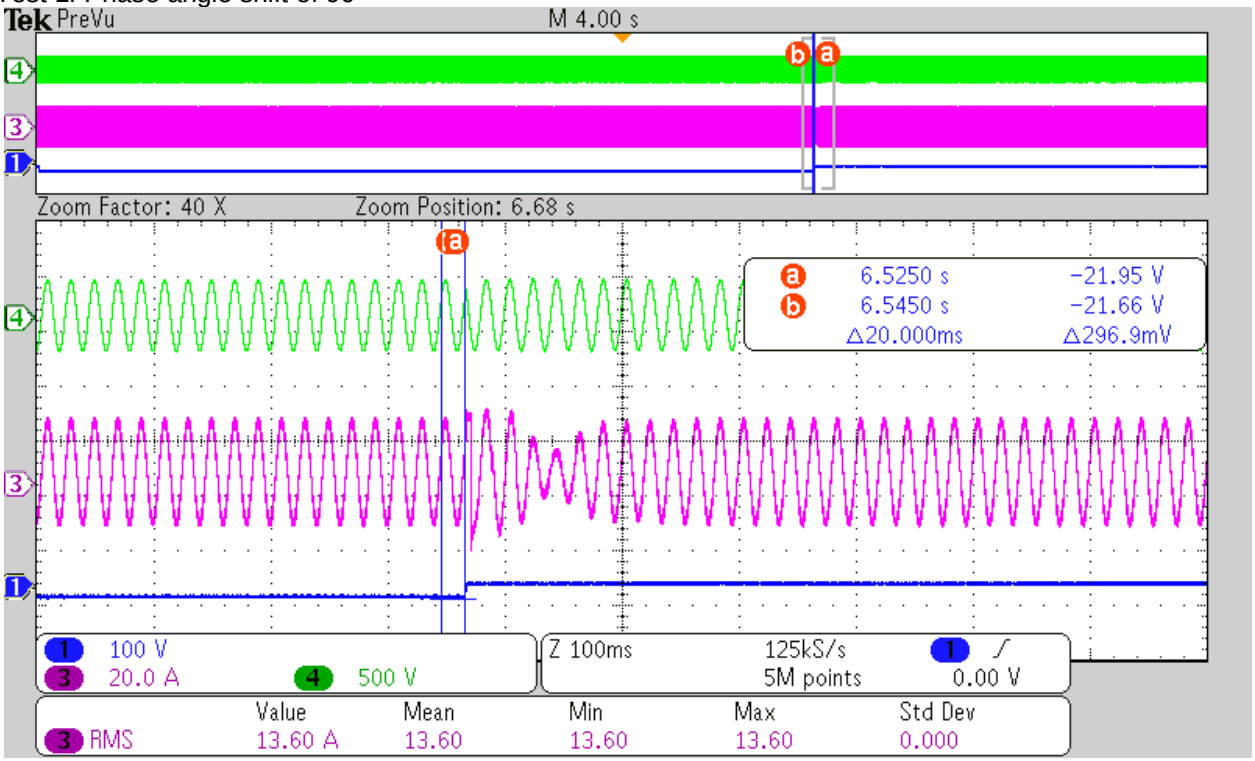
Note:

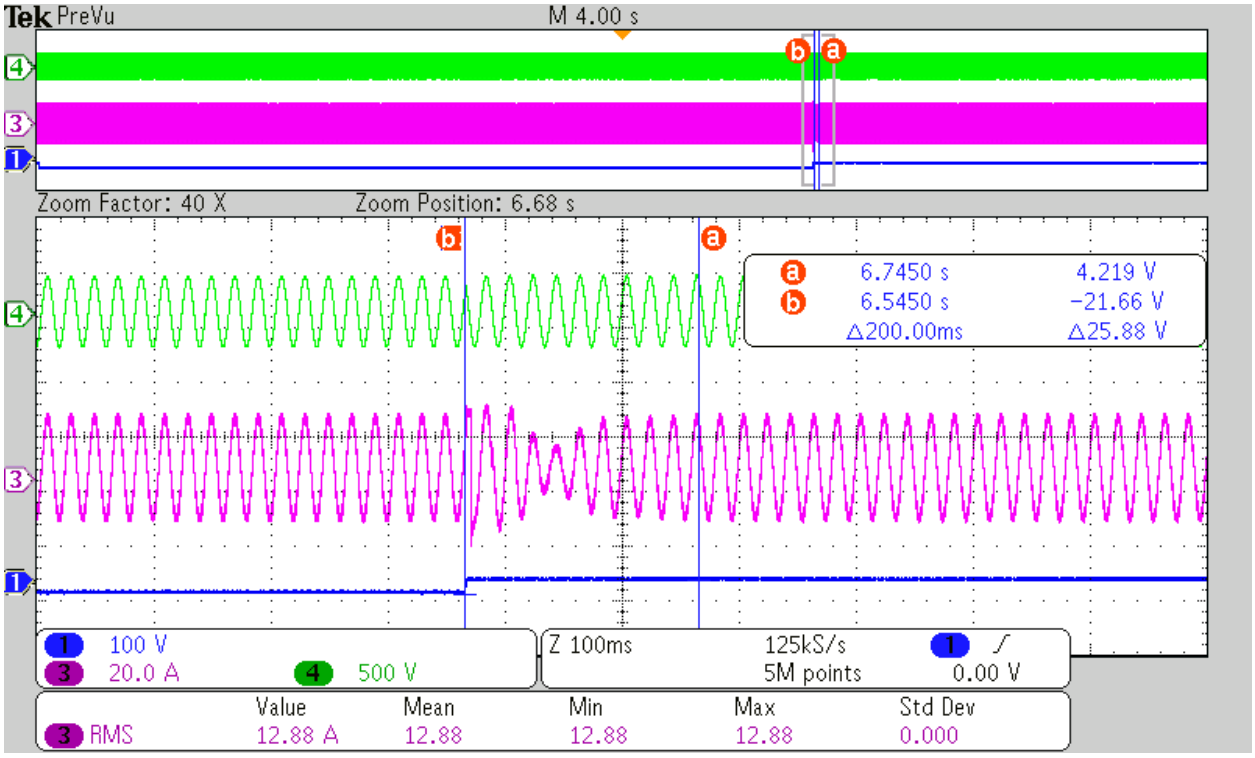
The generator must be brought into operation at rated power. Let the system operate under the set conditions for at least 5 min or the time necessary for the temperature inside the converter to stabilize.

The inverter should be operated with cos φ = 1 and nominal output power. The network simulator should create voltage phase shifts of 90° and 180°. As a result, 20ms before and 200ms after the voltage phase shift, should be documented.

CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

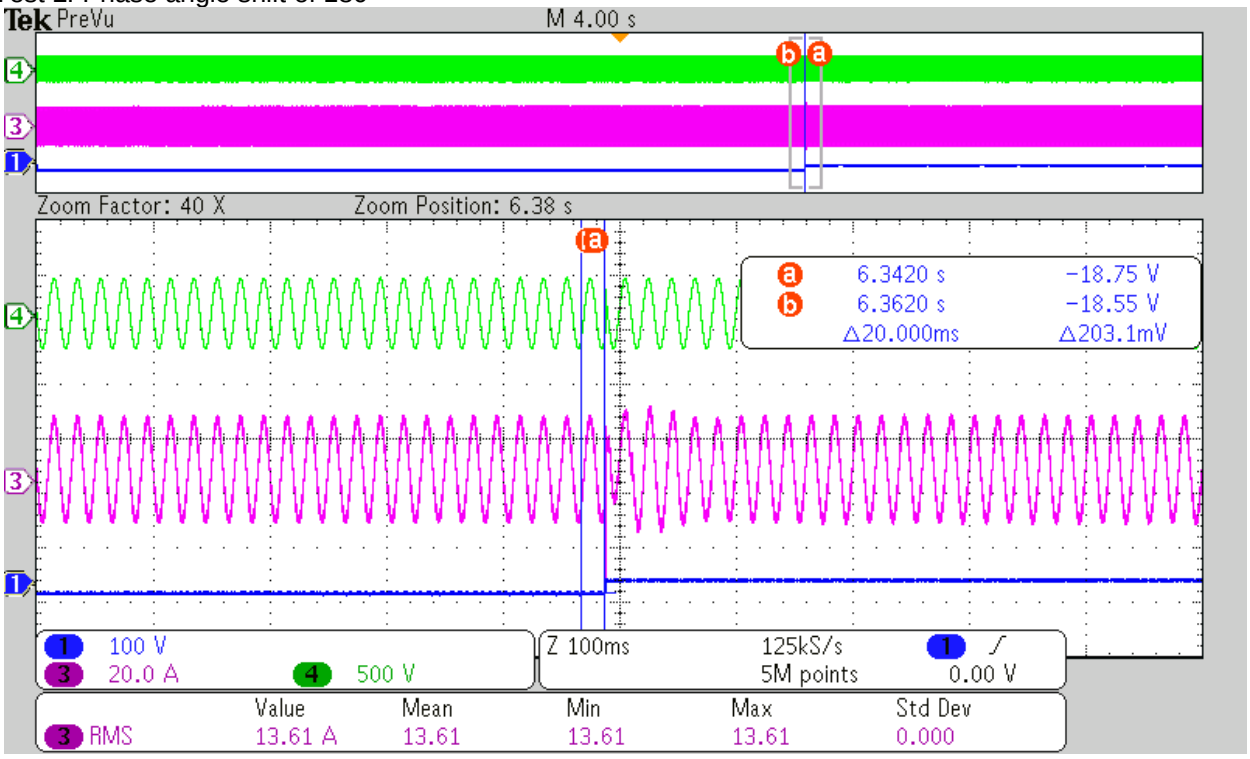
Test 1: Phase angle shift of 90°

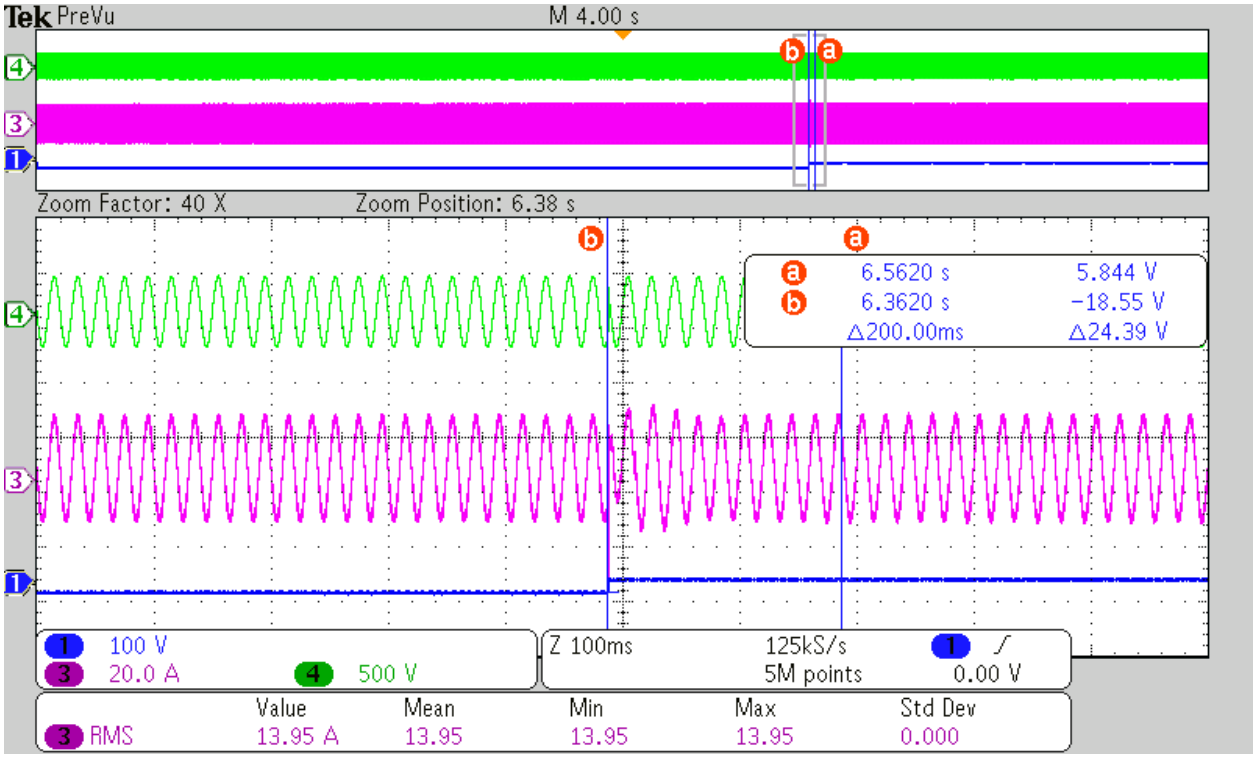




CEI 0-21			
Clause	Requirement - Test	Result - Remark	Verdict

Test 2: Phase angle shift of 180°





Annex 1
ISO 9001 certificate

AXEREGISTER

CERTIFICATE

N. CN23 – 12689A

This is to certify that the Quality Management System of

AFORE NEW ENERGY TECHNOLOGY (SHANGHAI) CO.,LTD.

Unified social credit code: 91310000561932991K
Registered Address
Building 7, No.333, Wanfang Road, Minhang District, Shanghai
Office & Production Address
Building 7, No.333, Wanfang Road, Minhang District, Shanghai, China

Has been independently assessed and found in conformance with the standard

ISO 9001:2015

For the following scope of activities:

R & D and Manufacture of Photovoltaic Inverter

IAF 19

For further and updated information regarding any changes in the status of this certification please contact via phone under +355696037861 / +39 0296368458 or via email to info@axe-register.com or verify directly on the website www.axe-register.com by using the organization name or the certificate number.

The validity of this certificate is subject to periodic yearly surveillance audit and triennial review of the entire management system of the certified organization.

Date of first registration	**10/07/2017**
Date of this certificate	**07/07/2023**
Date of expiry	**09/07/2026**

CS 007 26.02.18

Signatory of EA/MLA, Mutual Recognition Agreements

On behalf of the Certification Body
AXE REGISTER Ltd
Antonio Llavata
Technical Director

During validity period of the certificate a surveillance audit should be carried out once within each 12 months. The label should be pasted on specified position of right side of the certificate then it is valid. The certificate can be checked out at CNCA website (www.cnca.gov.cn).

(1) Surveillance Audit Mark

(2) Surveillance Audit Mark

AXE REGISTER
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ACM (CHINA) LIMITED, Rm B201, No 352, Waihuan Road, Minhang District, Shanghai 201199, China

Annex 2
Datasheet of the relay

SONG CHUAN

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Features

- ☐ 12A/14A/16A miniature PCB Power Relay.
- ☐ Contact gap can be greater than 1.85 & 2.1 mm.
- ☐ Conforms to European photovoltaic standard IEC 62109-1.
- ☐ Coil holding voltage can be reduced to 45~60%(for 210), 45~55%(for 210H) V of the nominal coil voltage for saving energy.
- ☐ High performance PCB power relay for photovoltaic power generation systems (solar inverter).
- ☐ Complies with RoHS-Directive 2011/65/EU.

Type List

◆ Standard type

Terminal style	Contact form	Insulation system	Designation (provided with) Flux tight
PCB terminal	2A (DPNO)	F	210-2AH-F-C
			210-2AH1-F-C

◆ High power type

PCB terminal	2A (DPNO)	F	210H-2AH-F-C
			210H-2AH1-F-C

Ordering Information

210 ☐ - 2A H ☐ - ☐ - C ☐
1 2 3 4 5 6 7 8

1. 210 -- Basic series designation
2. Blank -- Standard type
   H -- High power type
3. 2A -- Double pole normally open
4. H -- Contact material Ag alloy
5. Blank -- Contact gap ≥1.85mm
   1 -- Contact gap ≥2.1mm
6. Blank -- Standard type
   F -- Class F
7. C -- Flux tight
8. ☐ -- Coil voltage (please refer to the coil rating data for the availability)

Contact Rating

◆ Standard type

Resistive load	12A 250VAC, On 1s /Off 9s, at 85°C, 30K ops.

◆ High power type

Resistive load	14A 250VAC, On 1s /Off 9s, at 85°C, 30K ops.
	16A 250VAC, On 1s /Off 9s, at 75°C, 30K ops.

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Coil Rating (DC)

◆ For contact gap ≥1.85 mm

Rated voltage (V)	Rated current ±10 % at 23°C (mA)	Coil resistance ±10 % at 23°C (Ω)	Pick up voltage (Max.) at 23°C (1)	Drop out voltage (Min.) at 23°C	Continuous voltage at 85°C (2) (3)	Power consumption at rated / holding voltage
12	118	102	75 % of rated voltage	5 % of rated voltage	(210) 45~60%, (210H) 45~55% of rated voltage	approx. 1.4W / 0.29W (2)
24	58	411				

Notes : (1) To energize relay properly apply 100%~120% nominal coil voltage for 200ms.
(2) Coil holding voltage is 45~60%(for 210), 45~55 %(for 210H) of nominal voltage after applying nominal voltage for 200ms.
(3) At 85°C for contact rating 12A, 14A; at 75°C for contact rating 16A.

◆ For contact gap ≥2.1 mm

Rated voltage (V)	Rated current ±10 % at 23°C (mA)	Coil resistance ±10 % at 23°C (Ω)	Pick up voltage (Max.) at 23°C (1)	Drop out voltage (Min.) at 23°C	Continuous voltage at 85°C (2) (3)	Power consumption at rated / holding voltage
12	118	102	80 % of rated voltage	5 % of rated voltage	(210) 45~60%, (210H) 45~55% of rated voltage	approx. 1.4W / 0.29W (2)
24	58	411				

Notes : (1) To energize relay properly apply 100%~120% nominal coil voltage for 200ms.
(2) Coil holding voltage is 45~60%(for 210), 45~55 %(for 210H) of nominal voltage after applying nominal voltage for 200ms.
(3) At 85°C for contact rating 12A, 14A; at 75°C for contact rating 16A.

Specification

Contact material	Ag alloy	
Contact resistance (1)	100mΩ Max. (at 1A/6VDC by 4-wire resistance measurement) 6 mΩ Max. (By voltage drop 10A)	
Operate time (1)	20ms Max.	
Release time (1)	15ms Max.	
Vibration resistance	Operating extremes	10~55Hz , amplitude 1.5 mm
	Damage limits	10~55Hz , amplitude 1.5 mm
Shock resistance	Operating extremes	10G
	Damage limits	100G
Life expectancy	Mechanical	100,000 ops. (frequency 9,000 ops./hr)
Operating ambient temperature	-40~+85°C (no freezing) for contact rating 12A,14A -40~+75°C (no freezing) for contact rating 16A	
Weight	Approx.17 g	

Notes : (1) Initial value. Operate and release time excluding contact bounce.
(2) Unless otherwise specified, all tests are under room temperature and humidity.
(3) Consider the heat of PCB is necessary, please check the actual condition of PCB.
(4) Applying no diode to this relay. The life expectancy will be lower when a diode is used. To use a varistor (ZNR) could absorb the coil surge of relay that is recommended.
(5) Do not use the relay exceeding the coil rating, contact rating and life expectancy, or this may cause the risk of overheating.
(6) To assure optimum performance, avoid the relay from dropping, hitting, or other unnecessary shocks.
(7) Do not switch the contacts without any load as the contact resistance may become increased rapidly.
(8) Please contact Song Chuan for the detailed information.

SONG CHUAN

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Insulation Data

Insulation resistance (1)	1000MΩ Min. (DC 500V)	
Dielectric strength (1)	Between open contact	: AC 1500V, 50/60Hz 1 min.
	Between contact and coil	: AC 5000V, 50/60Hz 1 min.
	Between contact circuits	: AC 2500V, 50/60Hz 1 min.
Insulation of IEC 61810-1		
Clearance / creepage distances	Between coil to contact	: Double, Reinforce ≥3 mm / ≥5 mm
	Between open contact	: Basic, ≥1.5mm / ≥2.5mm
	Between contact circuits	: Double, Reinforce ≥3 mm / ≥5 mm
Rated insulation voltage	250V	
Rated impulse withstand voltage	2500V	
Pollution degree	2	
Rated voltage	230 / 400V	
Overvoltage category	II	
Compliant with European photovoltaic standard		
Contact gap	1.85mm Min. (IEC 62109-1 and VDE 0126)	
	2.1mm Min. (IEC 62109-1 and VDE 0126)	

Notes : (1) Initial value.

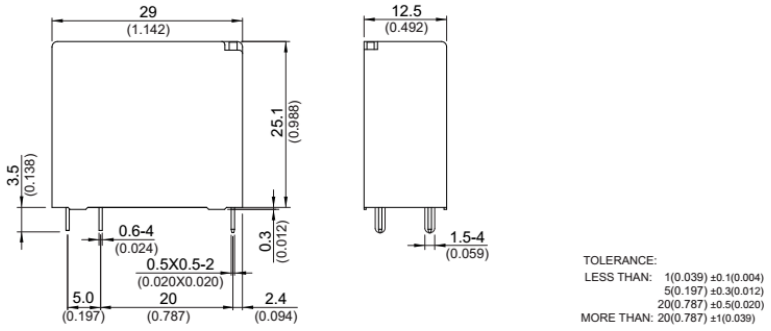
Safety Approval

Certified	UL / CUL	VDE
File No.	E88991	40007827

Safety Approval Rating

UL / CUL		VDE	
210	210H	210	210H
NO : 12A 277VAC	NO : 16A 277VAC NO : 14A 277VAC	NO : 12A 250VAC T85	NO : 16A 250VAC T75 NO : 14A 250VAC T85

Outline Dimensions



Wiring Diagram (Bottom view)

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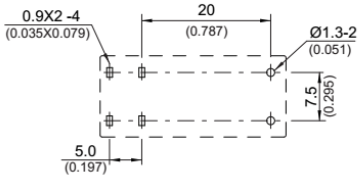
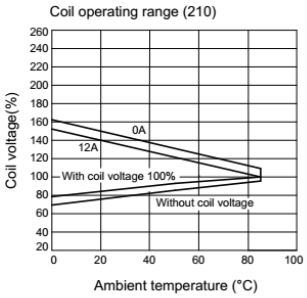
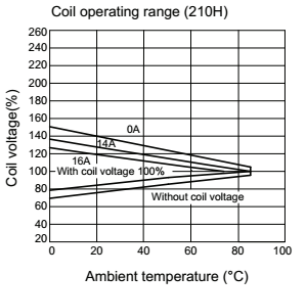
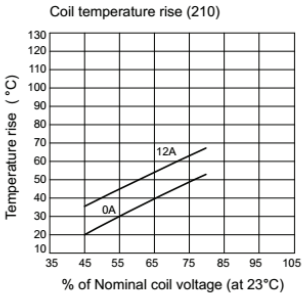
PC Board Layout (Bottom view)

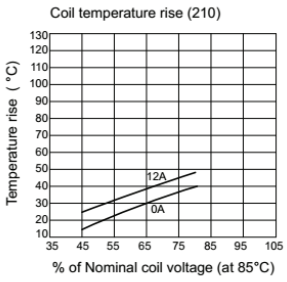


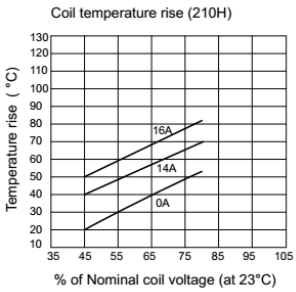
Engineering Data

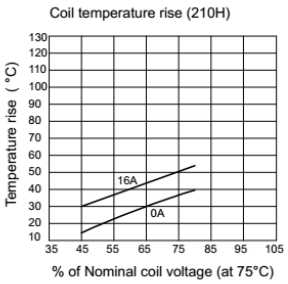


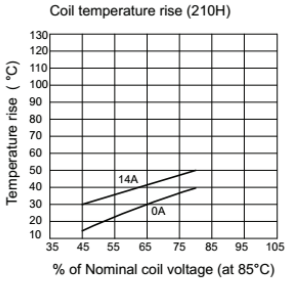






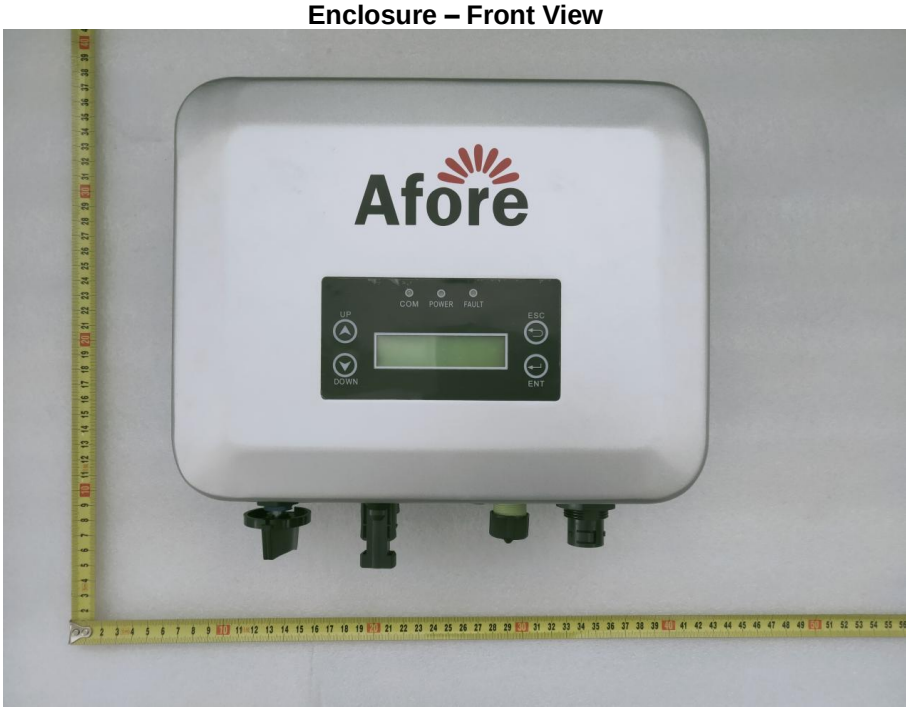




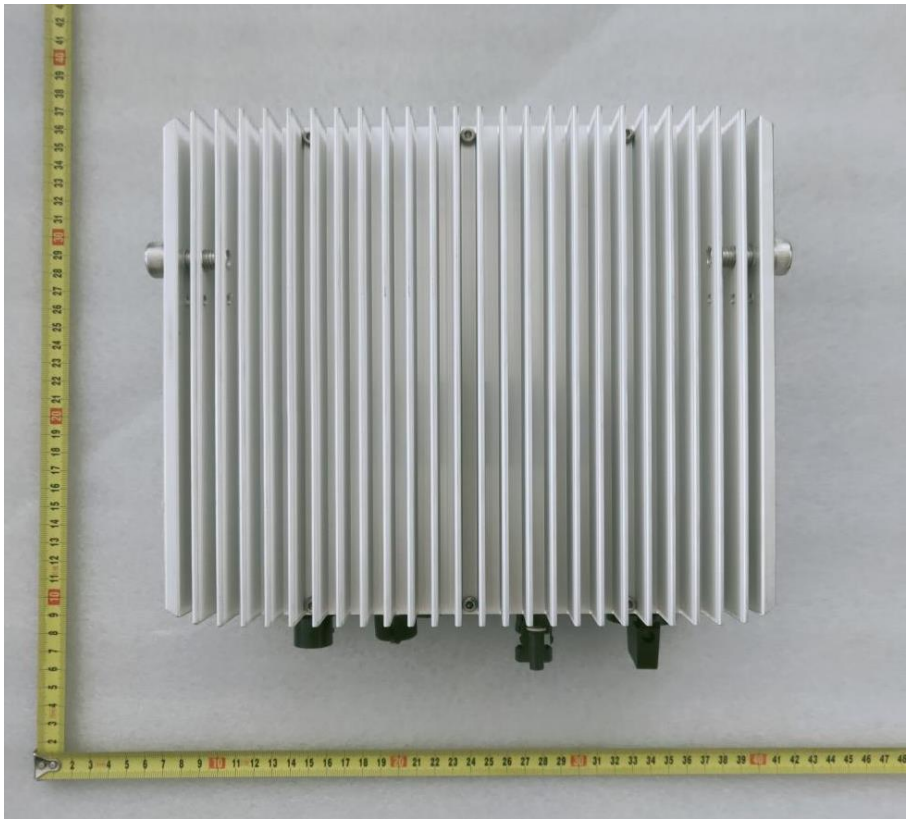


Annex 3
Pictures of the unit

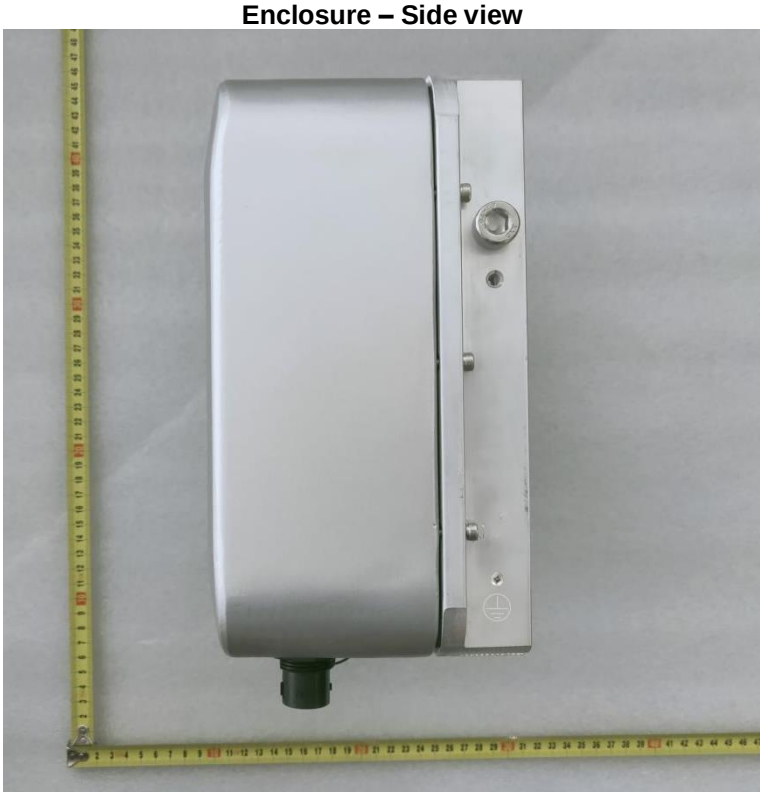
Enclosure – Front View



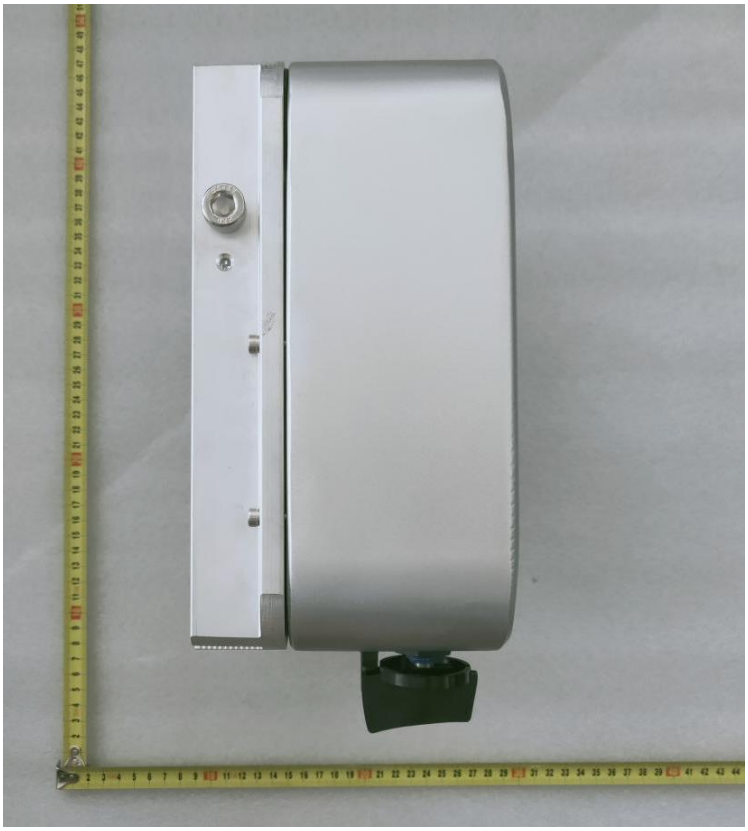
Enclosure – Rear View



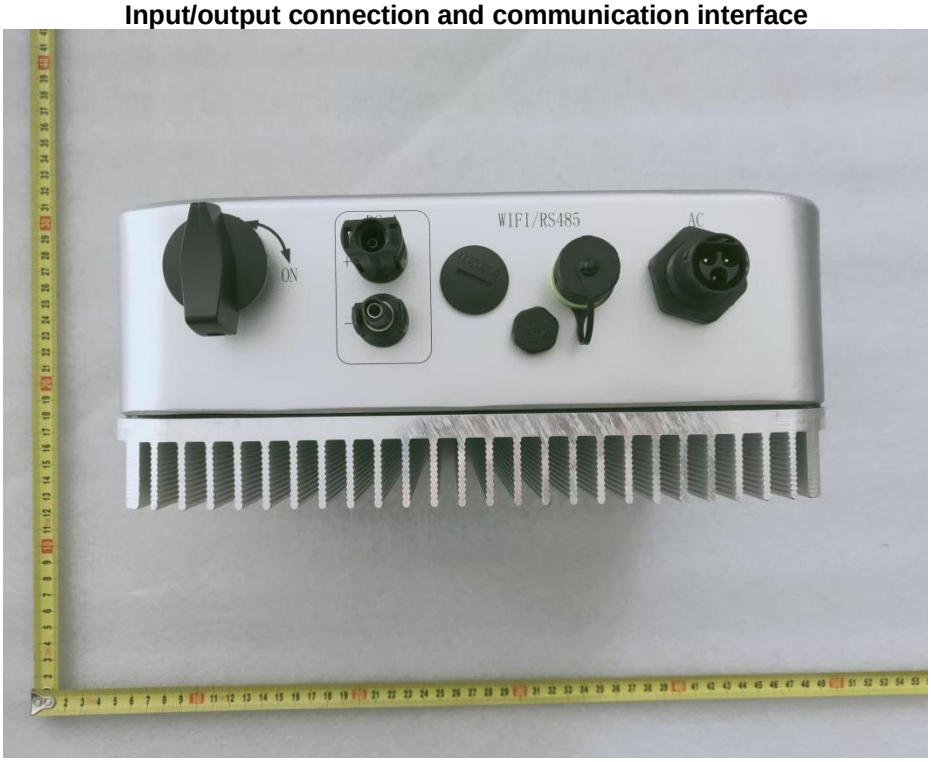
Enclosure – Side view



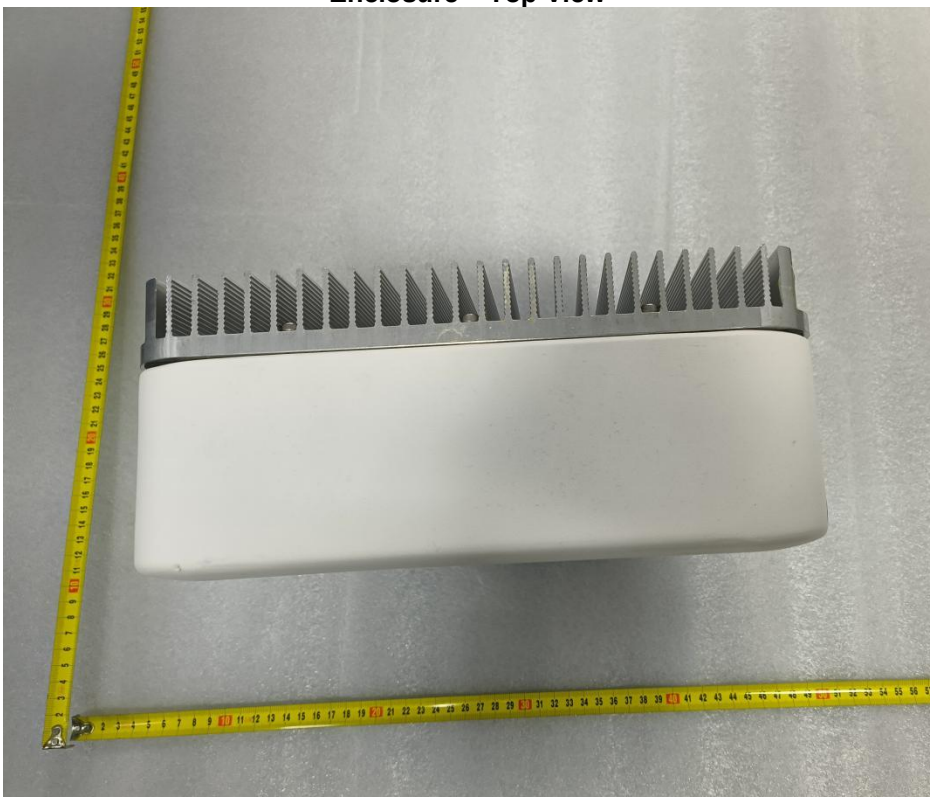
Enclosure – Side view



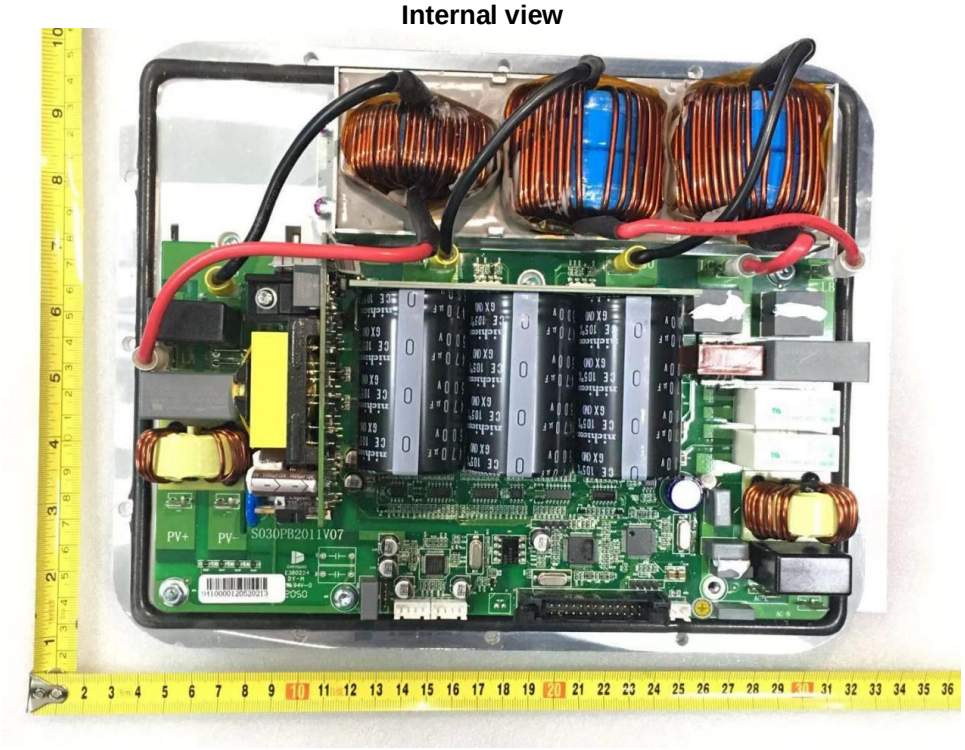
Input/output connection and communication interface



Enclosure – Top View



Internal view



--- End of test report---