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Test Report issued under the responsibility of:

TEST REPORT
NRS 097-2-1:2017
Test report for Grid interconnection of embedded generation
Part 2: Small-scale embedded generation
Section 1: Utility interface

Report Number.............................:	BL-DG2150442-B01(G1)
Date of issue..................................:	Aug. 11, 2023
Total number of pages...................	102
Name of Testing Laboratory preparing the Report......................:	Dongguan BALUN Testing Technology Co., Ltd.
Applicant's name ....:	Shenzhen ATESS Power Technology Co.,Ltd
Address..:	2nd Floor, No.23 Zhulongtian Road, Shuitian Community, Shiyan Street, Baoan District, Shenzhen
Test specification:	
Standard...:	NRS 097-2-1:2017 Edition 2.1
Test procedure ....:	Commissioned test
Non-standard test method ....:	N/A
Test item description ....:	Bidirectional Battery Inverter
Trade Mark ....:	ATESS
Manufacturer ....:	Same as the applicant
Model/Type reference ....:	PCS100, PCS250, PCS500, PCS630
Ratings ....:	See copy of marking label
Testing Laboratory.........................:	Dongguan BALUN Testing Technology Co., Ltd.
Testing location/ address ....:	Room 104, 204, 205, Building 1, No. 6, Industrial South Road, Songshan Lake District, Dongguan, Guangdong, China
Tested by (name, function, signature).......................................:	Andy Duan /Engineer
Approved by (name, function, signature).......................................:	Simon Qi /Chief Engineer

General disclaimer:

The test results presented in this report relate only to the object tested.

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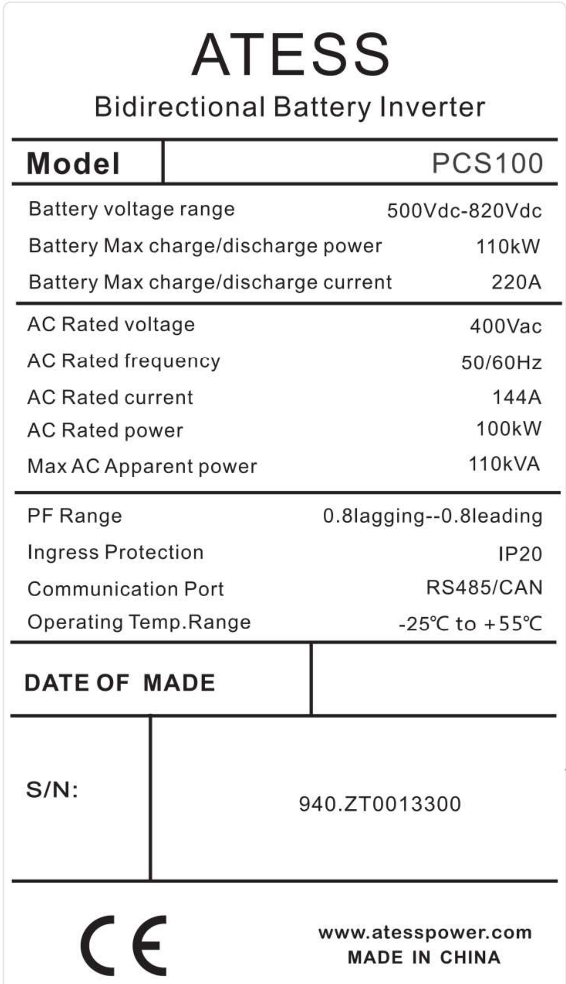
Note:

This report replaces the original report BL-DG2150442-B01 issued on Sept. 07, 2021, and the original report is invalid.

<table>
<tr><td colspan="2">List of Attachments (including a total number of pages in each attachment):</td></tr>
<tr><td colspan="2">Summary of testing:</td></tr>
<tr><td>Tests performed (name of test and test clause):
4.1.5 Voltage fluctuations and Flicker
4.1.6 Calculation of asymmetry
4.1.8 DC injection
4.1.10 Harmonics and waveform distortion
4.1.11.3 Power factor (no controllable reactive power)
4.1.11.4 Power factor (Fixed cos φ)
4.1.12 Synchronization
4.1.13 Electromagnetic compatibility (EMC)
4.2.2 Safety disconnect from utility network
4.2.2.3.2 Over voltage and under voltage
4.2.2.3.3 Over-frequency and under-frequency
4.2.2.3.3 Active power feed-in for over-frequency
4.2.2.4 Preventing of islanding</td><td>Testing location:
All tests except clause 4.1.13, 4.2.2 and 4.2.2.4 were performed at address listed on page 1.
The tests of clause 4.1.13 were performed in: Dongguan BALUN Testing Technology Co., Ltd. Report No:BL-DG2150442-401(G1), Issued by Dongguan BALUN Testing Technology Co., Ltd. (CNAS L14701) Dated on Aug. 11, 2023, total 44 pages.
The tests of clause 4.2.2 were performed in: EMTEK(SHENZHEN) CO., LTD Report No: ENS2305110124P004, Issued by EMTEK(SHENZHEN) CO., LTD (CNAS L2291) Dated on Mar. 31, 2023, total 86 pages.
The tests of clause 4.2.2.4 were performed in: EMTEK(SHENZHEN) CO., LTD Report No:ES200211003P, Issued by EMTEK(SHENZHEN) CO., LTD (CNAS L2291) Dated on Mar.01, 2020, total 33 pages.</td></tr>
<tr><td colspan="2">☒ The product fulfils the requirements of NRS 097-2-1:2017 Edition 2.1.</td></tr>
</table>

Copy of marking plate:



ATESS

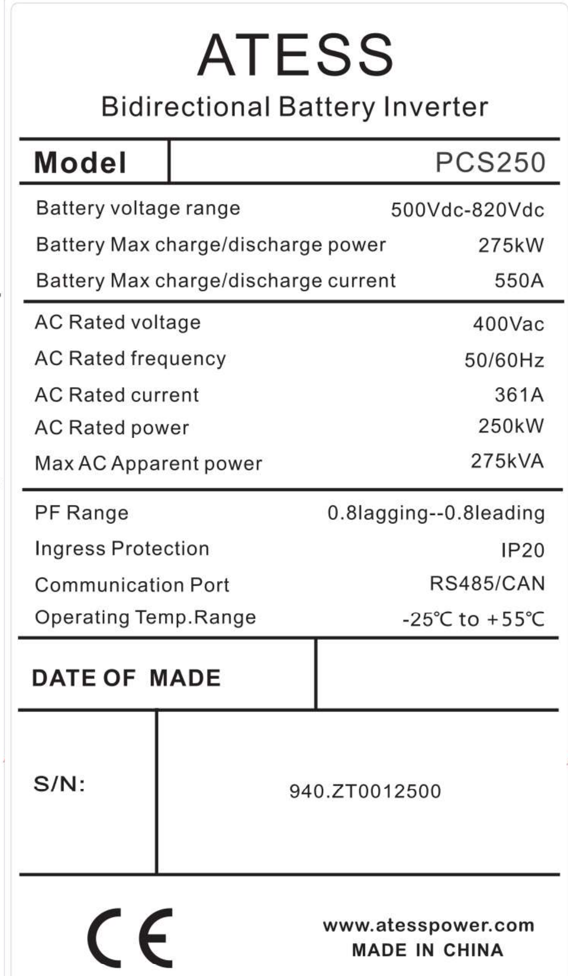
Bidirectional Battery Inverter

Model	PCS100
Battery voltage range	500Vdc-820Vdc
Battery Max charge/discharge power	110kW
Battery Max charge/discharge current	220A
AC Rated voltage	400Vac
AC Rated frequency	50/60Hz
AC Rated current	144A
AC Rated power	100kW
Max AC Apparent power	110kVA
PF Range	0.8lagging--0.8leading
Ingress Protection	IP20
Communication Port	RS485/CAN
Operating Temp.Range	-25℃ to +55℃
DATE OF MADE	
S/N:	940.ZT0013300

CE

www.atesspower.com

MADE IN CHINA



ATESS

Bidirectional Battery Inverter

Model	PCS250
Battery voltage range	500Vdc-820Vdc
Battery Max charge/discharge power	275kW
Battery Max charge/discharge current	550A
AC Rated voltage	400Vac
AC Rated frequency	50/60Hz
AC Rated current	361A
AC Rated power	250kW
Max AC Apparent power	275kVA
PF Range	0.8lagging--0.8leading
Ingress Protection	IP20
Communication Port	RS485/CAN
Operating Temp.Range	-25℃ to +55℃
DATE OF MADE	
S/N:	940.ZT0012500

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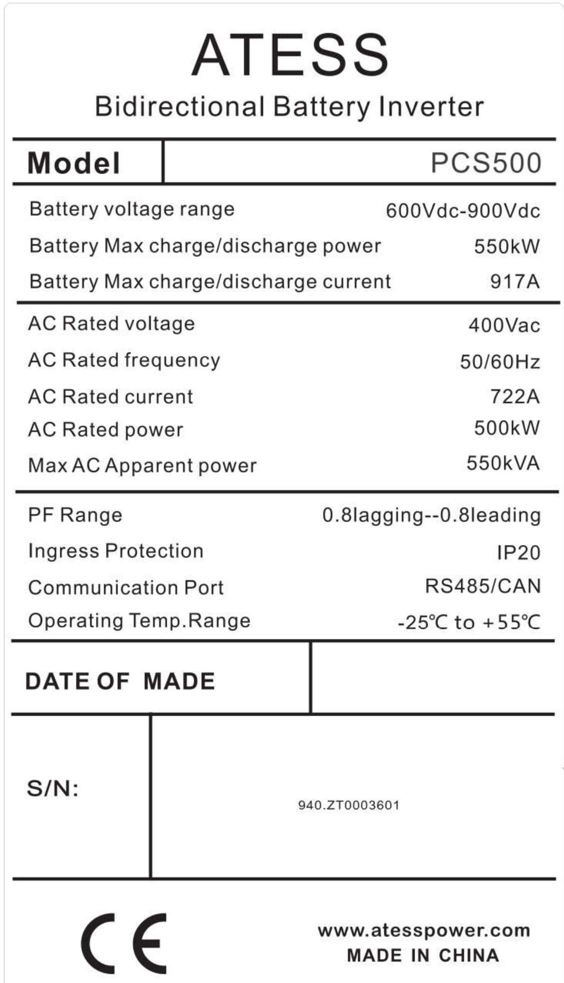
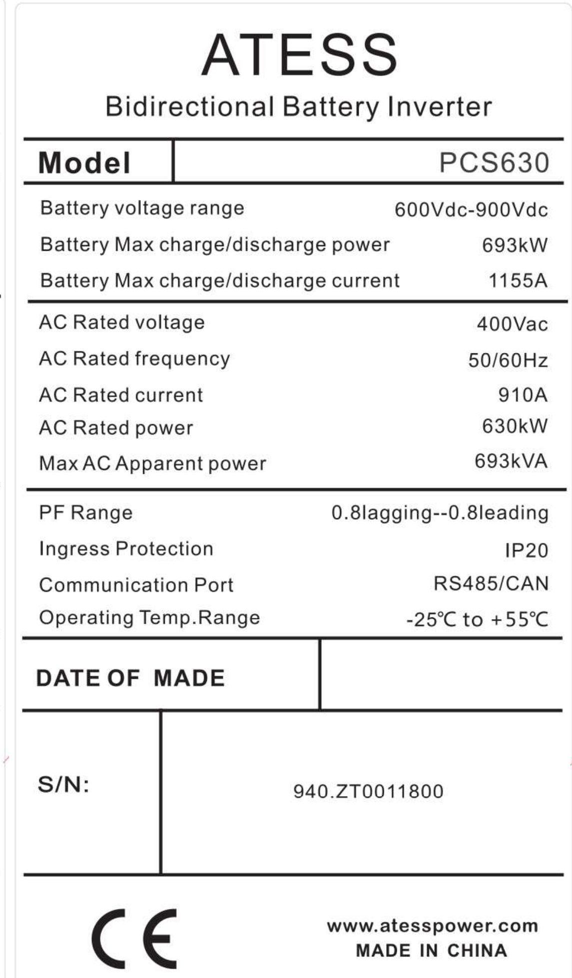




1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation

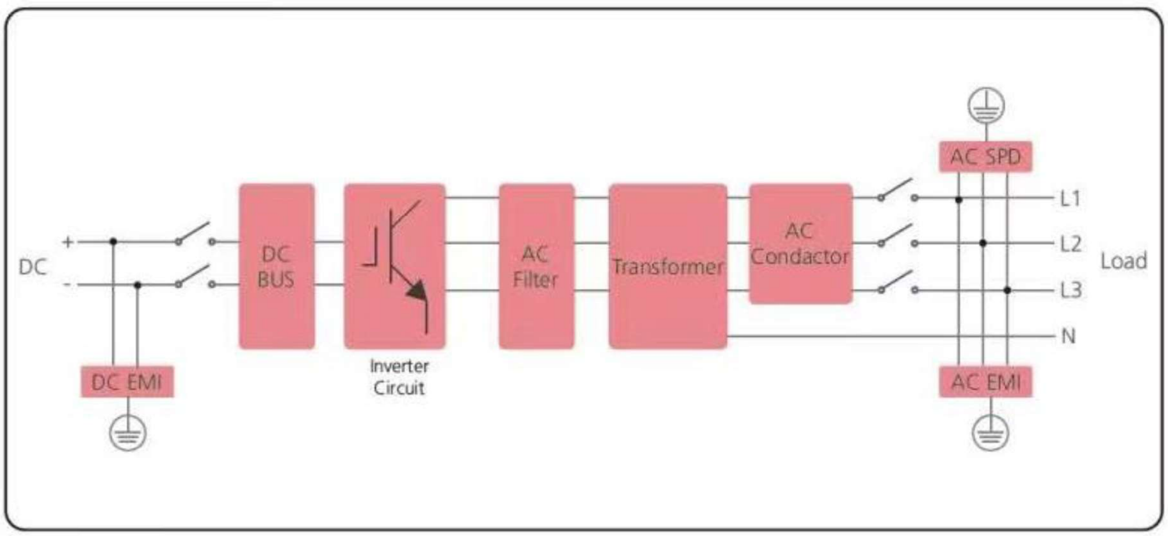
Test item particulars... :	
Classification of installation and use...................... :	Fixed
Supply Connection .... :	Permanent connection
.. :	
Possible test case verdicts:	
- test case does not apply to the test object ....:	N/A
- test object does meet the requirement..................:	P (Pass)
- test object does not meet the requirement ....:	F (Fail)
Testing ....:	
Date of receipt of test item..:	Jul. 13, 2021
Date (s) of performance of tests ....:	Jul. 13, 2021 to Aug. 13, 2021
General remarks:	
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report. The tests 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 testing laboratory. List of test equipment must be kept on file and available for review. Additional test data and/or information provided in the attachments to this report. Throughout this report a ☐ comma / ☒ point is used as the decimal separator. Determination of the test results includes consideration of measurement uncertainty from the test equipment and methods.	
Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided.. :	☐ **Yes** ☒ **Not applicable**
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies) ....:	Same as applicant.

General product information:

Brief description:
The PCE under test (EUT) is Bidirectional Battery Inverter. During inverter, which convert the variable DC power generated from the Batteries to the stable utility AC power which can be fed into the commercial electrical grid. When charging, the grid converts the alternating current into direct current into the battery through the Power Conversion System.

When single-fault occurs to one relay, the other redundant one will still maintain the basic insulation between Battery input and AC output circuit to the mains. All the relays have functional self-checking before the PCE starting.
The variants models have the same appearance, topology, PCB board and software. The output power and input power are different which controlled by software.Please refer to the parameter table and labels for specific differences.

Block Diagram:



Model list:

Model	PCS100	PCS250	PCS500	PCS630
Rating	Value			
DC input quantities				
VMAX DC (absolute maximum)	1000V			
DC input operating voltage range	500-820V	500-820V	600-900V	600-900V
Maximum operating DC input current	220A	550A	910A	1155A
ISC DC (absolute maximum)	220A	550A	910A	1155A
AC output quantities				
Voltage (nominal or range)	400Vac			
Current (maximum continuous)	144A	361A	722A	1155A
Frequency (nominal or range)	50Hz/60Hz			
Power factor range	0.8lagging-0.8leading			
Weight unit	850 kg	1465 kg	900 kg	950 kg
Power (maximum continuous)	100kW	250kW	500kW	630kW

Ingress Protection	IP20	
Environmental category	Indoor	
Suitability for wet locations	Not	
Pollution degree	II	
Elect.protection class	Class I	
Overvoltage category	Category I for AC output category II for DC input	
Mains connection	Permanent connection	
Transformer info	With isolating Transformer (Internal)	With isolating Transformer (External)
Insulation class	Class H	

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.1	**General**		**P**
4.1.1.1	This clause describes the technical issues and the responsibilities related to interconnecting an embedded generator to a utility network,	Noticed	**P**
4.1.1.2	The quality of power provided by the embedded generator in the case of the on-site a,c, loads and the power delivered to the utility is governed by practices and standards on voltage, flicker, frequency, harmonics and power factor, Deviation from these standards represents out-of-bounds conditions, The embedded generator is required to sense the deviation and might need to disconnect from the utility network,	Noticed	**P**
4.1.1.3	All power quality parameters (voltage, flicker, frequency and harmonics) shall be measured at the POC, unless otherwise specified (see annex A),	Power quality: voltage, flicker, frequency, and harmonics are performed at inverter unit output	**P**
	The power quality to be supplied to customers and influenced by SSEG shall comply with NRS 048-2, This implies that the combined voltage disturbances caused by the specific EG and other customers, added to normal background voltage disturbances, may not exceed levels stipulated by NRS 048-2, The maximum emission levels that may be contributed by SSEG are provided in this document (see 4.1.5 to 4.1.10).	Noticed	**P**
	The customer can expect power quality at the POC in line with NRS 048-2, As such, the generator may not contribute significant disturbances to the voltage supplied at the POC, Typical contributions for small customer installations (total installation) are provided in Annex D of NRS 048-4, NOTE 1 The frequency cannot be changed by a SSEG, NOTE 2 The utility is responsible for the power quality at the POC, however, the EG is responsible to mitigate power quality exceedances should it be shown to cause excessive power quality levels,	Must be taken under consideration for the installation	**N/A**
4.1.1.4	The embedded generator's a.c. voltage. current and frequency shall be compatible with the utility at the POC.	Noticed	**P**
4.1.1.5	The embedded generator shall be type approved, unless otherwise agreed upon with the utility (see annex A),	Noticed	**P**
4.1.1.6	The maximum size of the embedded generator is limited by the rating of the supply point on the premises, NOTE Also see NRS097-2-3,	Noticed	**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.1.7	The utility will approve the size of the embedded generator and will decide on the connection point and conditions, In some cases it may be required to create a separate supply point,	Must be taken under consideration for the installation	**N/A**
4.1.1.8	Embedded generators larger than 13.8 kVA shall be of the balanced three-phase type unless only a single-phase network supply is available. in which case NRS 097-2-3 recommendations can be applied based on the NMD. NOTE 1 This value refers to the maximum export potential of the generation device/system. NOTE 2 In the case of long feeder spurs the maximum desired capacity of the EG might require approval by the utility and might result in the requirement for a three-phase connection for smaller units.	Balanced three phase type of SSEG	**P**
4.1.1.9	A customer with a multiphase connection shall split the embedded generator in a balanced manner over all phases if the EG is larger than 4.6 kVA. NOTE Balancing phases in a multiphase embedded generator is deemed desirable.	Balanced three phase type of SSEG	**P**
4.1.1.10	Embedded generators or generator systems larger than 100 kVA may have additional requirements, for example, they must be able to receive communication signals for ceasing generation/disconnection from the utility supply, if the utility requires such, Communication facilities shall be provided to utility at no charge for integration with SCADA or other system when required, See Annex G (G,1), NOTE The RPP Grid Code requires category A3 units to be able to interface with the utility in order to receive stop and start signals,	Complied	**P**
4.1.1.11	In line with the current Renewable Power Plant Grid Code. embedded generators smaller than 1000 kVA connected to low-voltage form part of Category A generators. with the following subcategories:	,	**P**
	a) Category A1: 0 – 13.8 kVA; This sub-category includes RPPs of Category A with rated power in the range from 0 to 13.8 kVA. inclusive of 13.8 kVA.	Category A3	**N/A**
	b) Category A2: 13.8 kVA – 100 kVA; and This sub-category includes RPPs of Category A with rated power in the range greater than 13.8 kVA but less than 100 kVA.	Category A3	**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
	c) Category A3: 100 kVA – 1 MVA. This sub-category includes RPPs of Category A with rated power in the range from 100 kVA but less than 1 MVA. NOTE 1 These sub-categories must be cross-checked with the Renewable Power Plant Grid Code (or other part of the Grid Code where applicable); where applicable. requirements will apply per sub-category and not per sizes defined here. NOTE 2 Until a separate Grid Code for non-renewable technologies have been compiled and published. relevant categories from this document will apply to non-renewable SSEG.	630KVA See appended test table	**P**
4.1.1.12	In accordance with SANS 10142-1, all generators shall be wired permanently, NOTE 1 Some international companies are distributing so-called “plug-in” generators, where a small PV panel and inverter is connected to the supply circuit via a standard (load) plug, At present such installations are not regarded as safe and in contravention of SANS 10142-1, NOTE 2 This option will be reviewed when internationally accepted norms are finalised to ensure plugs and plug points are safe when feeding power into the grid as well as additional requirements for such generators or plugs,	Permanent connected	**P**
4.1.1.13	Any UPS/generating device that operates in parallel with the grid may only connect to the grid when it complies fully with the requirements of this part of NRS 097, This includes UPS configurations with or without EG, NOTE The requirement is applicable irrespective of the duration of parallel operation,	Without UPS function	**N/A**
4.1.1.14	Standby-generators are covered by SANS 10142-1,	No Standby-generators	**N/A**
4.1.1.15	All generators larger than 100 kVA will be controllable, i,e, be able to control the active output power dependent on network conditions/abnormal conditions, This includes several smaller units that totals more than 100 kVA at a single POC	Performed at inverter unit level	**P**
4.1.1.16	Maximum DC Voltage may not exceed 1000V, This is the voltage on the DC side of the inverter, for example when no load is taken and maximum source energy is provided, e,g, peak solar radiation occurs on the solar panels,	Considered,	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.2	**Normal voltage operating range**		**P**
4.1.2.1	In accordance with IEC 61727, utility-interconnected embedded generators do not normally regulate voltage, they inject current into the utility, Therefore the voltage operating range for embedded generators is designed as protection which responds to abnormal utility network conditions and not as a voltage regulation function,	Derived from tests	**P**
4.1.2.2	The embedded generator shall synchronise (see 4.1.12) with the utility network before a connection is established. The embedded generator shall not control the voltage. unless agreed to by the utility (see annex A).	See appended table	**P**
4.1.2.3	An embedded generator that operates in parallel with the utility system shall operate within the voltage trip limits defined in 4.2.2.3.2.		**P**
4.1.3	Reference source impedance and short-circuit levels (fault levels)	Noticed	**P**
4.1.3.1	The impact of the generator on the network voltage and quality of supply levels is directly linked to the (complex) source impedance and short-circuit level, The minimum short-circuit level to which a generator can be connected should be based on the size of the generator as well as the design criteria,		**P**
4.1.3.2	For general purposes of testing and design for potential worst case conditions. a minimum network strength of the following may be assumed: Z_{source} = 1.05 + j 0.32 ohm. i.e. I_{SC} = 210 A and S_{SC} = 146 kVA (three-phase). NOTE This does not imply a guarantee that the fault level will be more than this at all times. Fault levels less than this may be sufficient for small loads in certain applications.	Noticed	**P**
4.1.3.3	The maximum network strength will be assumed to be no more than 33 times the rated active power of the generator. The R/X ratio will be assumed between 0.33 to 3. NOTE 1 In practice. the generators will connect to the network at a wide range of short-circuit ratios. The assumption of a maximum ratio of 33 will allow safe connection of the SSEG in most practical situations. NOTE 2 The minimum fault level at which the generator may be connected is at the discretion of the manufacturer. provided that the requirements of this specification is met at the specified fault level.	Noticed	**P**
4.1.3.4	The relevant utility will advise whether equipment may be connected at other network characteristics, i,e, for weaker parts of the network,	To be considered in the end installation.	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.3.5	The generator documentation and nameplate shall state the reference impedance (complex impedance) and fault level that was used for design and certification and that it is not intended to connect the generator to a network with a higher network impedance than specified for the certification, NOTE See Annex C (Network Impedance), for more information,		**P**
4.1.4	**General QOS requirements**		**P**
4.1.4.1	Embedded generators can expect QOS levels on networks to be in line with NRS 048-2, It is expected that the embedded generator will be able to operate continuously under worst-case conditions,		**P**
4.1.4.2	Notwithstanding this, the embedded generator must protect itself from potential excursions beyond NRS 048-2 and ensure fail-safe conditions, Should the embedded generator be unable to operate according to requirements of this document for such excursions, it shall disconnect and cease generation onto the network,		**P**
4.1.5	**Flicker and voltage changes**	See appended table	**P**
4.1.5.1	When connected to a network impedance equal to the reference impedance used during certification. no SSEG may generate flicker levels higher than the following: a) short-term flicker severity (Pst) = 0.35; and b) long-term flicker severity (Plt) = 0.30.		**P**
4.1.5.2	It is anticipated that the utility will plan the connections in line with acceptable flicker limits, i,e, the ratio of the size of the generator to the network strength at the point of connection,		**P**
4.1.5.3	According to VDE-AR-N 4105, no generator shall be connected to a system where generation rejection (i,e, tripping of SSEG while generating at full capacity, regardless of reason) will lead to a voltage change of 3 % or more at the PCC, thereby minimising the potential to exceed rapid voltage change limits, NOTE 1 A voltage change of 3 % aligns to a ratio of the network fault level to generator size of 33 (ignoring network impedance angle and load power factor), NOTE 2 Standard connection conditions for customers typically include a maximum flicker contribution in line with annex D of NRS 048-4, Should these flicker levels be exceeded, the customer will be required to put mitigating measures in place as and when required by the utility,		**P**
4.1.6	**Voltage unbalance**		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.6.1	Under normal circumstances. for single and dual-phase EG. the unbalanced generation may not exceed 4.6 kVA connected between any two or different phases at an installation. Units larger than 4.6 kVA will be split evenly over the available phase connections so that this can be maintained.		**P**
4.1.6.2	Three-phase generators may not contribute more than 0.2 % voltage unbalance when connected to a network with impedance equal to the reference impedance, NOTE Standard connection conditions for customers typically include a maximum voltage unbalance contribution in line with NRS 048-4, Annex D, Should a three-phase customer exceed these voltage unbalance levels, the customer will be required to put mitigating measures in place as and when required by the utility,	Balanced three phase type of unit,	**P**
4.1.7	**Commutation notches**		**N/A**
	The relative depth of commutation notches due to line-commutated inverters shall not exceed 5 % of nominal voltage at the POC for any operational state,		**N/A**
4.1.8	**DC injection**	The product does not have this function, it needs to be connected to an power frequency transformer for use	**N/A**
4.1.8.1	The average d.c. current injected by the embedded generator shall not exceed 0.5 % of the rated a.c. output current over any 1-minute period. into the utility a.c. interface under any operating condition,		**N/A**
4.1.8.2	According to section 4.2.2.5. the generator(s) must disconnect within 500 ms when the d.c. current exceeds this value.		**N/A**
4.1.9	**Normal frequency operating range**		**P**
	An embedded generator that operates in parallel with the utility system shall operate within the frequency trip limits defined in 4.2.2.3.3.	See appended table	**P**
4.1.10	**Harmonics and waveform distortion**	See appended table	**P**
4.1.10.1	Only devices that inject low levels of current and voltage harmonics will be accepted; the higher harmonic levels increase the potential for adverse effects on connected equipment,		**P**
4.1.10.2	Acceptable levels of harmonic voltage and current depend upon distribution system characteristics, type of service, connected loads or apparatus, and established utility practice,		**P**
4.1.10.3	The embedded generator output shall have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.10.4	The harmonic and inter-harmonic current distortion shall comply with the relevant emission limits in accordance with IEC 61727, reproduced in table 1,		**P**
4.1.10.5	The harmonic and inter-harmonic distortion applies up to 3 kHz (60th harmonic), NOTE The harmonic limits above 2,5 kHz and all inter-harmonic limits refer to limits measured in accordance with IEC 61000-4-7,	See appended table	**P**
4.1.11	**Power factor**	See test results	**P**
4.1.11.1	Irrespective of the number of phases to which an embedded generator is connected. it shall comply with the power factor requirements in accordance with 4.1.11.2 to 4.1.11.12 on each phase for system normal conditions when the output power exceeds 20 % of rated active power,		**P**
4.1.11.2	For static power converter embedded generators and synchronous embedded generators of sub-categories A1 and A2, the power factor shall remain above 0.98 as shown in Figure 1, The embedded generator shall operate anywhere in the shaded area of figure 1, NOTE At the time of publication, this is in contradiction with the RPP Grid Code,	Sub-category A3	**N/A**
4.1.11.3	For asynchronous embedded generators of sub-categories A1 and A2, which cannot control the power factor over any range, the power factor shall reach the shaded area of figure 1 within 60 s, The power factor shall remain above 0.98 as shown in figure 1, The embedded generator shall operate anywhere in the shaded area, NOTE At the time of publication, this is in contradiction with the RPP Grid Code,		**N/A**
4.1.11.4	For static power converter embedded generators and synchronous embedded generators of sub-category A3, the power factor shall remain above 0.95 as shown in Figure 2, The embedded generator shall operate anywhere in the shaded area of Figure 2,	Static power converter embedded generators	**P**
4.1.11.5	For asynchronous embedded generators of sub-category A3, which cannot control the power factor over any range, the power factor shall reach the shaded area of Figure 2 within 60 s, The power factor shall remain above 0.95 as shown in Figure 2, The embedded generator shall operate anywhere in the shaded area,	Static power converter	**N/A**
4.1.11.6	Where the EG is capable of controlling the power factor at the POC, the EG should improve the power factor at the POC towards unity,	Inverter unit has capability to adjust power factor by itself.	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.11.7	Unless otherwise agreed with the utility, the standard power factor setting shall be unity for the full power output range,	Default setting for inverter unit is pf=1	**P**
4.1.11.8	The maximum tolerance on the reactive power setting is 5 % of the rated active power,		**P**
4.1.11.9	For embedded generators of sub-category A3, the power factor shall be settable to operate according to a characteristic curve provided by the utility, if required by the utility, within the range 0.95 leading and 0.95 lagging; An example of a standard characteristic curve is shown in figure 3,		**P**
4.1.11.10	These limits apply, unless otherwise agreed upon with the utility (see annex A),		**P**
4.1.11.11	Equipment for reactive power compensation shall either:	Reactive power compensation shall be considered in final installations.	**N/A**
	a) be connected or disconnected with the embedded generator, or		**N/A**
	b) operated via automatic control equipment for disconnection when not required,		**N/A**
4.1.11.12	The requirement for and type of detuning for reactive power compensation devices will be agreed upon by the owner of the generator and utility, NOTE Detuning is highly recommended for all reactive power compensation devices to prevent (a) potential current overloading of capacitors due to existing voltage harmonics, (b) potential voltage transient amplification at the POC due to upstream switching conditions, and (c) potential resonance with the network impedance that may lead to excessive harmonic amplification,		**P**
4.1.12	**Synchronization**		**P**
4.1.12.1	All embedded generators shall synchronize with the utility network before the parallel connection is made, This applies to all embedded generators where a voltage exists at the generator terminals before connection with the utility network,		**P**
4.1.12.2	Automatic synchronization equipment shall be the only method of synchronization,		**P**
4.1.12.3	For a synchronous generator, the limits for the synchronizing parameters for each phase are: a) frequency difference: 0.3 Hz, b) voltage difference: 5 % of nominal voltage per phase, and c) phase angle difference: 20 ° (degrees),		**P**
4.1.12.4	Mains excited generators do not need to synchronise when the generator is started as a motor before generation starts,		**N/A**
4.1.12.5	Mains excited generators may require soft-starting when the start-up voltage change is anticipated to be more than 3 %,		**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.12.6	The start-up current for static power converters shall not exceed the full-power rated current of the generator,	Noticed	**P**
4.1.12.7	Also refer to 4.2.4 for re-synchronising conditions,	Noticed	**P**
4.1.12.8	The embedded generator shall synchronize with the utility network only when the voltage and frequency has been stable within the ranges provided in 4.2.2.3 for at least 60 seconds. NOTE Some utilities may require this to be longer than 60 seconds,	See appended table	**P**
4.1.13	**Electromagnetic compatibility (EMC)**	Inverter units approved by Dongguan BALUN Testing Technology Co., Ltd in accordance with NRS 097-2-1:2017 Edition 2.1 (Contents 4.1.13). Report No.: BL-DG2150442-401 .	**P**
4.1.13.1	Electromagnetic compatibility (EMC) refers to the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. EMC comprises two components, namely a radiated and conducted component. Significant attention is given to radiated EMC due to the potential impact over larger distances. However, with advances in smart grids and business management systems, the potential impacts from conducted EMI must be considered. The conditions in 4.1.13.2 and 4.1.13.6 below apply to conducted unintentional signals, while clause 4.1.13.7 applies to radiated unintentional emissions from generating equipment.		**P**
4.1.13.2	All unintentional conducted emissions from generating equipment, in the frequency band 30 kHz to 150 kHz, shall be 9 dBμV lower than the compatibility levels specified in clause 4.12.3 of IEC 61000-2-2:2000+A2:2019 when measured in unsymmetrical voltage mode (i.e. between any phase or neutral and the earth) using a quasi-peak detector. An illustration of the limits is provided in Figure 4, below.		**p**
4.1.13.3	The test method and set up for verifying compliance with 4.1.13.1, herein, shall be according to clause 7 of CISPR 16-2-1. The test receiver used for verification shall comply with clauses 4 and 5 of CISPR 16-1-1:2019, and the AMN or LISN used for verification shall comply with clause 4 of CISPR 16-1-2. NOTE When measuring conducted emissions at high currents, for example at ⩾ 25 A, during testing, the AMN or LISN can be connected as a voltage probe. See clause A.5 in Annexure A of CISPR 16-1-1.		**p**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.1: Utility compatibility			
4.1.13.4	All unintentional conducted emissions from generating equipment, in the frequency band above 150 kHz to 30 MHz, shall comply with SANS 211 (CISPR11), in particular limits for Class A group 1 (< 20 kVA).		**P**
4.1.13.5	The conducted emission requirement applies to all ports or connections to the utility supply, whether the connection is intended for monitoring, communication, power transfer or any other reason for connecting to the utility supply.		**P**
4.1.13.6	In the event of susceptibility to electromagnetic interference, the unit shall be fail-safe, i.e. any deviation from intended performance must comply with all relevant specifications, both in terms of safety (i.e. disconnection) and impact on the network.		**P**
4.1.13.7	Notwithstanding this, should any interference be experienced to existing or new ripple-control, building management system equipment and/or other PLC-based communication, the owner of the embedded generator should take the necessary remedial action to prevent further interference as will be agreed with the utility or the other affected party.		**P**
4.1.13.8	All radiated emissions from generating equipment shall comply with ICASA requirements.		**P**
4.1.14	**Mains signalling (e,g, PLC and ripple control)**	No such device	**N/A**
4.1.14.1	Mains signalling refers to intentional signals induced into the utility supply network, where the intention is to facilitate data transfer from one component to another,		**N/A**
4.1.14.2	All intentional emissions (communication signals) from generating equipment shall comply with limits for intentional emissions in SANS 50065-1, limited to an acceptable band as prescribed by SANS 50065-1,		**N/A**
4.1.14.3	Notwithstanding this, should any interference be experienced to existing or new ripple control, building management system equipment and/or other PLC-based communication, the owner of the embedded generator shall take the necessary remedial action to prevent further interference as will be agreed with the utility or the other affected party,		**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.1	**General** The safe operation of the embedded generator in conjunction with the utility network shall be ensured at all times, Safe operation includes people and equipment safety	Noticed	**P**
	a) People safety: i) owner (including personnel and /or inhabitants of the property) of the embedded generator, ii) general public safety : iii) utility personnel; iv) general emergency response personnel,e,g, fire brigade should a fire arise at the embedded generator,	Noticed	**P**
	b) Equipment safety: i) Utility equipment; ii) Other customer's equipment connected to the same network(s);and **iii)** Generator own equipment,	Noticed,	**P**
4.2.2	**Safety disconnect from utility network**		**P**
4.2.2.1	**General**	Derived from tests,	**P**
4.2.2.1.1	All SSEG shall comply with the safety requirements in accordance with IEC 62109-1 and IEC 62109-2,	Inverter units approved by TÜV Rheinland in accordance with IEC 62109-1 and IEC 62109-2. Report No: ENS2305110124P004.	**P**
4.2.2.1.2	The embedded generator shall automatically and safely disconnect from the grid in the event of an abnormal condition, Abnormal conditions include:	Inverter units approved by TÜV Rheinland in accordance with IEC 62109-1 and IEC 62109-2. Report No: ENS2305110124P004.	**P**
	a) network voltage or frequency out-of-bounds conditions,	See appended table	**P**
	b) loss-of-grid conditions,	See appended table	**P**
	c) d.c. current injection threshold exceeded (per phase)..	See appended table	**P**
	d) and residual d,c, current (phase and neutral currents summated),		**P**
4.2.2.2	**Disconnection device (previously disconnection switching unit)**		**P**
4.2.2.2.1	The embedded generator shall be equipped with a disconnection device, which separates the embedded generator from the grid due to abnormal conditions, The disconnection unit may be integrated into one of the components of the embedded generator (for example the PV utility interconnected inverter) or may be an independent device installed between the embedded generator and the utility interface,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.2.2.2	The disconnection switching unit shall be able to operate under all operating conditions of the utility network, NOTE It is the responsibility of the embedded generator owner to enquire about the operating conditions of the utility network, e,g, fault levels for the foreseeable future,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-1, See appended table.	**P**
4.2.2.2.3	A failure within the disconnection device shall lead to disconnection of the generator from the utility supply and indication of the failure condition,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-1, See appended table.	**P**
4.2.2.2.4	A single failure within the disconnection switching unit shall not lead to failure to disconnect, Failures with one common cause shall be taken into account and addressed through adequate redundancy,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-1, See appended table.	**P**
4.2.2.2.5	The disconnection device shall disconnect the generator from the network by means of two series connected robust automated load disconnect switches,	The disconnection switching unit was tested according the single fault safety of the IEC 62109-1, See appended table.	**P**
4.2.2.2.6	Both switches shall be electromechanical switches,	Complied,	**P**
4.2.2.2.7	Each electromechanical switch shall disconnect the embedded generator on the neutral and the live wire(s), NOTE The switching unit need not disconnect its sensing circuits,	Models PCS100 and PCS250 have built-in isolation transformers, while models PCS500 and PCS630 have external isolation transformers	**P**
4.2.2.2.8	All rotating generating units, e,g, synchronous or asynchronous generating units shall have adequate redundancy in accordance with 4.2.2.2.5,	Not such type of SSEG,	**N/A**
4.2.2.2.9	A static power converter without simple separation shall make use of two series connected electromechanical disconnection switches,	Models PCS100 and PCS250 have built-in isolation transformers, while models PCS500 and PCS630 have external isolation transformers	**N/A**
4.2.2.2.10	The current breaking capacity of each disconnecting switch shall be appropriately sized for the application, In cases where the disconnecting device is an electromechanical switching device such as a contactor, this requires suitable coordination with the upstream short circuit protection device (circuit breaker),		**P**
4.2.2.2.11	Any programmable parameters of the disconnection switching unit shall be protected from interference by third-parties, i,e, password protected or access physically sealed,	Protected by password,	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.2.2.12	In order to allow customers to supply their own load in isolated operation (islanded) where this is feasible and required, the disconnection device may be incorporated upstream of part of or all of a customers' loads, provided that none of the network disconnection requirements in this document are violated,	Rely in the responsibility of the installer	**N/A**
4.2.2.2.13	All EG installations larger than 30 kVA shall have a central disconnection device, NOTE 1 This requirement may be amended by the utility, i,e, the utility may require a central disconnection switch unit for any size and type of generator, NOTE 2 This requirement may be amended by the utility, The central disconnection switch unit will typically be waived only when a lockable disconnection switch, accessible to the utility, is installed, NOTE 3 This is an interim requirement based on requirements of VDE AR 4105 and will be revisited as more information becomes available,	Rely in the responsibility of the installer	**N/A**
4.2.2.2.14	The network and system grid protection voltage and frequency relay for the central disconnection device will be type-tested and certified on its own (stand-alone tested), All clauses of 4.2.2. except 4.2.2.4 (anti-islanding) apply.	Rely in the responsibility of the installer	**N/A**
4.2.2.3.1	**General**		**P**
	The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,	Noticed	**P**
	The accuracy for frequency trip values shall be within 0 to +0.1 % of the fundamental frequency from the upper boundary trip setting, and within -0.1 % to 0 % of the fundamental frequency from the lower boundary the trip setting,	Noticed	**P**
4.2.2.3.2	**Overvoltage and undervoltage**		**P**
	The embedded generator in sub-category A1 and A2 shall cease to energize the utility distribution system should the network voltage deviate outside the conditions specified in table 2, The following conditions shall be met, with voltages in r.m.s. and measured at the POC, NOTE 1 All discussions regarding system voltage refer to the nominal voltage, NOTE 2 At the time of publication, these settings are in contradiction to the RPP Grid Code, These may only be applied with exemption to the relevant clause or after the RPP Grid Code has been suitably amended, NOTE 3 Measurements at the generator terminals will generally be sufficient for the overvoltage settings, If the expected voltage drop across the cable connecting the EG to the POC is too high, undervoltage settings might have to be adjusted,	See appended table	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
	The purpose of the allowed time delay is to ride through short-term disturbances to avoid excessive nuisance tripping, The generator does not have to cease to energize if the voltage returns to the normal utility continuous operating condition within the specified trip time, NOTE Induction/synchronous generators need to be mindful of synchronisation issues and may have to apply faster trip times,	Noticed,	**P**
	A customer with a multiphase connection shall monitor all phases for out-of-bounds voltage conditions, The EG shall be disconnected if an out-of-bounds voltage condition is detected on any of the phases,	Noticed,	**P**
	In line with NRS 048-2, it is recommended that A1 and A2 SSEG be able to ride through at least Y and X1 type dips, i,e, not disconnect for these events, The purpose is to avoid excessive nuisance tripping,		**N/A**
	Category A3 SSEG shall be able to ride through low and/or high voltage events in accordance with the RPP Grid Code,	See appended table	**P**
	The generator shall maintain the pre-dip current during any dip event for which it remains connected,	Noticed	**P**
	The ride-through and trip times are shown graphically in figure 4,	Noticed	**P**
4.2.2.3.3	**Over-frequency and under-frequency**		**P**
	This requirement is in line with the RPP Grid Code (version 2.8) and applies to all EG in category A,		**P**
	The embedded generation system shall cease to energize the utility network when the utility frequency deviates outside the specified conditions, Both over- and under-frequency conditions indicate system abnormal conditions and all generators are expected to assist in stabilising the system during such periods,	Noticed	**P**
	When the utility frequency is less than 47 Hz, the embedded generator shall disconnect from the utility network within 0.2 s,	See appended table,	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
	While the utility frequency is in the range of 47 Hz and 50.5 Hz. the system shall operate normally. In order to prevent hysteresis switching (on-off toggling) during over-frequency conditions. the output power shall be reduced as follows: When the utility frequency exceeds 50.5 Hz. the active power available at the time shall be stored as the maximum power value PM; this value PM shall not be exceeded until the frequency has stabilized below 50.5 Hz for at least 4 seconds. The EG system shall control the output power as a function of PM at a gradient of 50 % per Hertz as illustrated in figure 5. The power generation shall follow the curve shown in figure 5 up and down while the system frequency is in the range 50.5 Hz to 52 Hz. When the utility frequency is more than 52 Hz for longer than 4 seconds. the embedded generator shall cease to energise the utility line within 0.5 s.	See appended table	**P**
4.2.2.3.3.1	**Relaxation for non-controllable generators**	See appended tabel	**P**
	Non-controllable generators may disconnect randomly within the frequency range 50.5 Hz to 52 Hz. The disconnect frequency for non-controllable generators will each be set at a random value by the manufacturer. with the option of changing this to a utility provided setting. The random disconnect frequency shall be selected so that all generators from any specific manufacturer will disconnect uniformly over the range with 0.1 Hz increments.		**P**
	When the utility frequency is more than the non-controllable generator over-frequency setpoint for longer than 4 seconds. the non-controllable generator shall cease to energise the utility line within 0.5 s. NOTE At the time of publication. this is in contradiction with the RPP Grid Code.		**P**
4.2.2.4	**Prevention of islanding**		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.2.4.1	A utility distribution network can become de-energized for several reasons: for example, a substation breaker that opens due to a fault condition or the distribution network might be switched off for maintenance purposes, Should the load and (embedded) generation within an isolated network be closely matched, then the voltage and frequency limits may not be triggered, If the embedded generator control system only made use of passive voltage and frequency out-of-bounds detection, this would result in an unintentional island that could continue beyond the allowed time limits,	See appended table	**P**
4.2.2.4.2	In order to detect an islanding condition, the embedded generator shall make use of at least one active islanding detection method, An active islanding detection method intentionally varies an output parameter and monitors the response or it attempts to cause an abnormal condition at the utility interface to trigger an out-of-bounds condition, If the utility supply is available, the attempt to vary an output parameter or cause an abnormal condition will fail and no response will be detected, However, if the utility supply network is de-energized, there will be a response to the change which can be detected, This signals an island condition to the embedded generator upon detection of which the embedded generator shall cease to energize the utility network within a specific time period,	See appended table	**P**
4.2.2.4.3	Active island detection shall be used in all cases where the EG interfaces with the utility network,	Noticed,	**P**
4.2.2.4.4	An islanding condition shall cause the embedded generator to cease to energize the utility network within 2 s, irrespective of connected loads or other embedded generators, The embedded generator employing active islanding detection shall comply with the requirements of IEC 62116 (ed.1), NOTE Prevention of islanding measures is only considered on the embedded generator side, i,e, no utility installed anti-islanding measures are considered,	See appended table	**P**
4.2.2.4.5	All rotating generators shall use a minimum of two islanding detection methods (e.g. rate of-change-of-frequency and voltage vector shift detection due to the dead bands (slow detection) of islands in both methods), NOTE It is possible for a condition to exist, where a mains-excited generator becomes self-excited due to capacitance of the network (either cable capacitance or power factor correction), Under such conditions, the mains-excited generator will not disconnect from an island, hence effective islanding detection is required for all rotating generators,		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.2.4.6	Passive methods of islanding detection shall not be the sole method to detect an island condition. When used. passive methods of islanding detection shall be done by three-phase voltage detection and shall be verified by an AC voltage source.	Both methods of active and passive island detection are used.	**P**
4.2.2.4.7	The embedded generator shall physically disconnect from the utility network in accordance with the requirements in 4.2.2.2.	See 4.2.2.2.	**P**
4.2.2.5	**DC current injection**		**P**
	The embedded generator shall not inject d.c. current greater than 0.5 % of the rated a.c. output current into the utility interface under any operating condition. measured over a 1-minute interval. The EG shall cease to energize the utility network within 500 ms if this threshold is exceeded.	See appended table.	**P**
4.2.3	No requirements for emergency personnel safety (e.g. fire brigade) existed at the time of publication. It is expected that such issues will be dealt with in other documents. e.g. OHS Act. SANS 10142-1.	Rely in the responsibility of the installer.	**N/A**
4.2.4	**Response to utility recovery**		**P**
4.2.4.1	The embedded generator shall ensure synchronisation before re-energizing at all times in accordance with 4.1.12.	Complied.	**P**
4.2.4.2	After a voltage or frequency out-of-range condition that has caused the embedded generator to cease energizing the utility network, the generator shall not re-energize the utility network until the utility service voltage and frequency have remained within the specified ranges for a continuous and uninterrupted period of 60 s, The reconnection shall commence as follows:	See appended table,	**P**
4.2.4.2.1	Non-controllable generators may connect randomly within the 1 minute to 10 minute period after voltage and frequency recovery (period includes the 60 s to confirm recovery), The delay for non-controllable generators will each be set at a random value by the manufacturer, with the option of changing this to a utility provided setting, The random value shall be selected so that no more than 2 % of generators from any specific manufacturer will reconnect within 10s of each other,	Not such type of SSEG,	**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.4.2.2	Controllable generators may reconnect immediately after the 60 s delay confirming recovery of the system voltage and frequency at a maximum rate of 10 % of rated power per minute. i.e. full power output will only be reached after 10 minutes. This ramp rate may be modified at the request of the utility or in consultation with the utility.	See appended table	**P**
4.2.5	**Isolation**		**N/A**
4.2.5.1	In line with SANS 10142-1 (as amended). each energy source should have its own. appropriately rated. isolation device.		**N/A**
4.2.5.2	It is expected that isolation requirements will be dealt with in more detail in future in e.g. SANS 10142-1/3. Such requirements shall supersede 4.2.5.		**N/A**
4.2.5.3	The embedded generator shall provide a means of isolating from the utility interface in order to allow for safe maintenance of the EG. The disconnection device shall be a double pole for a single-phase EG. a three-pole for a three-phase delta-connected EG. and a four-pole for a three-phase star-connected EG. The grid supply side shall be wired as the source.	The installation instructions specify a disconnection device for the final installation, The correct assembling is part of the installer	**N/A**
4.2.5.4	The breaking capacity of the isolation circuit-breaker closest to the point of utility connection shall be rated appropriately for the installation point in accordance with SANS 60947-2. This disconnection device does not need to be accessible to the utility.	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer	**N/A**
4.2.5.5	For dedicated supplies. a means shall be provided of isolating from the point of supply in order to allow for safe maintenance of the utility network. The disconnection device shall be a double pole for a single-phase EG. a three-pole for a three-phase delta-connected EG. and a four-pole for a three-phase star-connected EG. This disconnection device shall be lockable and accessible to the utility. NOTE 1 A device inside a lockable box is deemed a lockable device. NOTE 2 This disconnection device may become the new point of control as defined by SANS10142-1.		**N/A**
4.2.5.6	The requirement for the utility accessible disconnection device may only be waived by the utility where the risk to the network is deemed acceptable to the utility. Such permission shall be provided in writing. NOTE Full verification form to be signed off and accepted by the utility.		**N/A**
4.2.6	**Earthing**		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
4.2.6.1	The electrical installation shall be earthed in accordance with SANS 10142-1 (as applicable), The earthing requirements for different embedded generation configurations in conjunction with the customer network are described in annex B for the most common earthing systems, NOTE SANS 10142-1 applies to EG feeding a UPS and no connection to the utility supply (see table B5),		**N/A**
4.2.6.2	Installations with utility-interconnected inverters without simple separation shall make use of earth leakage protection which are able to respond to d.c. fault currents including smooth d.c. fault currents (i.e. without zero crossings) according to IEC 62109-2 unless the inverter can exclude the occurrence of d.c. earth fault currents on any phase. neutral or earth connection through its circuit design1). This function may be internal or external to the inverter. NOTE IEC 62109-2. Edition 2011. section 4.8.3.5 gives selection criteria for RCD sensitivities.		**P**
4.2.6.3	Where an electrical installation includes a PV power supply system without at least simple separation between the AC side and the DC side, an integrated RCD function shall be present to provide fault protection by automatic disconnection of supply shall be type B according to IEC/TR 60755, amendment 2, Where the PV inverter by construction is not able to feed DC fault currents into the electrical installation, an RCD of type B according to IEC/TR 60755 amendment 2 is not required, NOTE 1 Consideration must also be given to ensure that any d,c, currents do not impair the effectiveness of any other RCD'S installed throughout the a,c, system, NOTE 2 The earth leakage unit may also fulfil the requirement of the all-pole disconnection device as stated in 4,2,6, NOTE 3 The function of this RCD is not to provide protection against circulating d,c, currents in the inverter and a,c, supply, i,e, does not override 4,1,8,		**N/A**
4.2.7	**Short-circuit protection**		**N/A**
4.2.7.1	The embedded generator shall have suitably rated short-circuit protection at the connection to the AC mains in accordance with SANS 10142-1 and 3,	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
4.2.7.2	The short-circuit characteristics for the SSEG shall be supplied to the utility,	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
4.2.8	**Maximum short-circuit contribution**		**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4.2: Safety protection and control			
	Embedded generators have the potential to increase the fault level of the network to which it is connected, In order to limit the fault level changes in low voltage networks and allow coordination of fault levels with the utility, no generator will exceed the following fault level contribution: NOTE At the time of installation, the short-circuit capacity of all existing equipment should be confirmed and upgraded where necessary, Suitable fault current limiting devices may be required to ensure a safe installation, The potential impact on neighbouring installations should also be considered to ensure that those installations remain safe,	See below,	**P**
	a) for synchronous generators: 8 times the rated current;		**P**
	b) for asynchronous generators: 6 times the rated current; and		**P**
	c) for generators with inverters: 1 times the rated current,		**P**
4.2.9	**Labelling**		**P**
4.2.9.1	A label on the distribution board of the premises where the embedded generator is connected shown in figure 6, shall state: “WARNING: ON-SITE EMBEDDED GENERATION , DO NOT WORK ON THIS EQUIPMENT UNTIL IT IS ISOLATED FROM BOTH MAINS AND ON-SITE GENERATION SUPPLIES,” or similar warning, Disconnection points for all supplies shall be indicated,		**P**
4.2.9.2	The label shall be permanent with lettering of height at least 8 mm,		**P**
4.2.9.3	The label shall comply to requirements of SABS 1186-1, 		**P**
4.2.9.4	The absence of emergency shutdown capabilities will be indicated on signage in accordance with 4.2.2. 		**P**
4.2.10	**Robustness requirements**		**P**
	According to 4.2.2.1 all SSEG shall comply with safety requirements in accordance to SANS/IEC 62109- 1 and IEC 62109-2 NOTE This section will be expanded in future revisions.	Inverter is tested according to SANS/IEC 62109- 1 and IEC 62109-2	**P**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
Metering			
4.3	**Metering**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**

NRS 097-2-1:2017			
Clause	Requirement – Test	Result – Remark	Verdict
Annex			
Annex A	**Notes to purchase**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex B	**Earthing system**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex C	**Network impedance**	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex D	**(Annex A of VDE-AR-N 4105) Explanations** (normative)	Noticed,	**P**
Annex E	**(Annex B of VDE-AR-N 4105) Connection examples** (normative)	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex F	**(Annex C of VDE-AR-N 4105) Example of meter panel configurations** (normative)	Rely in the responsibility of the installer and is stated in the installation instruction of the manufacturer,	**N/A**
Annex G	**Generation management network security management** (normative)	Noticed,	**P**

Test overview:		
NRS 097-2-1:2017		
Clause	**Test**	**Result**
4.	**Type test:**	
4.1.5	Voltage fluctuations and Flicker	**P**
4.1.6	Voltage unbalance	**P**
4.1.8	DC injection	**N/A**
4.1.10	Harmonics and waveform distortion	**P**
4.1.11.3	Power factor (no controllable reactive power)	**P**
4.1.11.4	Power factor (Fixed cos φ)	**P**
4.1.11.9	Test for a displacement factor/active power characteristic curve cos φ (P) (For embedded generators of sub-category A3)	**P**
4.1.12	Synchronization	**P**
4.2.2	Safety disconnect from utility network Response to protection operation - fault condition tests (according VDE AR-N 4105:2011 and VDE0124-100:2013)	**P**
4.2.2.3.2	Over voltage and under voltage	**P**
4.2.2.3.2	Low voltage fault Ride through capability	**P**
4.2.2.3.3	Over-frequency and under-frequency	**P**
4.2.2.3.3	Active power feed-in for over-frequency	**P**
4.2.2.4	Preventing of islanding	**P**

Test Results

4.1.5 Voltage fluctuation and flicker				P
Test conditions:	Maximum permissible voltage fluctuation (expressed as a percentage of nominal voltage at 100 % power) and flicker as per EN 61000-3-11			
	Starting	**Stopping**	**Running**	
Limit	3,3%	3,3%	Pst=1	Plt=0,65
Test value	*	*	*	*
inverter >16A				
Limit	dc% = 3.3		Pst=1	Plt=0.65
Test value	0		0.048	0.047

Note:

*The stationary deviance of dc% is more relevant than the dynamic deviance of d_{max} at starting and stopping,

Mains Impedance according EN61000-3-11: Rmax = 0.24Ω; jXmax= 0.15Ω @50Hz (|Zmax| = 0.283/0.4717Ω)

for single phase inverter use also Rn = 0.16Ω; jXn= 0.1Ω

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3{,}3\% / d_c(P_n)$

Rapid voltage changes			**P**
The purpose of the test is to determine k_i and k_{imax}, The following three cases must be tested to VDE-AR-N 4105, Annex F.3 (where applicable), - Switch-on for any capacity - Unfavourable case when switching the generator step - Switch-on for nominal capacity Note: For PV-plants the inverter is the generator Switch-off for nominal capacity (no emergency shutdown, but operative shutdown)			
Test conditions: Frequency: 50 Hz ± 0.5% THD of the voltage supply: ≤ 3 % Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %			
Switch-on for any capacity (10% P_{Emax})			
Single period effective values of the current [A]	253.3	258.0	260.5
Single period effective values of the voltage [V]	401.7	402.3	404.1
k_i value	0.279	0.284	0.286
k_{imax} value	0.286		
Switch-on for nominal capacity			
Single period effective values of the current [A]	939.4	973.3	983.5
Single period effective values of the voltage [V]	409.2	406.7	409.8
k_i value	1.033	1.070	1.082
k_{imax} value	1.082		
Switch-off for nominal capacity			
Single period effective values of the current [A]	923.0	955.8	969.5
Single period effective values of the voltage [V]	407.4	404.3	408.3
k_i value	1.015	1.051	1.066
k_{imax} value	1.066		
Highest k_{imax} value for all switching operations			
1.082			

Flicker
These tests are designed to provide evidence that the requirements of VDE-AR-N 4105, 5.4.3 are met.

The purpose of the test is to determine long-term flicker strength P_{lt},

For power generation systems with rated currents of up to 75 A, reactions are deemed to be limited sufficiently, if the power generation units comply with the limit values given in DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11), respectively,

Test conditions:
Voltage: 86% U_n to 109% U_n
Frequency: 50 Hz ± 0.5%
THD of the voltage supply: ≤ 3 %
Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %

Flicker to DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11) for generator units ≤ 75 A

Flicker to:	Result:		
	P_{lt}	P_{st}	*dc%*
DIN EN 61000-3-11	0.047	0.048	0

Assessment criterion:

Long-term flicker strength P_{lt} to DIN EN 61000-3-3 (VDE 0838-3)

Determination of the flicker coefficient:

$$c_{\psi k} = P_{st} \times (S_k / P_n)$$

where S_k is the short-circuit power of the network standby element (during the determination of the appropriate Pst values)

$R_A = 0.24\Omega$ $jX_A = 0.15\Omega$
$R_N = 0.16\Omega$ $jX_N = 0.10\Omega$

Flicker to DIN EN 61400-21 (VDE 0127-21) (or FGW TR3)

Grid impedance angle ψ_k	32°
Flicker coefficient $c(\psi_k)$	0.003
Short-term flicker P_{st}	0.016

Assessment criterion:
Long-term flicker strength: $P_{lt} \leq 0.3$

4.1.6 Calculation of asymmetry						P
Setting values	cos φ = 1:			1.000		
	cos φ over-excited:			-0.800		
	cos φ under-excited:			0.800		
1-min mean value	L1	L2	L3	L1 – L2	L2 – L3	L3 – L1
a) cos φ = 1 at 100 % P_n ± 5 % P_n						
S_{E60} [kVA]:	210.50	210.60	211.12	0.094	0.521	0.616
	210.49	210.57	211.17	0.079	0.602	0.681
	210.46	210.53	211.19	0.067	0.655	0.722
	210.42	210.46	211.17	0.045	0.704	0.749
	210.37	210.43	211.15	0.055	0.727	0.782
cos $φ_{E60}$:	0.995					
Max. asymmetry [kVA]:	0.782					
U_{60} [V]:	398.79	398.43	399.06	0.361	0.634	0.273
	398.79	398.42	399.12	0.373	0.700	0.327
	398.79	398.41	399.16	0.375	0.749	0.374
	398.79	398.41	399.19	0.383	0.780	0.397
	398.79	398.41	399.21	0.378	0.799	0.421
Max. asymmetry [V]:	0.799					
Max. asymmetry [%]:	0.092					
b) maximum under-excited (i) at 100 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:	263.10	262.67	262.03	0.431	0.647	1.078
	263.17	262.74	262.13	0.427	0.615	1.043
	263.19	262.70	262.16	0.486	0.543	1.029
	263.18	262.66	262.16	0.516	0.504	1.020
	263.18	262.63	262.16	0.550	0.465	1.015
cos $φ_{E60}$:	0.800					
Max. asymmetry [kVA]:	1.078					
U_{60} [V]:	400.26	400.01	400.15	0.251	0.137	0.115
	400.25	400.01	400.16	0.246	0.149	0.096
	400.26	400.01	400.19	0.250	0.174	0.076
	400.28	400.01	400.21	0.261	0.195	0.065
	400.28	400.01	400.23	0.266	0.216	0.050
Max. asymmetry [V]:	0.266					
Max. asymmetry [%]:	0.036					

c) maximum over-excited (c) at 100 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:	263.81	262.93	262.76	0.873	0.172	1.045
	263.86	262.83	262.93	1.023	0.099	0.924
	263.52	262.40	262.68	1.119	0.286	0.832
	263.60	262.40	262.72	1.203	0.327	0.876
	263.48	262.30	262.64	1.174	0.336	0.838
cos φ_{E60}:	0.800					
Max. asymmetry [kVA]:	1.203					
U_{60} [V]:	400.26	399.80	400.34	0.456	0.542	0.085
	400.44	400.10	400.44	0.340	0.346	0.006
	400.17	399.91	400.22	0.258	0.308	0.051
	400.21	399.90	400.27	0.313	0.376	0.062
	400.24	399.89	400.30	0.351	0.412	0.061
Max. asymmetry [V]:	0.542					
Max. asymmetry [%]:	0.084					
d) cos φ = 1 at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:	105.33	105.42	105.45	0.097	0.026	0.123
	105.30	105.38	105.48	0.086	0.094	0.180
	105.26	105.33	105.48	0.073	0.147	0.220
	105.26	105.32	105.50	0.061	0.181	0.242
	105.27	105.33	105.54	0.057	0.213	0.270
cos φ_{E60}:	0.995					
Max. asymmetry [kVA]:	0.270					
U_{60} [V]:	398.78	398.48	398.67	0.301	0.194	0.107
	398.77	398.46	398.78	0.313	0.324	0.011
	398.77	398.45	398.88	0.326	0.437	0.110
	398.78	398.44	398.93	0.341	0.494	0.153
	398.79	398.44	398.99	0.347	0.550	0.203
Max. asymmetry [V]:	0.550					
Max. asymmetry [%]:	0.044					
e) maximum under-excited (i) at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:	132.17	131.96	131.46	0.215	0.491	0.706
	131.75	132.27	131.22	0.521	1.054	0.533
	131.72	132.21	131.19	0.491	1.022	0.531
	131.74	132.20	131.20	0.467	1.006	0.539
	131.72	132.17	131.19	0.444	0.977	0.533
cos φ_{E60}:	0.799					
Max. asymmetry [kVA]:	1.054					

U_{60} [V]:	400.70	400.68	400.98	0.017	0.296	0.279
	400.27	400.05	400.04	0.220	0.005	0.225
	400.28	400.05	400.09	0.231	0.044	0.187
	400.29	400.04	400.12	0.244	0.080	0.164
	400.30	400.05	400.16	0.250	0.113	0.137
Max. asymmetry [V]:	0.296					
Max. asymmetry [%]:	0.048					
f) maximum over-excited (c) at 50 % P_n ± 5 % P_{Emax}						
S_{E60} [kVA]:	131.71	131.21	131.28	0.505	0.072	0.433
	131.63	131.14	131.39	0.498	0.250	0.248
	131.76	131.15	131.25	0.613	0.094	0.519
	131.84	131.19	131.30	0.643	0.104	0.539
	131.87	131.20	131.16	0.667	0.037	0.703
cos φ_{E60}:	0.799					
Max. asymmetry [kVA]:	0.703					
U_{60} [V]:	399.96	399.98	400.08	0.019	0.096	0.115
	399.98	399.99	400.10	0.009	0.112	0.121
	400.01	399.98	400.12	0.029	0.136	0.107
	400.03	399.98	400.14	0.044	0.154	0.110
	400.05	399.98	400.13	0.062	0.142	0.080
Max. asymmetry [V]:	0.154					
Max. asymmetry [%]:	0.019					
Power Limit [kVA]:	4.6					
Voltage Limit [%]:	0.2					

Test:
The maximum absolute difference between the apparent powers of the three phases is determined for each of the five measurements (1-min means) in the respective operating point, The maximum of these five values is again determined,

Assessment criterion:
The test is passed if the maximum value from the above measurements does not exceed 15 kVA for apparent power imbalance or 0.2% for voltage unbalance,

Note:
The maximum inductive and capacitive values are specified by the manufacturer.

4.1.8 DC-Injection					**N/A**
Test conditions:	U_N =; U_{input} = ; Power =				
DC Injection [A]	**Limits**	**Trip Time [ms]**			
+1A	I_{DC}:>0.5% than disconnection within 0.5 sec	--	--	--	
-1A		--	--	--	
Note: The EUT needs to be connected to an power frequency transformer for use.					

4.1.8 DC-Injection (Monitoring)									**N/A**
Limit:	0,5% of I_{nom} (3.62A)								
Output power:	25%			50%			100%		
Phase:	A	B	C	A	B	C	A	B	C
max test value:	--	--	--	--	--	--	--	--	--
The EUT needs to be connected to an power frequency transformer for use.									

4.1.10 Harmonics and waveform distortion	P
The currents of the interharmonics to 2 kHz must be measured in accordance with IEC 61000-4-7, Annex A, The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with IEC 61000-4-7, Annex B,	

Harmonics

P/Pn [%]	0/5	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	5.728	10.88	20.54	30.70	40.37	50.47	60.38	70.18	80.02	89.84	99.49
2	0.197	0.237	0.225	0.223	0.226	0.247	0.314	0.385	0.455	0.518	0.582
3	0.097	0.131	0.124	0.132	0.134	0.194	0.272	0.345	0.425	0.521	0.618
4	0.220	0.286	0.236	0.218	0.227	0.268	0.297	0.339	0.388	0.429	0.480
5	0.759	0.140	0.577	0.819	0.964	1.109	1.190	1.222	1.258	1.273	1.303
6	0.126	0.249	0.191	0.224	0.223	0.272	0.302	0.340	0.377	0.403	0.446
7	0.353	0.504	0.112	0.313	0.489	0.624	0.686	0.737	0.763	0.794	0.830
8	0.153	0.110	0.115	0.144	0.169	0.194	0.215	0.227	0.241	0.256	0.265
9	0.067	0.101	0.118	0.134	0.138	0.144	0.146	0.149	0.156	0.162	0.171
10	0.076	0.162	0.132	0.139	0.159	0.185	0.197	0.206	0.215	0.221	0.227
11	0.069	0.120	0.206	0.186	0.123	0.111	0.154	0.187	0.215	0.240	0.252
12	0.062	0.072	0.124	0.103	0.085	0.086	0.095	0.106	0.114	0.122	0.130
13	0.087	0.055	0.182	0.183	0.148	0.092	0.061	0.059	0.068	0.084	0.100
14	0.014	0.021	0.070	0.062	0.040	0.028	0.031	0.037	0.043	0.049	0.056
15	0.020	0.022	0.016	0.019	0.022	0.022	0.021	0.029	0.034	0.036	0.042
16	0.077	0.108	0.047	0.077	0.075	0.055	0.044	0.036	0.034	0.030	0.031
17	0.064	0.097	0.037	0.183	0.214	0.157	0.090	0.049	0.044	0.072	0.104
18	0.093	0.127	0.042	0.115	0.149	0.120	0.075	0.051	0.047	0.046	0.051
19	0.038	0.140	0.128	0.217	0.409	0.393	0.296	0.156	0.116	0.144	0.191
20	0.032	0.058	0.069	0.057	0.124	0.140	0.117	0.083	0.067	0.056	0.058
21	0.022	0.034	0.024	0.032	0.039	0.044	0.045	0.060	0.060	0.052	0.058
22	0.027	0.026	0.030	0.020	0.023	0.012	0.014	0.033	0.047	0.053	0.056
23	0.019	0.013	0.030	0.028	0.016	0.021	0.030	0.034	0.032	0.034	0.043
24	0.015	0.018	0.018	0.014	0.012	0.013	0.011	0.018	0.020	0.023	0.023
25	0.135	0.131	0.127	0.141	0.141	0.129	0.136	0.148	0.131	0.138	0.146
26	0.012	0.009	0.009	0.010	0.013	0.017	0.012	0.012	0.012	0.010	0.011
27	0.008	0.008	0.020	0.013	0.010	0.010	0.013	0.011	0.015	0.021	0.020
28	0.008	0.006	0.006	0.009	0.013	0.017	0.014	0.014	0.015	0.014	0.013
29	0.006	0.012	0.007	0.011	0.009	0.012	0.018	0.020	0.019	0.016	0.016
30	0.005	0.006	0.005	0.008	0.008	0.007	0.009	0.011	0.012	0.011	0.010
31	0.005	0.007	0.007	0.008	0.010	0.007	0.012	0.014	0.015	0.014	0.012
32	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007
33	0.005	0.006	0.006	0.006	0.007	0.007	0.007	0.006	0.006	0.006	0.008
34	0.006	0.008	0.006	0.006	0.008	0.006	0.006	0.007	0.007	0.007	0.006
35	0.006	0.005	0.005	0.007	0.006	0.006	0.011	0.011	0.008	0.008	0.008
36	0.004	0.005	0.006	0.005	0.007	0.006	0.006	0.006	0.006	0.006	0.006
37	0.004	0.005	0.005	0.005	0.006	0.006	0.006	0.007	0.006	0.006	0.007
38	0.005	0.005	0.005	0.005	0.006	0.005	0.006	0.006	0.006	0.005	0.006
39	0.005	0.005	0.005	0.006	0.005	0.006	0.006	0.006	0.006	0.006	0.006
40	0.004	0.004	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007
41	0.004	0.005	0.005	0.005	0.006	0.006	0.005	0.006	0.006	0.005	0.006
42	0.004	0.005	0.006	0.005	0.006	0.006	0.006	0.006	0.005	0.006	0.006
43	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
44	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.005	0.006	0.005	0.006
45	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.006
46	0.005	0.006	0.006	0.006	0.006	0.006	0.007	0.006	0.006	0.005	0.006
47	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.011	0.011

48	0.004	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.006
49	0.004	0.005	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.005	0.006
50	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.006
51	0.004	0.005	0.006	0.005	0.005	0.006	0.006	0.005	0.006	0.005	0.005
52	0.004	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.006
53	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.005
54	0.004	0.005	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.005
55	0.004	0.005	0.005	0.005	0.006	0.005	0.005	0.006	0.006	0.005	0.006
56	0.004	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.006
57	0.004	0.004	0.005	0.005	0.005	0.005	0.006	0.005	0.006	0.005	0.006
58	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.006	0.005
59	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.006	0.005	0.006
60	0.004	0.005	0.006	0.005	0.005	0.006	0.006	0.005	0.006	0.006	0.006

Interharmonics at continuous operation											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]	I_h [%]
75	0.024	0.026	0.030	0.033	0.036	0.041	0.045	0.049	0.051	0.056	0.059
125	0.020	0.022	0.024	0.025	0.026	0.029	0.030	0.031	0.033	0.036	0.037
175	0.019	0.021	0.024	0.026	0.027	0.028	0.029	0.032	0.033	0.034	0.037
225	0.021	0.023	0.024	0.026	0.027	0.028	0.030	0.030	0.031	0.033	0.035
275	0.020	0.022	0.023	0.025	0.026	0.027	0.028	0.029	0.029	0.031	0.032
325	0.020	0.022	0.023	0.025	0.025	0.026	0.027	0.027	0.028	0.028	0.029
375	0.017	0.019	0.021	0.021	0.022	0.023	0.023	0.024	0.025	0.025	0.026
425	0.017	0.019	0.020	0.021	0.021	0.021	0.022	0.023	0.023	0.023	0.024
475	0.017	0.018	0.019	0.020	0.020	0.021	0.021	0.022	0.022	0.022	0.023
525	0.016	0.018	0.019	0.019	0.020	0.020	0.021	0.021	0.021	0.021	0.021
575	0.016	0.017	0.018	0.019	0.019	0.020	0.020	0.020	0.020	0.020	0.021
625	0.017	0.017	0.018	0.019	0.019	0.019	0.020	0.020	0.020	0.020	0.021
675	0.015	0.016	0.017	0.019	0.019	0.019	0.019	0.020	0.020	0.020	0.021
725	0.015	0.016	0.018	0.018	0.019	0.019	0.019	0.019	0.020	0.019	0.019
775	0.016	0.016	0.018	0.019	0.019	0.019	0.020	0.020	0.021	0.020	0.020
825	0.016	0.017	0.019	0.019	0.020	0.020	0.020	0.021	0.021	0.021	0.021
875	0.017	0.019	0.020	0.022	0.022	0.023	0.023	0.024	0.023	0.023	0.023
925	0.024	0.030	0.036	0.039	0.041	0.042	0.045	0.047	0.047	0.051	0.049
975	0.019	0.026	0.030	0.032	0.034	0.034	0.036	0.036	0.038	0.043	0.038
1025	0.019	0.023	0.024	0.025	0.025	0.026	0.026	0.026	0.027	0.026	0.026
1075	0.019	0.021	0.022	0.023	0.023	0.023	0.023	0.023	0.024	0.024	0.023
1125	0.017	0.018	0.020	0.021	0.021	0.022	0.021	0.022	0.022	0.022	0.022
1175	0.016	0.017	0.019	0.019	0.019	0.020	0.020	0.020	0.020	0.020	0.021
1225	0.016	0.017	0.018	0.019	0.019	0.019	0.019	0.020	0.020	0.020	0.020
1275	0.015	0.016	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.020
1325	0.014	0.016	0.017	0.018	0.018	0.018	0.018	0.019	0.019	0.019	0.019
1375	0.016	0.017	0.018	0.019	0.019	0.020	0.020	0.020	0.020	0.020	0.020
1425	0.014	0.016	0.017	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019
1475	0.015	0.016	0.017	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.020
1525	0.014	0.015	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.019
1575	0.014	0.016	0.016	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.019
1625	0.013	0.015	0.016	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018
1675	0.014	0.016	0.017	0.018	0.018	0.018	0.019	0.019	0.019	0.019	0.019
1725	0.014	0.015	0.016	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.019
1775	0.013	0.015	0.016	0.017	0.017	0.018	0.018	0.018	0.018	0.019	0.019
1825	0.013	0.014	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018
1875	0.013	0.015	0.016	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018
1925	0.013	0.014	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018
1975	0.013	0.015	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018
2025	0.013	0.014	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018
2075	0.013	0.015	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018
2125	0.012	0.014	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.018

Interharmonics at continuous operation											
P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]
2175	0.013	0.015	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018
2225	0.013	0.014	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.018
2275	0.013	0.014	0.016	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018
2325	0.013	0.014	0.016	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018
2375	0.013	0.014	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018
2425	0.012	0.014	0.015	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.018
2475	0.013	0.015	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018
2525	0.013	0.014	0.015	0.016	0.017	0.017	0.017	0.017	0.017	0.017	0.017
2575	0.013	0.014	0.016	0.017	0.017	0.017	0.017	0.018	0.018	0.018	0.018
2625	0.013	0.014	0.015	0.016	0.017	0.017	0.017	0.018	0.017	0.017	0.018
2675	0.013	0.014	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018
2725	0.012	0.014	0.015	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.017
2775	0.013	0.014	0.016	0.017	0.017	0.017	0.018	0.018	0.018	0.018	0.018
2825	0.012	0.014	0.015	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.018
2875	0.012	0.014	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.017	0.018
2925	0.013	0.014	0.015	0.016	0.016	0.017	0.017	0.017	0.017	0.017	0.018
2975	0.013	0.014	0.016	0.016	0.017	0.017	0.018	0.018	0.018	0.017	0.018

Higher Frequencies components											
P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]
2.1	0.027	0.031	0.034	0.035	0.037	0.037	0.037	0.038	0.038	0.038	0.039
2.3	0.029	0.032	0.035	0.036	0.038	0.038	0.039	0.039	0.039	0.039	0.040
2.5	0.027	0.031	0.034	0.035	0.036	0.036	0.037	0.038	0.038	0.037	0.038
2.7	0.027	0.030	0.033	0.035	0.036	0.036	0.037	0.038	0.037	0.037	0.038
2.9	0.027	0.030	0.033	0.035	0.036	0.036	0.037	0.037	0.038	0.037	0.038
3.1	0.027	0.030	0.033	0.035	0.035	0.036	0.037	0.037	0.037	0.037	0.038
3.3	0.027	0.030	0.033	0.034	0.035	0.036	0.036	0.037	0.037	0.037	0.037
3.5	0.027	0.029	0.033	0.034	0.035	0.036	0.036	0.037	0.037	0.037	0.037
3.7	0.026	0.029	0.032	0.034	0.035	0.035	0.036	0.037	0.037	0.037	0.037
3.9	0.031	0.034	0.033	0.035	0.036	0.036	0.037	0.038	0.037	0.038	0.038
4.1	0.043	0.044	0.045	0.046	0.047	0.047	0.047	0.047	0.047	0.047	0.048
4.3	0.027	0.030	0.032	0.034	0.035	0.035	0.036	0.037	0.037	0.037	0.038
4.5	0.038	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.045	0.045	0.046
4.7	0.275	0.287	0.292	0.292	0.292	0.292	0.291	0.291	0.288	0.286	0.288
4.9	0.119	0.123	0.125	0.126	0.127	0.126	0.128	0.133	0.134	0.132	0.136
5.1	0.043	0.043	0.042	0.043	0.044	0.045	0.044	0.043	0.043	0.043	0.043
5.3	0.026	0.029	0.032	0.034	0.035	0.035	0.036	0.037	0.037	0.037	0.037
5.5	0.026	0.028	0.031	0.033	0.034	0.034	0.035	0.036	0.036	0.035	0.036
5.7	0.026	0.028	0.031	0.033	0.034	0.034	0.035	0.035	0.036	0.035	0.036
5.9	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.035	0.035	0.035	0.036
6.1	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.035	0.035	0.035	0.036
6.3	0.025	0.028	0.030	0.032	0.033	0.034	0.034	0.035	0.035	0.034	0.035
6.5	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.035	0.035	0.035	0.035
6.7	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.035	0.035	0.034	0.035
6.9	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.034	0.034	0.034	0.035
7.1	0.025	0.028	0.031	0.032	0.033	0.033	0.034	0.035	0.034	0.034	0.035
7.3	0.025	0.028	0.031	0.032	0.033	0.034	0.034	0.034	0.034	0.034	0.035
7.5	0.024	0.027	0.030	0.032	0.033	0.033	0.033	0.034	0.034	0.034	0.034
7.7	0.024	0.028	0.031	0.032	0.033	0.033	0.033	0.034	0.034	0.034	0.034
7.9	0.025	0.028	0.033	0.035	0.035	0.035	0.036	0.037	0.036	0.036	0.037
8.1	0.024	0.027	0.030	0.032	0.033	0.033	0.034	0.034	0.034	0.034	0.034
8.3	0.025	0.027	0.030	0.032	0.032	0.033	0.033	0.034	0.034	0.034	0.034
8.5	0.024	0.027	0.030	0.031	0.032	0.033	0.033	0.034	0.034	0.033	0.034
8.7	0.023	0.026	0.029	0.031	0.032	0.032	0.032	0.033	0.033	0.033	0.034

Higher Frequencies components											
P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]	Ih [%]
8.9	0.024	0.027	0.029	0.031	0.032	0.033	0.033	0.034	0.034	0.034	0.035

Assessment criterion:
The harmonic and inter-harmonic current distortion shall comply with the relevant emission limits in accordance with IEC 61727, reproduced in table 1.

4.1.10 Harmonics and waveform distortion In accordance with IEC 61727	**P**

Output Power [kW]	628.59
Grid-Voltage [V]	234.29
Output current [A]	896.56
Grid-Frequency [Hz]	49.99
THD [%]	1.804

Harmonics	**Current Magnitude [A]**			**Fundamental [%]**			**Harmonic Current Limits [%]**
	Phase L1	**Phase L2**	**Phase L3**	**Phase L1**	**Phase L2**	**Phase L3**	
1st	897.2	886.9	904.8	--	--	--	--
2nd	5.291	2.841	2.875	0.582	0.312	0.316	1.00
3rd	3.673	5.616	3.047	0.404	0.618	0.335	4.00
4th	1.756	4.366	2.776	0.193	0.480	0.305	1.00
5th	10.754	11.851	8.649	1.183	1.303	0.951	4.00
6th	1.702	4.052	2.382	0.187	0.446	0.262	1.00
7th	4.666	5.910	7.546	0.513	0.650	0.830	4.00
8th	0.818	2.257	2.413	0.090	0.248	0.265	1.00
9th	0.201	1.555	1.495	0.022	0.171	0.164	4.00
10th	0.250	1.808	2.065	0.028	0.199	0.227	1.00
11th	2.050	1.074	2.295	0.225	0.118	0.252	2.00
12th	0.162	1.179	1.119	0.018	0.130	0.123	0.50
13th	0.907	0.906	0.387	0.100	0.100	0.043	2.00
14th	0.285	0.511	0.356	0.031	0.056	0.039	0.50
15th	0.210	0.219	0.384	0.023	0.024	0.042	2.00
16th	0.280	0.209	0.255	0.031	0.023	0.028	0.50
17th	0.889	0.942	0.647	0.098	0.104	0.071	1.50
18th	0.213	0.461	0.287	0.023	0.051	0.032	0.38
19th	1.494	0.635	1.733	0.164	0.070	0.191	1.50
20th	0.268	0.529	0.390	0.029	0.058	0.043	0.38
21th	0.210	0.359	0.532	0.023	0.039	0.058	1.50
22th	0.125	0.396	0.511	0.014	0.044	0.056	0.38
23th	0.098	0.389	0.323	0.011	0.043	0.035	0.60
24th	0.059	0.139	0.212	0.006	0.015	0.023	0.15
25th	1.176	1.316	1.332	0.129	0.145	0.146	0.60
26th	0.068	0.097	0.066	0.007	0.011	0.007	0.15
27th	0.058	0.181	0.103	0.006	0.020	0.011	0.60
28th	0.053	0.117	0.080	0.006	0.013	0.009	0.15
29th	0.119	0.084	0.143	0.013	0.009	0.016	0.60
30th	0.048	0.080	0.087	0.005	0.009	0.010	0.15
31th	0.087	0.108	0.084	0.010	0.012	0.009	0.60
32th	0.050	0.062	0.048	0.005	0.007	0.005	0.15
33th	0.056	0.070	0.049	0.006	0.008	0.005	0.60
34th	0.053	0.054	0.042	0.006	0.006	0.005	0.15
35th	0.045	0.074	0.044	0.005	0.008	0.005	0.30

4.1.10 Harmonics and waveform distortion In accordance with IEC 61727	P

Output Power [kW]	628.59
Grid-Voltage [V]	234.29
Output current [A]	896.56
Grid-Frequency [Hz]	49.99
THD [%]	1.804

Harmonics	Current Magnitude [A]			Fundamental [%]			Harmonic Current Limits [%]
	Phase L1	Phase L2	Phase L3	Phase L1	Phase L2	Phase L3	
36th	0.041	0.052	0.042	0.005	0.006	0.005	0.08
37th	0.047	0.062	0.041	0.005	0.007	0.004	0.30
38th	0.043	0.052	0.038	0.005	0.006	0.004	0.08
39th	0.049	0.054	0.039	0.005	0.006	0.004	0.30
40th	0.043	0.059	0.040	0.005	0.007	0.004	0.08
41th	0.041	0.056	0.040	0.004	0.006	0.004	0.30
42th	0.042	0.054	0.034	0.005	0.006	0.004	0.08
43th	0.043	0.050	0.037	0.005	0.005	0.004	0.30
44th	0.042	0.052	0.038	0.005	0.006	0.004	0.08
45th	0.044	0.059	0.042	0.005	0.006	0.005	0.30
46th	0.041	0.051	0.035	0.005	0.006	0.004	0.08
47th	0.082	0.100	0.089	0.009	0.011	0.010	0.30
48th	0.043	0.053	0.038	0.005	0.006	0.004	0.08
49th	0.040	0.053	0.038	0.004	0.006	0.004	0.30
50th	0.039	0.052	0.035	0.004	0.006	0.004	0.08
51th	0.040	0.050	0.036	0.004	0.005	0.004	0.30
52th	0.046	0.053	0.036	0.005	0.006	0.004	0.08
53th	0.039	0.049	0.034	0.004	0.005	0.004	0.30
54th	0.040	0.048	0.035	0.004	0.005	0.004	0.08
55th	0.042	0.054	0.037	0.005	0.006	0.004	0.30
56th	0.041	0.052	0.036	0.005	0.006	0.004	0.08
57th	0.041	0.051	0.036	0.005	0.006	0.004	0.30
58th	0.039	0.048	0.033	0.004	0.005	0.004	0.08
59th	0.043	0.051	0.036	0.005	0.006	0.004	0.30
60th	0.042	0.050	0.036	0.005	0.006	0.004	0.08

4.1.11.3	**Power factor (no controllable reactive power)**				**P**
Test conditions:					
Output power [kW] / **Test voltage [Vac]**	**~10%**	**~20%**	**~50%**	**~75%**	**~100%**
	63.00	126.11	315.52	472.64	629.98
400	0.997	0.997	0.997	0.995	0.995

Note:
The PV system shall have a lagging power factor greater than 0.98 when the output is greater than 20% of the rated inverter output power.

4.1.11.3	**Power factor (Fixed cos φ)**			**P**
Test condition: over-excited (c) (cos φ = 0.95)				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
0%	2.98	10.18	0.281	397.8
10%	63.03	20.57	0.951	397.7
20%	125.82	41.02	0.951	397.8
30%	188.44	61.37	0.951	397.8
40%	251.04	81.70	0.951	397.8
50%	313.65	102.09	0.951	397.8
60%	377.19	123.13	0.951	397.8
70%	440.67	144.13	0.950	397.8
80%	503.93	164.73	0.951	397.8
90%	566.78	185.20	0.951	397.8
100%	629.74	205.06	0.951	397.8
Test condition: under-excited (i) (cos φ = 0.95)				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
0%	2.65	9.79	0.261	398.1
10%	62.83	20.28	0.952	399.1
20%	125.72	40.94	0.951	400.3
30%	188.49	57.32	0.957	401.3
40%	252.17	81.98	0.951	402.7
50%	314.35	103.01	0.950	403.8
60%	377.16	123.62	0.950	405.0
70%	440.00	144.81	0.950	406.2
80%	503.91	164.72	0.951	407.3
90%	566.52	185.21	0.950	407.4
100%	629.34	205.75	0.950	407.4
Test condition: power factor (cos φ = 1)				
Rating power [%]	Active power [kW]	Reactive power [kVar]	Power factor [cos φ]	Voltage [V]
0%	1.19	15.46	0.076	398.9

10%	63.00	4.82	0.997	401.3
20%	126.11	9.63	0.997	401.3
30%	189.66	14.65	0.997	401.3
40%	252.20	19.22	0.997	401.2
50%	315.52	24.09	0.997	401.2
60%	379.06	29.21	0.997	401.2
70%	440.82	43.85	0.995	401.6
80%	503.55	50.18	0.995	401.6
90%	568.55	57.17	0.995	401.6
100%	629.98	62.64	0.995	401.7

Assessment criterion:

The power factor resulting in each of the measurement points greater than between 20 % of the nominal power is equal to or lower than 0.98 for SSEG categories A1/A2 and 0.95 for SSEG categories A3 both in over excited and under excited operation,

The maximum tolerance on the reactive power setting is 5 % of the rated active power or ±0.01 of power factor,

Note:

a) 1 min-average-values were calculated using measurements at the basic frequency in a period of 200 ms,

b) For each of the 10 active power levels, at least 3 under excited and 3 over excited reactive power levels were recorded,

c) 1 min-average-values were calculated using voltage measurements at the basic frequency in a period of 200 ms,

4.1.11.9 Test for a displacement factor/active power characteristic curve cos φ (P) (For embedded generators of sub-category A3) — **P**

Test:

Rating power [%]	Active power P [kW]	Reactive power Q [kVar]	cos φ measured	cos φ expected	Δ cos φ
20%	126.30	12.19	0.995	1.000	-0.005
30%	189.70	18.35	0.995	1.000	-0.005
40%	253.25	24.63	0.995	1.000	-0.005
50%	315.97	30.43	0.995	1.000	-0.005
60%	377.74	55.61	0.989	0.990	-0.001
70%	442.12	88.55	0.981	0.980	0.001
80%	504.80	126.05	0.970	0.970	0
90%	566.81	163.70	0.961	0.960	0.001
100%	629.44	205.94	0.950	0.950	0

Assessment criterion:

Test: 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.

Note:

Using the standard characteristic curve increases the active power from 20% P_n in increments of 10% P_n to P_n, The test is carried out in reverse.

4.1.12 Synchronization 4.2.4 Response to utility recovery			P
Test:			
Voltage conditons			
a) Out of voltage range	<85% U_n for twice of observation time	>110% U_n for twice of observation time	
Connection:	No connection	No connection	
Limit	No connection allowed		
b) In voltage range at start-up	≥85% U_n within twice setting observation time	≤110% U_n within twice setting observation time	
Reconnection time [s]	84.68	120.00	
Limit:	Connected after setting observation time (≥60s)		
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,		
c) In voltage range after voltage failture	≥85% U_n for twice of setting observation time	≤110% U_n for twice of setting observation time	
Reconnection time [s]	86.18	119.60	
Limit:	Reconnection after setting observation time (≥60s)		
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,		
Frequency conditions			
d) Out of frequency range	<47Hz for twice of setting observation time	>50,5Hz for twice of setting observation time	
Connection:	No connection	No connection	
Limit	No connection allowed		
e) In frequency range at start-up	≥47Hz within twice of setting observation time	≤50,5Hz within twice of setting observation time	
Reconnection time [s]	193.64	204.68	
Limit:	Connected after setting observation time (≥60s)		
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,		

f) In frequency range after frequency failture	≥47Hz for twice of setting observation time	≤50,5Hz for twice of setting observation time
Reconnection time [s]	202.06	204.28
Limit:	Reconnection after setting observation time (≥60s)	
Gradient:	The maximum occurring active power gradient after connection respectively start generating electrical power is less than the configured maximum active power per minute Max gradient: 10%P_n/min, The connection after trip of the interface protection is delayed by a randomized value between 1 min and 10 min, For recorded gradient see diagram underneath,	

Test:

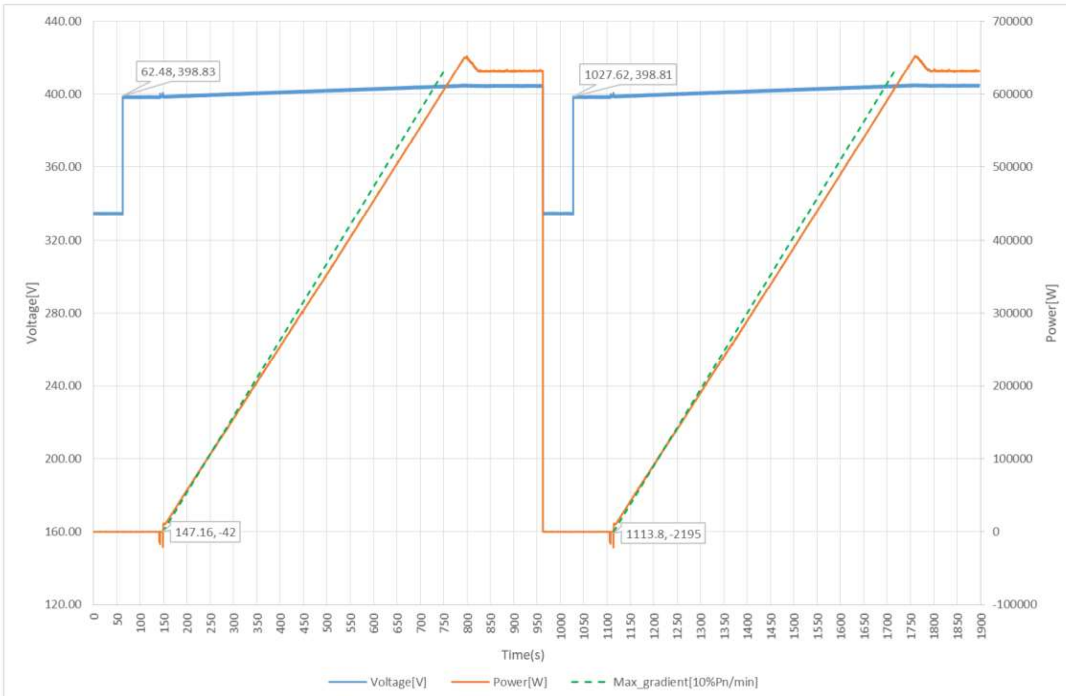
Test condition b) and c) : voltage within the limits of 85% to 110%U_n

Test condition e) and f) : frequency within the limits of 47.0Hz to 50.5Hz

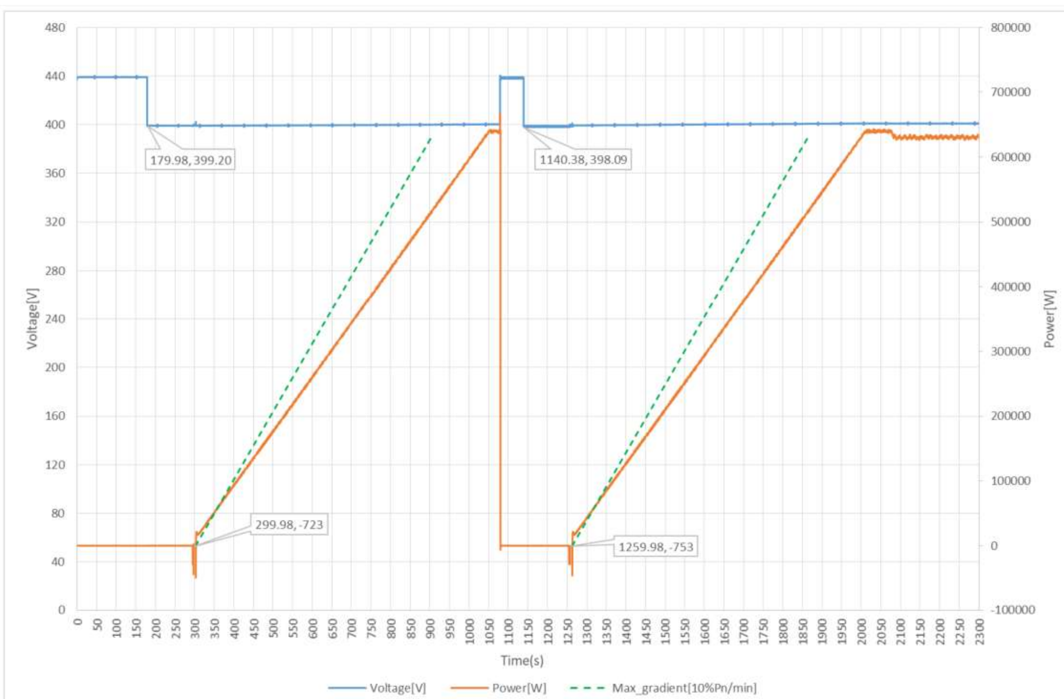
In order to avoid continuous starting and disengaging operations of the interface protection relay. the disengaging value of frequency and voltage functions shall be above 0.2%F_n and 2%U_n deviating from the operate value.

Controllable generators may reconnect immediately after the 60 s delay confirming recovery of the system voltage and frequency at a maximum rate of 10 % of rated power per minute. i.e. full power output will only be reached after 10 minutes.

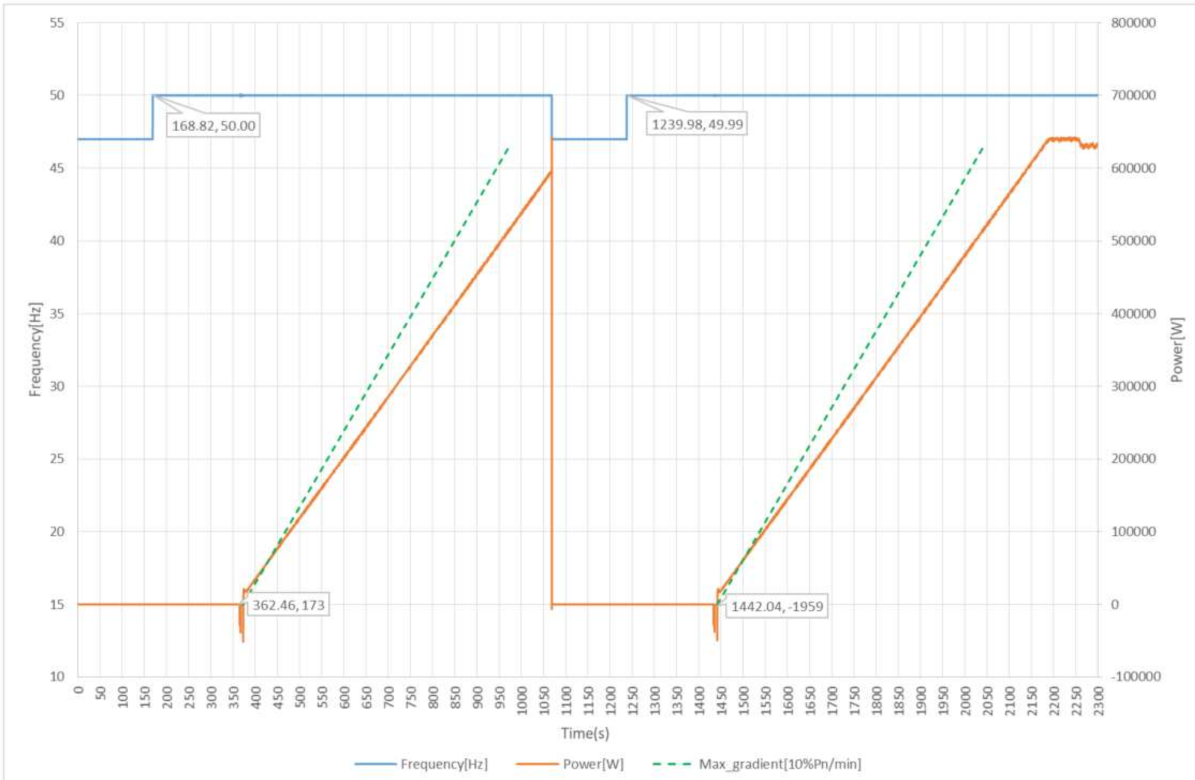
Graph of the gradual power supply: Test for ≥84%U



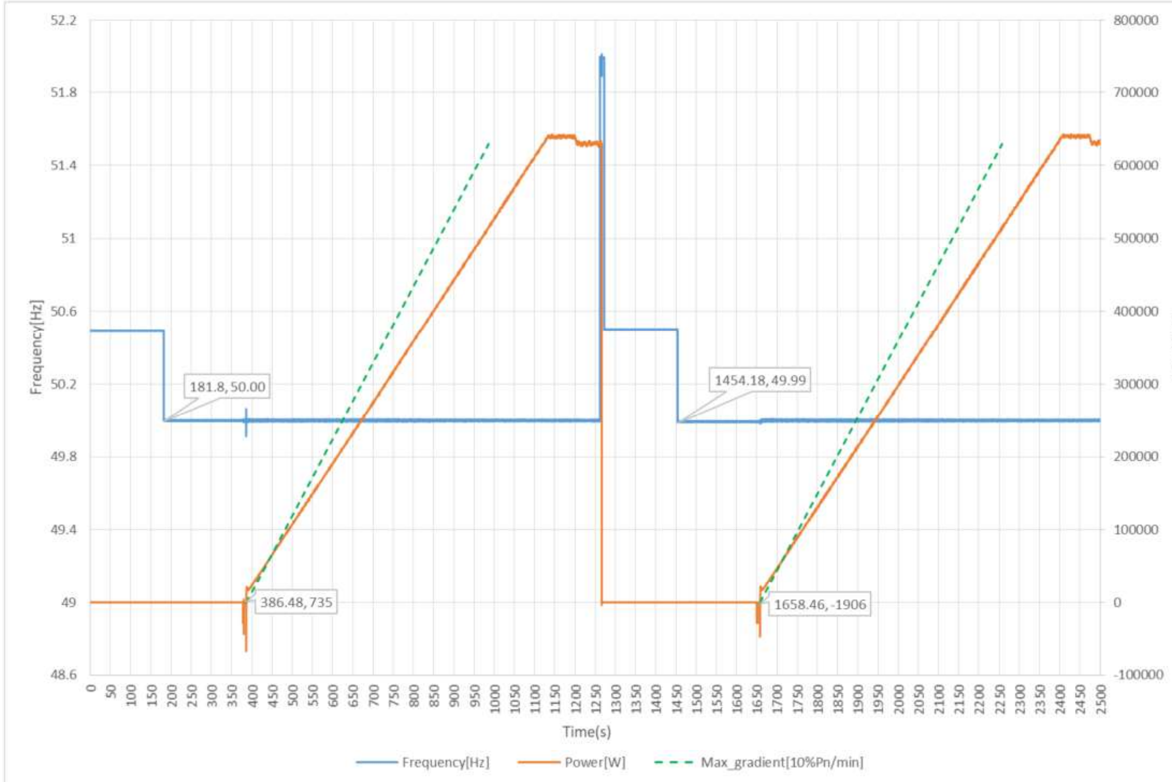
Graph of the gradual power supply : Test for ≤111%U



Graph of the gradual power supply: Test for ≥47,00



Graph of the gradual power supply : Test for ≤50,15



Frequency[Hz]
Power[W]
Time(s)
181.8, 50.00
386.48, 735
1454.18, 49.99
1658.46, -1906
Frequency[Hz]
Power[W]
Max_gradient[10%Pn/min]

4.2.2 Response to protection operation - fault condition tests	**P**
Note: Inverter units approved by EMTEK(SHENZHEN) CO., LTD in accordance with IEC 62109-1. Report No.: ENS2305110124P004.	

4.2.2.3.2 Overvoltage and undervoltage					P
Test: L1-L2					
First Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**340.0**		**440.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		339.35		441.21	
		339.79		441.84	
		339.84		441.58	
Parameter		Time [s]		Time [s]	
Limit		**≤ 10.0**		**≤ 40.0**	
Disconnetion time [s]	200V to 190V	1.521	248V to 258V	2.052	
		1.911		2.055	
		1.853		2.056	
Second Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**200.0**		**460.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		199.67		458.12	
		199.43		458.15	
		200.03		458.10	
Parameter		Time [s]		Time [s]	
Limit		**≤ 0.2**		**≤ 2.0**	
Disconnetion time [s]	200V to 113V	0.145	248V to 270V	1.062	
		0.186		1.038	
		0.143		1.038	

Third Level				
	--		**Over Voltage**	
Parameter				Voltage [V]
Set value				**480.0**
Measured trip value [V]	--		Phase	Line to Neutral
				479.91
				479.90
				479.67
Parameter				Time [s]
Limit				**<= 0.16**
Disconnetion time [s]	--		248V to 280V	0.150
				0.149
				0.149

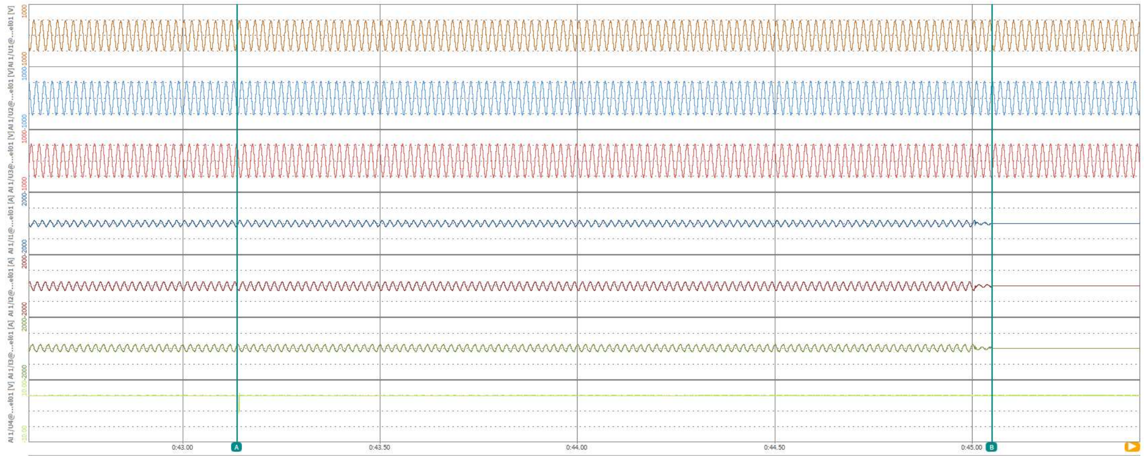
Note:

The NRS 097-2-1 provide limits of accuracy for the utility voltage and frequency measurement of the power system, The values for tolerances given in Table 2 are used,

The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,

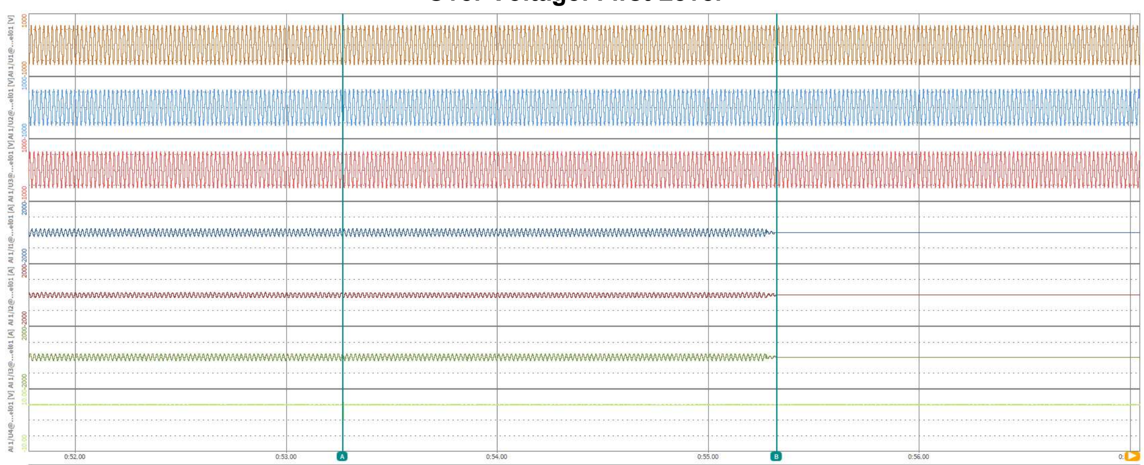
If multi-voltage control settings are not possible, the more stringent trip time should be implemented, e,g, 2 s between 110% and 120% of voltage,

Under Voltage: First Level



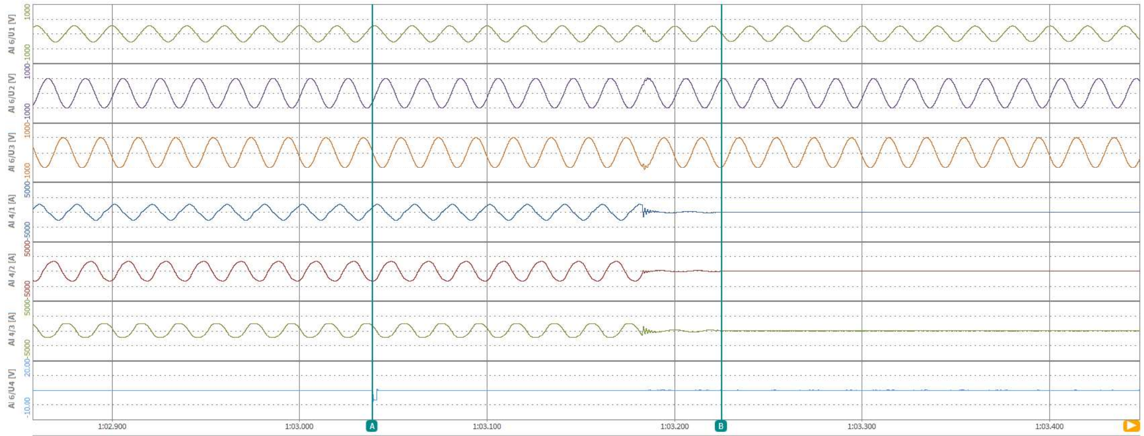
时间 [s]	A 0:43.138531	B 0:45.049841	间隔 1.911310
AI 1/U1@Trionet_Michael01 [V]	-205.5645	52.57845	258.1430
AI 1/U2@Trionet_Michael01 [V]	-339.8435	454.2215	794.0650
AI 1/U3@Trionet_Michael01 [V]	545.4518	-506.9448	-1052.397
AI 1/I1@Trionet_Michael01 [A]	-132.0593	-0.064812	131.9945
AI 1/I2@Trionet_Michael01 [A]	-34.86843	-50.28458	-15.41615
AI 1/I3@Trionet_Michael01 [A]	163.3026	47.20707	-116.0955
AI 1/U4@Trionet_Michael01 [V]	5.105734	5.105973	2.384e-4

Over Voltage: First Level



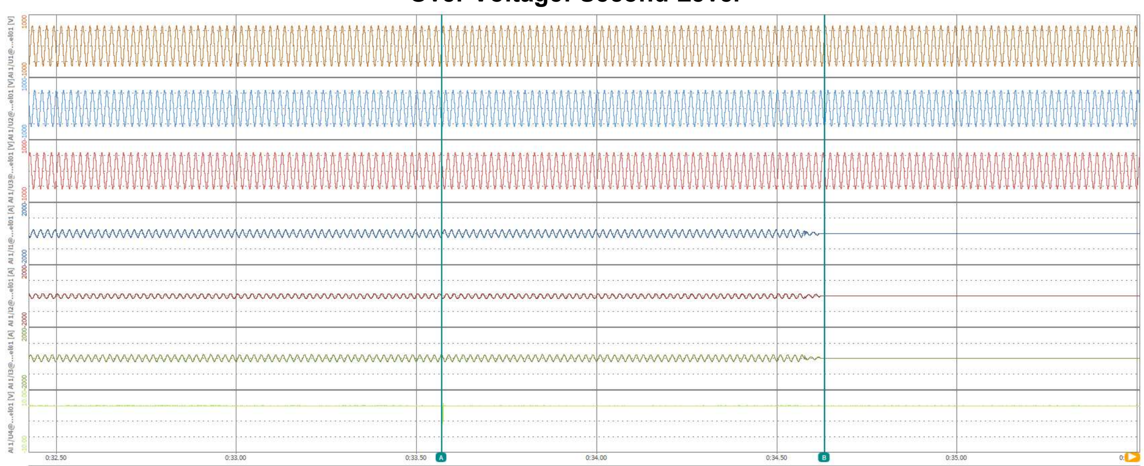
时间 [s]	A 0:53.267270	B 0:55.323549	间隔 2.056279
AI 1/U1@Trionet_Michael01 [V]	-293.1595	-612.8452	-319.6857
AI 1/U2@Trionet_Michael01 [V]	-286.6497	385.5021	672.1518
AI 1/U3@Trionet_Michael01 [V]	579.7943	227.3206	-352.4738
AI 1/I1@Trionet_Michael01 [A]	-238.7230	-0.789605	237.9334
AI 1/I2@Trionet_Michael01 [A]	38.34992	-2.501917	-40.85183
AI 1/I3@Trionet_Michael01 [A]	198.0426	-0.437308	-198.4799
AI 1/U4@Trionet_Michael01 [V]	5.105019	5.108357	3.338e-3

Under Voltage: Second Level



	A	B	Delta
Time [s]	1:03.0388405	1:03.2250082	0.1861677
AI 6/U1 [V]	263.5286	15.23209	-248.2965
AI 6/U2 [V]	-318.9638	475.3259	794.2896
AI 6/U3 [V]	55.63403	-490.3577	-545.9917
AI 4/1 [A]	759.3060	-10.87189	-770.1779
AI 4/2 [A]	-1680.985	-8.251668	1672.733
AI 4/3 [A]	901.5942	18.43929	-883.1549
AI 6/U4 [V]	5.159617	5.187750	0.028133

Over Voltage: Second Level



	A	B	间隔
时间 [s]	0:33.569883	0:34.631926	1.062043
AI 1/U1@Trionet_Michael01 [V]	-134.5472	253.2449	387.7921
AI 1/U2@Trionet_Michael01 [V]	-412.4379	-573.4947	-161.0568
AI 1/U3@Trionet_Michael01 [V]	546.9963	320.2223	-226.7740
AI 1/I1@Trionet_Michael01 [A]	-225.8878	-1.024447	224.8633
AI 1/I2@Trionet_Michael01 [A]	-11.63931	-2.468539	9.170771
AI 1/I3@Trionet_Michael01 [A]	235.2669	-1.393367	-236.6603
AI 1/U4@Trionet_Michael01 [V]	5.104781	5.106211	1.431e-3

Over Voltage: Third Level

	A	B	间隔
时间 [s]	0:48.0589827	0:48.2093555	0.1503728
AI 1/U1@Trionet_Michael01 [V]	287.5419	-360.5359	-648.0778
AI 1/U2@Trionet_Michael01 [V]	-583.6935	589.2339	1172.927
AI 1/U3@Trionet_Michael01 [V]	296.1351	-228.8049	-524.9400
AI 1/I1@Trionet_Michael01 [A]	-101.5286	-0.974379	100.5542
AI 1/I2@Trionet_Michael01 [A]	-108.7043	-3.126574	105.5777
AI 1/I3@Trionet_Michael01 [A]	208.7476	-0.948716	-209.6963
AI 1/U4@Trionet_Michael01 [V]	5.105257	5.102635	-2.623e-3

4.2.2.3.2	**Overvoltage and undervoltage**				**P**
Test: L2-L3					
First Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**340.0**		**440.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		339.26		441.95	
		340.23		441.87	
		340.16		441.88	
Parameter		Time [s]		Time [s]	
Limit		**≤ 10.0**		**≤ 40.0**	
Disconnetion time [s]	200V to 190V	1.053	248V to 258V	1.963	
		1.051		1.820	
		1.051		1.468	
Second Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**200.0**		**460.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		199.76		458.35	
		200.55		458.37	
		200.77		458.32	
Parameter		Time [s]		Time [s]	
Limit		**≤ 0.2**		**≤ 2.0**	
Disconnetion time [s]	200V to 113V	0.142	248V to 270V	1.056	
		0.142		1.479	
		0.144		1.056	

Third Level				
	--		Over Voltage	
Parameter				Voltage [V]
Set value				**480.0**
Measured trip value [V]	--		Phase	Line to Neutral
				480.13
				480.06
				480.17
Parameter				Time [s]
Limit				**<= 0.16**
Disconnetion time [s]	--		248V to 280V	0.149
				0.148
				0.148

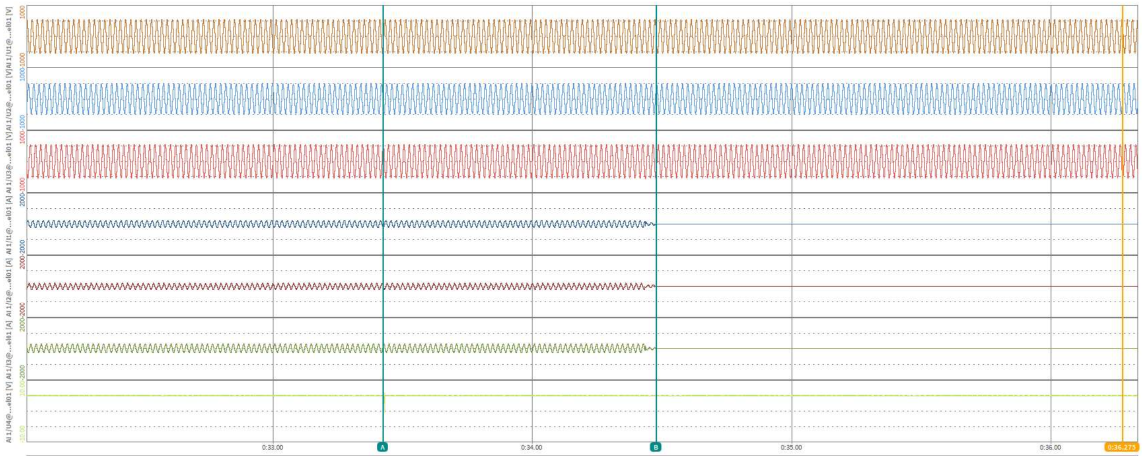
Note:

The NRS 097-2-1 provide limits of accuracy for the utility voltage and frequency measurement of the power system, The values for tolerances given in Table 2 are used,

The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,

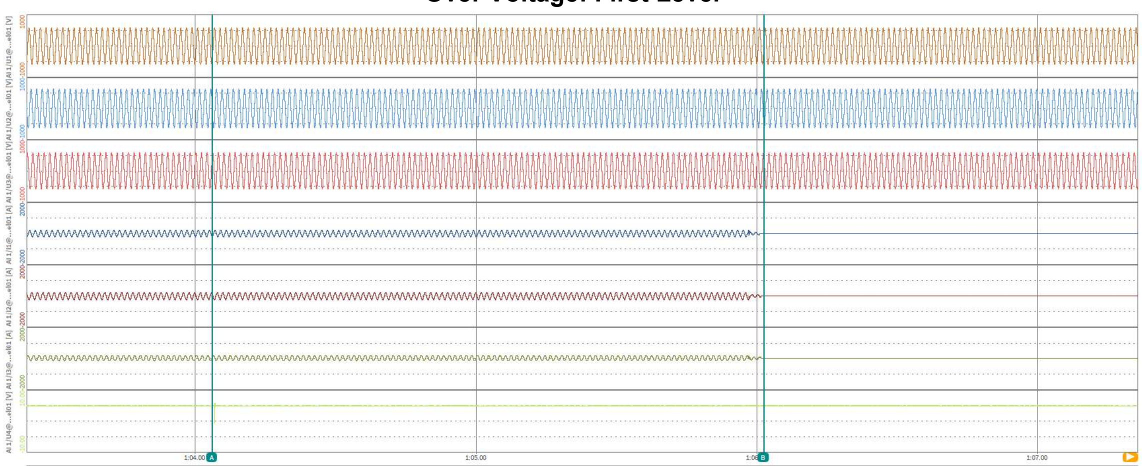
If multi-voltage control settings are not possible, the more stringent trip time should be implemented, e,g, 2 s between 110% and 120% of voltage,

Under Voltage: First Level



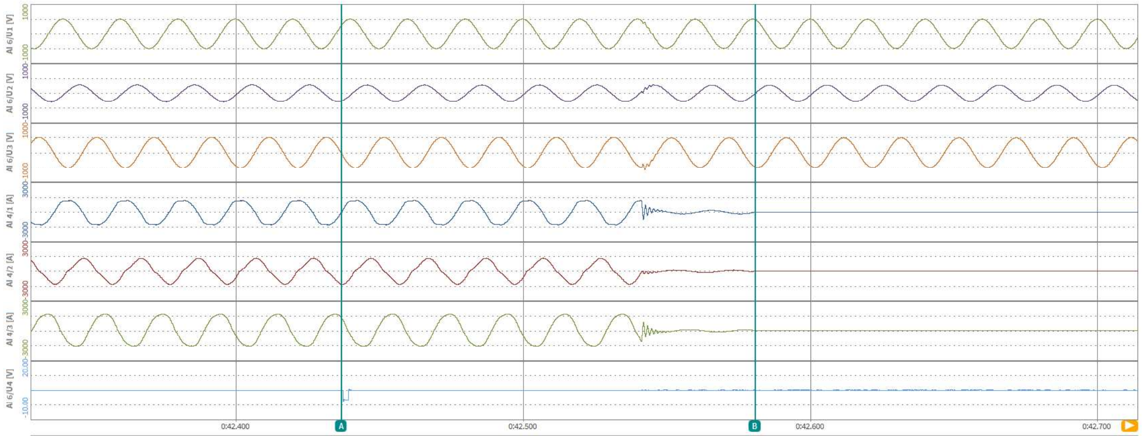
时间 [s]	A 0:33.424766	B 0:34.477627	间隔 1.052861
AI 1/U1@Trionet_Michael01 [V]	-490.8941	127.5444	618.4385
AI 1/U2@Trionet_Michael01 [V]	-2.389186	366.2284	368.6176
AI 1/U3@Trionet_Michael01 [V]	493.3130	-493.9009	-987.2139
AI 1/I1@Trionet_Michael01 [A]	-182.6172	-0.760994	181.8562
AI 1/I2@Trionet_Michael01 [A]	65.99098	-2.215815	-68.20679
AI 1/I3@Trionet_Michael01 [A]	115.7250	-0.949908	-116.6749
AI 1/U4@Trionet_Michael01 [V]	5.109072	5.105734	-3.338e-3

Over Voltage: First Level



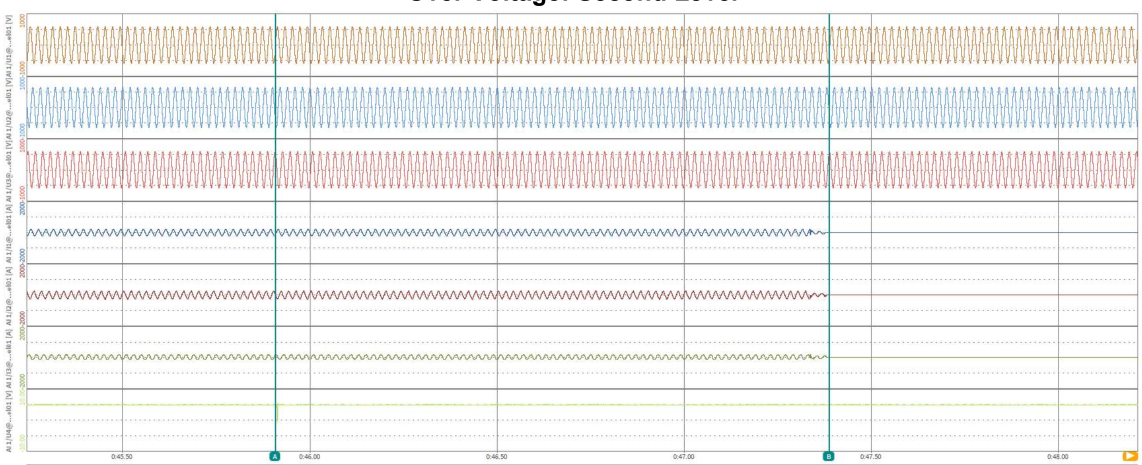
时间 [s]	A 1:04.061303	B 1:06.024748	间隔 1.963444
AI 1/U1@Trionet_Michael01 [V]	-485.1764	1.472235	486.6486
AI 1/U2@Trionet_Michael01 [V]	-10.58029	-526.3243	-515.7440
AI 1/U3@Trionet_Michael01 [V]	495.7599	524.8946	29.13475
AI 1/I1@Trionet_Michael01 [A]	-208.1208	-0.856362	207.2644
AI 1/I2@Trionet_Michael01 [A]	154.1212	-3.307772	-157.4290
AI 1/I3@Trionet_Michael01 [A]	52.44632	-1.821328	-54.26765
AI 1/U4@Trionet_Michael01 [V]	5.104542	5.107880	3.338e-3

Under Voltage: Second Level



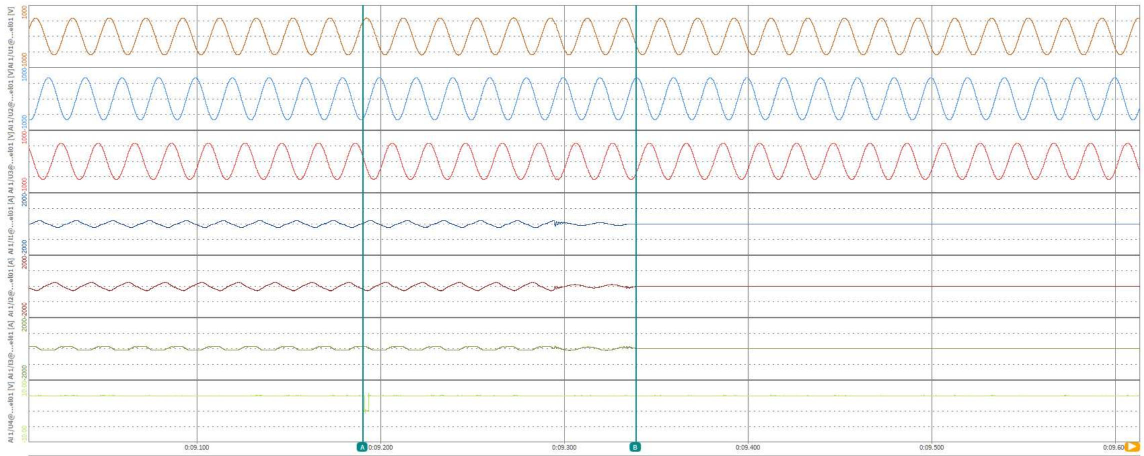
	A	B	Delta
Time [s]	0:42.4366750	0:42.5807328	0.1440578
AI 6/U1 [V]	288.0144	486.0907	198.0763
AI 6/U2 [V]	-270.4380	-1.463890	268.9741
AI 6/U3 [V]	-17.36188	-484.3748	-467.0129
AI 4/1 [A]	-48.70177	-13.03434	35.66742
AI 4/2 [A]	-1341.286	-7.169247	1334.117
AI 4/3 [A]	1363.463	21.75331	-1341.710
AI 6/U4 [V]	5.168677	5.188227	0.019550

Over Voltage: Second Level



	A	B	间隔
时间 [s]	0:45.908661	0:47.387345	1.478684
AI 1/U1@Trionet_Michael01 [V]	-42.66787	-298.6081	-255.9402
AI 1/U2@Trionet_Michael01 [V]	-512.0871	-279.2087	232.8785
AI 1/U3@Trionet_Michael01 [V]	554.7518	577.8443	23.09251
AI 1/I1@Trionet_Michael01 [A]	-100.5106	-1.297436	99.21313
AI 1/I2@Trionet_Michael01 [A]	-46.58075	-2.610398	43.97035
AI 1/I3@Trionet_Michael01 [A]	144.1910	-1.671125	-145.8621
AI 1/U4@Trionet_Michael01 [V]	5.104781	5.110264	5.484e-3

Over Voltage: Third Level



	A	B	间隔
时间 [s]	9.1904391	9.3390670	0.1486280
AI 1/U1@Trionet_Michael01 [V]	462.0498	-252.5845	-714.6342
AI 1/U2@Trionet_Michael01 [V]	-653.6205	666.3630	1319.984
AI 1/U3@Trionet_Michael01 [V]	191.5721	-413.8027	-605.3748
AI 1/I1@Trionet_Michael01 [A]	39.15624	-0.757418	-39.91366
AI 1/I2@Trionet_Michael01 [A]	-175.8453	-3.120613	172.7247
AI 1/I3@Trionet_Michael01 [A]	131.4106	-0.380088	-131.7906
AI 1/U4@Trionet_Michael01 [V]	5.105734	5.109072	3.338e-3

4.2.2.3.2	Overvoltage and undervoltage				P
Test: L3-L1					
First Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**340.0**		**440.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		339.76		442.09	
		340.86		441.93	
		339.23		441.95	
Parameter		Time [s]		Time [s]	
Limit		**≤ 10.0**		**≤ 40.0**	
Disconnetion time [s]	200V to 190V	1.052	248V to 258V	1.634	
		1.051		1.992	
		1.045		1.217	
Second Level					
	Under Voltage		**Over Voltage**		
Parameter		Voltage [V]		Voltage [V]	
Set value		**200.0**		**460.0**	
Measured trip value [V]	Phase	Line to Line	Phase	Line to Line	
		199.42		461.74	
		199.65		461.78	
		199.67		461.69	
Parameter		Time [s]		Time [s]	
Limit		**≤ 0.2**		**≤ 2.0**	
Disconnetion time [s]	200V to 113V	0.141	248V to 270V	1.656	
		0.142		1.471	
		0.141		1.731	

Third Level				
	--		Over Voltage	
Parameter				Voltage [V]
Set value				**480.0**
Measured trip value [V]	--		Phase	Line to Neutral
				480.12
				480.36
				480.29
Parameter				Time [s]
Limit				**<= 0.16**
Disconnetion time [s]	--		248V to 280V	0.147
				0.145
				0.144

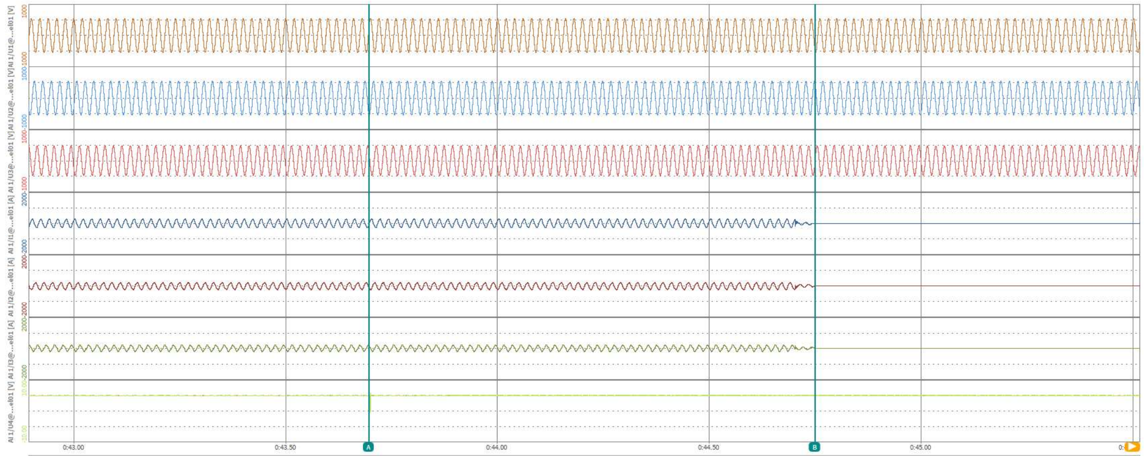
Note:

The NRS 097-2-1 provide limits of accuracy for the utility voltage and frequency measurement of the power system, The values for tolerances given in Table 2 are used,

The accuracy for voltage trip values shall be within 0 % to +1 % of the nominal voltage from the upper boundary trip setting, and within -1% to 0% of the nominal voltage from the lower boundary trip setting,

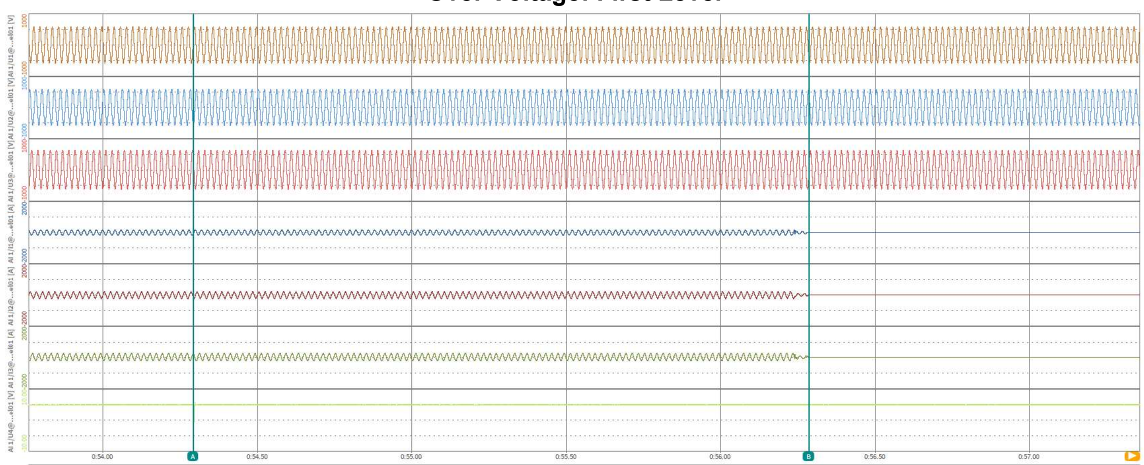
If multi-voltage control settings are not possible, the more stringent trip time should be implemented, e,g, 2 s between 110% and 120% of voltage,

Under Voltage: First Level



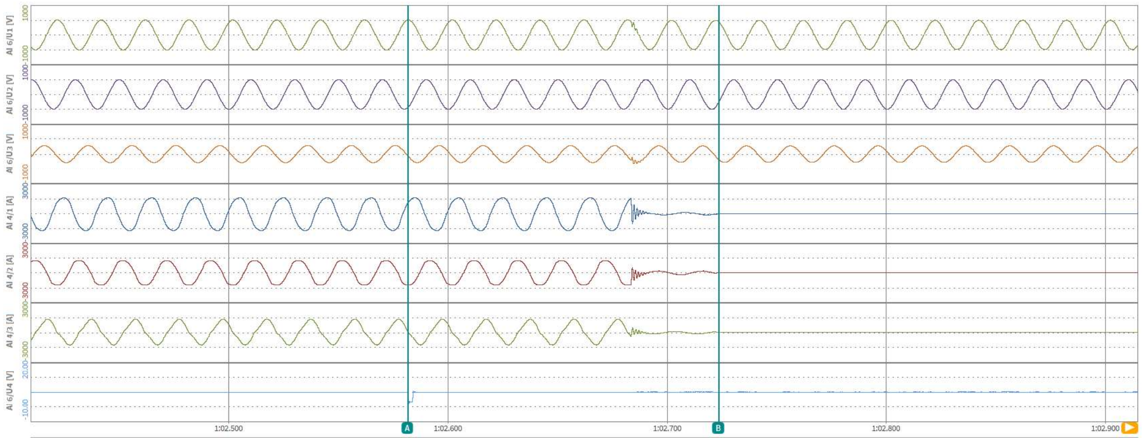
时间 [s]	A	B	间隔
	0:43.696976	0:44.749395	1.052420
AI 1/U1@Trionet_Michael01 [V]	158.9153	-459.7767	-618.6920
AI 1/U2@Trionet_Michael01 [V]	-510.9639	508.5771	1019.541
AI 1/U3@Trionet_Michael01 [V]	352.0574	-48.86518	-400.9226
AI 1/I1@Trionet_Michael01 [A]	-75.64351	-1.469098	74.17441
AI 1/I2@Trionet_Michael01 [A]	-117.2909	-2.344561	114.9464
AI 1/I3@Trionet_Michael01 [A]	191.1404	-1.748611	-192.8890
AI 1/U4@Trionet_Michael01 [V]	5.089283	5.109549	0.020266

Over Voltage: First Level



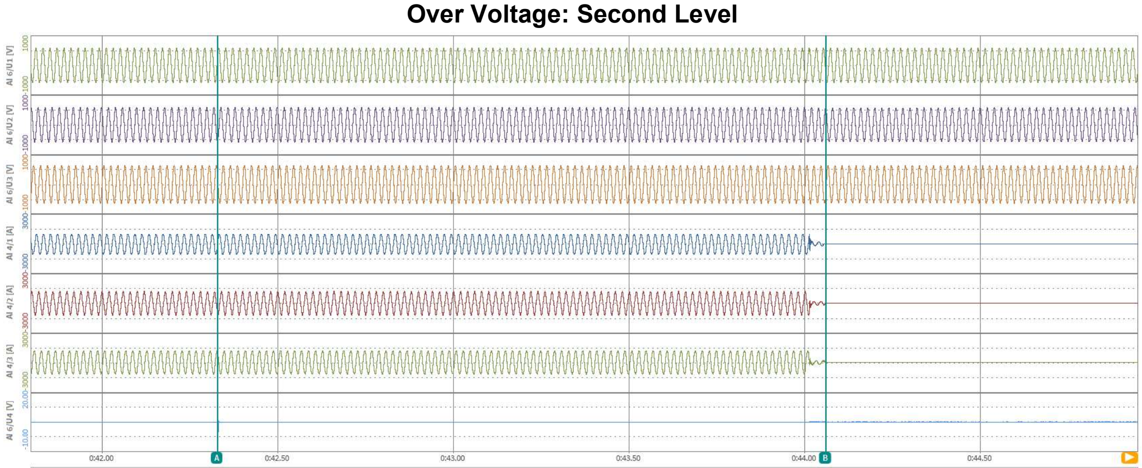
时间 [s]	A	B	间隔
	0:54.293309	0:56.285707	1.992398
AI 1/U1@Trionet_Michael01 [V]	110.3549	-441.8047	-552.1596
AI 1/U2@Trionet_Michael01 [V]	-565.4662	522.2626	1087.729
AI 1/U3@Trionet_Michael01 [V]	455.1112	-80.54815	-535.6593
AI 1/I1@Trionet_Michael01 [A]	-100.3127	-1.584731	98.72795
AI 1/I2@Trionet_Michael01 [A]	-140.7311	-3.536654	137.1944
AI 1/I3@Trionet_Michael01 [A]	237.9729	-1.346875	-239.3198
AI 1/U4@Trionet_Michael01 [V]	5.107165	5.108357	1.192e-3

Under Voltage: Second Level



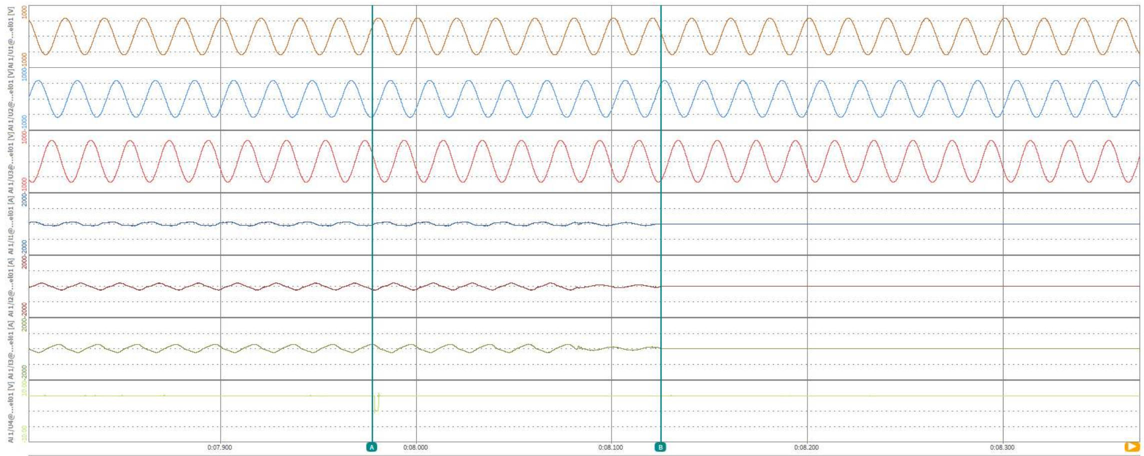
	A	B	Delta
Time [s]	1:02.5817251	1:02.7234708	0.1417457
AI 6/U1 [V]	511.5872	460.0578	-51.52941
AI 6/U2 [V]	-450.3777	-282.1851	168.1926
AI 6/U3 [V]	-60.95195	-177.6207	-116.6687
AI 4/1 [A]	1113.255	-10.24246	-1123.498
AI 4/2 [A]	-1204.224	-8.962155	1195.262
AI 4/3 [A]	88.22918	18.74209	-69.48710
AI 6/U4 [V]	5.169154	5.190611	0.021458

Over Voltage: Second Level



	A	B	Delta
Time [s]	0:42.328404	0:44.059324	1.730919
AI 6/U1 [V]	-64.56423	-50.69399	13.87024
AI 6/U2 [V]	-514.1609	554.1351	1068.296
AI 6/U3 [V]	578.9078	-503.1700	-1082.078
AI 4/1 [A]	-749.4092	-10.23531	739.1739
AI 4/2 [A]	-453.7487	-10.22816	443.5206
AI 4/3 [A]	1179.686	18.88037	-1160.805
AI 6/U4 [V]	5.183459	5.198956	0.015497

Over Voltage: Third Level



	A	B	间隔
时间 [s]	7.9776138	8.1251002	0.1474864
AI 1/U1@Trionet_Michael01 [V]	303.3927	151.5367	-151.8560
AI 1/U2@Trionet_Michael01 [V]	-586.5317	483.5596	1070.091
AI 1/U3@Trionet_Michael01 [V]	283.1825	-635.2655	-918.4480
AI 1/I1@Trionet_Michael01 [A]	-68.69718	-1.388035	67.30915
AI 1/I2@Trionet_Michael01 [A]	-210.9251	-33.64177	177.2833
AI 1/I3@Trionet_Michael01 [A]	276.6647	29.88715	-246.7775
AI 1/U4@Trionet_Michael01 [V]	5.102396	5.100251	-2.146e-3

4.2.2.3.2	**Low voltage fault Ride through capability (Category A1 and A2)**	**N/A**

General:

The purpose of these tests is to ensure that the converter, which in category A1 and A2, is insensitive to voltage dips according to the time-amplitude profile shown in the diagram,

Figure 4 — Graphical representation of voltage-ride-through and voltage disconnect requirements for A1 and A2 EG

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Tolerance	Duration [ms]	Form (*)
1 - three-phase symmetrical fault	0.60	± 0.05 ($V1/V_{nom}$)	150 ± 20	
2 - three-phase symmetrical fault	0.70	± 0.05 ($V2/V_{nom}$)	150 ± 20	
3 - three-phase symmetrical fault	0.80	± 0.05 ($V3/V_{nom}$)	600 ± 20	
4 - two-phase asymmetrical fault	0.60	± 0.05 ($V4/V_{nom}$)	150 ± 20	
5 - two -phase asymmetrical fault	0.70	± 0.05 ($V5/V_{nom}$)	150 ± 20	
6 - two -phase asymmetrical fault	0.80	± 0.05 ($V6/V_{nom}$)	600 ± 20	
7 - single-phase symmetrical fault	0.60	± 0.05 ($V7/V_{nom}$)	150 ± 20	
8 - single-phase symmetrical fault	0.70	± 0.05 ($V8/V_{nom}$)	150 ± 20	
9 - single-phase symmetrical fault	0.80	± 0.05 ($V9/V_{nom}$)	600 ± 20	

Assessment criterion:

The SSEG shall be able to withstand voltage drops without disconnecting, as shown in Figures 4 for Area X1 and Y, SSEGs of category A1 and A2 should not inject any reactive current into the network,

The test conditions are performed as worst case conditions, The inverter feeds maximal active and reactive power during the complete test,

Graph of LVRT test one				
List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Duration limit of Voltage dips [ms]	Duration measured [ms]	Result
1 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.60	150 + 20	--	--
1 – three-phase symmetrical fault (P > 0.9)	0.60	150 + 20	--	--
2 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.70	150 + 20	--	--
2 – three-phase symmetrical fault (P > 0.9)	0.70	150 + 20	--	--
3 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.80	600 + 20	--	--
3 – three-phase symmetrical fault (P > 0.9)	0.80	600 + 20	--	--
4 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.60	150 + 20	--	--
4 – two-phase asymmetrical fault (P > 0.9)	0.60	150 + 20	--	--
5 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.70	150 + 20	--	--
5 – two-phase asymmetrical fault (P > 0.9)	0.70	150 + 20	--	--
6 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.80	600 + 20	--	--
6 – two-phase asymmetrical fault (P > 0.9)	0.80	600 + 20	--	--
7 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.60	150 + 20	--	--
7 –single-phase symmetrical fault (P > 0.9)	0.60	150 + 20	--	--
8 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.70	150 + 20	--	--
8 –single-phase symmetrical fault (P > 0.9)	0.70	150 + 20	--	--
9 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.80	600 + 20	--	--
9 –single-phase symmetrical fault (P > 0.9)	0.80	600 + 20	--	--
Test conditions: Voltage simulator fall and rise time: < 10ms				
Note:				

4.2.2.3.2 Low voltage fault Ride through capability (Category A3 (For RPP Grid Code))	P

General:

The purpose of these tests is to ensure that the converter, which in category A3, is insensitive to voltage dips according to the time-amplitude profile shown in the diagram, (Area B)

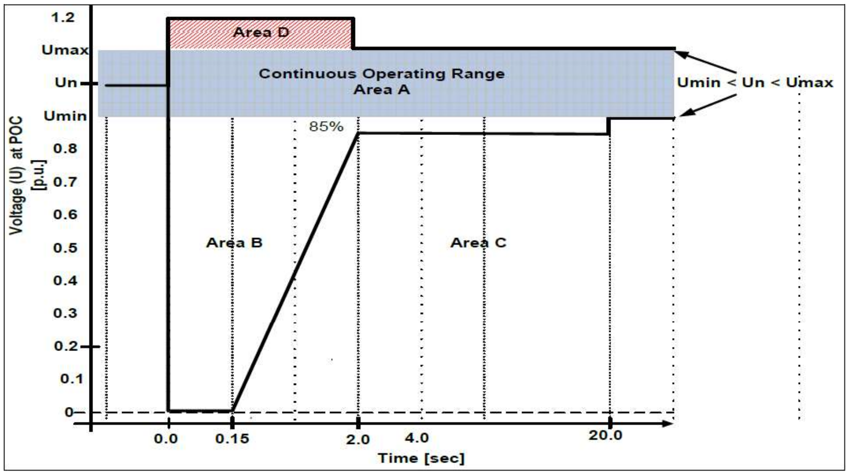


Figure 4: Voltage Ride through Capability for the RPPs of Category A3, B and C utilising non-synchronous machines

List of tests	Residual amplitude of phase-to-phase voltage V/V_{nom}	Tolerance	Duration [ms]	Form (*)
1 - three-phase symmetrical fault	0.00-0.05	$(V1/V_{nom})$	150 + 20	
2 - three-phase symmetrical fault	0.40	± 0.05$(V2//V_{nom})$	1075 + 20	
3 - three-phase symmetrical fault	0.75	± 0.05 $(V3/V_{nom})$	1780 + 20	
4 - three-phase symmetrical fault	0.85	± 0.05(V4/Vnom)	20000 + 20	
5 - two-phase asymmetrical fault	0.00-0.05	$(V5/V_{nom})$	150 + 20	
6 - two -phase asymmetrical fault	0.40	± 0.05 $(V6/V_{nom})$	1075 + 20	
7 - two -phase asymmetrical fault	0.75	± 0.05 $(V7/V_{nom})$	1780 + 20	
8 - two -phase asymmetrical fault	0.85	± 0.05 $(V8/V_{nom})$	20000 + 20	
9 - single-phase symmetrical fault	0.00-0.05	$(V9/V_{nom})$	150 + 20	
10 - single-phase symmetrical fault	0.40	± 0.05$(V10/V_{nom})$	1075 + 20	
11 - single-phase symmetrical fault	0.75	± 0.05$(V11/V_{nom})$	1780 + 20	
12 - single-phase symmetrical fault	0.85	± 0.05$(V12/V_{nom})$	20000 + 20	

Assessment criterion:

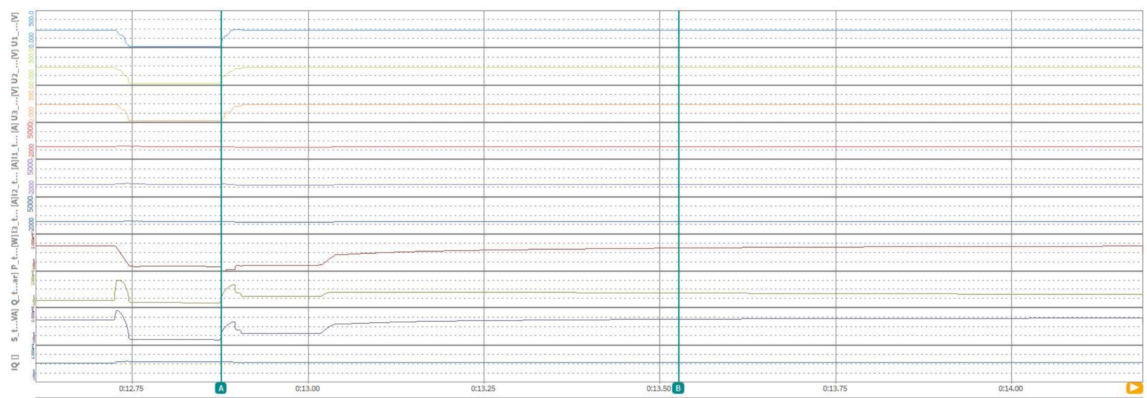
The SSEG shall be able to withstand voltage drops without disconnecting, as shown in Figures 4 for Area B, SSEGs of category A3 should not inject any reactive current into the network, The test conditions are performed as worst case conditions, The inverter feeds maximal active and reactive power during the complete test,

Graph of LVRT test one				
List of tests	**Residual amplitude of phase-to-phase voltage V/V_{nom}**	**Duration limit of Voltage dips [ms]**	**Duration measured [ms]**	**Result**
1 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.00-0.05	150 + 20	150	P
1 – three-phase symmetrical fault (P > 0.9)	0.00-0.05	150 + 20	160	P
2 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.40	1075 + 20	1083	P
2 – three-phase symmetrical fault (P > 0.9)	0.40	1075 + 20	1770	P
3 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.75	1780 + 20	1803	P
3 – three-phase symmetrical fault (P > 0.9)	0.75	1780 + 20	1809	P
4 – three-phase symmetrical fault (P = 0.1 - 0.3)	0.85	20000 + 20	20009	P
4 – three-phase symmetrical fault (P > 0.9)	0.85	20000 + 20	20017	P
5 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.00-0.05	150 + 20	152	P
5 – two-phase asymmetrical fault (P > 0.9)	0.00-0.05	150 + 20	150	P
6 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.40	1075 + 20	1080	P
6 – two-phase asymmetrical fault (P > 0.9)	0.40	1075 + 20	1083	P
7 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.75	1780 + 20	1803	P
7 – two-phase asymmetrical fault (P > 0.9)	0.75	1780 + 20	1792	P
8 – two-phase asymmetrical fault (P = 0.1 - 0.3)	0.85	20000 + 20	20006	P
8 – two-phase asymmetrical fault (P > 0.9)	0.85	20000 + 20	20015	P
9 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.00-0.05	150 + 20	153	P
9 –single-phase symmetrical fault (P > 0.9)	0.00-0.05	150 + 20	153	P
10 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.40	1075 + 20	1082	P
10 –single-phase symmetrical fault (P > 0.9)	0.40	1075 + 20	1081	P
11 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.75	1780 + 20	1800	P
11 –single-phase symmetrical fault (P > 0.9)	0.75	1780 + 20	1822	P

12 –single-phase symmetrical fault (P = 0.1 - 0.3)	0.85	20000 + 20	20007	P
12 –single-phase symmetrical fault (P > 0.9)	0.85	20000 + 20	20011	P
Test conditions: Voltage simulator fall and rise time: < 10ms				
Note:				

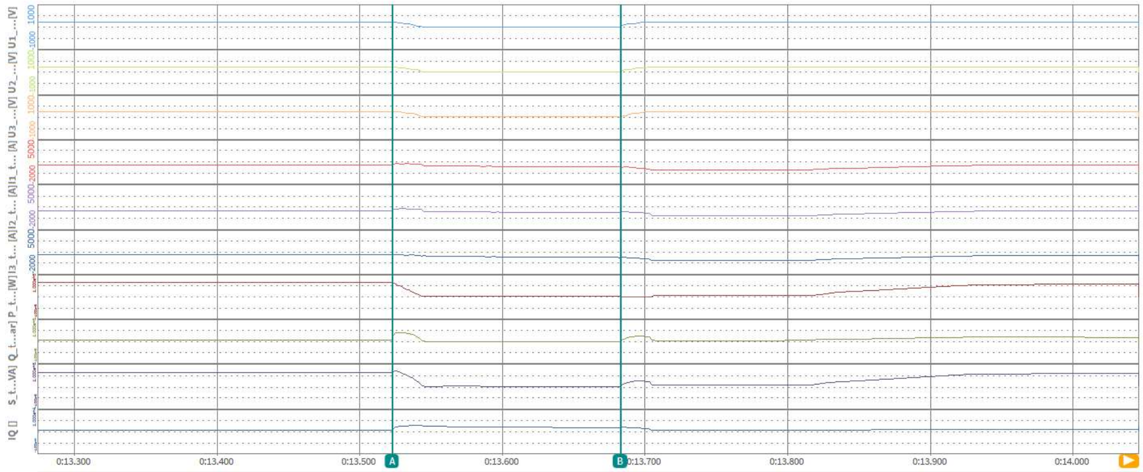
1 – three-phase symmetrical fault (P = 0.1 - 0.3)

时间 [s]	A 0:12.7265847	B 0:12.8768812	间隔 0.1502965
U1_tRMS_rc@AC [V]	229.8555	10.31461	-219.5409
U2_tRMS_rc@AC [V]	230.0902	10.28618	-219.8040
U3_tRMS_rc@AC [V]	230.3426	9.891539	-220.4510
I1_tRMS_rc@AC [A]	186.7142	208.5333	21.81905
I2_tRMS_rc@AC [A]	186.3685	209.6060	23.23749
I3_tRMS_rc@AC [A]	185.7672	209.0829	23.31570
P_t_rc@AC [W]	126592.4	2396.702	-124195.7
Q_t_rc@AC [var]	22571.55	5907.468	-16664.08
S_t_rc@AC [VA]	128589.0	6375.136	-122213.8
IQ []	98.09618	581.2086	483.1125

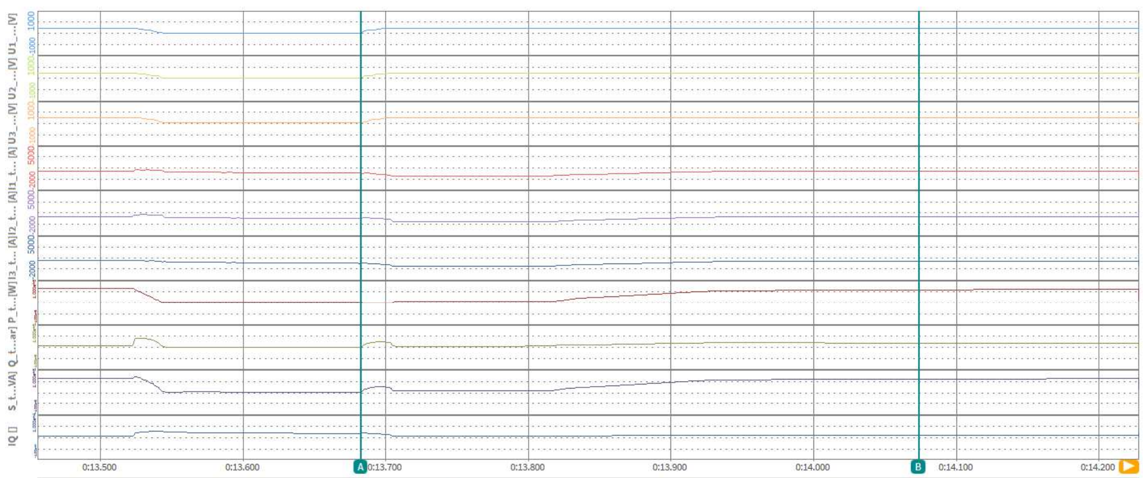


时间 [s]	A 0:12.8768812	B 0:13.5269035	间隔 0.6500223
U1_tRMS_rc@AC [V]	10.31461	230.1769	219.8623
U2_tRMS_rc@AC [V]	10.28618	230.3794	220.0932
U3_tRMS_rc@AC [V]	9.891539	230.6930	220.8015
I1_tRMS_rc@AC [A]	208.5333	190.1466	-18.38669
I2_tRMS_rc@AC [A]	209.6060	188.7682	-20.83780
I3_tRMS_rc@AC [A]	209.0829	188.7487	-20.33421
P_t_rc@AC [W]	2396.702	113419.8	111023.1
Q_t_rc@AC [var]	5907.468	65147.91	59240.44
S_t_rc@AC [VA]	6375.136	130798.7	124423.5
IQ []	581.2086	282.7398	-298.4688

1 – three-phase symmetrical fault (P > 0.9)

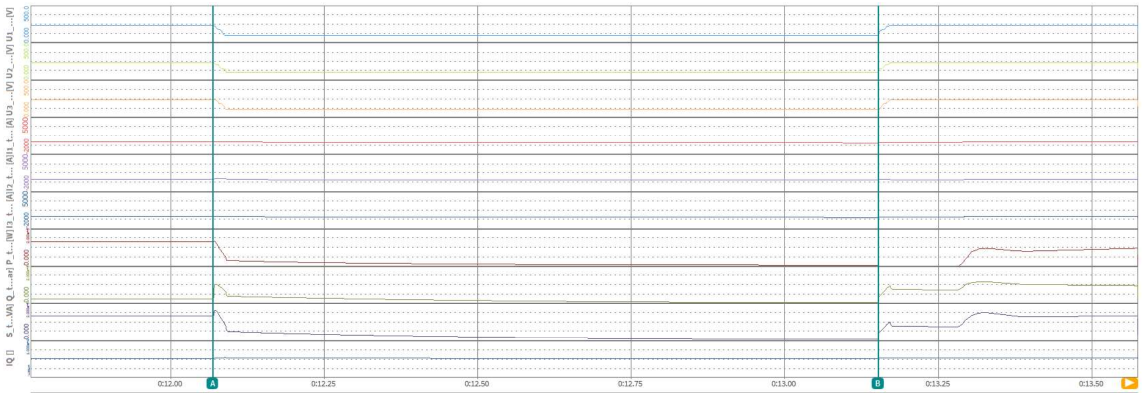


时间 [s]	A 0:13.5230047	B 0:13.6829086	间隔 0.1599039
U1_tRMS_rc@AC [V]	231.3684	9.790403	-221.5780
U2_tRMS_rc@AC [V]	230.5972	10.04053	-220.5567
U3_tRMS_rc@AC [V]	231.0553	9.573161	-221.4822
I1_tRMS_rc@AC [A]	913.3250	552.5497	-360.7753
I2_tRMS_rc@AC [A]	909.8695	536.6037	-373.2658
I3_tRMS_rc@AC [A]	921.9757	526.1241	-395.8516
P_t_rc@AC [W]	631117.3	5555.264	-625562.0
Q_t_rc@AC [var]	61999.71	14827.65	-47172.06
S_t_rc@AC [VA]	634155.3	15834.14	-618321.2
IQ []	268.3889	1512.814	1244.425

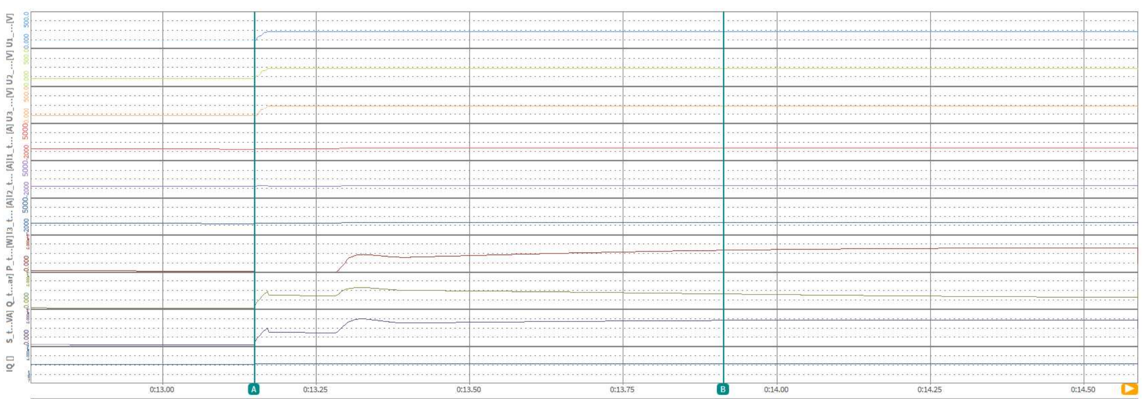


时间 [s]	A 0:13.6829086	B 0:14.0736041	间隔 0.3906955
U1_tRMS_rc@AC [V]	9.790403	231.8715	222.0811
U2_tRMS_rc@AC [V]	10.04053	231.2195	221.1790
U3_tRMS_rc@AC [V]	9.573161	231.8545	222.2813
I1_tRMS_rc@AC [A]	552.5497	864.8250	312.2752
I2_tRMS_rc@AC [A]	536.6037	859.5565	322.9528
I3_tRMS_rc@AC [A]	526.1241	868.9734	342.8493
P_t_rc@AC [W]	5555.264	567476.1	561920.9
Q_t_rc@AC [var]	14827.65	197158.0	182330.3
S_t_rc@AC [VA]	15834.14	600749.9	584915.7
IQ []	1512.814	851.1084	-661.7059

2 – three-phase symmetrical fault (P = 0.1 - 0.3)



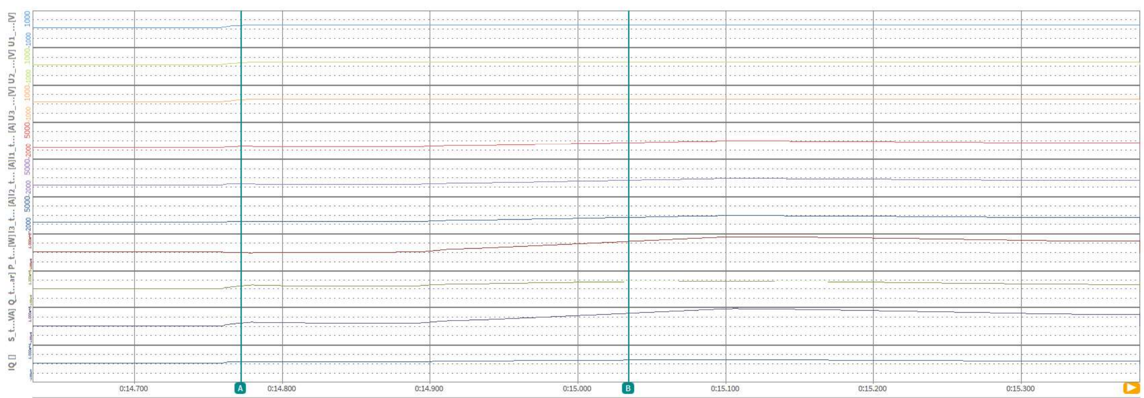
	A	B	间隔
时间 [s]	0:12.069380	0:13.152130	1.082750
U1_tRMS_rc@AC [V]	229.8429	92.08095	-137.7619
U2_tRMS_rc@AC [V]	230.0722	91.31439	-138.7578
U3_tRMS_rc@AC [V]	230.3520	91.73892	-138.6131
I1_tRMS_rc@AC [A]	187.1312	7.864375	-179.2668
I2_tRMS_rc@AC [A]	186.3868	10.44067	-175.9462
I3_tRMS_rc@AC [A]	186.3174	6.834132	-179.4833
P_t_rc@AC [W]	126838.2	947.5669	-125890.6
Q_t_rc@AC [var]	22462.21	2100.674	-20361.54
S_t_rc@AC [VA]	128811.8	2304.499	-126507.3
IQ []	97.62400	22.90526	-74.71874



	A	B	间隔
时间 [s]	0:13.149940	0:13.913264	0.763324
U1_tRMS_rc@AC [V]	91.40061	230.3109	138.9103
U2_tRMS_rc@AC [V]	91.50094	230.4261	138.9251
U3_tRMS_rc@AC [V]	92.26794	230.8774	138.6095
I1_tRMS_rc@AC [A]	8.092478	201.8823	193.7898
I2_tRMS_rc@AC [A]	10.72342	201.1666	190.4431
I3_tRMS_rc@AC [A]	6.923333	200.5421	193.6188
P_t_rc@AC [W]	978.3343	113468.0	112489.7
Q_t_rc@AC [var]	2147.293	80547.05	78399.75
S_t_rc@AC [VA]	2359.662	139150.4	136790.7
IQ []	23.41059	349.3871	325.9765

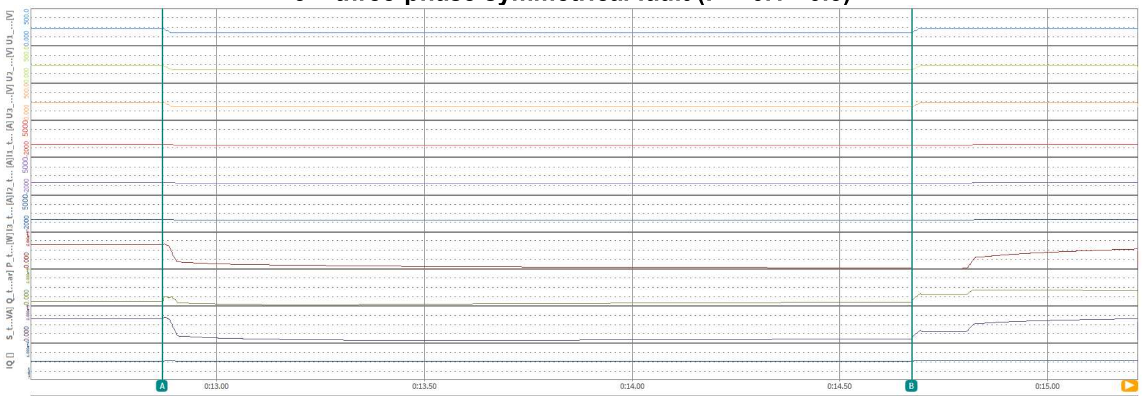
2 – three-phase symmetrical fault (P > 0.9)

	A	B	Delta
Time [s]	0:12.981750	0:14.751721	1.769971
U1_tRMS_rc@AC [V]	90.68198	91.77924	1.097260
U2_tRMS_rc@AC [V]	90.40652	91.79614	1.389626
U3_tRMS_rc@AC [V]	90.42624	91.95354	1.527306
I1_tRMS_rc@AC [A]	633.9929	17.28373	-616.7092
I2_tRMS_rc@AC [A]	552.3092	18.56669	-533.7425
I3_tRMS_rc@AC [A]	526.5041	19.23848	-507.2656
P_t_rc@AC [W]	91157.94	-1579.578	-92737.52
Q_t_rc@AC [var]	125402.3	4806.801	-120595.5
S_t_rc@AC [VA]	155033.9	5059.685	-149974.2
IQ []	1385.585	52.33717	-1333.248

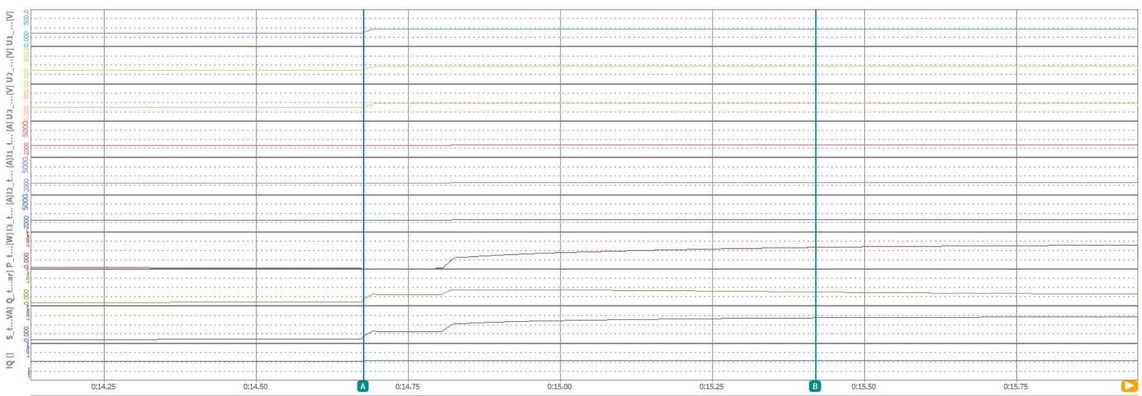


	A	B	Delta
Time [s]	0:14.772032	0:15.034321	0.262289
U1_tRMS_rc@AC [V]	182.0884	232.9024	50.81406
U2_tRMS_rc@AC [V]	187.6825	232.4811	44.79858
U3_tRMS_rc@AC [V]	175.5847	233.1633	57.57866
I1_tRMS_rc@AC [A]	279.1790	982.3312	703.1522
I2_tRMS_rc@AC [A]	329.1967	991.7952	662.5984
I3_tRMS_rc@AC [A]	202.5677	982.4791	779.9114
P_t_rc@AC [W]	-49289.88	567281.5	616571.4
Q_t_rc@AC [var]	139749.9	390051.3	250301.3
S_t_rc@AC [VA]	148187.5	688439.0	540251.5
IQ []	768.7640	1675.126	906.3617

3 – three-phase symmetrical fault (P = 0.1 - 0.3)

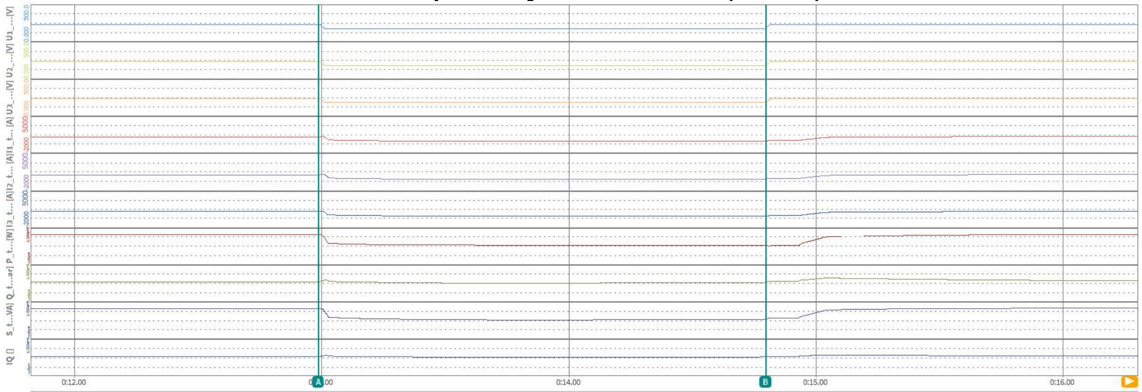


	A	B	间隔
时间 [s]	0:12.869940	0:14.673339	1.803399
U1_tRMS_rc@AC [V]	229.8362	171.9347	-57.90154
U2_tRMS_rc@AC [V]	230.0487	172.2420	-57.80666
U3_tRMS_rc@AC [V]	230.3405	172.4762	-57.86432
I1_tRMS_rc@AC [A]	186.8410	36.57398	-150.2670
I2_tRMS_rc@AC [A]	186.3542	37.91182	-148.4423
I3_tRMS_rc@AC [A]	186.1234	35.90997	-150.2135
P_t_rc@AC [W]	126736.1	704.5039	-126031.6
Q_t_rc@AC [var]	22311.69	18998.90	-3312.789
S_t_rc@AC [VA]	128685.1	19011.96	-109673.2
IQ []	96.97567	110.3191	13.34347

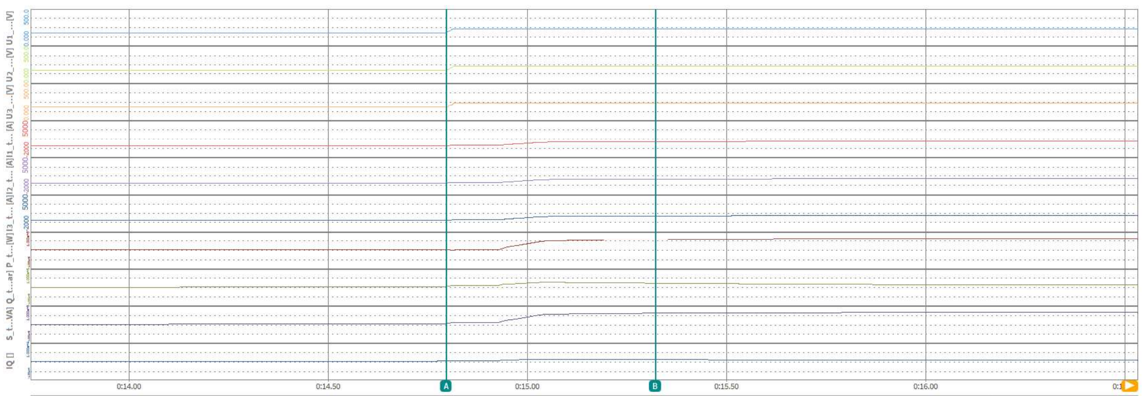


	A	B	间隔
时间 [s]	0:14.676577	0:15.419507	0.742930
U1_tRMS_rc@AC [V]	175.9810	230.2507	54.26970
U2_tRMS_rc@AC [V]	179.0831	230.3658	51.28271
U3_tRMS_rc@AC [V]	172.9603	230.7961	57.83578
I1_tRMS_rc@AC [A]	59.78668	196.6349	136.8482
I2_tRMS_rc@AC [A]	61.47736	195.2022	133.7249
I3_tRMS_rc@AC [A]	35.21004	194.7529	159.5428
P_t_rc@AC [W]	-5356.875	113453.2	118810.1
Q_t_rc@AC [var]	27096.37	73519.35	46422.98
S_t_rc@AC [VA]	27620.81	135191.4	107570.6
IQ []	153.9495	318.9963	165.0468

3 – three-phase symmetrical fault (P > 0.9)

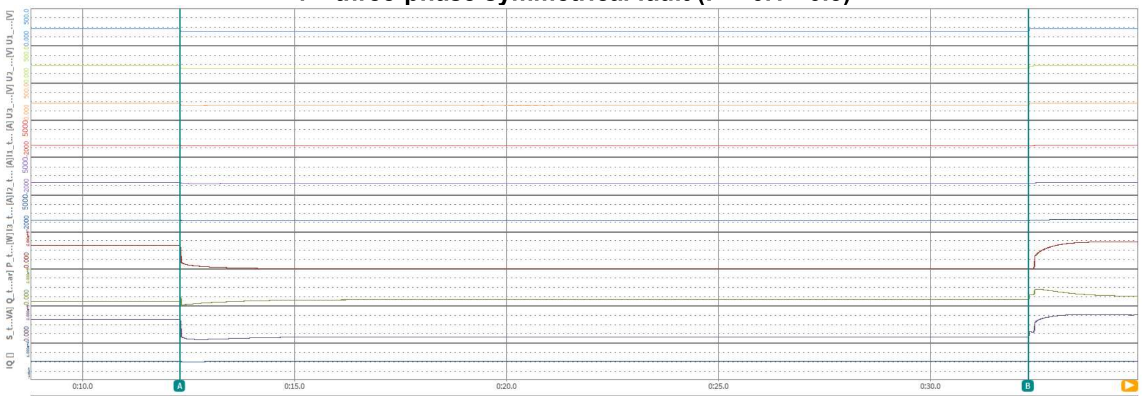


	A	B	间隔
时间 [s]	0:12.988080	0:14.796781	1.808701
U1_tRMS_rc@AC [V]	231.6465	171.9091	-59.73746
U2_tRMS_rc@AC [V]	230.0251	172.1648	-57.86038
U3_tRMS_rc@AC [V]	231.3597	172.4119	-58.94780
I1_tRMS_rc@AC [A]	915.8710	61.39515	-854.4758
I2_tRMS_rc@AC [A]	907.7257	63.33865	-844.3871
I3_tRMS_rc@AC [A]	922.8879	63.34211	-859.5458
P_t_rc@AC [W]	631419.1	-891.3635	-632310.5
Q_t_rc@AC [var]	62218.55	32367.73	-29850.82
S_t_rc@AC [VA]	634477.1	32380.00	-602097.1
IQ []	269.3322	188.0075	-81.32468

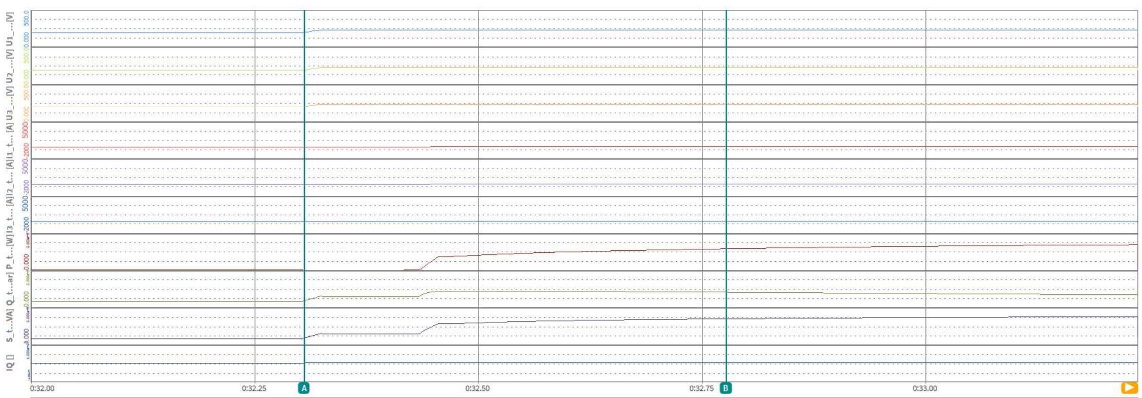


	A	B	间隔
时间 [s]	0:14.796781	0:15.321953	0.525171
U1_tRMS_rc@AC [V]	171.9091	232.0010	60.09190
U2_tRMS_rc@AC [V]	172.1648	231.3123	59.14755
U3_tRMS_rc@AC [V]	172.4119	231.8909	59.47903
I1_tRMS_rc@AC [A]	61.39515	886.1403	824.7452
I2_tRMS_rc@AC [A]	63.33865	879.7093	816.3706
I3_tRMS_rc@AC [A]	63.34211	886.8906	823.5485
P_t_rc@AC [W]	-891.3635	567429.4	568320.8
Q_t_rc@AC [var]	32367.73	236480.2	204112.4
S_t_rc@AC [VA]	32380.00	614734.9	582354.9
IQ []	188.0075	1020.478	832.4703

4 – three-phase symmetrical fault (P = 0.1 - 0.3)

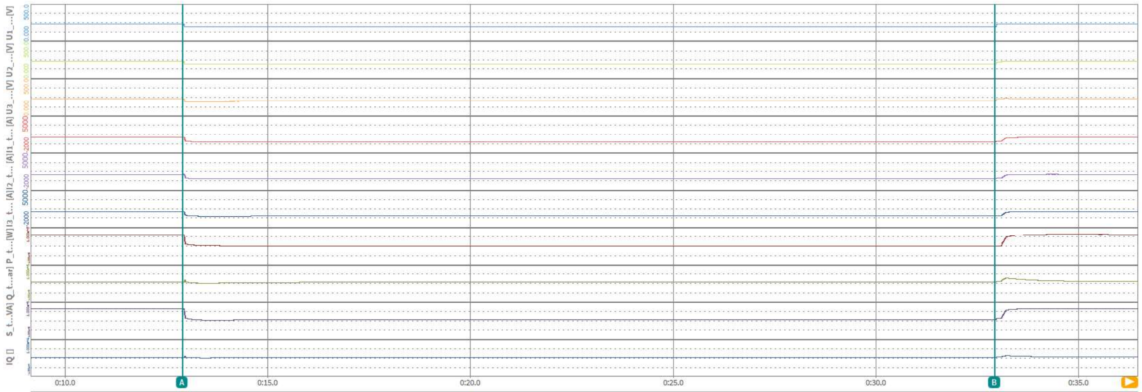


	A	B	间隔
时间 [s]	0:12.29861	0:32.30779	0:20.00918
U1_tRMS_rc@AC [V]	215.4859	202.5107	-12.97527
U2_tRMS_rc@AC [V]	221.0436	196.8668	-24.17677
U3_tRMS_rc@AC [V]	224.4948	198.3612	-26.13361
I1_tRMS_rc@AC [A]	198.6736	66.79759	-131.8761
I2_tRMS_rc@AC [A]	200.7706	59.38671	-141.3839
I3_tRMS_rc@AC [A]	197.5682	61.15794	-136.4102
P_t_rc@AC [W]	127067.1	-3611.058	-130678.1
Q_t_rc@AC [var]	34024.23	37174.89	3150.660
S_t_rc@AC [VA]	131543.5	37349.86	-94193.61
IQ []	154.4159	186.5776	32.16170

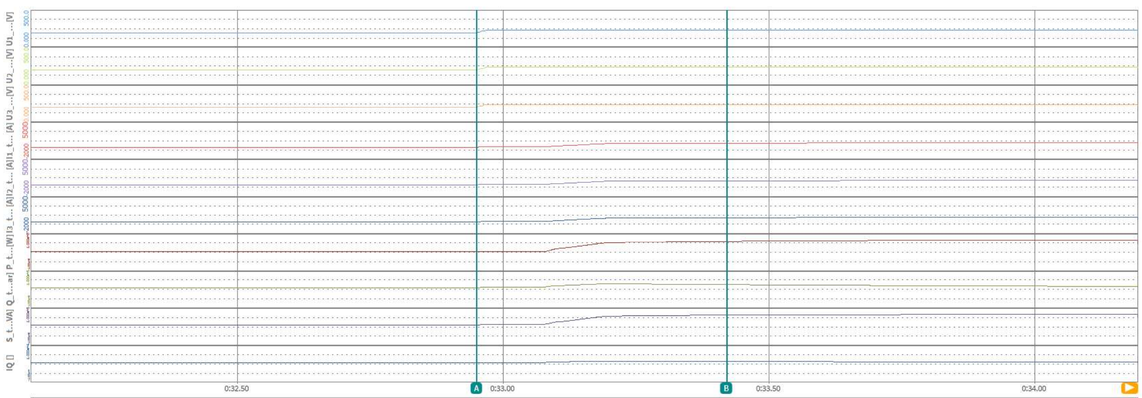


	A	B	间隔
时间 [s]	0:32.30547	0:32.77691	0.47144
U1_tRMS_rc@AC [V]	195.1887	231.0234	35.83473
U2_tRMS_rc@AC [V]	195.3956	230.1961	34.80048
U3_tRMS_rc@AC [V]	195.6286	230.8381	35.20953
I1_tRMS_rc@AC [A]	55.37864	204.9847	149.6061
I2_tRMS_rc@AC [A]	55.93333	203.6197	147.6863
I3_tRMS_rc@AC [A]	54.65086	202.0043	147.3535
P_t_rc@AC [W]	-204.8271	113514.9	113719.7
Q_t_rc@AC [var]	32429.04	83400.40	50971.36
S_t_rc@AC [VA]	32429.68	140859.0	108429.3
IQ []	165.9587	361.5323	195.5736

4 – three-phase symmetrical fault (P > 0.9)

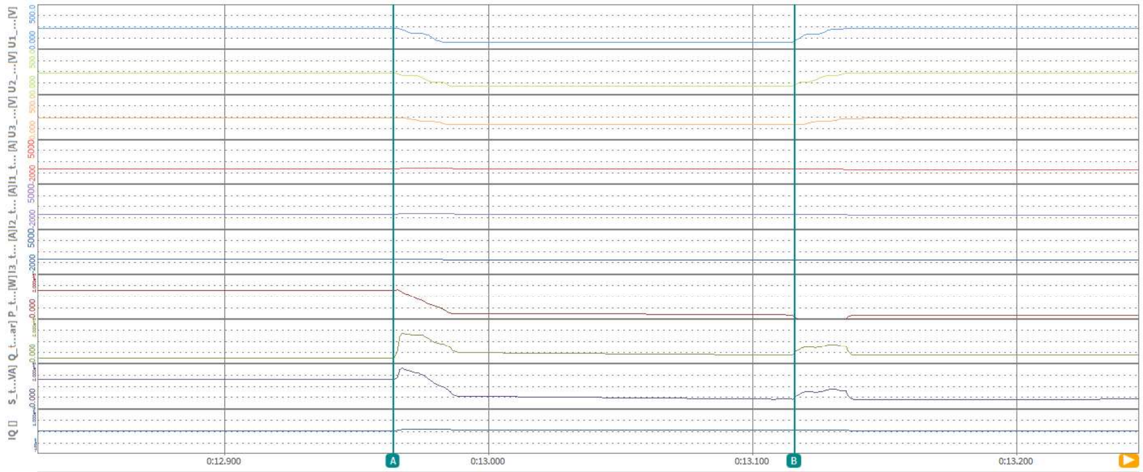


	A	B	间隔
时间 [s]	0:12.90347	0:32.92041	0:20.01694
U1_tRMS_rc@AC [V]	231.3573	194.9000	-36.45724
U2_tRMS_rc@AC [V]	230.6037	195.2055	-35.39824
U3_tRMS_rc@AC [V]	231.0773	195.4665	-35.61081
I1_tRMS_rc@AC [A]	911.7762	109.5159	-802.2603
I2_tRMS_rc@AC [A]	908.6163	110.7591	-797.8571
I3_tRMS_rc@AC [A]	920.5004	109.7388	-810.7617
P_t_rc@AC [W]	630202.9	-258.5287	-630461.5
Q_t_rc@AC [var]	61360.23	64415.18	3054.945
S_t_rc@AC [VA]	633183.1	64415.70	-568767.4
IQ []	265.6140	330.0116	64.39753

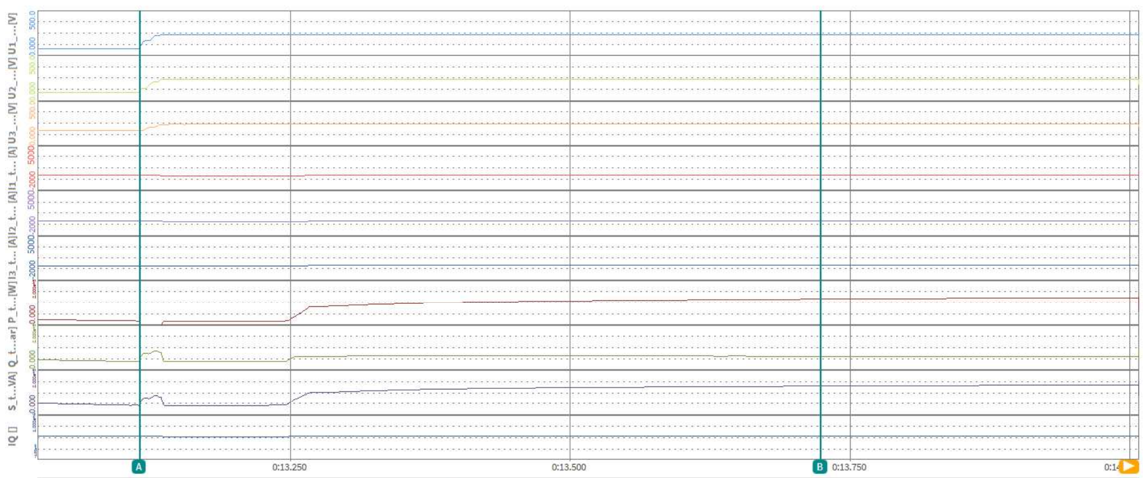


	A	B	间隔
时间 [s]	0:32.95048	0:33.42007	0.46960
U1_tRMS_rc@AC [V]	194.8768	232.0930	37.21620
U2_tRMS_rc@AC [V]	195.2375	231.4534	36.21594
U3_tRMS_rc@AC [V]	195.4831	231.9791	36.49597
I1_tRMS_rc@AC [A]	109.3002	893.3478	784.0476
I2_tRMS_rc@AC [A]	111.1287	887.3877	776.2590
I3_tRMS_rc@AC [A]	109.9950	894.4365	784.4415
P_t_rc@AC [W]	-156.2008	567854.6	568010.8
Q_t_rc@AC [var]	64498.53	249425.5	184926.9
S_t_rc@AC [VA]	64498.71	620219.3	555720.5
IQ []	330.4243	1075.843	745.4189

5 – two-phase asymmetrical fault (P = 0.1 - 0.3)

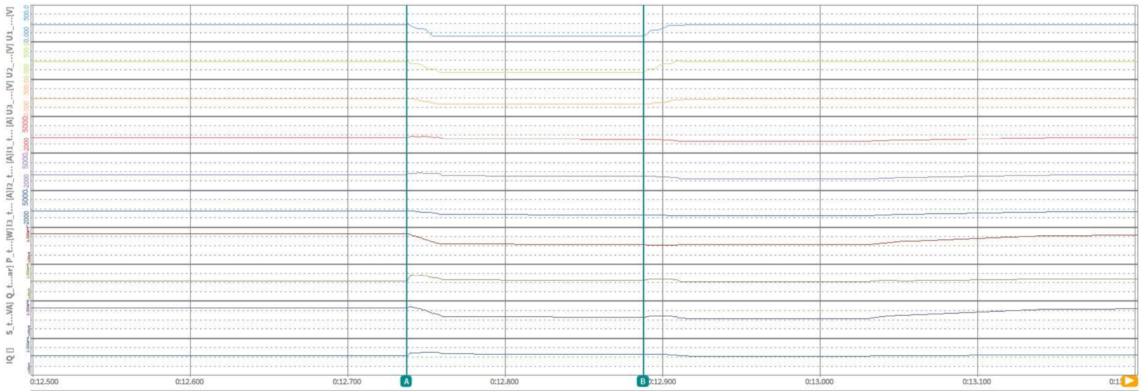


时间 [s]	A 0:12.9638201	B 0:13.1158380	间隔 0.1520178
U1_tRMS_rc@AC [V]	229.8846	75.67956	-154.2050
U2_tRMS_rc@AC [V]	230.0232	82.57539	-147.4478
U3_tRMS_rc@AC [V]	230.3656	155.6212	-74.74440
I1_tRMS_rc@AC [A]	186.6318	181.9901	-4.641693
I2_tRMS_rc@AC [A]	186.0946	210.6481	24.55351
I3_tRMS_rc@AC [A]	186.1539	48.65494	-137.4990
P_t_rc@AC [W]	126632.5	12425.01	-114207.5
Q_t_rc@AC [var]	22370.85	36692.38	14321.54
S_t_rc@AC [VA]	128593.3	38739.02	-89854.31
IQ []	97.22603	350.7025	253.4764

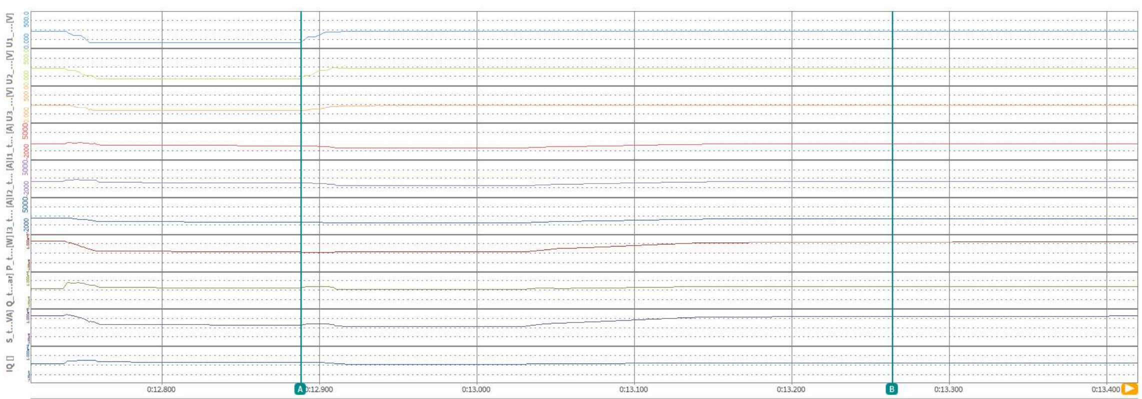


时间 [s]	A 0:13.1152225	B 0:13.7237310	间隔 0.6085085
U1_tRMS_rc@AC [V]	76.24105	230.0938	153.8528
U2_tRMS_rc@AC [V]	81.45866	230.3612	148.9025
U3_tRMS_rc@AC [V]	156.5486	230.6597	74.11113
I1_tRMS_rc@AC [A]	185.1355	187.0005	1.864990
I2_tRMS_rc@AC [A]	213.3700	185.6899	-27.68013
I3_tRMS_rc@AC [A]	48.21177	185.3341	137.1224
P_t_rc@AC [W]	12855.49	113432.0	100576.5
Q_t_rc@AC [var]	36866.13	60489.09	23622.96
S_t_rc@AC [VA]	39043.24	128552.5	89509.27
IQ []	351.9459	262.5718	-89.37401

5 – two-phase asymmetrical fault (P > 0.9)

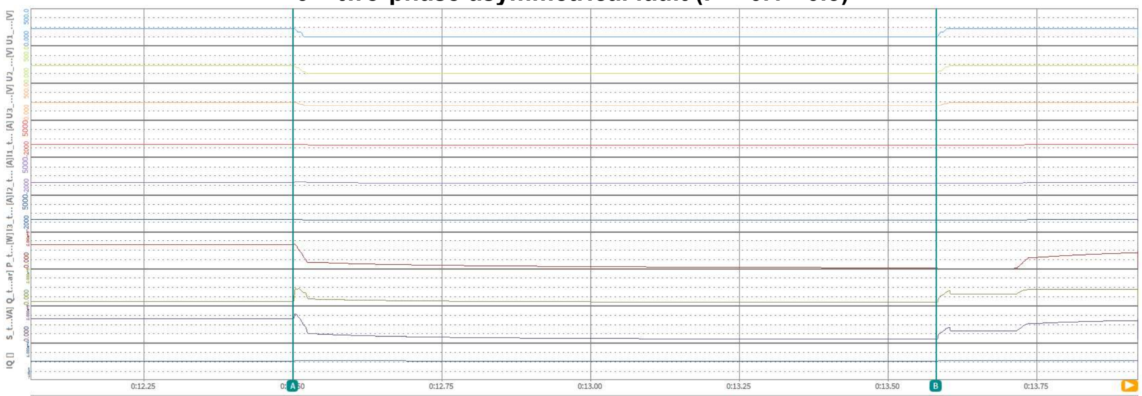


时间 [s]	A	B	间隔
	0:12.7375412	0:12.8878546	0.1503134
U1_tRMS_rc@AC [V]	231.4737	75.96129	-155.5124
U2_tRMS_rc@AC [V]	230.6330	81.50643	-149.1266
U3_tRMS_rc@AC [V]	231.0392	156.3888	-74.65044
I1_tRMS_rc@AC [A]	913.0060	499.2268	-413.7792
I2_tRMS_rc@AC [A]	909.3074	538.7632	-370.5443
I3_tRMS_rc@AC [A]	920.9163	193.3457	-727.5706
P_t_rc@AC [W]	630817.7	37351.64	-593466.0
Q_t_rc@AC [var]	61628.50	105664.1	44035.64
S_t_rc@AC [VA]	633820.9	112071.7	-521749.3
IQ []	266.7339	1009.992	743.2578

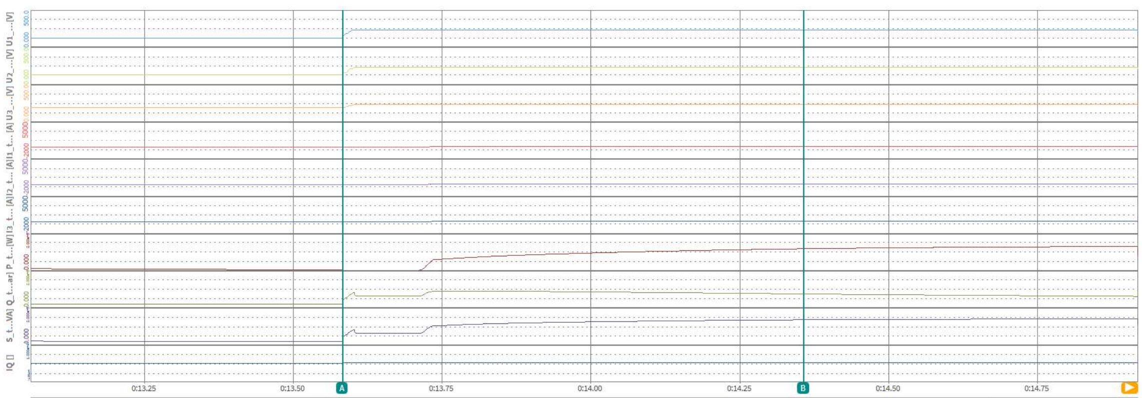


时间 [s]	A	B	间隔
	0:12.8882817	0:13.2637819	0.3755002
U1_tRMS_rc@AC [V]	75.96129	231.8847	155.9234
U2_tRMS_rc@AC [V]	81.50643	231.2894	149.7829
U3_tRMS_rc@AC [V]	156.3888	231.6354	75.24663
I1_tRMS_rc@AC [A]	499.2268	859.1190	359.8922
I2_tRMS_rc@AC [A]	538.7632	850.8177	312.0546
I3_tRMS_rc@AC [A]	193.3457	859.3849	666.0393
P_t_rc@AC [W]	37351.64	567501.7	530150.0
Q_t_rc@AC [var]	105664.1	179011.2	73347.04
S_t_rc@AC [VA]	112071.7	595065.7	482994.0
IQ []	1009.992	772.9220	-237.0697

6 – two-phase asymmetrical fault (P = 0.1 - 0.3)

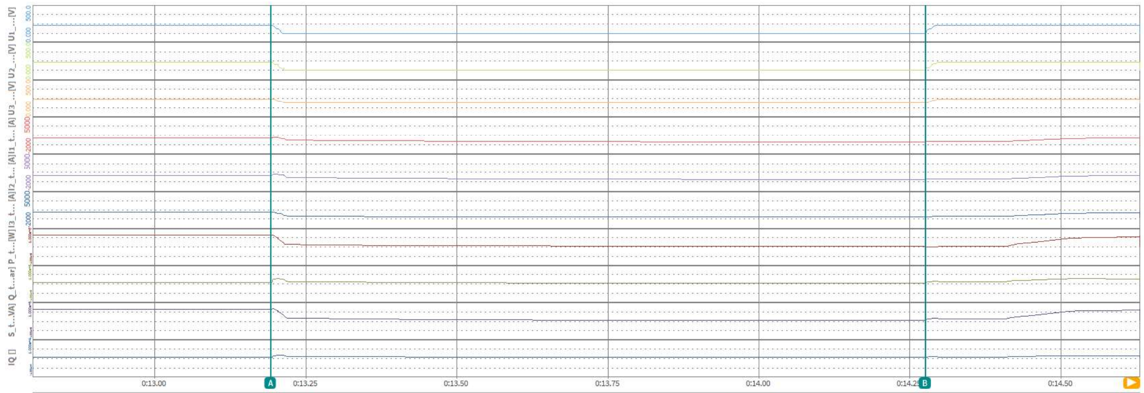


	A	B	间隔
时间 [s]	0:12.500178	0:13.580382	1.080204
U1_tRMS_rc@AC [V]	229.9413	121.4054	-108.5359
U2_tRMS_rc@AC [V]	230.0179	121.6420	-108.3759
U3_tRMS_rc@AC [V]	230.3892	184.7477	-45.64145
I1_tRMS_rc@AC [A]	186.1262	27.64817	-158.4780
I2_tRMS_rc@AC [A]	186.1166	44.38770	-141.7289
I3_tRMS_rc@AC [A]	186.0452	50.98565	-135.0595
P_t_rc@AC [W]	126507.3	539.6329	-125967.7
Q_t_rc@AC [var]	22376.51	18167.51	-4208.998
S_t_rc@AC [VA]	128471.1	18175.53	-110295.5
IQ []	97.24009	127.4034	30.16329

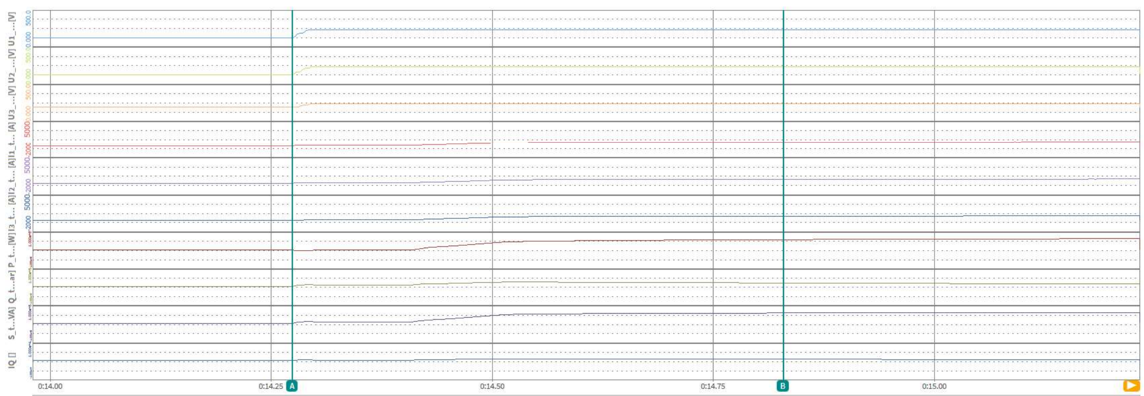


	A	B	间隔
时间 [s]	0:13.582642	0:14.357264	0.774623
U1_tRMS_rc@AC [V]	121.6673	230.3291	108.6618
U2_tRMS_rc@AC [V]	121.1136	230.3416	109.2280
U3_tRMS_rc@AC [V]	183.4480	230.8709	47.42288
I1_tRMS_rc@AC [A]	27.39187	197.1492	169.7574
I2_tRMS_rc@AC [A]	44.29223	195.8391	151.5468
I3_tRMS_rc@AC [A]	51.41420	195.4502	144.0360
P_t_rc@AC [W]	433.5720	113488.5	113054.9
Q_t_rc@AC [var]	18123.73	74292.33	56168.59
S_t_rc@AC [VA]	18128.92	135642.9	117513.9
IQ []	127.5634	322.2901	194.7267

6 – two-phase asymmetrical fault (P > 0.9)

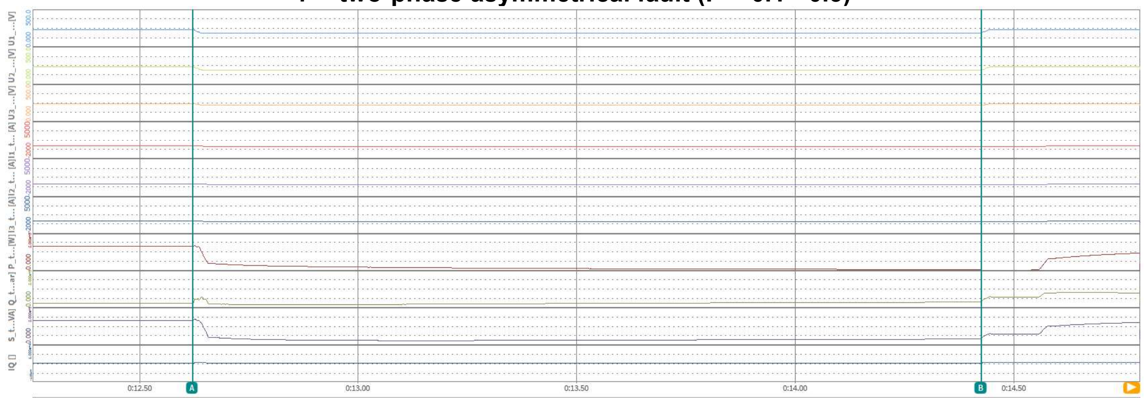


	A	B	间隔
时间 [s]	0:13.192217	0:14.275320	1.083103
U1_tRMS_rc@AC [V]	231.1967	121.4841	-109.7126
U2_tRMS_rc@AC [V]	231.1971	121.2225	-109.9746
U3_tRMS_rc@AC [V]	230.7863	183.2425	-47.54379
I1_tRMS_rc@AC [A]	910.8055	71.35073	-839.4548
I2_tRMS_rc@AC [A]	910.5709	85.08894	-825.4819
I3_tRMS_rc@AC [A]	918.8368	91.72028	-827.1165
P_t_rc@AC [W]	630097.6	-1493.618	-631591.2
Q_t_rc@AC [var]	62110.71	35758.54	-26352.17
S_t_rc@AC [VA]	633151.4	35789.72	-597361.7
IQ []	268.8077	251.8508	-16.95686

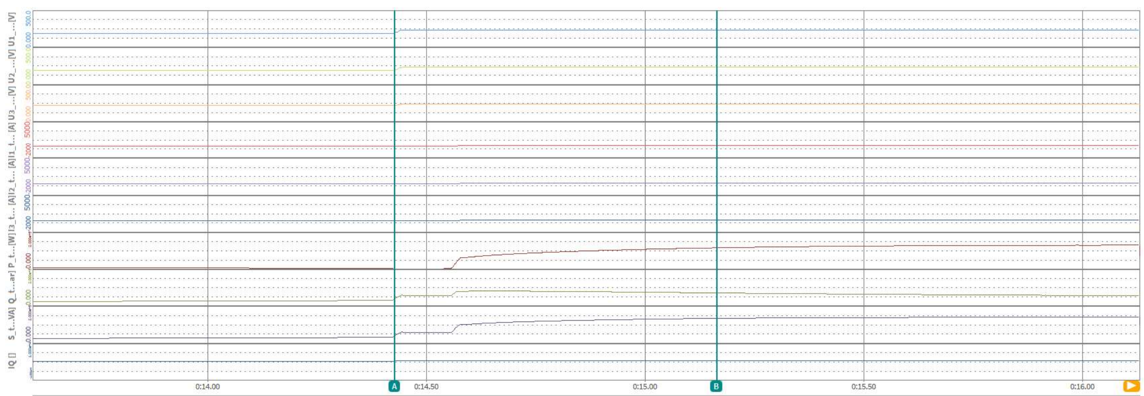


	A	B	间隔
时间 [s]	0:14.274207	0:14.828956	0.554749
U1_tRMS_rc@AC [V]	121.0363	231.9783	110.9420
U2_tRMS_rc@AC [V]	121.8959	231.1712	109.2754
U3_tRMS_rc@AC [V]	184.2815	231.8794	47.59793
I1_tRMS_rc@AC [A]	72.37240	882.8589	810.4865
I2_tRMS_rc@AC [A]	85.64181	878.2808	792.6390
I3_tRMS_rc@AC [A]	91.08315	886.9436	795.8605
P_t_rc@AC [W]	-1388.471	567903.1	569291.6
Q_t_rc@AC [var]	35957.21	232099.1	196141.9
S_t_rc@AC [VA]	35984.01	613501.4	577517.4
IQ []	252.5004	1001.825	749.3245

7 – two-phase asymmetrical fault (P = 0.1 - 0.3)



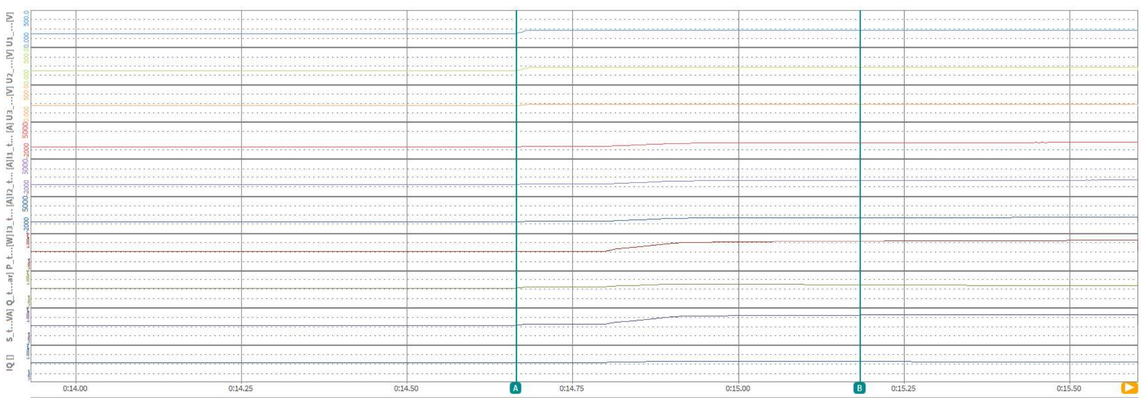
	A	B	间隔
时间 [s]	0:12.621638	0:14.424161	1.802524
U1_tRMS_rc@AC [V]	229.8582	182.2134	-47.64476
U2_tRMS_rc@AC [V]	230.0065	182.6859	-47.32057
U3_tRMS_rc@AC [V]	230.3825	210.9313	-19.45114
I1_tRMS_rc@AC [A]	186.6910	31.05263	-155.6384
I2_tRMS_rc@AC [A]	186.1671	48.73642	-137.4306
I3_tRMS_rc@AC [A]	186.5748	65.81242	-120.7624
P_t_rc@AC [W]	126754.6	662.9066	-126091.7
Q_t_rc@AC [var]	22382.74	28435.84	6053.102
S_t_rc@AC [VA]	128715.6	28443.56	-100272.1
IQ []	97.28140	148.1469	50.86547



	A	B	间隔
时间 [s]	0:14.427682	0:15.163641	0.735960
U1_tRMS_rc@AC [V]	182.3157	230.2875	47.97185
U2_tRMS_rc@AC [V]	182.8932	230.2951	47.40190
U3_tRMS_rc@AC [V]	210.9383	230.8115	19.87314
I1_tRMS_rc@AC [A]	31.35353	194.1040	162.7505
I2_tRMS_rc@AC [A]	48.50768	192.2196	143.7119
I3_tRMS_rc@AC [A]	65.73580	192.6018	126.8660
P_t_rc@AC [W]	558.5992	113488.5	112929.9
Q_t_rc@AC [var]	28448.68	70154.85	41706.17
S_t_rc@AC [VA]	28454.16	133421.7	104967.5
IQ []	148.1324	304.4061	156.2737

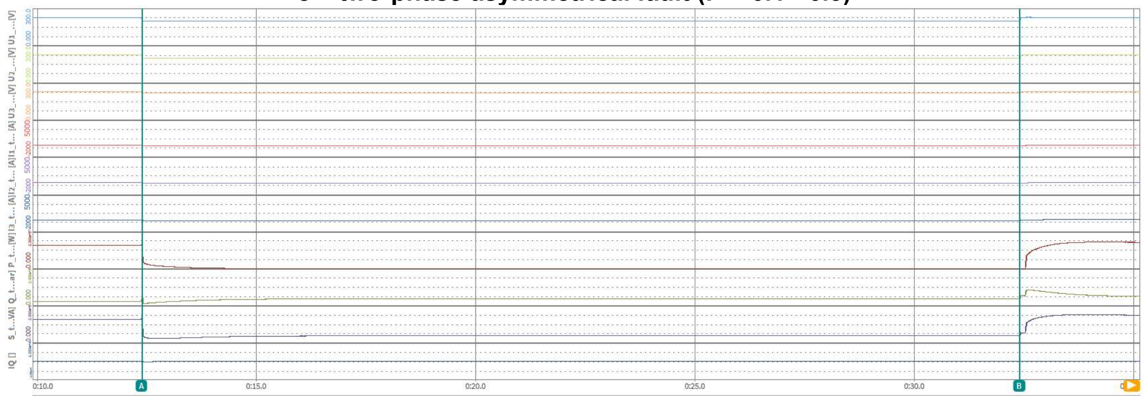
7 – two-phase asymmetrical fault (P > 0.9)

	A	B	间隔
时间 [s]	0:12.870439	0:14.662862	1.792424
U1_tRMS_rc@AC [V]	231.4085	182.1852	-49.22327
U2_tRMS_rc@AC [V]	230.6016	182.6247	-47.97690
U3_tRMS_rc@AC [V]	231.0891	210.8736	-20.21552
I1_tRMS_rc@AC [A]	912.9123	54.12767	-858.7846
I2_tRMS_rc@AC [A]	909.0707	87.67265	-821.3981
I3_tRMS_rc@AC [A]	921.1061	122.7965	-798.3097
P_t_rc@AC [W]	630708.1	-688.3223	-631396.4
Q_t_rc@AC [var]	61983.03	51762.42	-10220.61
S_t_rc@AC [VA]	633746.5	51767.00	-581979.5
IQ []	268.2864	269.7441	1.457741

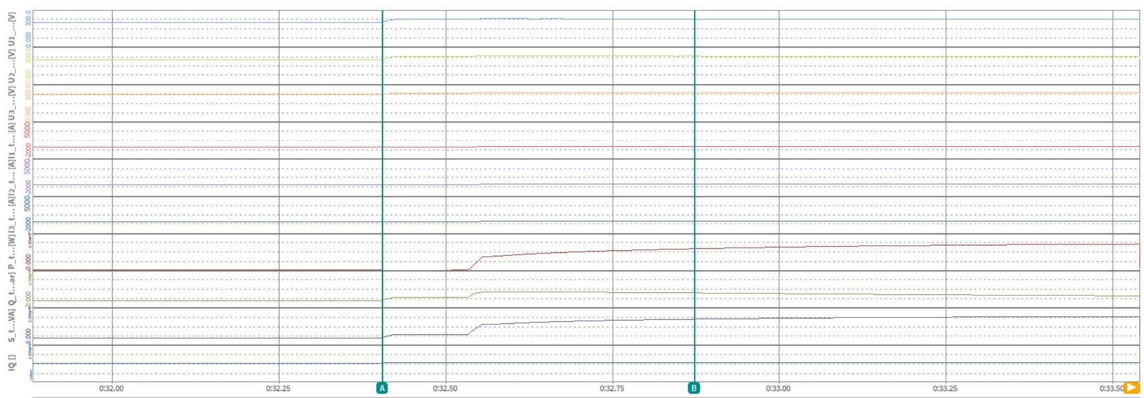


	A	B	间隔
时间 [s]	0:14.664497	0:15.183549	0.519052
U1_tRMS_rc@AC [V]	182.1835	231.9749	49.79143
U2_tRMS_rc@AC [V]	182.6350	231.2758	48.64078
U3_tRMS_rc@AC [V]	210.8737	231.8778	21.00410
I1_tRMS_rc@AC [A]	54.31591	879.3242	825.0083
I2_tRMS_rc@AC [A]	87.71359	872.9954	785.2818
I3_tRMS_rc@AC [A]	122.8315	882.8173	759.9858
P_t_rc@AC [W]	-675.2772	567043.3	567718.5
Q_t_rc@AC [var]	51812.57	226454.4	174641.9
S_t_rc@AC [VA]	51816.97	610589.6	558772.7
IQ []	270.0014	977.3204	707.3190

8 – two-phase asymmetrical fault (P = 0.1 - 0.3)



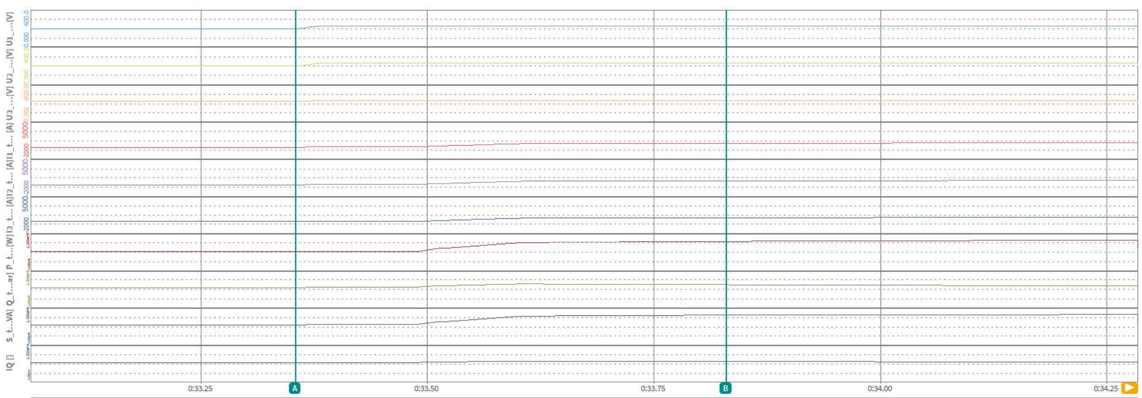
	A	B	间隔
时间 [s]	0:12.39425	0:32.40050	0:20.00625
U1_tRMS_rc@AC [V]	228.8904	200.8035	-28.08693
U2_tRMS_rc@AC [V]	228.2604	201.2975	-26.96286
U3_tRMS_rc@AC [V]	229.7175	218.6335	-11.08403
I1_tRMS_rc@AC [A]	189.8641	49.14576	-140.7184
I2_tRMS_rc@AC [A]	196.3366	58.05703	-138.2796
I3_tRMS_rc@AC [A]	187.2646	71.66071	-115.6039
P_t_rc@AC [W]	128214.3	-240.0688	-128454.4
Q_t_rc@AC [var]	28260.41	37222.03	8961.623
S_t_rc@AC [VA]	131291.9	37222.80	-94069.12
IQ []	123.4316	179.8935	56.46193



	A	B	间隔
时间 [s]	0:32.40518	0:32.87278	0.46760
U1_tRMS_rc@AC [V]	200.8031	230.4252	29.62215
U2_tRMS_rc@AC [V]	201.3179	230.5833	29.26540
U3_tRMS_rc@AC [V]	218.6262	230.9954	12.36920
I1_tRMS_rc@AC [A]	49.31426	201.5704	152.2562
I2_tRMS_rc@AC [A]	58.04093	200.1889	142.1480
I3_tRMS_rc@AC [A]	71.54331	199.8199	128.2766
P_t_rc@AC [W]	-191.1841	113461.2	113652.4
Q_t_rc@AC [var]	37227.89	79888.57	42660.68
S_t_rc@AC [VA]	37228.38	138764.6	101536.2
IQ []	179.9181	346.3357	166.4176

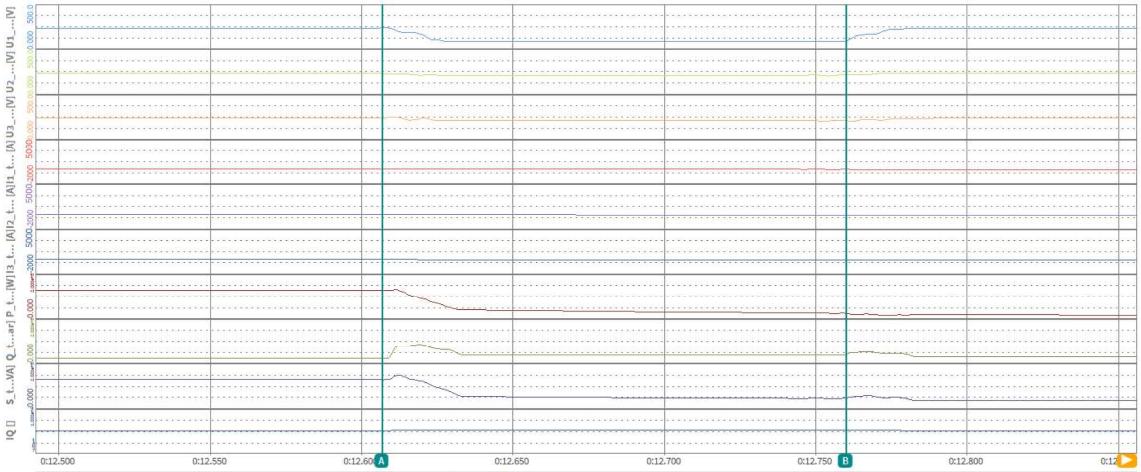
8 – two-phase asymmetrical fault (P > 0.9)

	A	B	间隔
时间 [s]	0:13.34022	0:33.35479	0:20.01457
U1_tRMS_rc@AC [V]	231.3423	200.8690	-30.47324
U2_tRMS_rc@AC [V]	230.6513	201.2685	-29.38280
U3_tRMS_rc@AC [V]	231.0519	218.6093	-12.44261
I1_tRMS_rc@AC [A]	912.8766	98.14506	-814.7316
I2_tRMS_rc@AC [A]	909.5616	115.7014	-793.8602
I3_tRMS_rc@AC [A]	920.3414	144.1572	-776.1842
P_t_rc@AC [W]	630577.7	-467.9325	-631045.6
Q_t_rc@AC [var]	62069.40	74513.98	12444.58
S_t_rc@AC [VA]	633625.2	74515.45	-559109.7
IQ []	268.6811	360.1177	91.43666

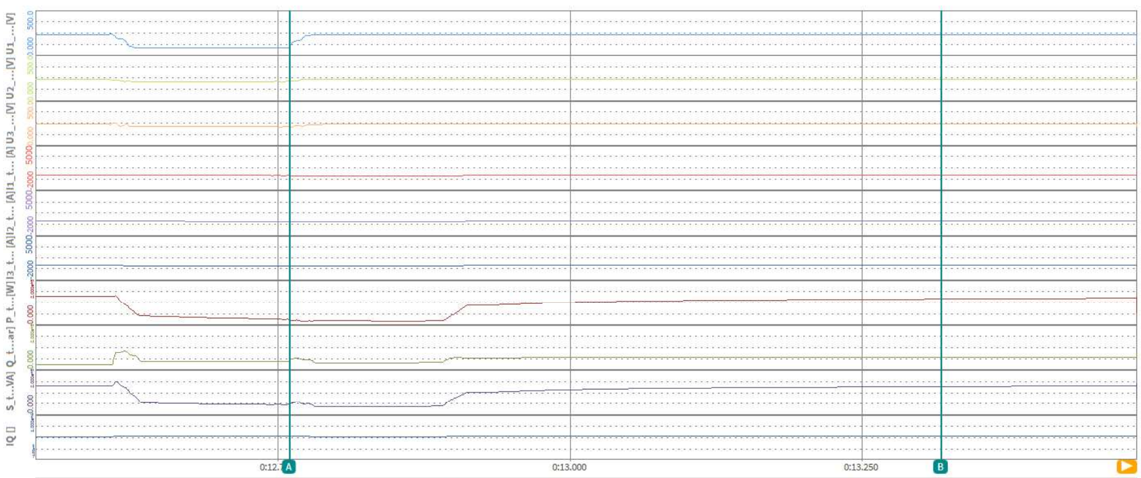


	A	B	间隔
时间 [s]	0:33.35442	0:33.82961	0.47519
U1_tRMS_rc@AC [V]	200.8690	232.0515	31.18243
U2_tRMS_rc@AC [V]	201.2685	231.3804	30.11186
U3_tRMS_rc@AC [V]	218.6093	231.9823	13.37297
I1_tRMS_rc@AC [A]	98.14506	887.8655	789.7204
I2_tRMS_rc@AC [A]	115.7014	882.9243	767.2230
I3_tRMS_rc@AC [A]	144.1572	891.4065	747.2493
P_t_rc@AC [W]	-467.9325	567865.4	568333.4
Q_t_rc@AC [var]	74513.98	241570.9	167056.9
S_t_rc@AC [VA]	74515.45	617112.4	542596.9
IQ []	360.1177	1042.131	682.0134

9 –single-phase symmetrical fault (P = 0.1 - 0.3)

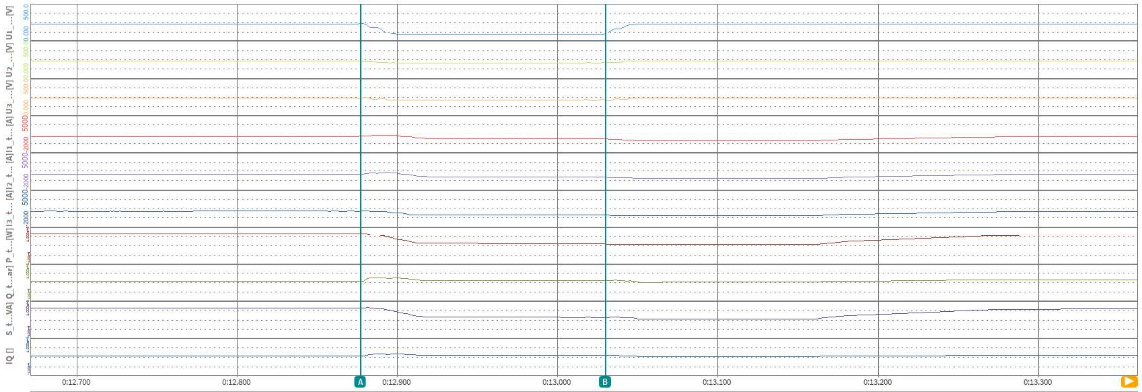


时间 [s]	A 0:12.6068570	B 0:12.7598657	间隔 0.1530087
U1_tRMS_rc@AC [V]	230.9918	81.69301	-149.2988
U2_tRMS_rc@AC [V]	230.6402	209.6181	-21.02205
U3_tRMS_rc@AC [V]	228.6267	205.6325	-22.99416
I1_tRMS_rc@AC [A]	187.3102	141.3257	-45.98447
I2_tRMS_rc@AC [A]	186.8242	116.7338	-70.09034
I3_tRMS_rc@AC [A]	184.6854	33.48579	-151.1996
P_t_rc@AC [W]	126608.1	21240.88	-105367.2
Q_t_rc@AC [var]	22433.80	37273.15	14839.35
S_t_rc@AC [VA]	128580.3	42900.61	-85679.64
IQ []	97.50170	225.0143	127.5126

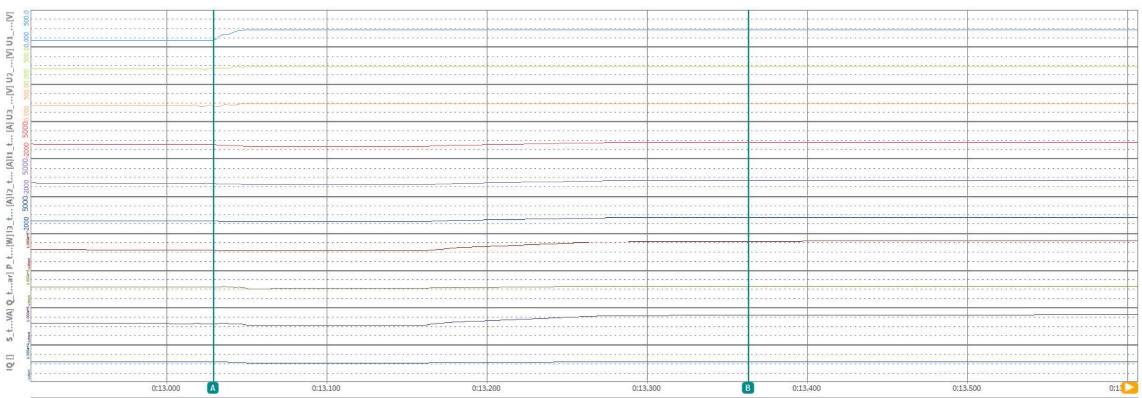


时间 [s]	A 0:12.7599675	B 0:13.3176912	间隔 0.5577236
U1_tRMS_rc@AC [V]	81.69301	230.1123	148.4193
U2_tRMS_rc@AC [V]	209.6181	230.3265	20.70839
U3_tRMS_rc@AC [V]	205.6325	230.6336	25.00108
I1_tRMS_rc@AC [A]	141.3257	183.7456	42.41992
I2_tRMS_rc@AC [A]	116.7338	182.6199	65.88602
I3_tRMS_rc@AC [A]	33.48579	182.4653	148.9795
P_t_rc@AC [W]	21240.88	113443.8	92202.92
Q_t_rc@AC [var]	37273.15	55805.70	18532.55
S_t_rc@AC [VA]	42900.61	126426.9	83526.32
IQ []	225.0143	242.2570	17.24265

9 –single-phase symmetrical fault (P > 0.9)

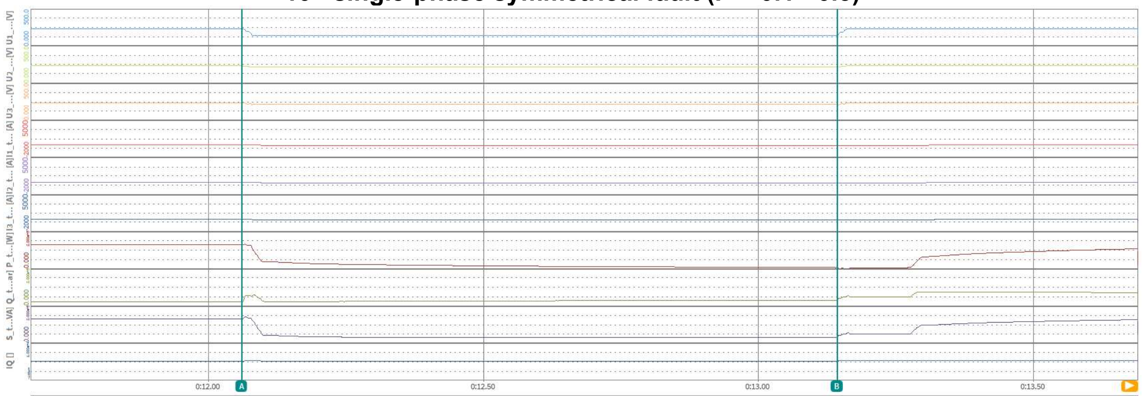


	A	B	间隔
时间 [s]	0:12.8771107	0:13.0298717	0.1527610
U1_tRMS_rc@AC [V]	234.9677	80.80636	-154.1614
U2_tRMS_rc@AC [V]	231.1088	211.0844	-20.02444
U3_tRMS_rc@AC [V]	226.6026	205.7731	-20.82941
I1_tRMS_rc@AC [A]	928.4323	427.3484	-501.0839
I2_tRMS_rc@AC [A]	912.1105	278.8593	-633.2513
I3_tRMS_rc@AC [A]	899.0362	159.7949	-739.2413
P_t_rc@AC [W]	629468.8	60759.44	-568709.4
Q_t_rc@AC [var]	63586.68	110698.3	47111.66
S_t_rc@AC [VA]	632672.3	126276.8	-506395.5
IQ []	275.3945	667.3079	391.9133



	A	B	间隔
时间 [s]	0:13.0294521	0:13.3632596	0.3338075
U1_tRMS_rc@AC [V]	80.26495	231.3735	151.1086
U2_tRMS_rc@AC [V]	210.2202	231.4293	21.20901
U3_tRMS_rc@AC [V]	208.3510	231.6226	23.27158
I1_tRMS_rc@AC [A]	422.0826	850.9686	428.8860
I2_tRMS_rc@AC [A]	280.4487	847.6106	567.1619
I3_tRMS_rc@AC [A]	153.5066	850.6852	697.1786
P_t_rc@AC [W]	60845.48	567052.3	506206.8
Q_t_rc@AC [var]	108982.9	163277.5	54294.56
S_t_rc@AC [VA]	124817.7	590091.4	465273.8
IQ []	655.4232	705.3782	49.95501

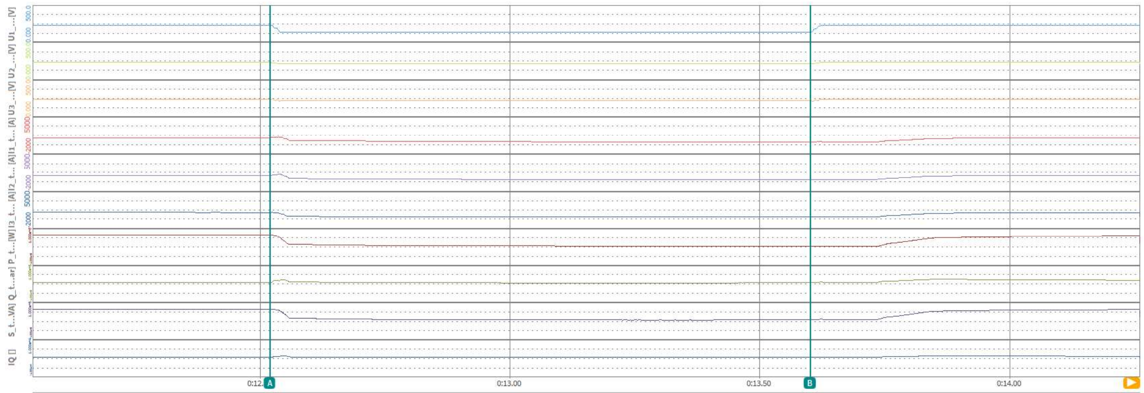
10 –single-phase symmetrical fault (P = 0.1 - 0.3)



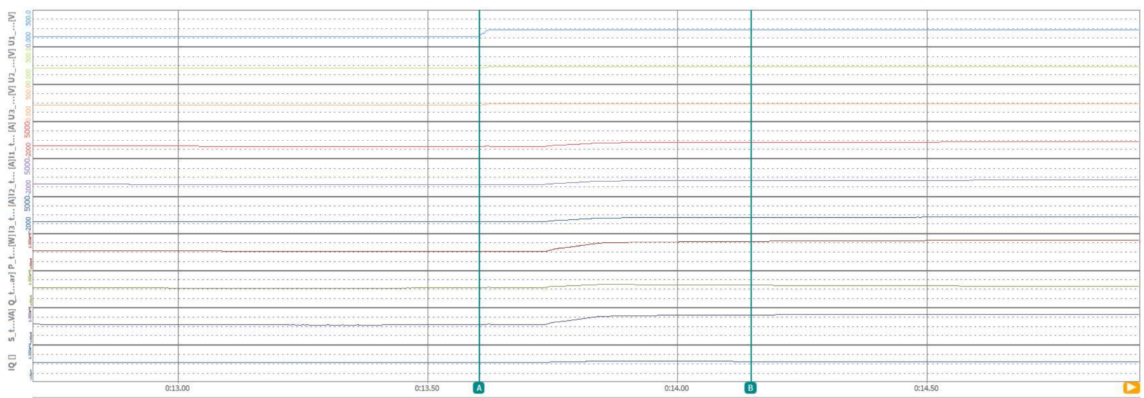
	A	B	间隔
时间 [s]	0:12.060379	0:13.143263	1.082884
U1_tRMS_rc@AC [V]	229.8531	135.2488	-94.60426
U2_tRMS_rc@AC [V]	229.9927	212.0644	-17.92828
U3_tRMS_rc@AC [V]	230.3204	214.6936	-15.62679
I1_tRMS_rc@AC [A]	186.4826	27.09068	-159.3919
I2_tRMS_rc@AC [A]	186.1587	72.81901	-113.3397
I3_tRMS_rc@AC [A]	186.3401	54.57224	-131.7678
P_t_rc@AC [W]	126642.1	1865.727	-124776.3
Q_t_rc@AC [var]	22335.90	30766.10	8430.195
S_t_rc@AC [VA]	128596.7	30822.61	-97774.05
IQ []	97.08923	164.2298	67.14060

	A	B	间隔
时间 [s]	0:13.144487	0:13.902312	0.757825
U1_tRMS_rc@AC [V]	134.7642	230.2085	95.44423
U2_tRMS_rc@AC [V]	214.0393	230.3107	16.27133
U3_tRMS_rc@AC [V]	213.7925	230.7404	16.94788
I1_tRMS_rc@AC [A]	27.46307	191.3734	163.9104
I2_tRMS_rc@AC [A]	72.71101	189.8663	117.1553
I3_tRMS_rc@AC [A]	54.31087	190.1789	135.8680
P_t_rc@AC [W]	2237.393	113411.7	111174.3
Q_t_rc@AC [var]	30794.14	66885.84	36091.70
S_t_rc@AC [VA]	30875.31	131666.0	100790.6
IQ []	164.2074	290.2781	126.0708

10 –single-phase symmetrical fault (P > 0.9)

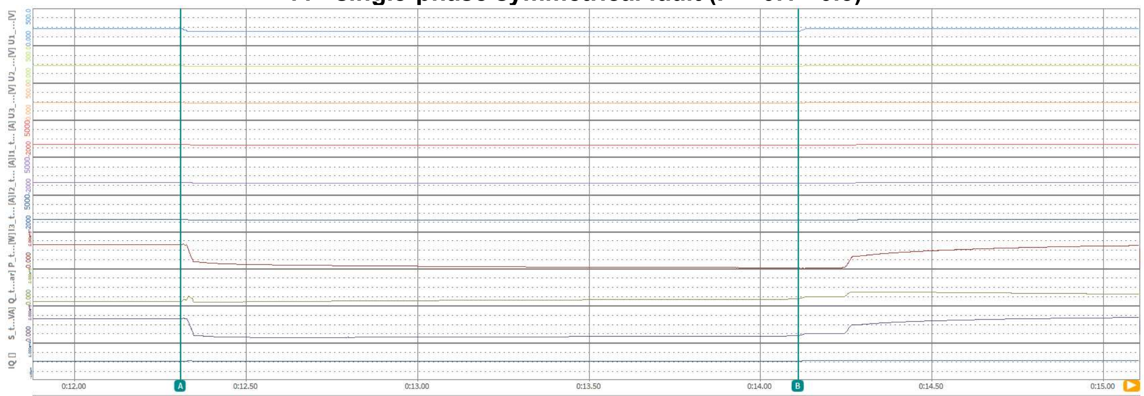


	A	B	间隔
时间 [s]	0:12.519719	0:13.600930	1.081211
U1_tRMS_rc@AC [V]	231.1155	137.2685	-93.84702
U2_tRMS_rc@AC [V]	230.7355	210.9897	-19.74579
U3_tRMS_rc@AC [V]	231.0524	210.7415	-20.31090
I1_tRMS_rc@AC [A]	907.4670	61.60639	-845.8606
I2_tRMS_rc@AC [A]	905.4224	132.6178	-772.8046
I3_tRMS_rc@AC [A]	913.1281	99.17645	-813.9516
P_t_rc@AC [W]	626613.4	3118.194	-623495.2
Q_t_rc@AC [var]	61489.33	57253.34	-4235.984
S_t_rc@AC [VA]	629623.1	57338.19	-572284.9
IQ []	266.2247	307.2632	41.03852

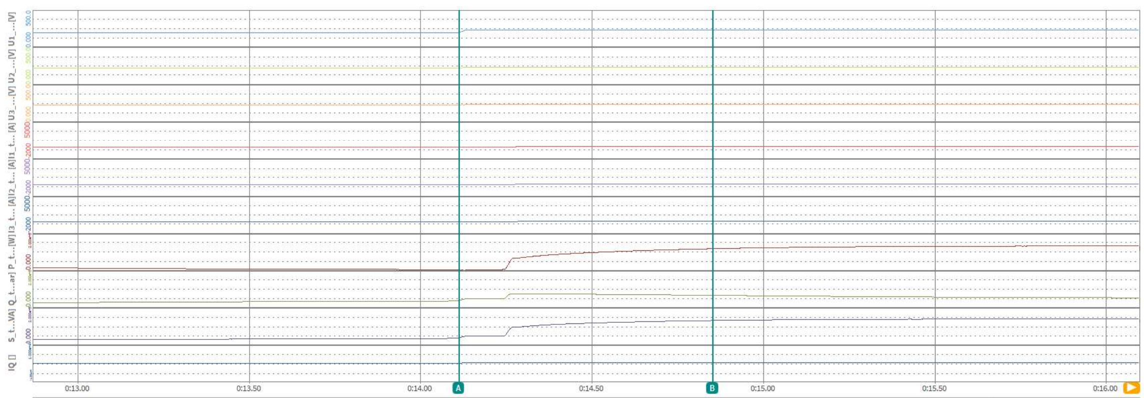


	A	B	间隔
时间 [s]	0:13.603623	0:14.147595	0.543972
U1_tRMS_rc@AC [V]	135.1734	231.6628	96.48940
U2_tRMS_rc@AC [V]	211.9866	231.3556	19.36903
U3_tRMS_rc@AC [V]	214.7154	231.7363	17.02095
I1_tRMS_rc@AC [A]	61.50314	871.1279	809.6247
I2_tRMS_rc@AC [A]	130.2925	867.8160	737.5235
I3_tRMS_rc@AC [A]	98.96349	872.3362	773.3727
P_t_rc@AC [W]	1481.521	567053.8	565572.2
Q_t_rc@AC [var]	57163.64	210126.7	152963.1
S_t_rc@AC [VA]	57182.83	604733.9	547551.1
IQ []	305.2117	907.3419	602.1303

11 –single-phase symmetrical fault (P = 0.1 - 0.3)

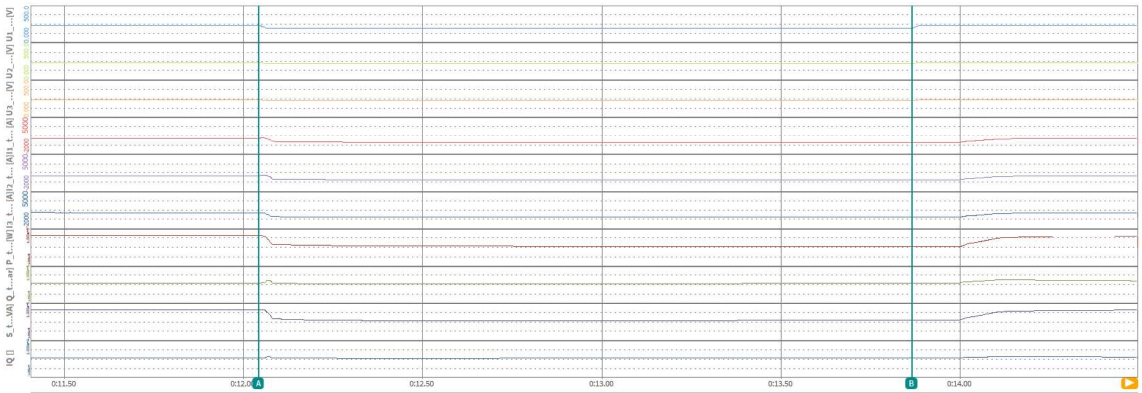


	A	B	间隔
时间 [s]	0:12.309019	0:14.109675	1.800655
U1_tRMS_rc@AC [V]	229.8794	190.4944	-39.38499
U2_tRMS_rc@AC [V]	230.0494	221.2015	-8.847870
U3_tRMS_rc@AC [V]	230.3646	221.5499	-8.814743
I1_tRMS_rc@AC [A]	186.8089	32.21994	-154.5890
I2_tRMS_rc@AC [A]	186.3402	71.18014	-115.1600
I3_tRMS_rc@AC [A]	186.5092	61.23657	-125.2726
P_t_rc@AC [W]	126824.2	1125.182	-125699.0
Q_t_rc@AC [var]	22336.10	35431.97	13095.87
S_t_rc@AC [VA]	128776.1	35449.83	-93326.27
IQ []	97.07219	167.8588	70.78665

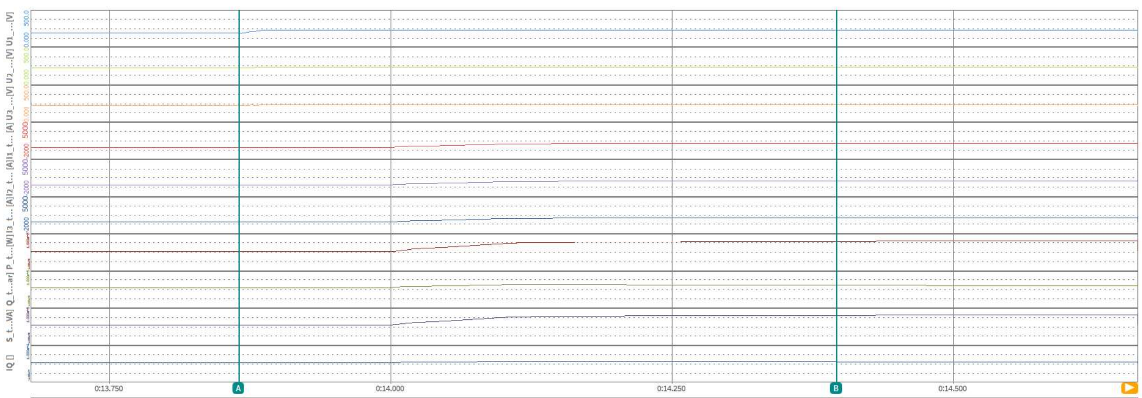


	A	B	间隔
时间 [s]	0:14.111636	0:14.851728	0.740092
U1_tRMS_rc@AC [V]	190.7467	230.2379	39.49118
U2_tRMS_rc@AC [V]	221.5028	230.3627	8.859955
U3_tRMS_rc@AC [V]	220.9302	230.7406	9.810394
I1_tRMS_rc@AC [A]	32.18072	191.2043	159.0235
I2_tRMS_rc@AC [A]	71.27491	189.7762	118.5013
I3_tRMS_rc@AC [A]	61.32399	189.6466	128.3226
P_t_rc@AC [W]	1219.472	113431.8	112212.4
Q_t_rc@AC [var]	35453.31	66522.19	31068.88
S_t_rc@AC [VA]	35474.28	131499.0	96024.71
IQ []	167.9775	288.6658	120.6883

11 –single-phase symmetrical fault (P > 0.9)

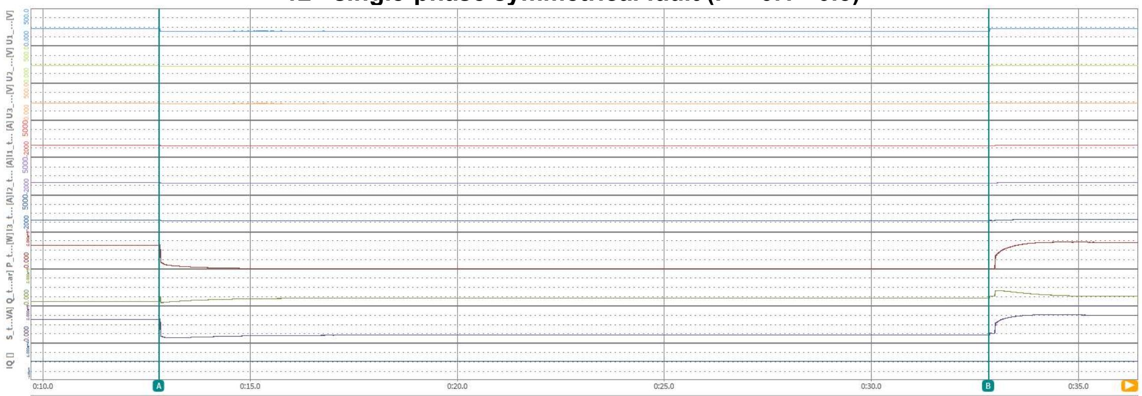


	A	B	间隔
时间 [s]	0:12.043010	0:13.864887	1.821878
U1_tRMS_rc@AC [V]	231.2151	190.9255	-40.28963
U2_tRMS_rc@AC [V]	230.7655	220.9294	-9.836060
U3_tRMS_rc@AC [V]	231.0850	221.0850	-10.00008
I1_tRMS_rc@AC [A]	910.2749	53.57705	-856.6979
I2_tRMS_rc@AC [A]	906.3595	131.1876	-775.1719
I3_tRMS_rc@AC [A]	915.0181	114.1326	-800.8854
P_t_rc@AC [W]	627986.0	-45.81150	-628031.8
Q_t_rc@AC [var]	62340.86	64445.42	2104.559
S_t_rc@AC [VA]	631072.8	64445.44	-566627.3
IQ []	269.8483	305.4576	35.60925

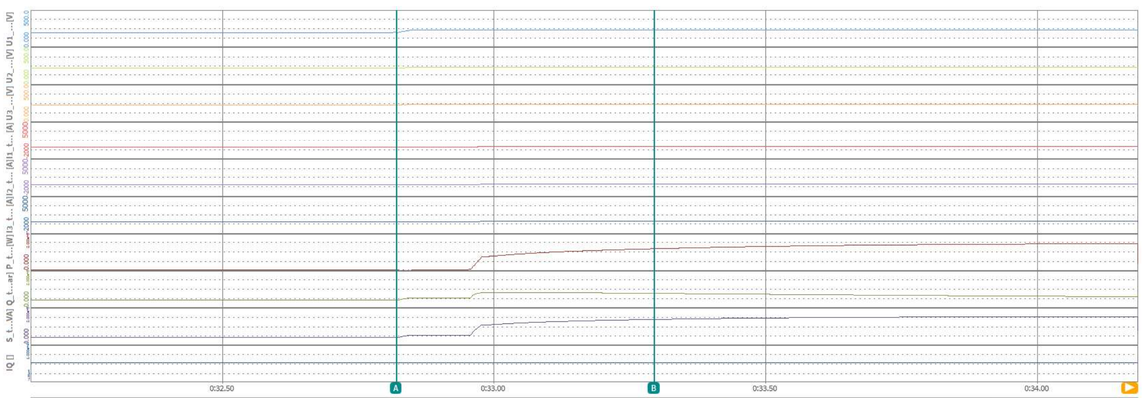


	A	B	间隔
时间 [s]	0:13.864887	0:14.396007	0.531120
U1_tRMS_rc@AC [V]	190.9255	231.8401	40.91469
U2_tRMS_rc@AC [V]	220.9294	231.3307	10.40126
U3_tRMS_rc@AC [V]	221.0850	231.8072	10.72224
I1_tRMS_rc@AC [A]	53.57705	874.8350	821.2580
I2_tRMS_rc@AC [A]	131.1876	868.4224	737.2347
I3_tRMS_rc@AC [A]	114.1326	875.8300	761.6973
P_t_rc@AC [W]	-45.81150	567517.8	567563.6
Q_t_rc@AC [var]	64445.42	214604.2	150158.8
S_t_rc@AC [VA]	64445.44	606738.3	542292.9
IQ []	305.4576	926.3783	620.9207

12 –single-phase symmetrical fault (P = 0.1 - 0.3)

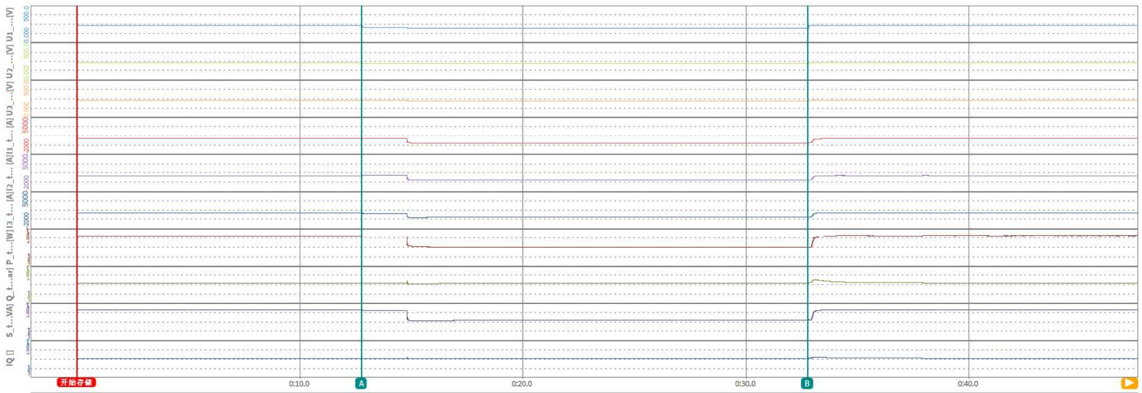


	A	B	间隔
时间 [s]	0:12.81291	0:32.82026	0:20.00735
U1_tRMS_rc@AC [V]	230.2747	199.5835	-30.69116
U2_tRMS_rc@AC [V]	230.1516	221.7214	-8.430161
U3_tRMS_rc@AC [V]	229.8010	222.4613	-7.339737
I1_tRMS_rc@AC [A]	187.0509	44.23827	-142.8126
I2_tRMS_rc@AC [A]	186.2503	76.24329	-110.0070
I3_tRMS_rc@AC [A]	185.7988	67.94884	-117.8500
P_t_rc@AC [W]	126666.6	-390.5187	-127057.1
Q_t_rc@AC [var]	22421.01	40848.12	18427.10
S_t_rc@AC [VA]	128635.6	40849.98	-87785.66
IQ []	97.45057	190.3554	92.90479

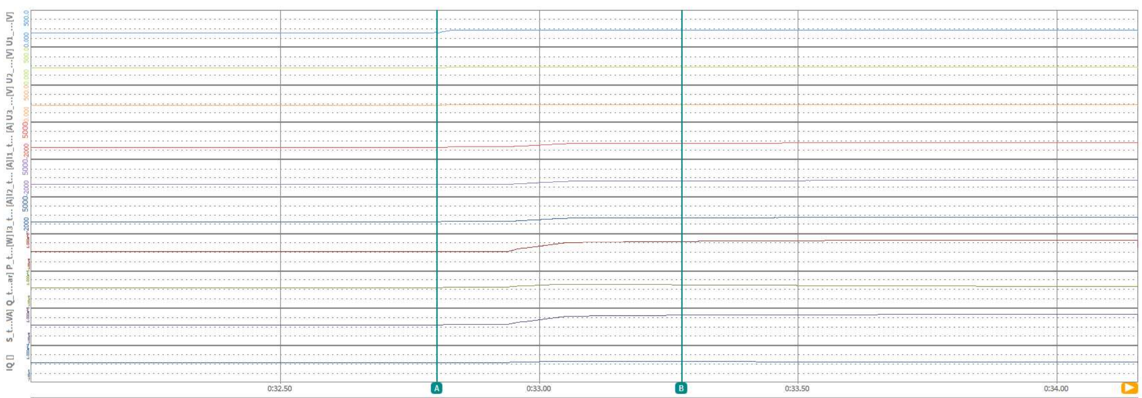


	A	B	间隔
时间 [s]	0:32.82052	0:33.29491	0.47439
U1_tRMS_rc@AC [V]	199.5835	230.3478	30.76425
U2_tRMS_rc@AC [V]	221.7214	230.5752	8.853790
U3_tRMS_rc@AC [V]	222.4613	230.9149	8.453613
I1_tRMS_rc@AC [A]	44.23827	199.6138	155.3755
I2_tRMS_rc@AC [A]	76.24329	197.9955	121.7522
I3_tRMS_rc@AC [A]	67.94884	198.2567	130.3079
P_t_rc@AC [W]	-390.5187	113484.9	113875.4
Q_t_rc@AC [var]	40848.12	77483.88	36635.76
S_t_rc@AC [VA]	40849.98	137413.9	96563.91
IQ []	190.3554	335.9915	145.6361

12 –single-phase symmetrical fault (P > 0.9)



	A	B	间隔
时间 [s]	0:12.75969	0:32.77077	0:20.01108
U1_tRMS_rc@AC [V]	231.1789	198.6368	-32.54213
U2_tRMS_rc@AC [V]	230.7178	222.6504	-8.067413
U3_tRMS_rc@AC [V]	231.0896	222.8050	-8.284576
I1_tRMS_rc@AC [A]	912.3783	88.53554	-823.8428
I2_tRMS_rc@AC [A]	909.8171	151.9742	-757.8429
I3_tRMS_rc@AC [A]	918.2296	135.8775	-782.3521
P_t_rc@AC [W]	629908.7	-1409.045	-631317.7
Q_t_rc@AC [var]	62754.79	81685.55	18930.77
S_t_rc@AC [VA]	633026.9	81697.71	-551329.2
IQ []	271.6711	380.4683	108.7972



	A	B	间隔
时间 [s]	0:32.80291	0:33.27527	0.47237
U1_tRMS_rc@AC [V]	199.2881	231.9772	32.68912
U2_tRMS_rc@AC [V]	221.5058	231.5683	10.06252
U3_tRMS_rc@AC [V]	222.9492	231.9943	9.045090
I1_tRMS_rc@AC [A]	88.41656	886.4717	798.0551
I2_tRMS_rc@AC [A]	153.2929	879.3461	726.0532
I3_tRMS_rc@AC [A]	135.9263	886.7943	750.8681
P_t_rc@AC [W]	-1341.359	567169.3	568510.6
Q_t_rc@AC [var]	81869.30	237792.9	155923.6
S_t_rc@AC [VA]	81880.28	615001.1	533120.8
IQ []	381.5309	1025.648	644.1167

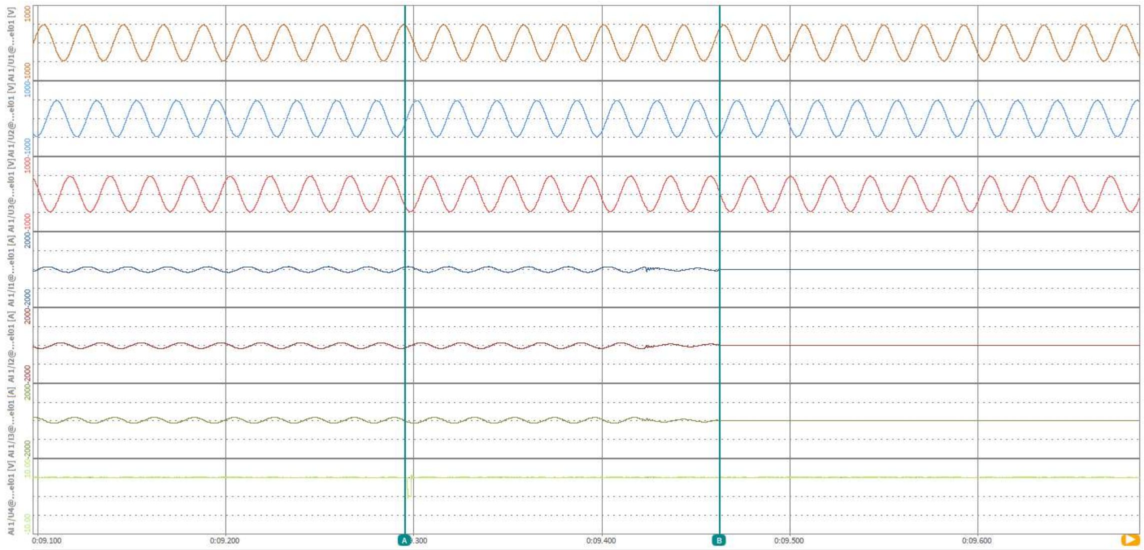
4.2.2.3.3	**Overfrequency and underfrequency**								**P**
	Under frequency				**Over frequency**				
Parameter		Frequency [Hz]				Frequency [Hz]			
Output Voltage		~85%U_N	~U_N	~110% U_N		~85%U_N	~U_N	~110%U_N	
Limit [s]	47.00Hz	0.2s			52.00 Hz	4 ≤ t ≤ 4.5s			
Measured trip value [Hz]		46.988	47.015	46.978		52.036	52.011	52.012	
Disconnetion time [s]	48.0 Hz to 46.5 Hz	0.167	0.130	0.130	51.0 Hz to 52.5 Hz	4.222	4.119	4.306	

Note:
Method for ramp:
It was measured at a continuous change of frequency of 1Hz/s at lower. nominal and upper U_N and arbitary output power. The trip value was determined manually by reducing the frequency in 10mHz steps. When the trip value is known (e.g. 47Hz). the ac-source is programmed to run from e.g. 47.50Hz to 46.50Hz with 1Hz/s. The disconnection time is calculated by the measured time minus the 500ms from 47.5Hz to 47Hz.

Method for trip:
The frequency which inverter stops feeding power to electrical system in each test must be in the range of the frequency trip setting +/- 0,1Hz and the time it takes to cut off the power must be within limit value,

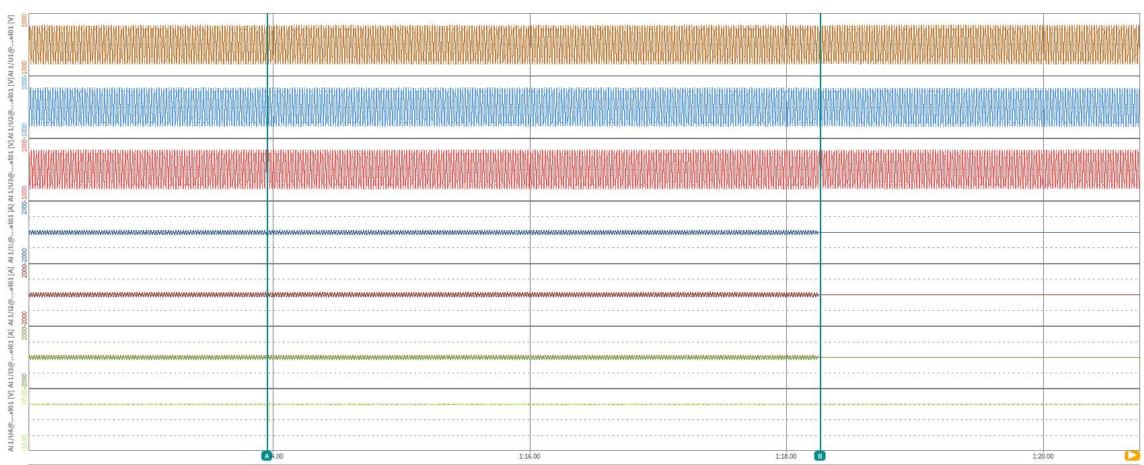
The accuracy for frequency trip values shall be within 0 % to +1 % of the nominal frequency from the upper boundary trip setting, and within -1% to 0% of the nominal frequency from the lower boundary trip setting,

Under frequency:



	A	B	间隔
时间 [s]	9.2953345	9.4626449	0.1673104
AI 1/U1@Trionet_Michael01 [V]	475.9009	358.8665	-117.0344
AI 1/U2@Trionet_Michael01 [V]	-174.8812	-456.6338	-281.7526
AI 1/U3@Trionet_Michael01 [V]	-301.0987	97.76202	398.8607
AI 1/I1@Trionet_Michael01 [A]	132.9680	2.963104	-130.0049
AI 1/I2@Trionet_Michael01 [A]	-141.6263	-4.064751	137.5616
AI 1/I3@Trionet_Michael01 [A]	4.581403	-2.014447	-6.595850
AI 1/U4@Trionet_Michael01 [V]	5.109072	5.111218	2.146e-3

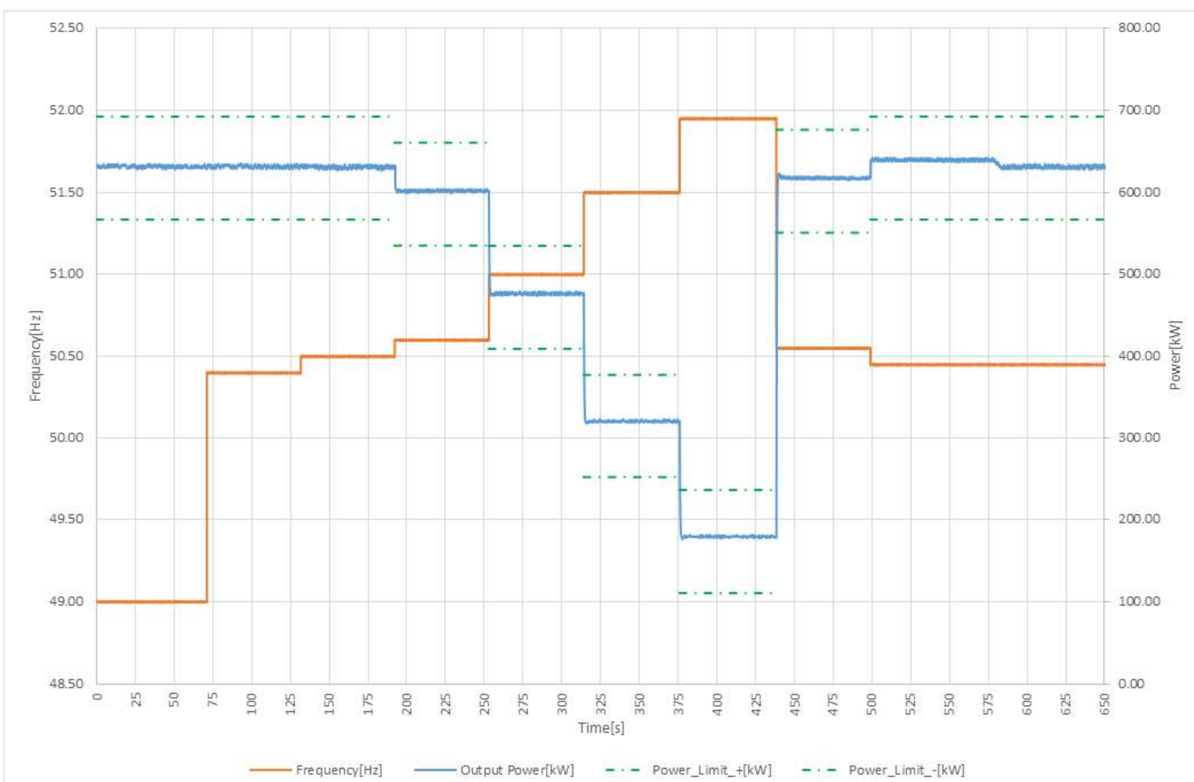
Over frequency:



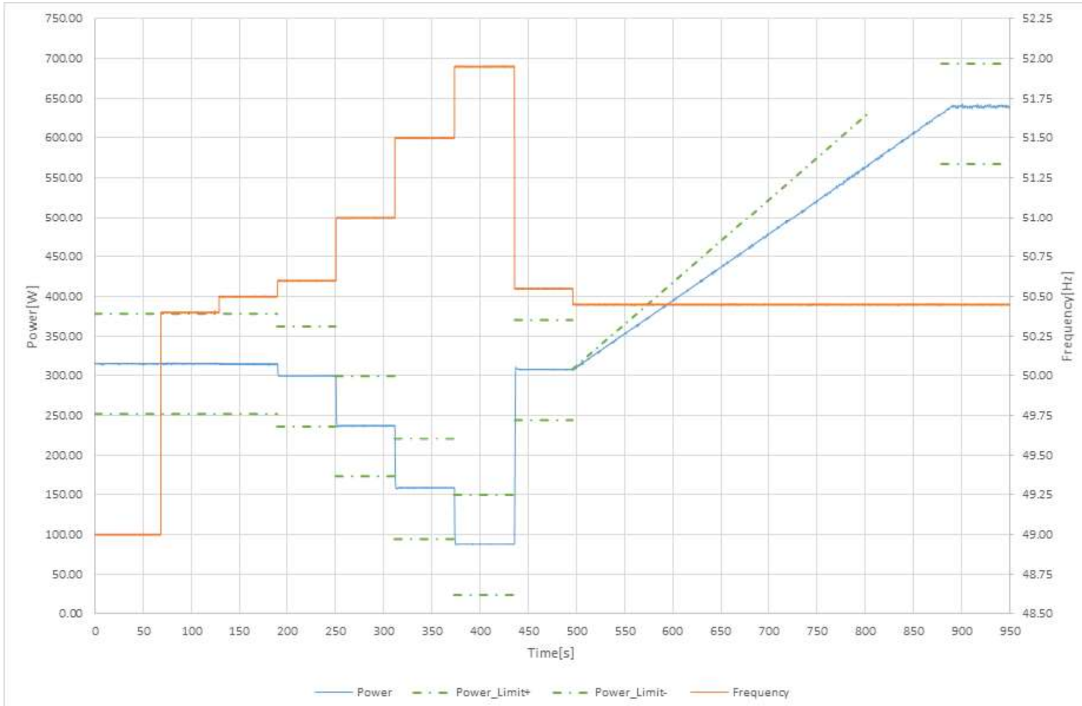
	A	B	间隔
时间 [s]	1:13.955894	1:18.261595	4.305701
AI 1/U1@Trionet_Michael01 [V]	619.2646	581.6603	-37.60433
AI 1/U2@Trionet_Michael01 [V]	-284.7352	-472.1985	-187.4633
AI 1/U3@Trionet_Michael01 [V]	-334.6666	-109.4860	225.1806
AI 1/I1@Trionet_Michael01 [A]	72.19748	-0.619135	-72.81661
AI 1/I2@Trionet_Michael01 [A]	-108.6757	-2.039385	106.6363
AI 1/I3@Trionet_Michael01 [A]	32.29637	-0.939179	-33.23555
AI 1/U4@Trionet_Michael01 [V]	5.115748	5.112410	-3.338e-3

4.2.2.3.3	Active power feed-in for over-frequency								P
Test:									
1-min mean value [Hz]	a) 49.00	b) 50.40	c) 50.50	c) 50.60	d) 51.00	e) 51.50	g) 51.95	h) 50.55	i) 50.45
1, Measurement a) to g): Active power output > 80% P_n									
Frequency [Hz]:	49.0	50.4	50.5	50.6	51.0	51.5	51.95	50.55	50.45
$P_{setpoint}$ [kW]:	630.00	630.00	630.00	598.50	472.50	315.00	173.25	614.25	630.00
P_{E60} [kW]:	628.61	629.91	629.15	600.64	474.33	318.94	178.01	614.76	633.78
$\Delta P_{E60}/P_{Setpoint}$ [%]:	-0.221	-0.014	-0.135	0.340	0.290	0.625	0.756	0.081	0.600
2, Measurement a) to i): Active power output 40% and 60% after freezing > 80% P_n									
Frequency [Hz]:	49.0	50.4	50.5	50.6	51.0	51.5	51.95	50.55	50.45
$P_{setpoint}$ [kW]:	315.00	315.00	315.00	299.25	236.25	157.50	86.63	307.13	630.00
P_{E60} [kW]:	314.87	313.61	315.14	299.58	237.50	158.39	87.71	308.12	633.13
$\Delta P_{E60}/P_{Setpoint}$ [%]:	-0.021	-0.221	0.022	0.052	0.198	0.141	0.171	0.157	0.497
Limit $\Delta P_{E60}/P_{Setpoint}$:	± 10 % of P_{Emax}								

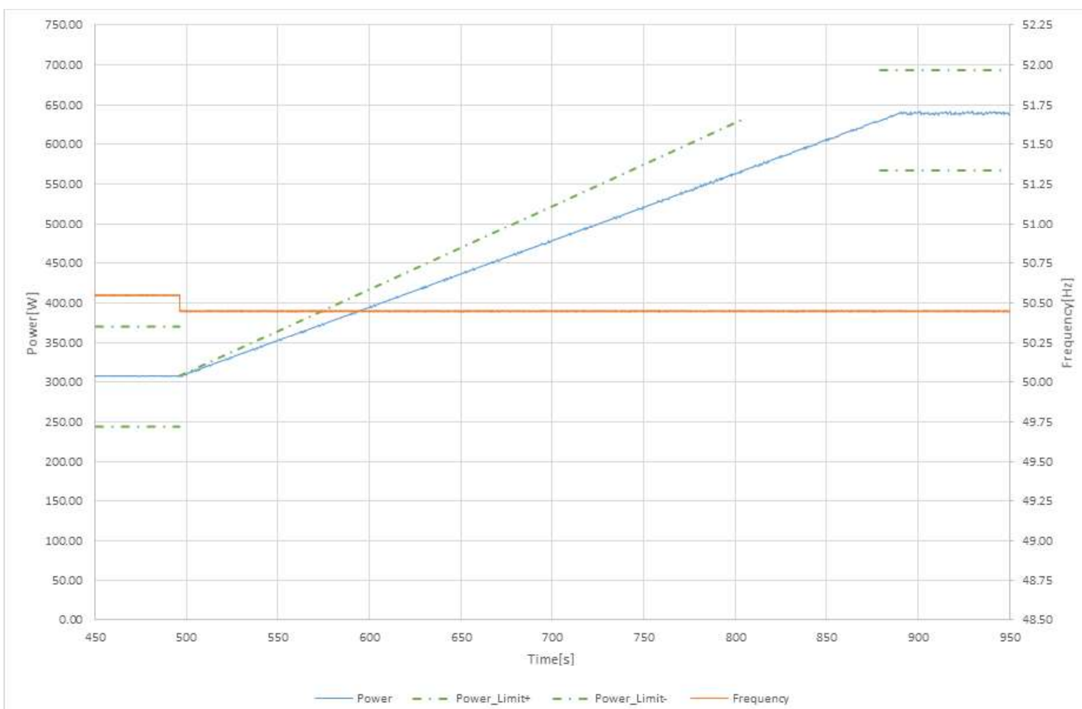
Graph of Measurement 1,: Active power output > 80% P_n



Graph of Measurement 2,:Active power output 40% and 60% after freezing > 80% P_n



Graph of power gradient:



Test: The test is conducted for two powers, First, the test must start at a power > 80% P_n ("Measurement 1"), and in a second test, for a power between 40% to 60% P_n ("Measurement 2"), In the second test, after freezing of the PM, the available active power output must be increased to a value > 80% P_n, and after the network frequency of 50.5 Hz is fallen below, the rise of the active power gradient must be recorded,
Assessment criterion: For f=50.5 Hz. the value of the PM active power currently being generated is "frozen". For adjustable PGUs when: 1) the active power reduces between measuring points c) and g) given above with a gradient of 50% P_M per Hz for a decreasing frequency (or rises for a frequency decreasing again). 2) the reaction value of the setpoint determined by the gradient characteristic curve does not differ from P_n by more than ± 10%. When the utility frequency exceeds 50.5 Hz. the active power available at the time shall be stored as the maximum power value P_M; this value P_M shall not be exceeded until the frequency has stabilised below 50.5 Hz for at least 4 seconds.

4.2.2.4 Preventing of islanding

Test circuit and parameters

Parameter	Symbol	Units
EUT DC Input		
DC voltage	V_{DC}	V
DC Current	I_{DC}	A
DC Power	P_{DC}	W
EUT AC ouput		
AC voltage	V_{EUT}	V
AC current	I_{EUT}	A
Real power	P_{EUT}	W
Reactive power	Q_{EUT}	VAr
Test Load		
Resistive load current	I_R	A
Inductive load current	I_L	A
Capacitive load current	I_C	A
AC (utility) power source		
Utility real power	P_{AC}	W
Utility reactive power	Q_{AC}	VAr
Utility current	I_{AC}	A

Block diagram test circuit IEC 62116:2014

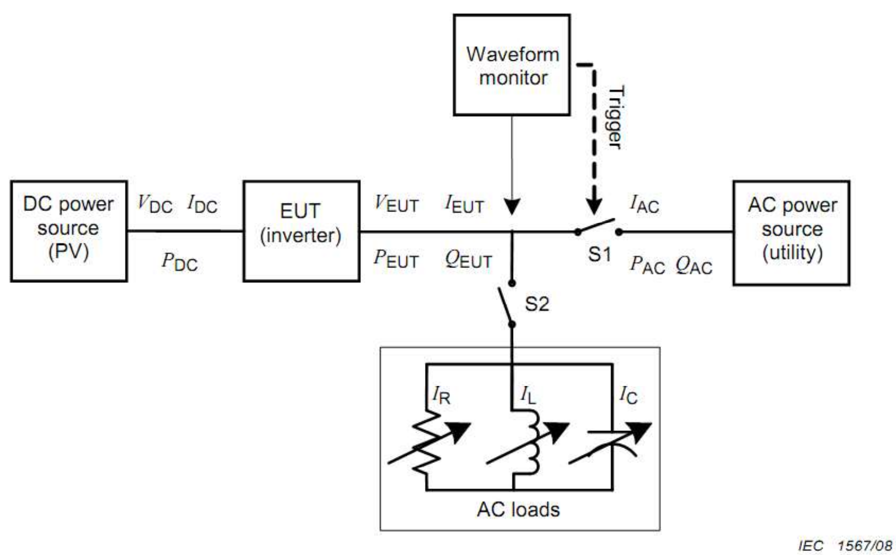


Figure 1 – Test circuit for islanding detection function in a power conditioner (inverter)

4.2.2.4	**Islanding protection according IEC 62116 table 6** **Load imbalance (real, reactive load) for test condition A** **(EUT ouput = 100%)**	**P**
Note: Inverter units approved by EMTEK(SHENZHEN) CO., LTD in accordance with IEC 62116:2014. Report No.: ES200211003P.		

4.2.2.4	**Islanding protection according IEC 62116 table 6** **Load imbalance (real, reactive load) for test condition B** **(EUT output = 50% – 66%)**	**P**
Note: Inverter units approved by EMTEK(SHENZHEN) CO., LTD in accordance with IEC 62116:2014. Report No.: ES200211003P.		

4.2.2.4	**Islanding protection according IEC 62116 table 6** **Load imbalance (real, reactive load) for test condition C** **(EUT output = 25% – 33%)**	**P**
Note: Inverter units approved by EMTEK(SHENZHEN) CO., LTD in accordance with IEC 62116:2014. Report No.: ES200211003P.		

Photo documentation

Picture 1. Enclosure front view for all model


Picture 2. Enclosure rear view for all model

List of test equipment used:

No	Test Equipment	Equipment model	Equipment No.	Calibration due date
1	DC power source	WDGC-1000KW	BZ-DGD-L002	2021/11/08
2	AC power source	WPLA-33-1000KVA	BZ-DGD-L001	2021/11/08
3	Power analyzer	DEWE2-PA7	BZ-DGD-L119	2022/02/02
4	Power analyzer	PA6000H	BZ-DGD-L059	2021/11/17
5	AC/DC current sensor	CT6863-05	BZ-DGD-L027-1	2022/02/28
6	AC/DC current sensor	CT6863-05	BZ-DGD-L027-2	2022/02/28
7	AC/DC current sensor	CT6863-05	BZ-DGD-L027-4	2022/02/28
8	AC/DC current sensor	CT6863-05	BZ-DGD-L027-5	2022/02/28

--- End of test report---