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Test Report issued under the responsibility of:

DEKRA

TEST REPORT
Engineering Recommendation G99/1-8
Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

Report	
Report Number. :	6134228.51V1.1
Date of issue :	2023-03-16
Total number of pages :	247 pages
Testing Laboratory :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Address :	No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
Applicant's name :	Sungrow Power Supply Co., Ltd.
Address :	No.1699 Xiyou Rd., New & High Technology Industrial Development Zone, 230088, Hefei, P. R. China
Test specification:	
Standard :	Engineering Recommendation G99 Issue 1 – Amendment 8: 2021 (G99/1-8:2021)
Test procedure :	Type test
Non-standard test method :	N/A
Test Report Form No. :	G99/1-8_V1.0
Test Report Form(s) Originator :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Master TRF :	Dated 2022-05
Test item description :	Grid-connected PV inverter
Trade Mark :	SUNGROW
Manufacturer :	Sungrow Power Supply Co., Ltd.
	No.1699 Xiyou Rd., New & High Technology Industrial Development Zone, 230088, Hefei, P. R. China
Model/Type reference :	SG285HX, SG320HX, SG350HX

Ratings .... :	SG285HX: PV input: Max. 1500 Vdc, MPPT voltage range: 500-1500 Vdc, max 12*40 A, Isc PV: 12*60 A AC Output: 3/PE, 800Vac, 50/60 Hz, rated 285 kW, max 285 kVA, max 206 A SG320HX: PV input: Max. 1500 Vdc, MPPT voltage range: 500-1500 Vdc, max 12*40 A or 14*30 A or 16*30 A, Isc PV: 12*60 A or 14*60 A or 16*60 A AC Output: 3/PE, 800Vac, 50/60 Hz, rated 295 kW, max 352 kVA, max 254 A SG350HX: PV input: Max. 1500 Vdc, MPPT voltage range: 500-1500 Vdc, max 12*40 A or 14*30 A or 16*30 A, Isc PV: 12*60 A or 14*60 A or 16*60 A AC Output: 3/PE, 800Vac, 50/60 Hz, rated 320 kW, max 352 kVA, max 254 A

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

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

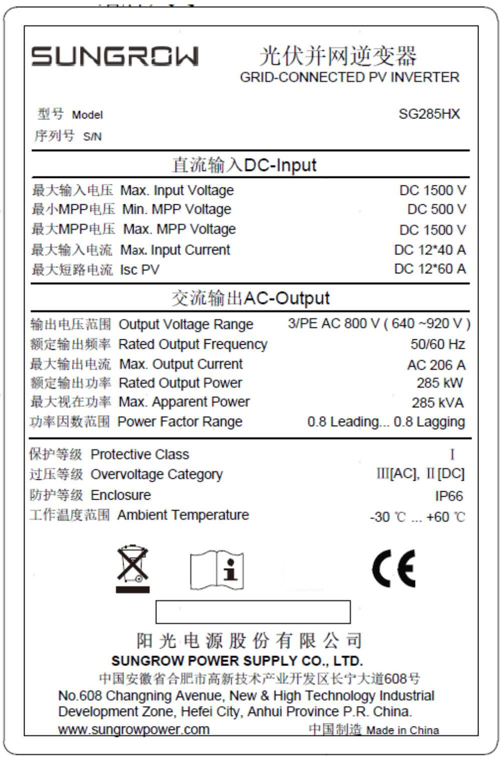
Appendix 1: Compliance Verification Report – Tests for Type B, C and D Inverter Connected Power Generating Modules (97 pages)

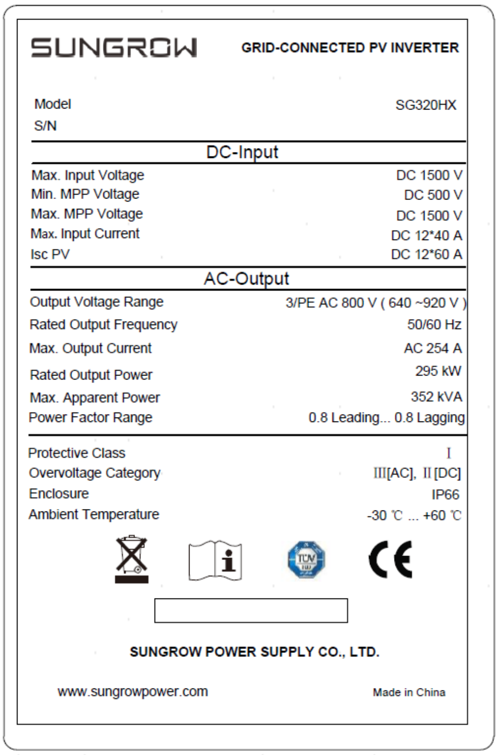
Appendix 2: Photo documentation (4 pages)

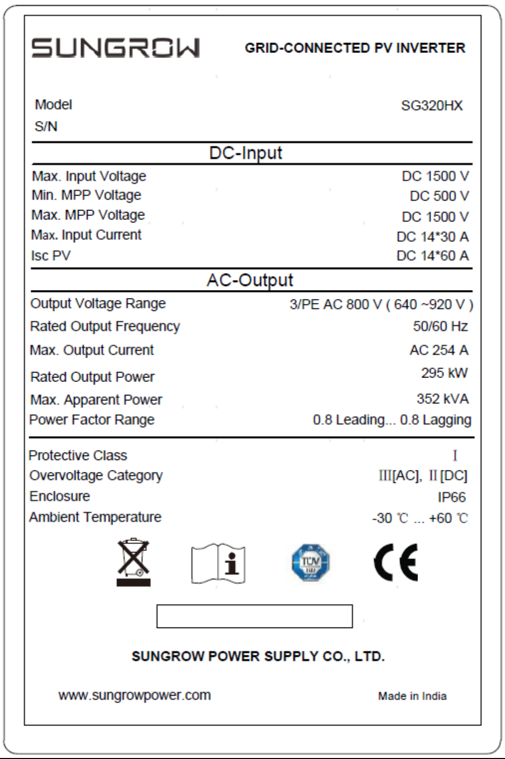
Summary of testing:

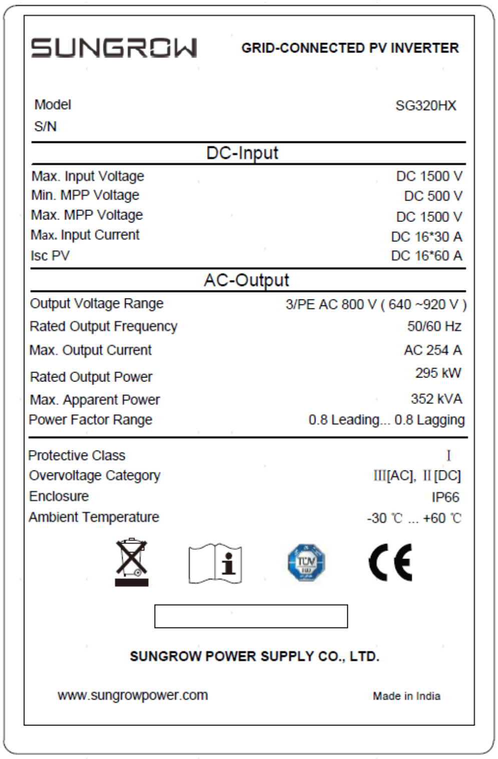
Tests performed (name of test and test clause):	**Testing location:**
All tests (except clause 4.8 EMC tests)	DEKRA Testing and Certification (Suzhou) Co., Ltd. No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
EMC and power quality – EMC test (The EMC test report 64.772.21.80078.02 provided by the customer)	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch 5/F & East of 8/F., Communication Building, No.163, Pingyun Road, West of Huangpu Avenue, Guangzhou, China

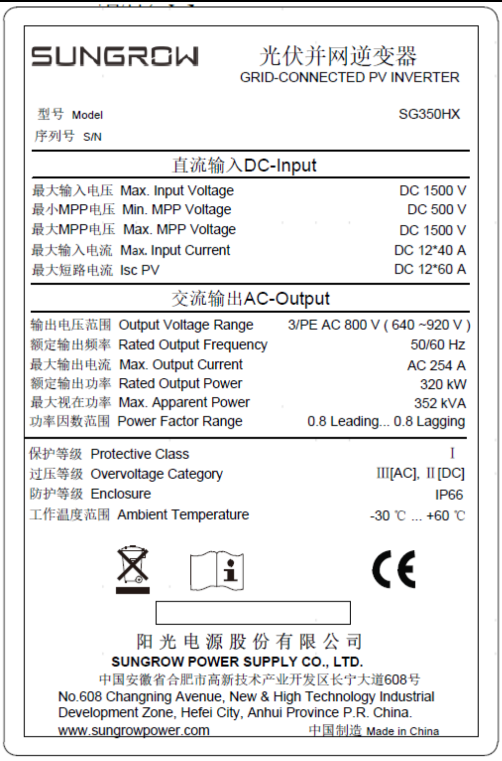
Copy of marking plate:

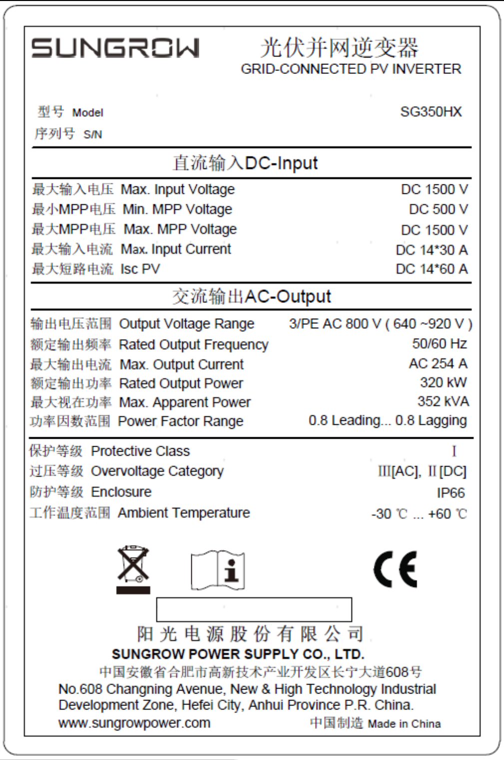


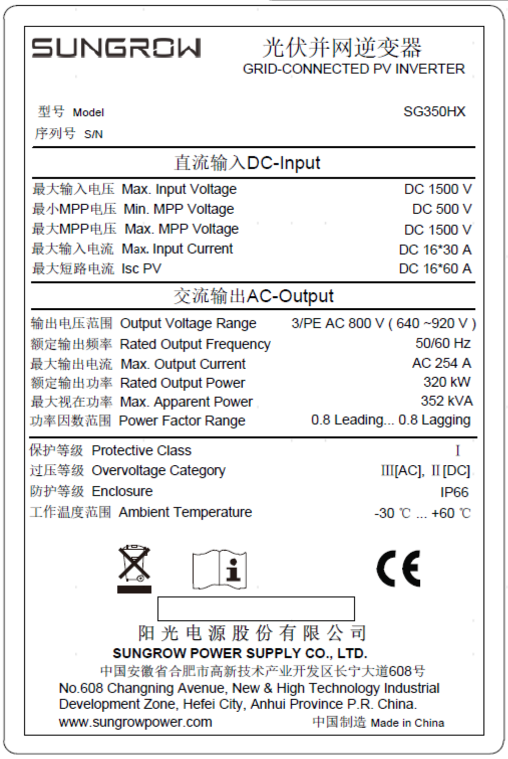










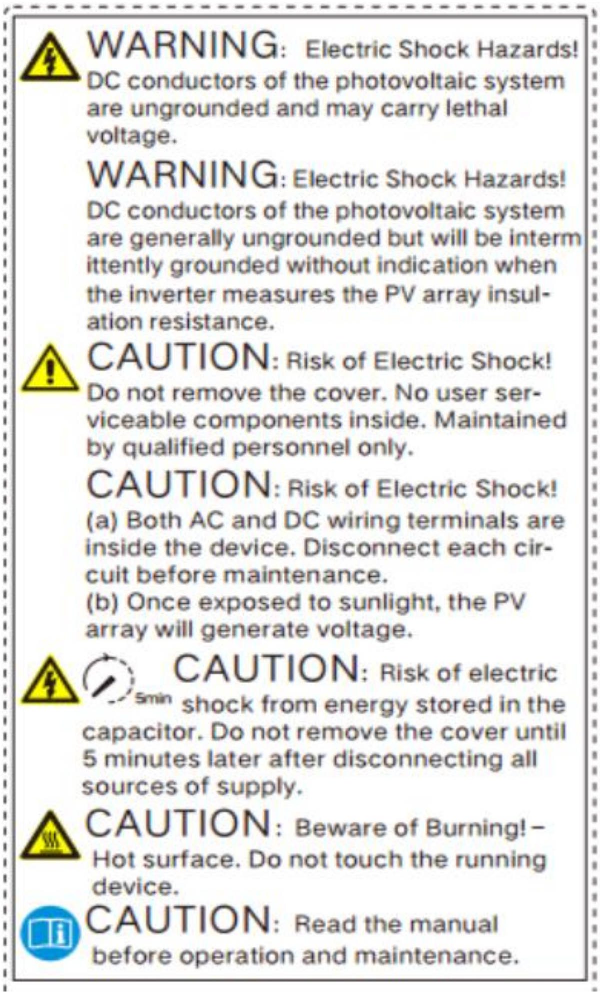


Remark:

There are three rating labels for model SG320HX and SG350HX, the three version labels are different in MPPT numbers and max input current. There will be only one label on final delivery PCE according to customer's selection, under factory quality system to ensure that achieved.

As Great Britain public Low Voltage Distribution Networks grid code G99 required, only 800 Vac / 50Hz output setting was verified in this test report.

Warning Label:



Test item particulars:	
Equipment mobility :	movable hand-held stationary fixed transportable for building-in
Connection to the mains :	pluggable equipment direct plug-in permanent connection for building-in
Environmental category :	outdoor indoor unconditional indoor conditional
Over voltage category Mains :	OVC I OVC II OVC III OVC IV
Over voltage category PV :	OVC I OVC II OVC III OVC IV
Mains supply tolerance (%) :	±10 %
Tested for power systems :	TN
IT testing, phase-phase voltage (V) :	--
Class of equipment :	Class I Class II Class III Not classified
Mass of equipment (kg) :	Approx. 110kg
Pollution degree :	Outside PD3; Inside PD2
IP protection class :	IP66
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)
- test object does not evaluate according to manufacturer requirements :	N/E
- this clause is information reference for installation :	Info.
Testing:	
Date of receipt of test item :	2022-07-14 (samples provided by applicant)
	No sample (Amendment 1 report)
Date (s) of performance of tests :	2022-07-14 to 2022-09-14
	No tests (Amendment 1 report)

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
The measurement result is considered in conformance with the requirement if it is within the prescribed limit. It is not necessary to account the uncertainty associated with the measurement result.
The information provided by the customer in this report may affect the validity of the results, the test lab is not responsible for it.
This report is not used for social proof function in China market.

"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

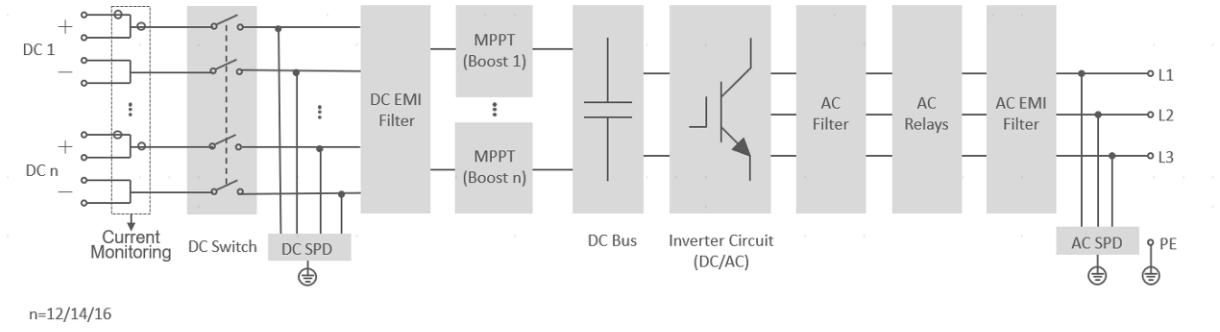
Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Name and address of factory (ies):
1. Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd., New & High Technology Industrial Development Zone, Hefei 230088 P.R. China
2. Sungrow Power Supply Co., Ltd.
No. 608 Changning Avenue, New & High Technology Industrial Development Zone, Hefei 230088 P.R. China
3. Sungrow Developers (India) Private Limited
Survey No.250/3, T-Begur Village, Kasaba Hobli,Nelamangala Taluk, Bangalore, Karnataka-562123, India

General product information:

These devices are transformer-less grid-connected PV inverters which converts direct current optimized by photovoltaic DC conditioner to alternating current, and they are intended to be connected in parallel with the low-voltage mains or high-voltage grid via isolating transformer to feed current into grid. They are intended for professional incorporation into PV system, and they are assessed on a component test basis.

Block Diagram:



Model difference:

SG350HX: basic model

SG320HX and SG285HX: same family design product, same hardware as basic model, except output power and current are limited by software.

The product was tested on:

Unless otherwise specified, all tests were performed on the representative model of SG350HX and applicable for other models since they are similar in hardware and just power derating by software.

Hardware version:

V1.0

Software version:

LCD_EUCLASE-S_V11_V01_A;
MDSP_EUCLASE-S_V11_V01_A.

Amendment 1 report:
The previous test report No. 6134228.50 issued by DEKRA Testing and Certification (Suzhou) Co., Ltd. dated on 2022-11-28 were updated and including below modification:
--- Add CNAS logo on the first page of the test report.
--- Update the description of cyber security evaluated in clause 9.1.7.
After reviewing. No tests were considered necessary.

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
6	**CONNECTION APPLICATION**		-
6.1	**General**		-
6.1.1	This document describes the processes that shall be adopted for both connection of a single Power Generating Module and installations that comprise of a number of Power Generating Modules.		Info.
6.1.2	Type A Power Generating Module(s) ≤ 16A per phase and EREC G98 compliant	Type B, C, D Power Generating Modules.	N/A
6.1.2.1	A connection procedure to facilitate the connection and operation of Fully Type Tested Power Generating Modules with aggregate Registered Capacity of less than or equal to 16 A per phase in parallel with public Low Voltage Distribution Network is given in EREC G98 and is not considered further in this document. These are referred to as micro-generators.		N/A
6.1.3	Power Park Modules		P
6.1.3.1	Where an installation comprises a single Generating Unit, the application process, technical and commissioning requirements are based on the Registered Capacity of that Generating Unit. Where an installation comprises multiple Generating Units the application process, technical and commissioning requirements will generally be based on the Registered Capacity of each Power Park Module, and also on the extent to which each Power Park Module is Type Tested.		P
6.1.3.2	Where a new Generating Unit is connected to an existing installation the treatment of the addition will depend on the EREC under which the existing installation was connected. If the existing installation was connected under EREC G59 or EREC G83 then the new Generating Unit will be treated as a separate Power Park Module and managed for compliance with this EREC G99 as a separate Power Generating Module. If, however, the existing installation was completed in compliance with EREC G98 or EREC G99, then the new Power Park Module must be added to the aggregate capacity of the complete installation which shall be used to determine which EREC is applicable.		P
6.1.4	Synchronous Power Generating Modules		N/A
6.1.4.1	Where an installation comprises a single Synchronous Power Generating Module or multiple Synchronous Power Generating Modules, the application process, technical and commissioning requirements are based on the Registered Capacity of each Synchronous Power Generating Module.	Not Synchronous Power Generating Modules.	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
6.1.4.2	Where one or more new Synchronous Power Generating Module(s) is to be connected to an existing installation then each new Power Generating Module will be treated as a separate Synchronous Power Generating Module. Only the new Power Generating Module will be required to meet the requirements of this EREC G99 or EREC G98 if applicable. However, note that if the aggregated capacity of all the Power Generating Modules in the Power Generating Facility (ie the Registered Capacity of the Power Generating Facility) reaches the threshold for large as defined in the Grid Code (ie 10 MW in the north of Scotland; 30 MW in the south of Scotland, 100 MW in England and Wales), then the Generator will have to ensure compliance with relevant parts of the Grid Code. Similarly if the Registered Capacity of a Power Generating Facility in England and Wales is 50 MW or more, the Generator will have to comply with paragraphs 6.4.4 and 13.8.		N/A
6.1.5	Illustrative examples		Info.
6.1.5.1	Table 6.1 is provided to illustrate some of the connection scenarios and the EREC requirements.		Info.
6.1.5.2	In respect of Table 6.1 the aggregate Registered Capacity of all the Power Generating Modules in the Power Generating Facility will be taken into account when the DNO considers the effect of the connection on the Distribution Network.		Info.

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Clause	Requirement - Test	Result - Remark	Verdict
	Table 6.1 Examples of connection scenarios		Info.

Table 6.1 Examples of connection scenarios

Details of the existing **Power Generating Facility**	Planned expansion to the **Power Generating Facility**	Compliance requirements
Nil	**Type A Generating Unit(s)**	The unit(s) comprise a new **Power Generating Module** for compliance EREC G99[4].
Synchronous Power Generating Modules commissioned under EREC G83 or EREC G59	**Synchronous Power Generating Modules** Figure 6.1	Original and additional **Power Generating Modules** treated separately. Only additional **Power Generating Modules** need to comply with EREC G99; the entire **Power Generating Facility** needs to comply with operational requirements.
Synchronous Power Generating Modules commissioned under EREC G98 or EREC G99	**Synchronous Power Generating Modules** Figure 6.2	Original and additional **Power Generating Modules** treated separately. All **Power Generating Modules** need to comply with EREC G99[5] and with operational requirements.
Synchronous Power Generating Modules commissioned under EREC G83 or EREC G59 and **Synchronous Power Generating Modules** commissioned under EREC G98 or EREC G99	**Synchronous Power Generating Modules** Figure 6.3	Original and additional **Power Generating Modules** treated separately. Additional **Power Generating Modules** need to comply with EREC G99; all need to comply with operational requirements.
Power Park Module commissioned under EREC G83 or EREC G59	Asynchronous **Generating Units** Figure 6.4	New units form a new **Power Park Module**. Original and additional **Power Park Modules** treated separately. Only additional **Power Park Modules** need to comply with EREC G99; all need to comply with operational requirements.
Power Park Module commissioned under EREC G98 or EREC G99	Asynchronous **Generating Units** Figure 6.5	Units aggregated to form a new single **Power Generating Module**. Compliance required for the new module size, with EREC G99 and with operational requirements.
Power Park Module commissioned under EREC G98 or EREC G99	Storage DC coupled (ie connected to the existing **Inverters** with no change to Inverters) Figure 6.6	No compliance effect. Compliance remains based on existing **Inverters**, ie on the existing **Power Park Module**. The **Generator** must, under their **Connection Agreement** apply to the **DNO** before connecting the new storage.
Power Park Module commissioned under EREC	Storage AC coupled – ie storage	The new storage units form an independent **Power Park Module**

Clause	Requirement - Test	Result - Remark	Verdict
6.1.6	Interaction with the NETSO		P
6.1.6.1	It should be noted that if the Registered Capacity of all Power Generating Module (synchronous together with asynchronous) on one or more sites in common ownership is >50 MW, then the Generator becomes licensable.		Info.
6.1.6.2	Generators with an agreement with the NETSO may be required to comply with applicable requirements of the Grid Code. Where Grid Code requirements apply, it is the Generator's responsibility to comply with the relevant parts of both the Distribution Code and Grid Code.		P
6.2	**Application for Connection**		P

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Clause	Requirement - Test	Result - Remark	Verdict
6.2.1	Information about the Power Generating Module(s) is needed by the DNO so that it can assess the effect that a Power Generating Facility may have on the Distribution Network. This document details the parameters to be supplied by a Generator wishing to connect Power Generating Module(s) that do not comply with EREC G98 to a Distribution Network. This document also enables the DNO to request more detailed information if required.		P
6.2.2	Integrated Micro Generation and Storage procedure		N/A
6.2.2.1	The Generator may wish to install Integrated Micro Generation and Storage. Where all of the following conditions apply, the Integrated Micro Generation and Storage procedure can be followed: 1. The Power Generating Modules are located in a single Generator's Installation; 2. The total aggregate capacity of the Power Generating Modules (including Electricity Storage devices) is between 16 A and 32 A per phase; 3. The total aggregate capacity of the Power Generating Modules that are Electricity Storage devices does not exceed 16 A per phase and the total aggregate capacity of the Power Generating Modules that are not Electricity Storage devices does not exceed 16 A per phase. Note that if the total aggregated capacity of Electricity Storage and non- Electricity Storage devices is no greater than 16 A per phase, the single premises procedure described in EREC G98 applies; 4. All of the Power Generating Modules (including Electricity Storage devices) are connected via EREC G98 Fully Type Tested Inverters; 5. An EREC G100 compliant export limitation scheme is present that limits the export from the Generator's Installation to the Distribution Network to 16 A per phase; and 6. The Power Generating Modules will not operate when there is a loss of mains situation.		N/A
6.2.2.2	If all the conditions in 6.2.2.1 are satisfied, the Generator should complete an application in a format as shown in Form A1-2 (Annex A.1). Otherwise the Generator should refer to the connection application procedure for Type A Power Generating Modules.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
6.2.2.3	The planned commissioning date stated on the application form shall be within 10 working days and 3 months from the date that the application is submitted to the DNO. Confirmation of the commissioning of each Power Generating Module shall be made no later than 28 days after commissioning (where tests and checks are not witnessed). Confirmation shall be provided in a format as shown in Form A3-2 (Annex A.3). In addition to Form A3-2, an EREC G100 Export Limitation Scheme Installation and Commissioning Tests form shall be submitted to the DNO to confirm that the Export Limitation Scheme meets the requirements set out in EREC G100. Confirmation shall be provided in a format as shown in EREC G100 Appendix B.		N/A
6.2.3	Power Generating Facilities which include Type A Power Generating Modules	Type B, C, D Power Generating Modules.	N/A
6.2.3.1	For Type A Power Generating Modules the compliance, testing and commissioning requirements are detailed in Section 16 of this EREC G99.	Type B, C, D Power Generating Modules.	N/A
6.2.3.2	The Generator should apply to the local DNO for connection using the DNO's Standard Application Form (available from the DNO's website). On receipt of the application, the DNO will assess whether any Distribution Network studies are required and whether there is a requirement to witness the commissioning tests. In some cases studies to assess the impact on the Distribution Network may need to be undertaken before a firm quotation can be provided to the Generator. On acceptance of the quote, any works at the connection site and any associated facilitating works will need to be completed before the Power Generating Module can be commissioned. On successful completion of the commissioning tests, the DNO will sanction permanent energisation of the Power Generating Module in accordance with Section 16 of this EREC G99.		N/A
6.2.4	Power Generating Facilities which include Type B, Type C or Type D Power Generating Modules		P
6.2.4.1	The connection process is similar to that described in paragraph 6.2.2 above, although detailed system studies will almost certainly be required and consequently the Generator might need to provide additional information. The information should be provided using the Standard Application Form (generally available from the DNO's website). The data that will generally be required is defined in the Distribution Code, Data Registration Code (DDRC), Schedules 5a, 5b and 5c.		P
6.2.4.2	For Type B and Type C Power Generating Modules the compliance, testing and commissioning requirements are detailed in Sections 17 and 18 respectively of this EREC G99. On successful completion of a Type B or Type C Power Generating Module Document the DNO will issue a Final Operational Notification to the Generator.		P

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Clause	Requirement - Test	Result - Remark	Verdict
6.2.4.3	For a Type D Generating Unit, once all the relevant documents have been provided to the DNO to its satisfaction, the DNO will issue an Energisation Operational Notification to the Generator followed by an Interim Operational Notification and a Final Operational Notification. This staged process is described further in Section 19 of this EREC G99.		P
6.2.4.4	Generators who own Type B and Type C Power Generating Modules do not have permanent rights to operate their Power Generating Modules without a valid Final Operational Notification which will be issued by the DNO following completion of the commissioning tests and process, refer to paragraphs 17.4.3 and 18.4.3.		P
6.2.4.5	Generators who own Type D Power Generating Modules do not have rights to operate their Power Generating Modules without either: (a) a valid Final Operational Notification, refer to paragraph 19.5.4; (b) an Interim Operational Notification, refer to paragraph 19.3.6; or (c) a Limited Operational Notification, refer to paragraph 19.6.4.1.		P
6.3	**System Analysis for Connection Design Type A, Type B, Type C and Type D**		Info.
6.4	**Provision of Information**		Info.
7	**CONNECTION ARRANGEMENTS**		P
7.1	**Operating Modes**		P
7.1.1	Power Generating Modules may be designed for one of three operating modes. These are termed long-term parallel operation, infrequent short-term parallel operation and switched alternative-only operation. In the case that a Power Generating Module is designed to switch between these modes of operation, it must be designed to comply with the requirements for each mode.	Long-Term Parallel Operation.	P
7.1.2	Equipment other than Generating Units (eg traction loads, lift motors etc) may act as a short term source of energy, and inject electrical energy into the Customer's Installation when they operate in a regenerative mode. In general EREC G99 will not apply as there will be no need to make any specific design accommodation for such equipment as it is unlikely that they will support any possible power island for a significant length of time. Where such equipment can act as a source of electrical energy for more than a few seconds (say typically 20 s), the DNO will advise the Customer if the Customer's Installation requires any special consideration such as reverse power protection on a case by case basis.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
7.1.3	In general the technical requirements in EREC G99 will not apply for non-controllable storage technology such as synchronous compensators and synchronous flywheels. This is because there will be no need to make any specific design accommodation for such equipment as it is unlikely that they will support any possible power island for a significant length of time. Where such equipment can act as a source of electrical energy for more than a few seconds (say typically 20 s), the DNO will advise the Customer if the Customer's Installation requires any special consideration, such as reverse power protection or short circuit current contribution assessment, on a case by case basis.		N/A
7.2	**Long-Term Parallel Operation**		P
7.2.1	This refers to the frequent or long-term operation of Power Generating Modules in parallel with the Distribution Network. Unless otherwise stated, all sections in this EREC G99 are applicable to this mode of operation.		P
7.3	**Infrequent Short-Term Parallel Operation**		N/A
7.4	**Switched Alternative-Only Operation**		N/A
7.5	**Phase Balance of Type A Power Generating Module output at LV**		N/A
7.5.1	Connection of single phase Power Generating Modules may require Distribution Network reinforcement and extension before commissioning for technical reasons (such as voltage issues and unacceptable phase imbalance) depending on the point of connection and Distribution Network design.	Type B, C, D Power Generating Modules.	N/A
7.5.2	A solution to these voltage issues and phase imbalance issues may be to utilise 3-phase Power Generating Modules or to use multiple single phase Power Generating Modules connected across three phases.		N/A
7.5.3	Where single phase Power Generating Modules are being used the Generator should design the installation on a maximum unbalance output of 16 A between the highest and lowest phase.	3-phase PV inverter	N/A
7.5.4	In order to illustrate this requirement examples of acceptable and unacceptable connections have been given in Annex A.5.		N/A
7.6	**Type A Power Generating Module capacity for single and split LV phase supplies**		N/A
7.6.1	The maximum aggregate capacity of Power Generating Modules that can be connected to a single phase supply is 17 kW. The maximum aggregate capacity of Power Generating Modules that can be connected to a split single phase supply is 34 kW.	3-phase PV inverter	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
7.6.2	There is no requirement to provide intertripping between single phase Inverters where these are installed on multi-phase supplies up to a limit of 17 kW per phase (subject to balance of site output as per Section 7.5). A single phase 17 kW connection may result in an imbalance of up to 17 kW following a Distribution Network or Power Generating Module outage. However the connection design should result in imbalance under normal operation to be below 16 A between phases as noted above.		N/A
7.6.3	Power Generating Facilities with a capacity above 17 kW per phase are expected to comprise three phase units. The requirement to disconnect all phases following a fault in the Generator's Installation or a Distribution Network outage applies to three phase the Power Generating Modules only and will be tested as part of the compliance testing of the Power Generating Module. In some parts of the country where provision of three phase networks is costly then the DNO may be able to provide a solution using single or spilt phase networks for Power Generating Facilities above the normal limits as set out above.		N/A
7.7	**Voltage Management Units in Generator's premises**		P
7.7.1	Voltage Management Units are becoming more popular and use various methods, in most cases, to reduce the voltage supplied from the DNO's Distribution Network before it is used by the Generator. In some cases where the DNO's Distribution Network voltage is low they may increase the voltage supplied to the Generator. Some technologies are only designed to reduce voltage and cannot increase the voltage.		Info.
7.7.2	The use of such equipment has the advantage to the Generator of running appliances at a lower voltage and in some cases this can reduce the energy consumption of the appliance. Some appliances when running at a lower voltage will result in higher current consumption as the device needs to take the same amount of energy from the system to carry out its task.		Info.
7.7.3	If a Voltage Management Unit is installed between the Connection Point and the Power Generating Module in a Generators Installation, it may result in the voltage at the Generator side of the Voltage Management Unit remaining within the limits of the protection settings defined in Table 10.1 while the voltage at the Connection Point side of the unit might be outside the limits of the protection settings. This would negate the effect of the protection settings. Therefore, this connection arrangement is not acceptable and all Power Generating Modules connected to the DNO's LV Distribution Network under this Engineering Recommendation must be made on the Connection Point side of any Voltage Management Unit installed in a Generator's Installation.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
7.7.4	Generators should note that the overvoltage setting defined in Table 10.1 is 4% above the maximum voltage allowed for the voltage from the DNO's Distribution Network under the ESQCR and that provided they have designed their installation correctly there should be very little nuisance tripping of the Power Generating Module. Frequent nuisance tripping of a Power Generating Module may be due to a fault in the Generator's Installation or the operation of the DNO's Distribution Network at too high a voltage. Generators should satisfy themselves that their installation has been designed correctly and all Power Generating Modules are operating correctly before contacting the DNO if nuisance tripping continues. Under no circumstances should they resort to the use of Voltage Management Units installed between the Connection Point and the Power Generating Module.		P
8	**EARTHING**		P
8.1	**General**		P
8.1.1	The earthing arrangements of the Power Generating Module shall satisfy the requirements of DPC4 of the Distribution Code.		P
8.2	**Power Generating Modules with a Connection Point at HV**		P
8.3	**Power Generating Modules with a Connection Point at LV**		P
8.3.1	LV Distribution Networks are always solidly earthed, and the majority are multiple earthed. Design practice for protective multiple earthing is detailed in the Energy Networks Association publications including Engineering Recommendation G12, and in the references contained in those publications.		P
8.3.2	The winding configuration and method of earthing connection shall be agreed with the DNO.		P
8.3.3	In addition, where the Power Generation Facility's Connection Point is at Low Voltage the following shall apply: Where an earthing terminal is provided by the DNO it may be used by a Power Generation Facility for earthing the Power Generating Module, provided the DNO earth connection is of adequate capacity.		P
9	**NETWORK CONNECTION DESIGN AND OPERATION**		P
9.1	**General Criteria**		P
9.1.1	As outlined in Section 5, DNOs have to meet certain statutory and Distribution Licence obligations when designing and operating their Distribution Networks. These obligations will influence the options for connecting Power Generating Modules.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.1.2	The technical and design criteria to be applied in the design of the Distribution Network and Power Generating Module connection are detailed in this document and DPC 4 of the Distribution Code. The criteria are based upon the performance requirements of the Distribution Network necessary to meet the above obligations.		P
9.1.3	The Distribution Network, and any Power Generating Module connection to that network, shall be designed:		P
	(a) to comply with the obligations (to include security, frequency and voltage; voltage disturbances and harmonic distortion; auto reclosing and single phase protection operation).		P
	(b) according to design principles in relation to Distribution Network’s plant and equipment, earthing, voltage regulation and control, and protection as outlined in DPC4, subject to any Modification to which the DNO may reasonably consent.		P
9.1.4	Power Generating Modules should meet a set of technical requirements in relation to its performance with respect to frequency and voltage, control capabilities, protection coordination requirements, Phase (Voltage) Unbalance requirements, neutral earthing provisions, islanding and Black Start Capability as applicable. The technical connection requirements in this chapter are common to all Power Generating Modules.		P
9.1.5	In addition requirements for Type A Power Generating Modules are detailed in Section 11. Requirements for Type B Power Generating Modules are detailed in Section 12. Requirements for Type C and Type D Power Generating Modules are detailed in Section 13.		P
9.1.6	The Reactive Power and voltage control requirements are given in Section 11, Section 12 and Section 13 for Type A Power Generating Modules, Type B Power Generating Modules, and Type C and Type D Power Generating Modules respectively. They are summarised in Table D.4 for information.		P
9.1.7	Every Power Generating Module and any associated equipment must be designed and operated appropriately to comply with cyber security requirements. The Generator shall consider all cyber security risks applicable to the Power Generating Module in terms of the communication between any energy management system etc and also in terms of interaction with any system of the Manufacturer for product management.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.1.8	The Generator shall provide information describing the high level cyber security approach, as well as the specific cyber security requirements complied with. The statement will make appropriate reference to the Power Generating Facilities compliance with: • ETSI EN 303 645; • relevant aspects of PAS 1879 “Energy smart appliances – Demand side response operation – Code of practice”; • relevant aspects of “Distributed Energy Resources – Cyber Security Connection Guidance” published by BEIS and the ENA; • Any other relevant standard that has been incorporated in the design of the Power Generating Module.	The communication between the inverter and the external network is implemented by a separate device (data logger with model name Logger 4000 manufactured by the same manufacturer as inverter - Sungrow). High level cyber security approach as well as the specific cyber security requirements are evaluated against ETSI EN 303 645. Compliance to ETSI EN 303 645 is recorded in a separate document and is provided by manufacturer.	P
9.2	**Network Connection Design for Power Generating Modules**		P
9.3	**Step Voltage Change and Rapid Voltage Change**		P
9.4	**Power Quality**		P
9.4.1	Introduction		P
9.4.1.1	The connection and operation of Power Generating Modules may cause Phase (Voltage) Unbalance and/or a distortion of the Distribution Network voltage waveform resulting in voltage fluctuations and harmonics.		P
9.4.2	Flicker		P
9.4.2.1	Where the input motive power of the Power Generating Module may vary rapidly, causing corresponding changes in the output power, flicker may result. The operation of a Power Generating Module including synchronisation, run-up and desynchronisation shall not result in flicker that breaches the limits for flicker that is non-compliant with EREC P28.		P
9.4.2.2	The supply impedance of the Distribution Network needs to be considered to ensure that the emissions produced by the Power Generating Module do not cause a problem on the Distribution Network.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.4.2.3	For Power Generating Modules up to 17 kW per phase or 50 kW three phase voltage step change and flicker measurements as required by BS EN 61000-3-11 shall be made and recorded in the test declaration form A2-1 or form A2-3 as applicable for the Power Generating Module. The DNO will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with EREC P28. This calculation may show that the voltage fluctuations will be greater than those permitted and hence reinforcement of the Distribution Network may be required before the Power Generating Module can be connected. Detailed testing requirements are described in Annex A.7.		P
9.4.3	Harmonic Emissions		P
9.4.3.1	Harmonic currents produced within the Generator's system and modification of the harmonic impedance caused by the addition of the Generator's installation may cause excessive harmonic voltage distortion in the Distribution Network. The Generator's Installation must be designed and operated to comply with the planning criteria for harmonic voltage distortion as specified in EREC G5. EREC G5, like all planning standards referenced in this recommendation, is applicable at the time of connection of additional equipment to a Generator's Installation.		P
9.4.3.2	For Power Generating Modules of up to 17 kW per phase or 50 kW three phase harmonic measurements as required by BS EN 61000-3-12 shall be made and recorded in the test declaration form A2-1 or form A2-3 as applicable for the Power Generating Module. The DNO will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with BS EN 61000-3-12 and will use this data in their design of the connection for the Power Generating Module. This standard requires a minimum ratio between source fault level and the size of the Power Generating Module, and connections in some cases may require the installation of a transformer between 2 and 4 times the rating of the Power Generating Module in order to accept the connection to a DNO's Distribution Network. Detailed testing requirements are described in Annex A.7		P
9.4.3.3	Where the Power Generating Module is connected via a long cable circuit the likelihood of a resonant condition is greatly increased, especially at 132 kV. This arises from the reaction of the transformer inductance with the cable capacitance. Resonance is likely in the low multiples of the fundamental frequency (8th-11th harmonic). The resonant frequency is also a function of the Total System fault level. If there is the possibility that this can change significantly eg by the connection of another Power Generating Module then a full harmonic study should be carried out.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
9.4.4	Voltage imbalance		P
9.4.4.1	EREC P29 is a planning standard which provides limits for voltage unbalance caused by uneven loading of three phase supply systems. Power Generating Modules should be capable of performing satisfactorily under the conditions it defines. The existing voltage unbalance on an urban Distribution Network rarely exceeds 0.5% but higher levels, in excess of 1%, may be experienced at times of high load and when outages occur at voltage levels above 11 kV. 1% may exist continuously due to unbalance of the system impedance (common on remote rural networks). In addition, account can be taken of the neutralising effect of rotating plant, particularly at 11 kV and below. BS EN 50160 contains details of the variations and disturbances to the voltage which shall be taken into account in selecting equipment from an appropriate specification for installation on or connected to the Distribution Network.		P
9.4.4.2	The level of voltage unbalance at the Point Of Common Coupling should be no greater than 1.3% for systems with a nominal voltage below 33 kV, or 1% for other systems with a nominal voltage no greater than 132 kV. Overall, voltage unbalance should not exceed 2% when assessed over any one minute period. EREC P29, like all planning standards, is applicable at the time of connection.		P
9.4.4.3	For Power Generating Facilities of 50 kW or less Section 7.5 of this document specifies maximum unbalance of Power Generating Modules. Where these requirements are met then no further action is required by the Generator.		P
9.4.5	Power Factor correction equipment is sometimes used with Power Park Modules to decrease Reactive Power flows on the Distribution Network. Where the Power Factor correction equipment is of a fixed output, stable operating conditions in the event of loss of the DNO supply are extremely unlikely to be maintained, and therefore no special protective actions are required in addition to the standard protection specified in this document.		P
9.4.6	DC Injection		P
9.4.6.1	The effects of, and therefore limits for, DC currents injected into the Distribution Network is an area currently under investigation. Until these investigations are concluded the limit for DC injection is less than 0.25% of the AC rating per Power Generating Module.	See appended table.	P
9.4.6.2	The main source of these emissions are from transformer-less Inverters. Where necessary DC emission requirements can be satisfied by installing a transformer on the AC side of an Inverter.		P
9.5	**System Stability**		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.5.1	Instability in Distribution Networks may result in unacceptable quality of supply and tripping of Generator's plant. In severe cases, instability may cascade across the Distribution Network, resulting in widespread tripping and loss of demand and generation. There is also a risk of damage to plant.		P
9.5.2	In general, System Stability is an important consideration in the design of Power Generating Module connections to the Distribution Network at 33 kV and above. Stability considerations may also be appropriate for some Power Generating Module connections at lower voltages. The risks of instability generally increase as Power Generating Module capacity increases relative to the fault level infeed from the Distribution Network at the Connection Point.		P
9.5.3	System Stability may be classified into several forms, according firstly to the main system variable in which instability can be observed, and secondly to the size of the system disturbance. In Distribution Networks, the forms of stability of interest are rotor angle stability and voltage stability.		P
9.5.3.1	Rotor angle stability refers to the ability of synchronous machines in an interconnected system to remain in Synchronism after the system is subjected to a disturbance.		N/A
9.5.3.2	Voltage stability refers to the ability of a system to maintain acceptable voltages throughout the system after being subjected to a disturbance.		P
9.5.3.3	Both rotor angle stability and voltage stability can be further classified according to the size of the disturbance.		N/A
9.5.3.4	Small-disturbance stability refers to the ability of a system to maintain stability after being subjected to small disturbances such as small changes in load, operating points of Power Generating Modules, transformer tap-changing or other normal switching events.		P
9.5.3.5	Large-disturbance stability refers to the ability of a system to maintain stability after being subjected to large disturbances such as short-circuit faults or sudden loss of circuits or Power Generating Modules.		P
9.5.3.6	Traditionally, large-disturbance rotor angle stability (also referred to as transient stability) has been the form of stability predominantly of interest in Distribution Networks with synchronous machines. However, it should be noted that the other forms of stability may also be important and may require consideration in some cases.		N/A
9.5.4	It is recommended that a Power Generating Module and its connection to the Distribution Network be designed to maintain stability of the Distribution Network for a defined range of initial operating conditions and a defined set of system disturbances.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.5.4.1	The range of initial operating conditions should be based on those which are reasonably likely to occur over a year of operation. Variables to consider include system loads, system voltages, system outages and configurations, and Power Generating Module operating conditions.		P
9.5.4.2	The system disturbances for which stability should be maintained should be selected on the basis that they have a reasonably high probability of occurrence. It is recommended that these include short-circuit faults on single Distribution Network circuits (such as transformers, overhead lines and cables) and busbars, that are quickly cleared by main protection.		P
9.5.5	With the system in its normal operating state, it is desirable that all Power Generation Modules remain connected and stable for any of the following credible fault outages; i. any one single circuit overhead line, transformer feeder or cable circuit, independent of length, ii. any one transformer or reactor, iii. any single section of busbar at or nearest the point of connection where busbar protection with a total clearance time of less than 200ms is installed, iv. if demand is to be secured under a second circuit outage as required by EREC P2, fault outages (a) or (b), overlapping with any pre-existing first circuit outage, usually for maintenance purposes. In this case the combination of circuit outages considered should be that causing the most onerous conditions for System Stability, taking account of the slowest combination of main protection, circuit breaker operating times and strength of the connections to the system remaining after the faulty circuit or circuits have been disconnected.		P
9.5.6	It should be noted that it is impractical and uneconomical to design for stability in all circumstances. This may include double circuit fault outages and faults that are cleared by slow protection. Power Generating Modules that become unstable following system disturbances shall be disconnected as soon as possible to reduce the risk of plant damage and disturbance to the system.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.5.7	Various measures may be used, where reasonably practicable, to prevent or mitigate system instability. These may include Distribution Network and Power Generating Module solutions, such as: (a) improved fault clearance times by means of faster protection; (b) improved performance of Power Generating Module control systems (excitation and governor/prime mover control systems; Power System Stabilisers to improve damping); (c) improved system voltage support (provision from either Power Generating Module or Distribution Network plant); (d) reduced plant reactance's (if possible); (e) installation of protection to identify pole-slipping; (f) increased fault level infeed. In determining mitigation measures which are reasonably practicable, due consideration should be given to the cost of implementing the measures and the benefits to the Distribution Network and Generators in terms of reduced risk of system instability.		P
9.6	**Island Mode**		P
9.6.1	There are two specific instances of island mode to be considered: (a) where the Generator wishes to deliberately move from the long-term parallel mode of operation to the situation where the Generator's Power Generating Module(s) is arranged to supply just the load presented by the Customer's Installation, with the Customer's Installation disconnected from the DNO's Distribution Network; or (b) where one or more Power Generating Modules, belonging to one or more Generators, support an isolated part of the DNO's Distribution Network, maintaining supplies to other Customers of the DNO.		P
9.6.2	Customer's Installation Island		P
9.6.2.1	Wherever a Generator's Power Generating Module runs in parallel with the DNO's Distribution Network for more than 5 minutes per month, the design of the Power Generating Module and the Customer's Installation must meet the requirements for long-term parallel operation and comply with all the appropriate requirements of this EREC G99.		P
9.6.2.2	Where a Generator intends to operate the Power Generating Module so that it supplies just the Customer's Installation, it is the Generator's responsibility to ensure the safety of the Customer's Installation in respect of electrical and general safety.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.6.2.3	The arrangements of Figures 8.6 (HV) and 8.9 (LV) will generally be appropriate for earthing and switching arrangements. Exact designs of Customer's Installations will vary, but the functional requirements of these figures should be implemented.		P
9.6.2.4	It is the Generator's responsibility to ensure appropriate and safe synchronisation to, and disconnection from, the DNO's Distribution Network, respecting the requirements of EREC P28 on voltage disturbances on the DNO's Distribution Network.		P
9.6.3	DNO's Distribution Network Island		P
9.6.3.1	A fault or planned outage, which results in the disconnection of a Power Generating Module, together with an associated section of Distribution Network, from the remainder of the Total System, creates the potential for island mode operation. It will be necessary for the DNO to decide, dependent on local network conditions, if it is desirable for the Generators to continue to generate onto the islanded DNO's Distribution Network. The key potential advantage of operating in island mode is to maintain continuity of supply to the portion of the Distribution Network containing the Power Generating Module. The principles discussed in this section generally also apply where Power Generating Modules on a Generator's site is designed to maintain supplies to that site in the event of a failure of the DNO supply.		P
9.6.3.2	When considering whether Power Generating Modules can be permitted to operate in island mode,10 detailed studies need to be undertaken to ensure that the islanded system will remain stable and comply with all statutory obligations and relevant planning standards when separated from the remainder of the Total System. Before operation in island mode can be allowed, a contractual agreement between the DNO and Generator shall be in place and the legal liabilities associated with such operation shall be carefully considered by the DNO and the Generator. Consideration should be given to the following areas: (a) load flows, voltage regulation, frequency regulation, voltage unbalance, voltage flicker and harmonic voltage distortion; (b) earthing arrangements; (c) short circuit currents and the adequacy of protection arrangements; (d) System Stability; (e) re-synchronisation to the Total System; (f) safety of personnel.		P

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Clause	Requirement - Test	Result - Remark	Verdict
9.6.3.3	Suitable equipment will need to be installed to detect that an island situation has occurred and an intertripping scheme is preferred to provide absolute discrimination at the time of the event. Confirmation that a section of Distribution Network is operating in island mode, and has been disconnected from the Total System, will need to be transmitted to the Power Generating Module(s) protection and control schemes.		P
9.6.3.4	The ESQCR requires that supplies to Customers are maintained within statutory limits at all times ie when they are supplied normally and when operating in island mode. Detailed system studies including the capability of the Power Generating Module and its control / protections systems will be required to determine the capability of the Power Generating Module to meet these requirements immediately as the island is created and for the duration of the island mode operation.		P
9.6.3.5	The ESQCR also require that Distribution Networks are earthed at all times. Generators, who are not permitted to operate their installations and plant with an earthed star-point when in parallel with the Distribution Network, shall provide an earthing transformer or switched star-point earth for the purpose of maintaining an earth on the system when islanding occurs. The design of the earthing system that will exist during island mode operation should be carefully considered to ensure statutory obligations are met and that safety of the Distribution Network to all users is maintained. Further details are provided in Section 8		P
9.6.3.6	Detailed consideration shall be given to ensure that protection arrangements are adequate to satisfactorily clear the full range of potential faults within the islanded system taking into account the reduced fault currents and potential longer clearance times that are likely to be associated with an islanded system.		P
9.6.3.7	Switchgear shall be rated to withstand the voltages which may exist across open contacts under islanded conditions. The DNO may require interlocking and isolation of its circuit breaker(s) to prevent out of phase voltages occurring across the open contacts of its switchgear. Intertripping or interlocking should be agreed between the DNO and the Generator where appropriate.	It’s depended on Installer.	N/A
9.6.3.8	It will generally not be permissible to interrupt supplies to DNO Customers for the purposes of re-synchronisation. The design of the islanded system shall ensure that synchronising facilities are provided at the point of isolation between the islanded network and the DNO supply. Specific arrangements for this should be agreed and recorded in the Connection Agreement with the DNO. If no facilities exist for the subsequent re-synchronisation with the rest of the DNO’s Distribution Network then the Generator will, under DNO instruction, ensure that the Power Generating Module is disconnected for re-synchronisation.		P
9.7	**Fault Contributions and Switchgear Considerations**		P

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Clause	Requirement - Test	Result - Remark	Verdict
10	**PROTECTION**		P
10.1	**General**		P
10.1.1	The main function of the protection systems and settings described in this document is to prevent the Power Generating Module supporting an islanded section of the Distribution Network when it would or could pose a hazard to the Distribution Network or Customers connected to it. The settings recognize the need to avoid nuisance tripping and therefore require a two stage approach where practicable, ie to have a long time delay for smaller excursions that may be experienced during normal Distribution Network operation, to avoid nuisance tripping, but with a faster trip, where possible, for greater excursions.		P
10.1.2	In accordance with established practice it is for the Generator to install, own and maintain this protection. The Generator can therefore determine the approach, ie per Power Generating Module or per installation, and where in the installation the protection is sited.		P
10.1.3	Where a common protection system is used to provide the protection function for multiple Power Generating Modules the complete installation cannot be considered to comprise Fully Type Tested Power Generating Modules if the protection and connections are made up on site and so cannot be factory tested or Type Tested. If the units or Power Generating Modules are specifically designed to be interconnected on site via plugs and sockets, then provided the assembly passes the function tests required in Annex A.2 (Form A2-4), the Power Generating Modules can retain Type Tested status.		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.1.4	Type Tested Interface Protection shall have protection settings set during manufacture. An Interface Protection device or relay can only be considered Type Tested if: (a) The frequency and LoM protection settings are factory set in firmware by the Manufacturer to those in Table 10.1 and cannot be changed outside the factory (except as provided by (e) below). (b) The voltage protection settings are factory set to those in Table 10.1 and can be changed by agreement with the DNO and by personnel specifically instructed by the Generator to make this change. (c) The access by the personnel specifically instructed shall be controlled by a password, pin or a physical switch that has the facility to be sealed. (d) Any Interface Protection device functionality other than the voltage protection settings (eg such as any auto reclosing functionality) can only be changed by personnel specifically empowered to do so by the Generator. (e) Any changes to device firmware etc, where Type Tested status is to be retained, outside of the original factory environment shall be undertaken by personnel specifically empowered and equipped for that task by the Manufacturer.		P
10.1.5	Once the Power Generating Modules has been installed and commissioned the protection settings shall only be altered following written agreement between the DNO and the Generator.		P
10.1.6	In exceptional circumstances additional protection may be required by the DNO to protect the Distribution Network and its Customers from the Power Generating Module.		P
10.1.7	Note that where the Generator installs an Export Limiting Scheme in accordance with EREC G100 the installation will also need to comply with the requirements of that EREC.		P
10.2	**Co-ordinating with DNO's Distribution Network's Existing Protection**		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.2.1	It will be necessary for the protection associated with Power Generating Modules to co-ordinate with the Protection associated with the DNO's Distribution Network as follows: (a) For Power Generating Modules directly connected to the DNO's Distribution Network the Power Generating Module must meet the target clearance times for fault current interchange with the DNO's Distribution Network in order to reduce to a minimum the impact on the DNO's Distribution Network of faults on circuits owned by the Generator. The DNO will ensure that the DNO protection settings meet its own target clearance times. The target clearance times are measured from fault current inception to arc extinction and will be specified by the DNO to meet the requirements of the relevant part of the Distribution Network. (b) The settings of any protection controlling a circuit breaker or the operating values of any automatic switching device at any point of connection with the DNO's Distribution Network, as well as the Generator's maintenance and testing regime, shall be agreed between the DNO and the Generator in writing during the connection consultation process.		P
	It will be necessary for the Power Generating Module protection to co-ordinate with any auto-reclose policy specified by the DNO. In particular the Power Generating Module protection should detect a loss of mains situation and disconnect the Power Generating Module in a time shorter than any auto reclose dead time. This should include an allowance for circuit breaker operation and generally a minimum of 0.5 s should be allowed for this. For auto-reclosers set with a dead time of 3 s, this implies a maximum Interface Protection response time of 2.5 s. Where auto-reclosers have a dead time of less than 3 s, there may be a need to reduce the operating time of the Interface Protection. For Type Tested Power Park Modules no changes are required to the operating times irrespective of the auto-reclose times. In all other cases where the auto-recloser dead time is less than 3 s the Generator will need to agree site-specific Interface Protection settings with the DNO.		P
10.2.2	Specific protection required for Power Generating Modules		P

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Clause	Requirement - Test	Result - Remark	Verdict
	In addition to any protection installed by the Generator to meet his own requirements and statutory obligations on him, the Generator must install protection to achieve the following objectives: (a) For all Power Generating Modules: i. To disconnect the Power Generating Module from the system when a system abnormality occurs that results in an unacceptable deviation of the frequency or voltage at the Connection Point, recognizing the requirements to ride through faults as detailed in Sections 12.3 and 13.4; ii. To ensure the automatic disconnection of the Power Generating Module, or where there is constant supervision of an installation, the operation of an alarm with an audio and visual indication, in the event of any failure of supplies to the protective equipment that would inhibit its correct operation.		P
	(b) For polyphase Power Generating Modules: i. To inhibit connection of Power Generating Modules to the system unless all phases of the DNO’s Distribution Network are present and within the agreed ranges of protection settings; ii. To disconnect the Power Generating Module from the system in the event of the loss of one or more phases of the DNO’s Distribution Network;		P
	(c) For single phase Power Generating Modules: i. To inhibit connection of Power Generating Modules to the system unless that phase of the DNO’s Distribution Network is present and within the agreed ranges of protection settings; ii. To disconnect the Power Generating Module from the system in the event of the loss of that phase of the DNO’s Distribution Network;		N/A
10.3	**Protection Requirements**		P
10.3.1	Suitable protection arrangements and settings will depend upon the particular Generator installation and the requirements of the DNO’s Distribution Network. These individual requirements must be ascertained in discussions with the DNO. To achieve the objectives above, the protection must include the detection of: • Under Voltage (1 stage); • Over Voltage (2 stage); • Under Frequency (2 stage); • Over Frequency (1 stage); • Loss of Mains (LoM).		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The LoM protection will depend for its operation on the detection of some suitable parameter, for example, rate of change of frequency (RoCoF), or unbalanced voltages. More details on LoM protection are given in Section 10.4.		P
10.3.2	The protective equipment, provided by the Generator, to meet the requirements of this section must be installed in a suitable location that affords visual inspection of the protection settings and trip indicators and is secure from interference by unauthorised personnel.		P
10.3.3	Installation of automatic reconnection systems for Type B, Type C and Type D shall be subject to prior authorisation by the DNO. Unless Generators of Type D Power Generating Modules have prior authorisation from the DNO for the installation of automatic reconnection systems, they must obtain authorisation from the DNO, or NETSO as applicable, prior to synchronisation.	Type B, C, D Power Generating Modules	P
10.3.4	The frequency and voltage at the DNO's side of the supply terminals at the Connection Point must be within the frequency and voltage ranges of the Interface Protection as listed in paragraph 10.6.7 for at least 20 s before the Power Generating Module is allowed to automatically reconnect to the DNO's Distribution Network. There is in general no maximum admissible ramp rate for Active Power output on connecting or reconnecting, although it is a requirement to state the assumed maximum ramp rate for the Power Generating Module as part of the application for connection.		P
10.3.5	If automatic resetting of the protective equipment is used, there must be a time delay to ensure that healthy supply conditions exist for a minimum continuous period of 20 s. Reset times may need to be co-ordinated where more than one Power Generating Module is connected to the same feeder. The automatic reset must be inhibited for faults on the Generator's Installation.		P
10.3.6	Protection equipment is required to function correctly within the environment in which it is placed and shall satisfy the following standards: • BS EN 61000 (Electromagnetic Standards); • BS EN 60255 (Electrical Relays); • BS EN 61810 (Electrical Elementary Relays); • BS EN 60947 (Low Voltage Switchgear and Control gear); • BS EN 61869 (Instrument Transformers; Additional requirements for current transformers). • Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable.		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.3.7	Protection equipment and protection functions may be installed within, or form part of the Power Generating Module control equipment as long as: (a) the control equipment satisfies all the requirements of Section 10 including the relevant standards specified in paragraph 10.3.6; (b) the Power Generating Module shuts down in a controlled and safe manner should there be an equipment failure that affects both the protection and control functionality, for example a power supply failure or microprocessor failure; and (c) (c) the equipment is designed and installed so that protection calibration and functional tests can be carried out easily and safely using secondary injection techniques (ie using separate Low Voltage test equipment).		P
10.3.8	The health of protection tripping and/or auxiliary supplies must be monitored such that any failure of these supplies is either brought to the immediate attention of the Generator via an automatic alarm that is monitored by the Generator in real time, or the failure of the protection tripping and/or auxiliary supplies causes the Power Generation Module to be tripped, and reconnection prevented before restoration of the protection tripping and/or auxiliary supplies that have been lost.		P
10.4	**Loss of Mains (LoM)**		P
10.4.1	To achieve the objectives of Section 10.1.1, in addition to protection installed by the Generator for his own purposes, the Generator must install protection to achieve (amongst other things) disconnection of the Power Generating Module from the Distribution Network in the event of loss of one or more phases of the DNOs supply.		P
10.4.2	LoM protection is required for all Type A, Type B and Type C Power Generating Modules. For Type D Power Generating Modules the DNO will advise if LoM protection is required. The requirements of paragraph 10.6.2 apply to LoM protection for all Power Generating Modules.		P
10.4.3	A problem can arise for Generators who operate a Power Generating Module in parallel with the Distribution Network prior to a failure of the network supply because if their Power Generating Module continues to operate in some manner, even for a relatively short period of time, there is a risk that when the network supply is restored the Power Generating Module will be out of Synchronism with the Total System and suffer damage. LoM protection can be employed to disconnect the Power Generating Module immediately after the supply is lost, thereby avoiding damage to the Power Generating Module.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
10.4.4	Where the amount of Distribution Network load that the Power Generating Module will attempt to pick up following a fault on the Distribution Network is significantly more than its capability the Power Generating Module will rapidly disconnect, or stall. However, depending on the exact conditions at the time of the Distribution Network failure, there may or may not be a sufficient change of load on the Power Generating Module to be able to reliably detect the failure. The Distribution Network failure may result in one of the following load conditions being experienced by the Power Generating Module: (a) The load may slightly increase or reduce, but remain within the capability of the Power Generating Module. There may even be no change of load; (b) The load may increase above the capability of the prime mover, in which case the Power Generating Module will slow down, even though the alternator may maintain voltage and current within its capacity. This condition of speed/frequency reduction can be easily detected; or (c) The load may increase to several times the capability of the Power Generating Module, in which case the following easily detectable conditions will occur: • Overload and accompanying speed/frequency reduction • Over current and under voltage on the alternator		P
10.4.5	Conditions (b) and (c) are easily detected by the under and over voltage and frequency protection required in this document. However, condition (a) presents most difficulty, particularly if the load change is extremely small and therefore there is a possibility that part of the Distribution Network supply being supplied by the Power Generating Module will be out of Synchronism with the Total System. LoM protection is designed to detect these conditions.		P
10.4.6	LoM signals can also be provided by means of intertripping signals from circuit breakers that have operated in response to the Distribution Network fault.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
10.4.7	The LoM protection can utilise one or a combination of the passive protection principles such as reverse Active Power flow, reverse Reactive Power and rate of change of frequency (RoCoF). Alternatively, active methods such as reactive export error detection or frequency shifting may be employed. These may be arranged to trip the interface circuit breaker at the DNO Generator interface, thus, leaving the Power Generating Module available to satisfy the load requirements of the site or the Power Generating Module circuit breaker can be tripped, leaving the breaker at the interface closed and ready to resume supply when the Distribution Network supply is restored. The most appropriate arrangement is subject to agreement between the DNO and Generator.	See appended table.	P
10.4.8	Protection based on measurement of reverse flow of Active Power or Reactive Power can be used when circumstances permit and must be set to suit the Power Generating Module rating, the site load conditions and requirements for Reactive Power.		P
10.4.9	Where the Power Generating Facility capacity is such that the site will always import power from the Distribution Network, a reverse power relay may be used to detect failure of the supply. It will usually be appropriate to monitor all three phases for reverse power.		P
10.4.10	However, where the Power Generating Facilities normal mode of operation is to export power, it is not possible to use a reverse power relay and consequently failure of the supply cannot be detected by measurement of reverse power flow. The protection should then be specifically designed to detect loss of the mains connection using techniques to detect the rate of change of frequency and/or Power Factor. All these techniques are susceptible to Distribution Network conditions and the changes that occur without islanding taking place. These relays must be set to prevent islanding but with the best possible immunity to unwanted nuisance operation.		P
10.4.11	RoCoF relays use a measurement of the period of the mains voltage cycle. The RoCoF technique measures the rate of change in frequency caused by any difference between prime mover power and electrical output power of the Power Generating Module over a number of cycles. RoCoF relays should normally ignore the slow changes but respond to relatively rapid changes of frequency which occur when the Power Generating Module becomes disconnected from the Total System. The voltage vector shift technique is not an acceptable loss of mains protection.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
10.4.12	Should spurious tripping present a nuisance to the Generator, the cause must be jointly sought with the DNO. Raising settings on any relay to avoid spurious operation may reduce a relay's capability to detect islanding and it is important to evaluate fully such changes. Annex D.2 provides some guidance for assessments, which assume that during a short period of islanding the trapped load is unchanged. In some circumstances it may be necessary to employ a different technique, or a combination of techniques to satisfy the conflicting requirements of safety and avoidance of nuisance tripping. In those cases where the DNO requires LoM protection this must be provided by a means not susceptible to spurious or nuisance tripping, eg intertripping.		P
10.4.13	For a radial or simple Distribution Network controlled by circuit breakers that would clearly disconnect the entire circuit and associated Power Generating Module, for a LoM event an intertripping scheme can be easy to design and install. For meshed or ring Distribution Networks, it can be difficult to define which circuit breakers may need to be incorporated in an intertripping scheme to detect a LoM event and the inherent risks associated with a complex system should be considered alongside those associated with a using simple, but potentially less discriminatory LoM relay.		P
10.4.14	It is the responsibility of the Generator to incorporate what they believe to be the most appropriate technique or combination of techniques to detect a LoM event in his protection systems. This will be based on knowledge of the Power Generating Module, site and network load conditions. The DNO will assist in the decision making process by providing information on the Distribution Network and its loads. The settings applied must be biased to ensure detection of islanding under all practical operating conditions.		P
10.5	**Additional DNO Protection**		P
10.5.1	Following the DNO connection study, the risk presented to the Distribution Network by the connection of a Power Generating Module may require additional protection to be installed and may include the detection of: • Neutral Voltage Displacement (NVD); • Over Current; • Earth Fault; • Reverse Power.		P
10.5.2	Neutral Voltage Displacement (NVD) Protection		N/A
10.6	**Protection Settings**		P
10.6.1	The following notes aim to explain the settings requirements as given in Section 10.6.7 below.		P
10.6.2	Loss of Mains	See appended table.	P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	A LoM protection of the RoCoF type will generally be appropriate for Type A, Type B and Type C Power Generating Modules, but this type of LoM protection must not be installed for Power Generating Facilities at or above 50 MW. In those cases where the DNO requires LoM protection this must be provided by a means not susceptible to spurious or nuisance tripping, eg intertripping.		P
10.6.3	Under Voltage	See appended table.	P
	In order to help maintain Total System Stability, the protection settings aim to facilitate transmission fault ride through capability (as required in Sections 12.3 and 13.3 below). The overall aim is to ensure that Power Generating Module is not disconnected from the Distribution Network unless there is material disturbance on the Distribution Network, as disconnecting generation unnecessarily will tend to make an under voltage situation worse. To maximize the transmission fault ride through capability a single undervoltage setting of - 20% with a time delay of 2.5 s should be applied.		P
10.6.4	Over Voltage	See appended table.	P
	Over voltages are potentially more dangerous than under voltages and hence the acceptable excursions from the norm are smaller and time delays shorter, a 2-Stage over voltage protection6 is to be applied as follows: • Stage 1 (LV) should have a setting of +14% (ie the LV statutory upper voltage limit of +10%, with a further 4% permitted for voltage rise internal to the Generator's Installation and measurement errors), with a time delay of 1.0 s (to avoid nuisance tripping for short duration excursions); • Stage 2 (LV) should have a setting of +19% with a time delay of 0.5 s (ie recognising the need to disconnect quickly for a material excursion);		P
	• Stage 1 (HV) should have a setting of +10% with a time delay of 1.0 s (ie the HV statutory upper voltage limit of +6%, with a further 4% permitted for voltage rise internal to the Generator's Installation and measurement errors), with a time delay of 1.0 s to avoid nuisance tripping for short duration excursions); • Stage 2 (HV) should have a setting of +13% with a time delay of 0.5 s (ie recognising the need to disconnect quickly for a material excursion).		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	To achieve high utilisation and Distribution Network efficiency, it is common for the HV Distribution Network to be normally operated near to the upper statutory voltage limits. The presence of Power Generating Module within such Distribution Network may increase the risk of the statutory limit being exceeded, eg when the Distribution Network is operating abnormally. In such cases the DNO may specify additional over voltage protection at the Power Generating Module Connection Point. This protection will typically have an operating time delay long enough to permit the correction of transient over voltages by automatic tap-changers.		P
10.6.5	Over Frequency		P
	Power Generating Modules are required to stay connected to the Total System for frequencies up to 52 Hz for up to 15 minutes so as to provide the necessary regulation to control the Total System frequency to a satisfactory level. In order to prevent the unnecessary disconnection of a large volume of smaller Power Generating Module for all LV and HV connected Power Generating Module a single stage protection is to be applied that has a time delay of 0.5 s and a setting of 52 Hz. If the frequency rises to or above 52 Hz as the result of an undetected islanding condition, the Power Generating Module will be disconnected with a delay of 0.5 s plus circuit breaker operating time.	See appended table.	P
10.6.6	Under Frequency		P
	All Power Generating Facilities are required to maintain connection unless the Total System frequency falls below 47.5 Hz for 20 s or below 47 Hz. For all LV and HV connected Power Generating Module, the following 2-stage under frequency protection should be applied: • Stage 1 should have a setting of 47.5 Hz with a time delay of 20 s; • Stage 2 should have a setting of 47.0 Hz with a time delay of 0.5 s;	See appended table.	P
10.6.7	Protection Settings		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

10.6.7.1 — Verdict: P

Table 10.1 Settings for Long-Term Parallel Operation

Protection Function	Type A, Type B and Type C Power Generating Modules				Type D Power Generating Modules and Power Generating Facilities with a Registered Capacity > 50 MW	
	LV Protection(1)		**HV** Protection(1)			
	Trip Setting	Time Delay Setting	Trip Setting	Time Delay Setting	Trip Setting	Time Delay Setting
U/V	Vφ-n† -20%	2.5 s*	Vφ-φ‡ -20%	2.5 s*	Vφ-φ‡- 20%	2.5 s*
O/V st 1	Vφ-n† + 14%	1.0 s	Vφ-φ‡ + 10%	1.0 s	Vφ-φ‡ + 10%	1.0 s
O/V st 2	Vφ-n†+ 19%$	0.5 s	Vφ-φ‡ + 13%	0.5 s		
U/F st 1	47.5 Hz	20 s	47.5 Hz	20 s	47.5 Hz	20 s
U/F st 2	47.0 Hz	0.5 s	47.0 Hz	0.5 s	47.0 Hz	0.5 s
O/F	52.0 Hz	0.5 s	52.0 Hz	0.5 s	52.0 Hz	0.5 s
LoM (RoCoF)#	1 Hzs^{-1} time delay 0.5 s		1 Hzs^{-1} time delay 0.5 s		Intertripping expected	

Verdict: P

(1) HV and LV Protection settings are to be applied according to the voltage at which the voltage related protection reference is measuring, eg:

• If the EREC G99 protection takes its voltage reference from an LV source then LV settings shall be applied. Where a private non standard LV network exists the settings shall be calculated from HV settings values as indicated by Section 10.6.14;

• If the EREC G99 protection takes its voltage reference from an HV source then HV settings shall be applied.

†A value of 230 V shall be used in all cases for Power Generating Facilities connected to a DNO's LV Distribution Network ie the U/V LV trip setting is 184 V, the O/V stage 1 setting is 262.2 V and the O/V stage 2 setting is 273.7 V.

‡A value to suit the nominal voltage of the HV Connection Point.

* Might need to be reduced if auto-reclose times are <3 s. (see 10.2.1).

Intertripping may be considered as an alternative to the use of a LoM relay.

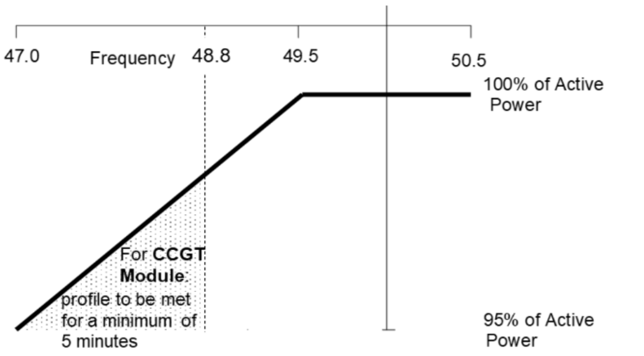
$ For voltages greater than 230 V +19% which are present for periods of<0.5 s the Power Generating Module is permitted to reduce/cease exporting in order to protect the Power Generating Module.

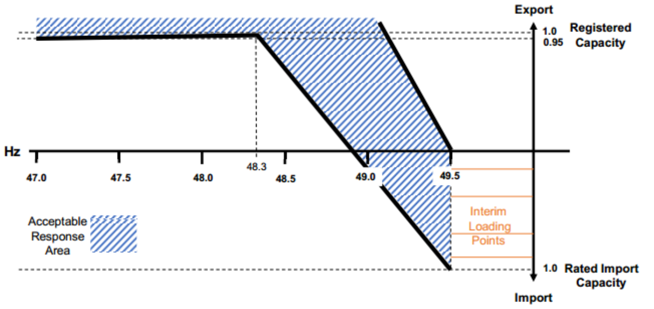
<table>
<tr><th colspan="4">G99/1-8</th></tr>
<tr><th>Clause</th><th>Requirement - Test</th><th>Result - Remark</th><th>Verdict</th></tr>
<tr><td></td><td>The required RoCoF protection requirement is expressed in Hertz per second (Hzs^{-1}). The time delay should begin when the measured RoCoF exceeds the threshold expressed in Hzs^{-1}. The time delay should be reset if measured RoCoF falls below that threshold. The relay must not trip unless the measured rate remains above the threshold expressed in Hzs^{-1} continuously for 500 ms. Setting the number of cycles on the relay used to calculate the RoCoF is not an acceptable implementation of the time delay since the relay would trip in less than 500 ms if the system RoCoF was significantly higher than the threshold.</td><td></td><td>P</td></tr>
<tr><td></td><td>(2) Note that the times in the table are the time delays to be set on the appropriate relays. Total protection operating time from condition detection to circuit breaker opening will be of the order of 100 ms longer than the time delay settings in the above table with most circuit breakers, slower operation is acceptable in some cases.</td><td></td><td>P</td></tr>
<tr><td></td><td>The Manufacturer must ensure that the Interface Protection in a Type Tested Power Generating Module is capable of measuring voltage to an accuracy of ±1.5% of the nominal value and of measuring frequency to ± 0.2% of the nominal value across its operating range of voltage, frequency and temperature.</td><td></td><td>P</td></tr>
<tr><td>10.6.7.2</td><td>Table 10.2 – Settings for Infrequent Short-Term Parallel Operation
<table>
<tr><th rowspan="3">Protection Function</th><th colspan="4">Type A, Type B and Type C Power Generating Module</th></tr>
<tr><th colspan="2">LV Protection</th><th colspan="2">HV Protection</th></tr>
<tr><th>Trip Setting</th><th>Time Delay Setting</th><th>Trip Setting</th><th>Time Delay Setting</th></tr>
<tr><td>U/V</td><td>Vφ-n† -10%</td><td>0.5 s</td><td>Vφ-φ‡ -6%</td><td>0.5 s</td></tr>
<tr><td>O/V</td><td>Vφ-n† + 14%</td><td>0.5 s</td><td>Vφ-φ‡ + 6%</td><td>0.5 s</td></tr>
<tr><td>U/F</td><td>49.5 Hz</td><td>0.5 s</td><td>49.5 Hz</td><td>0.5 s</td></tr>
<tr><td>O/F</td><td>50.5 Hz</td><td>0.5 s</td><td>50.5 Hz</td><td>0.5 s</td></tr>
</table>
†A value of 230 V shall be used in all cases for Power Generating Facilities connected to a DNO’s LV Distribution Network (ie the U/V LV trip setting is 207 V and the O/V trip setting is 262.2 V).
‡A value to suit the voltage of the HV Connection Point.</td><td>Long-Term Parallel Operation.</td><td>N/A</td></tr>
<tr><td>10.6.8</td><td>Over and Under voltage protection must operate independently for all three phases in all cases.</td><td></td><td>P</td></tr>
<tr><td>10.6.9</td><td>The settings in Table 10.1 should generally be applied to all Power Generating Modules. In exceptional circumstances Generators have the option to agree alternative settings with the DNO if there are valid justifications in that the Power Generating Module may become unstable or suffer damage with the settings specified in Table 10.1. The agreed settings should be recorded in the Connection Agreement.</td><td></td><td>P</td></tr>
</table>

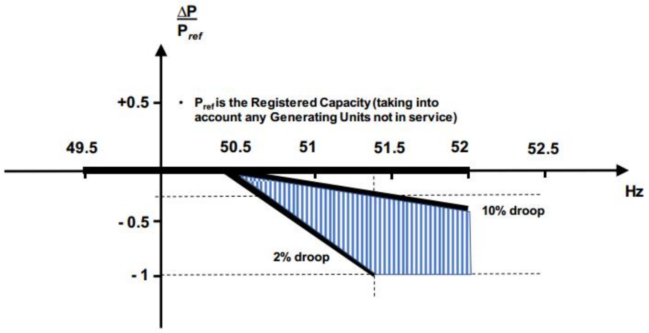
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
10.6.10	Once the settings of relays have been agreed between the Generator and the DNO they must not be altered without the written agreement of the DNO. Any revised settings should be recorded again in the amended Connection Agreement.		P
10.6.11	The under/over voltage and frequency protection may be duplicated to protect the Power Generating Module when operating in island mode although different settings may be required.		P
10.6.12	For LV connected Power Generating Modules the voltage settings will be based on the 230 V nominal system voltage. In some cases Power Generating Modules may be connected to LV systems with non-standard operating voltages. Paragraph 10.6.14 details how suitable settings can be calculated based upon the HV connected settings in Table 10.1. Note that Power Generating Modules with non-standard LV protection settings need to be agreed by the DNO on a case by case basis.		P
10.6.13	Where an installation contains Power Factor correction equipment which has a variable susceptance controlled to meet the Reactive Power demands, the probability of sustained generation is increased. For LV installations, additional protective equipment provided by the Generator, is required as in the case of self-excited asynchronous machines.	No such equipment used.	N/A
10.6.14	Non-Standard private LV networks calculation of appropriate protection settings		N/A
10.6.15	The Generator shall provide a means of displaying the protection settings so that they can be inspected if required by the DNO to confirm that the correct settings have been applied. The Manufacturer needs to establish a secure way of displaying the settings in one of the following ways: (a) A display on a screen which can be read; (b) A display on an electronic device which can communicate with the Power Generating Module and confirm that it is the correct device by means of a Identification number / name permanently fixed to the device and visible on the electronic device screen at the same time as the settings; (c) Display of all settings including nominal voltage and current outputs, alongside the identification number / name of the device, permanently fixed to the Power Generating Module.		P

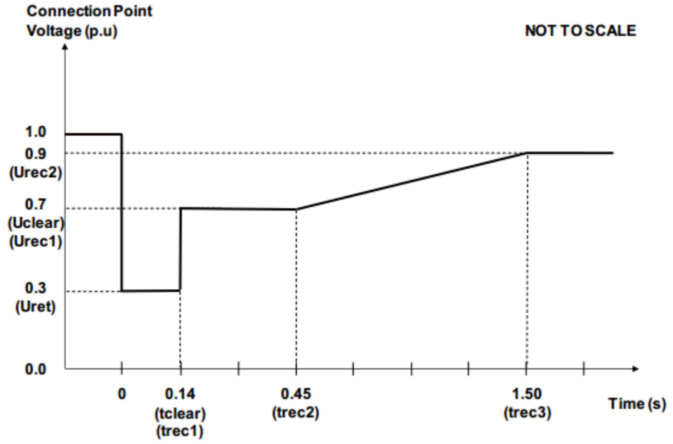
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	The provision of loose documents, documents attached by cable ties etc., a statement that the device conforms with a standard, or provision of data on adhesive paper based products which are not likely to survive due to fading, or failure of the adhesive, for at least 20 years is not acceptable. The protection arrangements (including changes to protection arrangements) for individual schemes will be agreed between the Generator and the DNO in accordance with this document.		P
10.6.16	Whilst the protection schemes and settings for internal electrical faults should mitigate any damage to the Power Generating Module they must not jeopardise the performance of a Power Generating Module, in line with the requirements set out in this EREC.		P
10.6.17	The Generator shall organise its protection and control devices in accordance with the following priority ranking (from highest to lowest) for Type B, Type C and Type D Power Generating Modules: (a) network and Power Generating Module protection; (b) synthetic inertia, if applicable; (c) frequency control (Active Power adjustment -if any); (d) power restriction (if any); and (e) power gradient constraint (if any).		P
10.6.18	For the avoidance of doubt where an internal fault on the Power Generating Module occurs during any significant event on the Total System, the Power Generating Module's internal protection should trip the module to ensure safety and minimise damage to the Power Generating Module.		P
10.7	**Typical Protection Application Diagrams**		Info.
10.7.1	This Section provides some typical protection application diagrams in relation to parallel operation of Power Generating Modules within DNO Distribution Networks. The diagrams only relate to DNO requirements in respect of the connection to the Distribution Network and do not necessarily cover the safety of the Generator's Installation. The diagrams are intended to illustrate typical installations.		Info.
11	**TYPE A POWER GENERATING MODULE TECHNICAL REQUIREMENTS**		N/A
11.1	**Power Generating Module Performance and Control Requirements – General**	As Manufacturer declares, the test unit was Type B, C and D Power Generating Module.	N/A
11.2	**Frequency response**		N/A
11.3	**Fault Ride Through and Phase Voltage Unbalance**		N/A
11.4	**Voltage Limits and Control**		N/A
12	**TYPE B POWER GENERATING MODULE TECHNICAL REQUIREMENTS**		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.1	**Power Generating Module Performance and Control Requirements - General**		P
12.1.2	The Active Power output of a Power Generating Module should not be affected by voltage changes within the statutory limits declared by the DNO in accordance with the ESQCR.		P
12.1.3	Power Generating Modules shall be equipped with a communication interface (input port) in order to be able to reduce Active Power output following an instruction at the input port.		P
12.1.4	The Power Generating Module and its associated control equipment shall be designed for stable operation in parallel with the Distribution Network.		P
12.1.5	Load flow and System Stability studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The Connection Agreement should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of Power Generating Module output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the Power Generating Module.		P
12.2	**Frequency response**		P
12.2.1	Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the DNO's Distribution Network could rise above 50.5 Hz. Therefore all Power Generating Modules should be capable of continuing to operate in parallel with the Distribution Network in accordance with the following:		P
	a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range. b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. c) 49.0 Hz – 51.0 Hz Continuous operation of the Power Generating Module is required. d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.	See appended table.	P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.2.2	With regard to the rate of change of frequency withstand capability, a Power Generating Module shall be capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the Power Generating Module's own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.		P
12.2.3	Output power with falling frequency		P
12.2.3.1	Each Power Generating Module, must be capable of:		P
	a) continuously maintaining constant Active Power output for system frequency changes within the range 50.5 to 49.5 Hz; and		P
	b) (subject to the provisions of paragraph 12.2.1) maintaining its Active Power output at a level not lower than the figure determined by the linear relationship shown in Figure 12.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the Active Power output does not decrease by more than 5%.  **Figure 12.1 Change in Active Power with falling frequency**		P
12.2.3.2	For the avoidance of doubt in the case of a Power Generating Module using an Intermittent Power Source where the power input will not be constant over time, the requirement is that the Active Power output shall be independent of system frequency under (a) above and should not drop with system frequency by greater than the amount specified in (b) above.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.2.3.2	Electricity Storage Power Generation Modules can support the Total System by being arranged to automatically respond to falling frequency in line with the characteristic of Figure 12.2 until the stored energy is depleted.  **Figure 12.2 Change in Active Power of Electricity Storage Device with falling frequency** (not to scale)	Not Electricity Storage Power Generation Modules	N/A
12.2.4	Limited Frequency Sensitive Mode – Over frequency		P
12.2.4.1	Each Power Generating Module shall be capable of reducing Active Power output in response to frequency on the Total System when this rises above 50.4 Hz. The Power Generating Module shall be capable of operating stably during LFSM-O operation. If a Power Generating Module has been contracted to operate in Frequency Sensitive Mode the requirements of LFSM-O shall apply when frequency exceeds 50.5 Hz.	See appended table.	P
	(a) The rate of change of Active Power output must be at a minimum a rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a Droop of 10%) as shown in Figure 12.2. For the avoidance of doubt, this would not preclude a Generator from designing their Power Generating Module with a Droop of less than 10%, but in all cases the Droop should be 2% or greater.		P
	(b) The Power Generating Module shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the initial delay exceeds 2 s the Generator shall justify the delay, providing technical evidence to the DNO, who will pass this evidence to the NETSO.		P
	(c) For deviations in frequency up to 50.9 Hz at least half of the proportional reduction in Active Power output shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz.		P
	(d) For deviations in frequency beyond 50.9 Hz the measured rate of change of Active Power reduction shall exceed 0.5% s^{-1} of the initial output.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(e) The LFMS-O response shall be reduced when the frequency subsequently falls again and, when to a value less than 50.4 Hz, at least half the proportional increase in Active Power shall be achieved in 10 s. For a frequency excursion returning from beyond 50.9 Hz the measured rate of change Active Power increase shall exceed 0.5% s^{-1}.		P
	(f) If the reduction in Active Power is such that the Power Generation Module reaches its Minimum Stable Operating Level, it shall continue to operate stably at this level.		P
	 P_{ref} is the reference **Active Power** to which ΔP is related and. ΔP is the change in **Active Power** output from the **Power Generating Module**. **Figure 12.3 Active Power Frequency Response capability when operating in LFSM-O**		P
12.2.4.2	When the Power Generating Module is providing Limited Frequency Sensitive Mode Over frequency (LFSM-O) response it must continue to provide the frequency response until the frequency has returned to, or is below, 50.4 Hz.		P
12.2.4.3	Steady state operation below Minimum Stable Operating Level is not expected but if system operating conditions cause operation below Minimum Stable Operating Level which give rise to operational difficulties then the Generator shall be able to return the output of the Power Generating Module to an output of not less than the Minimum Stable Operating Level.		P
12.3	**Fault Ride Through and Phase Voltage Unbalance**		P
12.3.1	Paragraphs 12.3.1.1 to 12.3.1.7 inclusive set out the Fault Ride Through, principles and concepts applicable to Synchronous Power Generating Modules and Power Park Modules, subject to disturbances from faults on the Network up to 140 ms in duration.		P
12.3.1.1	Each **Synchronous Power Generating Module** and **Power Park Module** is required to remain connected and stable for any balanced and unbalanced fault where the voltage at the Connection Point remains on or above the heavy black line shown in Figures 12.3 and 12.4 below.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.3.1.2	The voltage against time curves defined in Table 12.1 and Table 12.2 express the lower limit (expressed as the ratio of its actual value and its reference 1pu) of the actual course of the phase to phase voltages (or phase to earth voltage in the case of asymmetrical/unbalanced faults) on the network voltage level at the Connection Point during a symmetrical or asymmetrical/unbalanced fault, as a function of time before, during and after the fault.		P
12.3.1.3	 **Figure 12.4 - Voltage against time curve applicable to Type B Synchronous Power Generating Modules**		N/A
12.3.1.4	**Table 12.1 Voltage against time parameters applicable to Type B Synchronous Power Generating Modules** (see table below)		N/A

Voltage parameters (pu)		Time parameters (s)	
U_{ret}	0.3	t_{clear}	0.14
U_{clear}	0.7	t_{rec1}	0.14
U_{rec1}	0.7	t_{rec2}	0.45
U_{rec2}	0.9	t_{rec3}	1.5

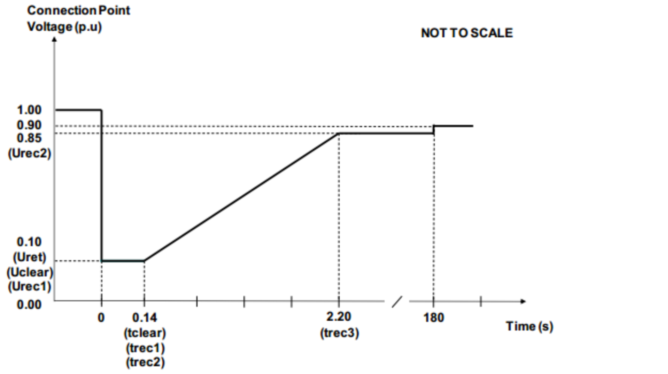
<table>
<tr><th colspan="4">G99/1-8</th></tr>
<tr><th>Clause</th><th>Requirement - Test</th><th>Result - Remark</th><th>Verdict</th></tr>
<tr><td>12.3.1.5</td><td>


Figure 12.5 - Voltage against time curve applicable to Type B Power Park Modules
</td><td></td><td>P</td></tr>
<tr><td>12.3.1.6</td><td>

Table 12.2 Voltage against time parameters applicable to Type B Power Park Modules

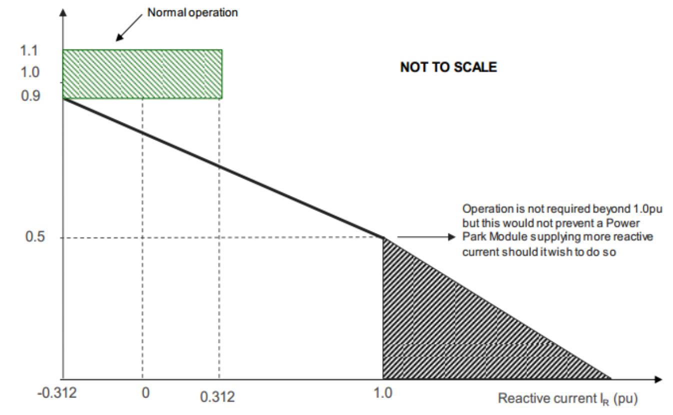
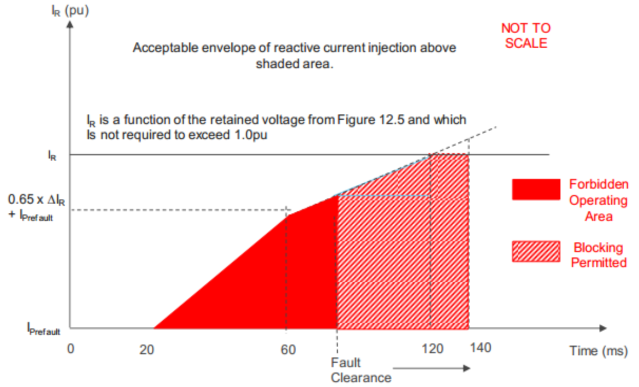
<table>
<tr><th colspan="2">Voltage parameters (pu)</th><th colspan="2">Time parameters (s)</th></tr>
<tr><td>U_{ret}</td><td>0.1</td><td>t_{clear}</td><td>0.14</td></tr>
<tr><td>U_{clear}</td><td>0.10</td><td>t_{rec1}</td><td>0.14</td></tr>
<tr><td>U_{rec1}</td><td>0.10</td><td>t_{rec2}</td><td>0.14</td></tr>
<tr><td>U_{rec2}</td><td>0.85</td><td>t_{rec3}</td><td>2.2</td></tr>
</table>
</td><td></td><td>P</td></tr>
<tr><td>12.3.1.7</td><td>In addition to the requirements in 12.3.1.2 to 12.3.1.6:</td><td></td><td>P</td></tr>
<tr><td></td><td>(a) Each Power Generating Module shall be capable of satisfying the above requirements at the Connection Point when operating at Registered Capacity output and maximum leading Power Factor as specified in paragraph 12.5.1.</td><td></td><td>P</td></tr>
<tr><td></td><td>(b) The pre-fault voltage shall be taken to be 1.0 pu and the post fault voltage shall not be less than 0.9 pu.</td><td></td><td>P</td></tr>
<tr><td></td><td>(c) The DNO will publish fault level data under maximum demand conditions in the Long Term Development Statements. To allow a Generator to model the Fault Ride Through performance of its Power Generating Modules, the DNO will provide generic fault level values derived from typical cases. Where necessary, on reasonable request the DNO will specify the pre-fault and post fault short circuit capacity (in MVA) at the Connection Point and will provide additional network data as may reasonably be required for the Generator to undertake such study work.</td><td></td><td>P</td></tr>
</table>

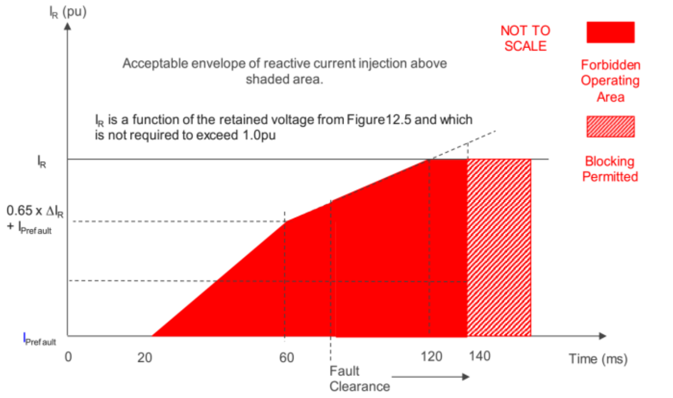
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(d) The protection schemes and settings for internal electrical faults shall not jeopardise Fault Ride Through performance as specified in Section 12.3. For the avoidance of doubt where an internal fault on the Power Generating Module occurs during a Fault Ride Through condition, the Power Generating Module's internal protection should trip the module to ensure safety and minimise damage.		P
	(e) Each Power Generating Module shall be designed such that within 0.5 s of restoration of the voltage at the Connection Point to 90% of nominal voltage or greater, Active Power output shall be restored to at least 90% of the level immediately before the fault. Once Active Power output has been restored to the required level, Active Power oscillations shall be acceptable provided that:		P
	i. The total active energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant. ii. The oscillations are adequately damped. iii. In the event of power oscillations, Power Generating Modules shall retain steady state stability when operating at any point on the Generator Performance Chart.		P
	For Power Park Modules, comprising switched reactive compensation equipment (such as mechanically switched capacitors and reactors), such switched reactive compensation equipment shall be controlled such that it is not switched in or out of service during the fault but may act to assist in post fault voltage recovery.		P
12.3.2	In addition to paragraphs 12.3.1.1 – 12.3.1.7, where it has been specifically agreed between the DNO and the Generator that a Power Generating Facility will contribute to the DNO's Distribution Network security (eg for compliance with EREC P2) the Power Generating Module(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the Phase (Voltage) Unbalance imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the DNO's main protection. The DNO will advise the Generator in each case of the likely tripping time of the DNO's protection, and for phase-phase faults, the likely value of Phase (Voltage) Unbalance during the fault clearance time		P
12.3.3	In the case of phase to phase faults on the DNO's Distribution Network that are cleared by system back-up protection which will be within the plant short time rating on the DNO's Distribution Network the DNO, on request during the connection process, will advise the Generator of the expected Phase (Voltage) Unbalance.		P
12.3.4	Other Fault Ride Through Requirements		N/A

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(a) In the case of a Power Park Module, the requirements in this Section 12.3. do not apply when the Power Park Module is operating at less than 5% of its Registered Capacity or during very high primary energy source conditions when more than 50% of the Generating Units in a Power Park Module have been shut down or disconnected under an emergency shutdown sequence to protect Generator's plant and apparatus.		N/A
	(b) For the avoidance of doubt the requirements specified in this Section 12.3 do not apply to Power Generating Modules connected to an unhealthy circuit and islanded from the Distribution Network even for delayed auto reclosure times.		N/A
12.4	**Voltage Limits and Control**		P
12.4.1	Where a Power Generating Module is remote from a Network voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the DNO should agree with the Generator the declared voltage and voltage range at the Connection Point. Immunity of the Power Generating Module to voltage changes of ± 10% of the declared voltage is recommended, subject to design appraisal of individual installations.		P
12.4.2	The connection of a Power Generating Module to the Distribution Network shall be designed in such a way that operation of the Power Generating Module does not adversely affect the voltage profile of and voltage control employed on the Distribution Network. ETR 126 provides DNOs with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the DNO if requested by the Generator.		P
12.4.3	Excitation Performance Requirements		N/A
12.4.3.1	Each Synchronous Generating Unit within a Synchronous Power Generating Module shall be equipped with a permanent automatic Excitation System that has the capability to provide constant terminal voltage (assuming a high enough Network source impedance to allow the Power Generating Module to achieve this while remaining within its ratings) at a selectable setpoint without instability over the entire operating range of the Synchronous Power Generating Module.		N/A

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.4.3.2	The DNO will agree with the Generator the operation of the control system of the Synchronous Power Generating Module or Power Park Module such that it shall contribute, as agreed, to voltage control or Reactive Power control or Power Factor control at the Connection Point. In some cases, for example, on large industrial sites etc where the Power Generating Module is embedded in the Generator's Installation, the DNO and Generator might agree a different control point, such as the Power Generating Module's terminals. The performance requirements of the control system including Slope (where applicable) shall be agreed between the DNO and the Generator.		P
12.4.3.3	As part of the connection application process the Generator shall agree with the DNO the set points of the control scheme for voltage control, Power Factor control or Reactive Power control as appropriate. These settings, and any changes to these settings, shall be agreed with the DNO and recorded in the Connection Agreement. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.		P
12.4.4	The final responsibility for control of Distribution Network voltage does however remain with the DNO.		P
12.4.5	Automatic Voltage Control (AVC) schemes employed by the DNO often assume that power flows from parts of the Distribution Network operating at a higher voltage to parts of the Distribution Network operating at lower voltages. Export from Power Generating Modules in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the Low Voltage side may not operate correctly without an import of Reactive Power and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of Power Generating Modules becomes significant compared to normal loads, it may be necessary to switch any compounding out of service.		P
12.4.6	Power Generating Modules can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in Active Power and Reactive Power flows. ETR 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.		P
12.5	**Reactive Capability**		P

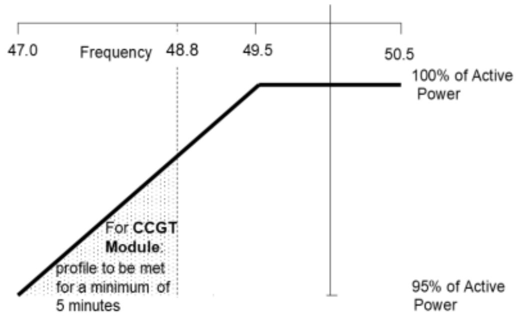
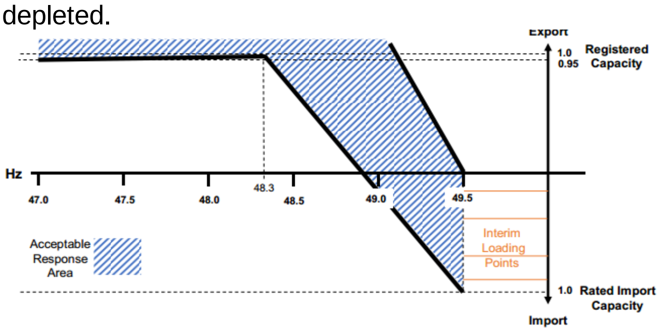
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
12.5.1	When supplying Registered Capacity all Power Generating Modules shall be capable of continuous operation at any points between the limits of 0.95 Power Factor lagging and 0.95 Power Factor leading at the Connection Point or the Generating Unit terminals as appropriate for the Power Generating Facility and as agreed with the DNO.		P
12.5.2	At Active Power output levels other than Registered Capacity, all Synchronous Power Generating Modules or Generating Units within a Power Park Module shall be capable of continuous operation at any point between the Reactive Power capability limits identified on the Generator Performance Chart. Generators should take any site demand such as auxiliary supplies and the Active Power and Reactive Power losses of the Power Generating Module transformer or Station Transformer into account unless advised otherwise by the DNO.		P
12.5.3	Where the Power Generating Module is contained within a Customer’s Installation comprising both demand and generation the DNO will advise the Generator if it is more appropriate for the Power Factor requirements to be specified at the Power Generating Module terminals, rather than at the Connection Point. Any specific Power Factor requirements will be documented in the Connection Agreement.		P
12.6	**Fast Fault Current Injection**		P
12.6.1	Fast Fault Current injection is necessary to support the Total System during a fault on the Transmission System. The design of Fast Fault Current injection is tailored to this, and does not relate directly to faults on the Distribution Network, not least as those will tend to have longer clearing times than those of the Transmission System for which Fast Fault Current injection is designed. In this Section 12.6 the faults referred to are Transmission System faults which clear within 140 ms and which will be seen in the Distribution Network as a voltage depression. For this section 12.6 voltage and current quantities are assumed to be positive phase sequence values.		P
12.6.2	Each Power Park Module shall be required to satisfy the following requirements:		P
	(a) For any balanced fault on the Transmission System which results in the voltage at the Connection Point falling below 0.9 pu each Power Park Module shall, unless otherwise agreed with the DNO, be required to inject a reactive current IR that lies above the heavy black line shown in Figure 12.6.		P

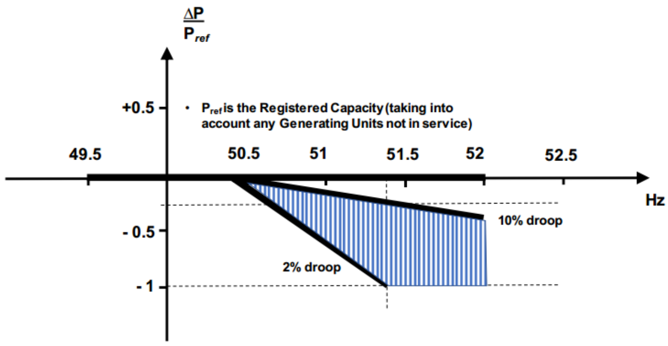
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(b) Figure 12.6 defines the reactive current IR that is to be supplied during a fault on the Transmission System and which is dependent on the pre-fault operating conditions, and the voltage retained at the Connection Point. Each Power Park Module shall inject a reactive current I_R which shall not be less than its pre-fault reactive current and which shall as a minimum increase with the fall in retained voltage each time the retained voltage at the Connection Point falls below 0.9 pu, whilst ensuring that the overall rating of the Power Park Module is not exceeded.  **Figure 12.6 – locus of magnitude of injected Reactive Current**		P
	(c) In addition each Power Park Module shall be required to satisfy the reactive current requirements shown in Figures 12.7 which shows how the reactive current should be injected over time from the fault inception. The injected current shall be above the shaded area shown in Figure 12.7 (a) and Figure 12.7 (b) with priority being given to reactive current injection with any residual capability being supplied as active current. Under any fault condition, where the voltage falls below 0.9 pu, there would be no requirement for any Power Park Module or constituent Generating Unit to exceed its transient or steady state rating.  **Figure 12.7(a) Chart showing area of reactive current injections for voltage depressions of ≤ 140 ms duration**		P

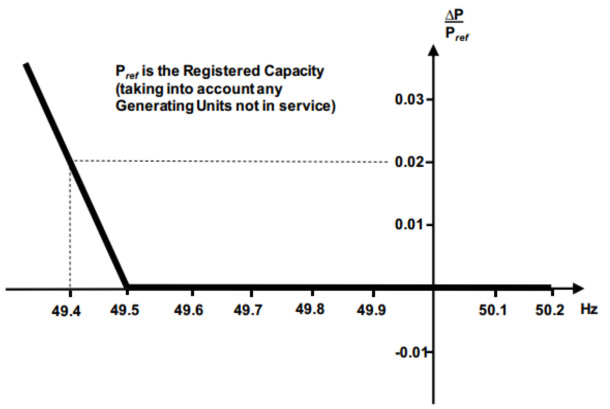
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	 **Figure 12.7(b) Chart showing area of Reactive Current injections for voltage depressions of > 140 ms duration**		P
	(d) For the purposes of this requirement, the maximum rated current is taken to be the maximum current each Generating Unit can supply when operating at Registered Capacity and 0.95 Power Factor at a nominal voltage of 1.0 pu.		P
	(e) All Power Park Module equipment shall be designed to ensure a smooth transition between any of its voltage, power factor or reactive control modes and fault ride through mode in order to prevent the risk of instability which could arise in the transition between the steady state voltage operating range and abnormal conditions where the retained voltage falls below 0.90 pu of nominal voltage. Such a requirement is necessary to ensure adequate performance between the pre-fault operating condition of the Power Park Module and its subsequent behaviour under fault conditions.		P
	(f) Each Power Park Module shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. Generators shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figures 12.7 (a) and Figure 12.7 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The DNO may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the Connection Agreement. Where the Generator is able to demonstrate to the DNO that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions Generators are required to both advise and agree with the DNO the control strategy, which must also include the approach taken to de-blocking.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(g) To permit additional flexibility for example from Power Park Modules made up of full converter Generating Units, DFIG Generating Units or induction Generating Units, the DNO will permit transient deviations below the shaded area shown in Figures 12.7 (a) or Figure 12.7 (b) provided that the overall reactive current supplied over time is greater than the minimum requirement shown in Figures 12.7 (a) or Figure 12.7 (b). This agreement will be formalised in the Connection Agreement.		P
	(h) In the case of an unbalanced fault, each Park Module or each Generating Unit within a Power Park Module shall be required to inject maximum reactive current without exceeding the transient rating of the Power Park Module (or constituent element thereof).		P
12.7	**Operational monitoring**		P
12.7.1	At each Power Generating Facility the DNO will install its own Telecontrol/SCADA outstation which will generally meet all the DNO's necessary and legal operational data requirements. The DNO will inform the Generator if additional specific data are required.		P
13	**TYPE C AND TYPE D POWER GENERATING MODULE TECHNICAL REQUIREMENTS**		P
13.1	**Power Generating Module Performance and Control Requirements**		P
13.1.1	The requirements of this Section 13 do not apply in full to: (a) Power Generation Facilities that are designed and installed for infrequent short-term parallel operation only; or (b) Electricity Storage Power Generation Modules within the Power Generating Facility commissioned before 01 September 2022.		Info.
13.1.2	The Active Power output of a Power Generating Module should not be affected by voltage changes within the statutory limits declared by the DNO in accordance with the ESQCR.		P
13.1.3	Power Generating Modules shall be capable of adjusting the Active Power setpoint in accordance with instructions issued by the DNO.		P
13.1.4	Any changes to the Active Power or voltage/Reactive Power control setpoints shall result in the Power Generating Module achieving the new Active Power or voltage/Reactive Power output, as appropriate, within 2 minutes.		P
13.1.5	Each item of a Power Generating Module and its associated control equipment shall be designed for stable operation in parallel with the Distribution Network.		P

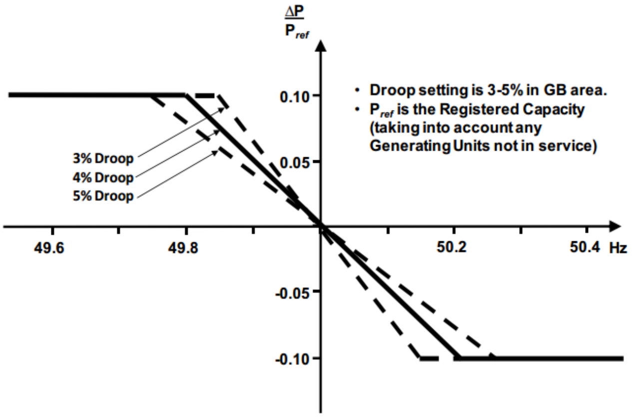
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
13.1.6	Load flow and System Stability studies may be necessary to determine any output constraints or post fault actions necessary for n-1 fault conditions and credible n-2 conditions (where n-1 and n-2 conditions are the first and second outage conditions as, for example, specified in EREC P2) involving a mixture of fault and planned outages. The Connection Agreement should include details of the relevant outage conditions. It may be necessary under these fault conditions, where the combination of Power Generating Module output, load and through flow levels leads to circuit overloading, to rapidly disconnect or constrain the Power Generating Module.		P
13.2	**Frequency response**		P
13.2.1	Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the DNO's Distribution Network could rise above 50.5 Hz. Therefore all Power Generating Modules should be capable of continuing to operate in parallel with the Distribution Network in accordance with the following:		P
	(a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range. (b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. (c) 49.0 Hz – 51.0 Hz Continuous operation of the Power Generating Module is required. (d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range. (e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.	See appended table.	P
13.2.2	With regard to the rate of change of frequency withstand capability, a Power Generating Module shall be capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms unless disconnection was triggered by a rate of change of frequency type loss of mains protection or by the Power Generating Module's own protection system for a co-incident internal fault as detailed in paragraph 10.6.18.		P
13.2.3	Output power with falling frequency	See appended table.	P
13.2.3.1	Each Power Generating Module, must be capable of:		P
	(a) continuously maintaining constant Active Power output for system frequency changes within the range 50.5 to 49.5 Hz; and		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(b) (subject to the provisions of paragraph 13.2.1) maintaining its Active Power output at a level not lower than the figure determined by the linear relationship shown in Figure 13.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the Active Power output does not decrease by more than 5%.  **Figure 13.1 Change in Active Power with falling frequency**		P
13.2.3.2	For the avoidance of doubt in the case of a Power Generating Module using an Intermittent Power Source where the power input will not be constant over time, the requirement is that the Active Power output shall be independent of system frequency under (a) above and should not drop with system frequency by greater than the amount specified in (b) above.		P
13.2.3.3	Electricity Storage Power Generation Modules can support the Total System by being arranged to automatically respond to falling frequency in line with the characteristic of Figure 13.2 until the stored energy is depleted.  **Figure 13.2 Change in Active Power of Electricity Storage Device with falling frequency** (not to scale)		N/A
13.2.4	Limited Frequency Sensitive Mode – Over frequency		P

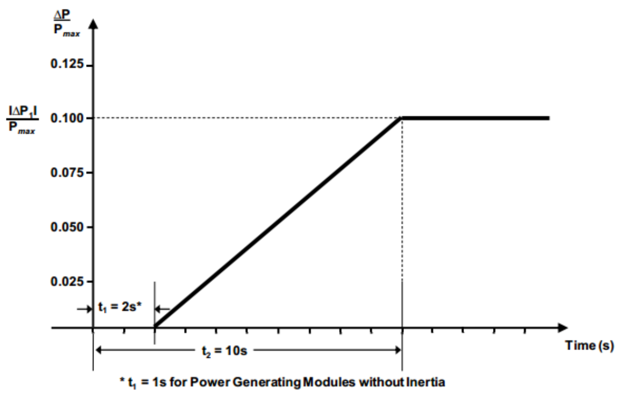
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
13.2.4.1	Each Power Generating Module shall be capable of reducing Active Power output in response to frequency on the Total System when this rises above 50.4 Hz. The Power Generating Module shall be capable of operating stably during LFSM-O operation. If a Power Generating Module has been contracted to operate in Frequency Sensitive Mode the requirements of LFSM-O shall apply when frequency exceeds 50.5 Hz.		P
	(a) The rate of change of Active Power output shall be at a minimum a rate of 2% of output per 0.1 Hz deviation of system frequency above 50.4 Hz (ie a Droop of 10%) as shown in Figure 13.3. For the avoidance of doubt, this would not preclude a Generator from designing the Power Generating Module with a Droop of less than 10%, (for example between 3 – 5%), but in all cases the Droop should be 2% or greater.	See appended table.	P
	 P_{ref} is the reference **Active Power** to which ΔP is related and. ΔP is the change in **Active Power** output from the **Power Generating Module**. **Figure 13.3 Active Power Frequency Response capability when operating in LFSM-O**		P
	(b) The reduction in Active Power output shall be continuously and linearly proportional, as far as is practicable, to the excess of frequency above 50.4 Hz and shall be provided increasingly with time over the period specified in (c) below.		P
	(c) As much as possible of the proportional reduction in Active Power output shall result from the frequency control device (or speed governor) action and shall be achieved within 10 s of the time of the frequency increase above 50.4 Hz. The Power Generating Module shall be capable of initiating a power frequency response with an initial delay that is as short as possible. If the delay exceeds 2 s the Generator shall justify the delay, providing technical evidence to the DNO, who will pass this evidence to the NETSO.		P
13.2.4.2	When the Power Generating Module is providing Limited Frequency Sensitive Mode Over frequency (LFSM-O) response it must continue to provide the frequency response until the frequency has returned to or below 50.4 Hz.		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
13.2.4.3	Steady state operation below Minimum Stable Operating Level is not expected but if system operating conditions cause operation below Minimum Stable Operating Level which give rise to operational difficulties then the Generator shall be able to return the output of the Power Generating Module to an output of not less than the Minimum Stable Operating Level.		P
13.2.5	Limited Frequency Sensitive Mode – Under frequency (LFSM-U)		P
13.2.5.1	Each Power Generating Module shall be capable of increasing Active Power output in response to system frequency when this falls below 49.5 Hz. it is not anticipated Power Generating Modules are operated in an inefficient mode to facilitate delivery of LFSM-U response, but any inherent capability should be made available without undue delay. The Power Generating Module shall be capable of stable operation during LFSM-U Mode.	See appended table.	P
	(a) The rate of change of Active Power output shall be at a minimum a rate of 2 percent of output per 0.1 Hz deviation of system frequency below 49.5 Hz (ie a Droop of 10%) as shown in Figure 13.4 below. This requirement only applies if the Power Generating Module has headroom and the ability to increase Active Power output. In the case of a Power Park Module the requirements of Figure 13.4 shall be reduced pro-rata to the amount of Generating Units in service and available to generate. For example, for a Power Park Module with a Registered Capacity of 40 MW but with only 80% of the Generating Units in service Pref would be 32 MW. For the avoidance of doubt, this would not preclude a Generator from designing the Power Generating Module with a lower Droop setting, for example between 3 – 5%.  P_{ref} is the **Registered Capacity**, taking into account any **Interface Protections** not in service to which ΔP is related and ΔP is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide a positive **Active Power** output change with a **Droop** of 10% or less based on P_{ref}. **Figure 13.4 - Limited Frequency Sensitive Mode – Underfrequency capability of Power Generating Modules**		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(b) As much as possible of the proportional increase in Active Power output shall result from the frequency control device (or speed governor) action and shall be achieved for frequencies below 49.5 Hz. The Power Generating Module shall be capable of initiating a power frequency response with minimal delay. If the delay exceeds 2 s the Generator shall justify the delay, providing technical evidence to the DNO who will pass this evidence to the NETSO.		P
	(c) The actual delivery of Active Power Frequency Response in LFSM-U mode shall take into account • The ambient conditions when the response is to be triggered. • The operating conditions of the Power Generating Module. In particular limitations on operation near Registered Capacity at low frequencies. • The availability of primary energy sources.		P
	(d) In LFSM-U Mode the Power Generating Module shall be capable of providing a power increase up to its Registered Capacity (based on the number of Generating Units in service at that point in time).		P
13.2.6	Frequency Sensitive Mode – (FSM)		P
13.2.6.1	Each Power Generating Module will be capable of FSM in addition to LFSM-O and LFSM-U. By default Power Generating Modules will be set to operate in LFSM, unless the Generator has a specific contract with the NETSO to operate in FSM.		P
13.2.6.2	The frequency control device (or speed governor) in co-ordination with other control devices shall t control each Power Generating Module Active Power output with stability over the entire operating range of the Power Generating Module; and		P
13.2.6.3	Power Generating Modules shall also meet the following minimum requirements:		P

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(a) Power Generating Modules shall be capable of providing Active Power Frequency Response in accordance with the performance characteristic shown in Figure 13.5 and parameters in Table 13.1.  **Figure 13.5 – Frequency Sensitive Mode capability of Power Generating Modules and Power Park Modules**		P
	Table 13.1 – Parameters for Active Power Frequency Response in Frequency Sensitivity Mode including the mathematical expressions in Figure 13.5		P

Parameter	Setting
Nominal system frequency	50 Hz
Active Power as a percentage of **Registered Capacity** ($\frac{\lvert\Delta P_1\rvert}{P_{max}}$)	10%
Frequency Response Insensitivity in mHz ($\lvert\Delta f_i\rvert$)	±15mHz
Frequency Response Insensitivity as a percentage of nominal frequency ($\frac{\lvert\Delta f_i\rvert}{f_n}$)	±0.03%
Frequency Response Deadband in mHz	0 (mHz)
Droop (%)	3 – 5%

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
	(b) In satisfying the performance requirements specified in paragraph 13.2.6.2 Generators in respect of each Power Generating Module should be aware: i. in the case of overfrequency, the Active Power Frequency Response is limited by the Minimum Stable Operating Level, ii. in the case of underfrequency, the Active Power Frequency Response is limited by the Registered Capacity, iii. the actual delivery of Active Power Frequency Response depends on the operating and ambient conditions of the Power Generating Module when this response is triggered, in particular limitations on operation near Registered Capacity at low frequencies as specified in 13.2.5 and available primary energy sources. iv. The frequency control device (or speed governor) shall also be capable of being set so that it operates with an overall speed Droop of between 3 – 5%. The Frequency Response Deadband and Droop shall be able to be reset at any time and as required by the DNO. For the avoidance of doubt, in the case of a Power Park Module the speed Droop should be equivalent of a fixed setting between 3% and 5% applied to each Generating Unit in service.		P
	(c) In the event of a frequency step change, each Power Generating Module shall be capable of activating full and stable Active Power Frequency Response (without undue power oscillations), in accordance with the performance characteristic shown in Figure 13.6 and parameters in Table 13.2.  P_{max} is the **Registered Capacity** to which ΔP relates. ΔP is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide **Active Power** output ΔP up to the point ΔP_1 in accordance with the times t_1 and t_2 with the values of ΔP_1, $t_1$and t_2 being specified in Table 13.2. t_1 is the initial delay. t_2 is the time for full activation.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Table 13.2 – Parameters for full activation of Active Power Frequency Response resulting from a frequency step change | **Parameter** | **Setting** | | **Active power** as a percentage of **Registered Capacity** (frequency response range) ($\frac{\|\Delta P_1\|}{P_{max}}$) | 10% | | Maximum admissible initial delay t_1 for **Power Generating Modules** with inertia unless justified as specified in 13.2.6.4(d) | 2 s | | Maximum admissible initial delay t_1 for **Power Generating Modules** which do not contribute to system inertia unless justified as specified in 13.2.6.4(d) | 1 s | | Activation time t_2 | 10 s | Table 13.2 also includes the mathematical expressions used in Figure 13.6.		P
	(d) The initial activation of Active Power primary frequency response shall not be unduly delayed. For Power Generating Modules with inertia the delay in initial Active Power Frequency Response shall not be greater than 2 s. For Power Generating Modules without inertia the delay in initial Active Power Frequency Response shall not be greater than 1 s. If the Generator cannot meet this requirement the Generator shall provide technical evidence to the DNO, who will pass this evidence to the NETSO, demonstrating why a longer time is needed for the initial activation of Active Power Frequency Response.		P
	(e) with regard to disconnection due to underfrequency, Generators responsible for Power Generating Modules capable of acting as a load, including but not limited to pumped-storage Power Generating Modules, shall be capable of disconnecting their load in case of underfrequency which will be agreed with the DNO. For the avoidance of doubt this requirement does not apply to station auxiliary supplies.		P
	(f) In addition to the requirements of Section 13.2.6 each Power Generating Module shall be capable of meeting the minimum frequency response requirement profile subject to and in accordance with the provisions of Annex C.10.		P
13.3	**Fault Ride Through**		P
13.3.1	Paragraphs 13.3.1.1 to 13.3.1.10 inclusive set out the Fault Ride Through, principles and concepts applicable to Synchronous Power Generating Modules and Power Park Modules, subject to disturbances from faults on the Network up to 140 ms in duration.		P
13.3.1.1	Each Synchronous Power Generating Module and Power Park Module is required to remain connected and stable for any balanced and unbalanced fault where the voltage at the Connection Point remains on or above the heavy black line shown in Figures 13.7 to 13.10 below.		P

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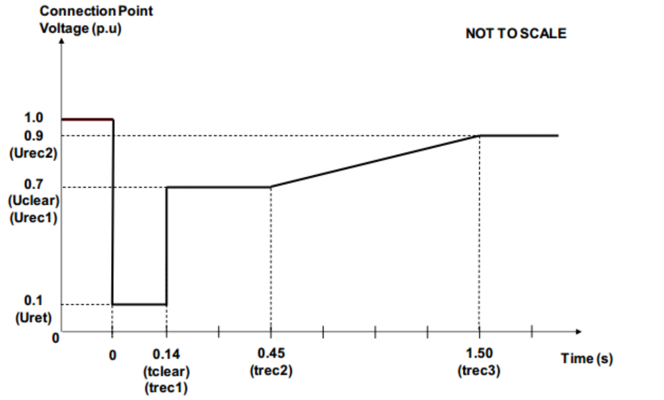
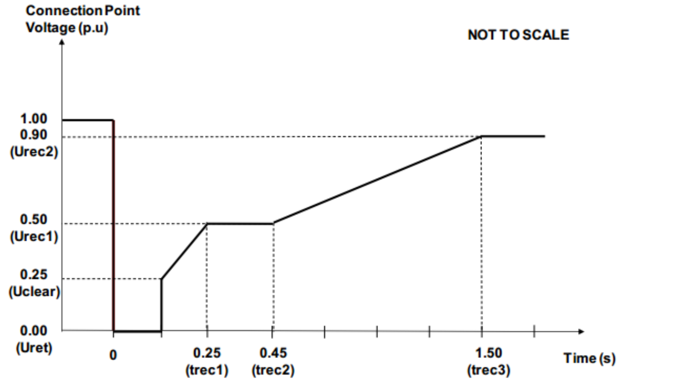
Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.2	The voltage against time curves defined in Table 13.3 to Table 13.6 expresses the lower limit (expressed as the ratio of its actual value and its reference 1 pu) of the actual course of the phase to phase voltages (or phase to earth voltage in the case of asymmetrical/unbalanced faults) on the network voltage level at Connection Point during a symmetrical or asymmetrical/unbalanced fault, as a function of time before, during and after the fault.		P
13.3.1.3	 **Figure 13.7 Voltage against time curve applicable to Type C and Type D Synchronous Power Generating Modules connected below 110 kV**		N/A
13.3.1.4	**Table 13.3 Voltage against time parameters applicable to Type C and D Synchronous Power Generating Modules connected below 110 kV**		N/A

Voltage parameters (pu)		Time parameters (s)	
U_{ret}	0.1	t_{clear}	0.14
U_{clear}	0.7	t_{rec1}	0.14
U_{rec1}	0.7	t_{rec2}	0.45
U_{rec2}	0.9	t_{rec3}	1.5

13.3.1.5	 **Figure 13.8 - Voltage against time curve applicable to Type D Synchronous Power Generating Modules connected at or above 110 kV**		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.6	Table 13.4 Voltage against time parameters applicable to Type D Synchronous Power Generating Modules connected at or above 110 kV		N/A

Voltage parameters (pu)		Time parameters (s)	
U_{ret}	0	t_{clear}	0.14
U_{clear}	0.25	t_{rec1}	0.25
U_{rec1}	0.5	t_{rec2}	0.45
U_{rec2}	0.9	t_{rec3}	1.5

Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.7	Figure 13.9 - Voltage against time curve applicable to Type C and Type D Power Park Modules connected below 110 kV		P

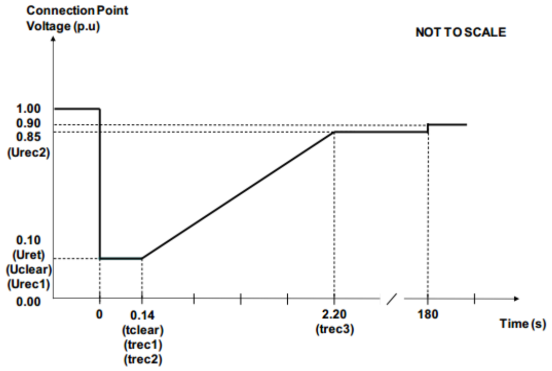

Figure 13.9 - Voltage against time curve applicable to Type C and Type D Power Park Modules connected below 110 kV

Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.8	Table 13.5 Voltage against time parameters applicable to Type C and Type D Power Park Modules connected below 110 kV		P

Voltage parameters (pu)		Time parameters (s)	
U_{ret}	0.1	t_{clear}	0.14
U_{clear}	0.10	t_{rec1}	0.14
U_{rec1}	0.10	t_{rec2}	0.14
U_{rec2}	0.85	t_{rec3}	2.2

Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.9	Figure 13.10 - Voltage against time curve applicable to Type D Power Park Modules connected at or above 110 kV		P

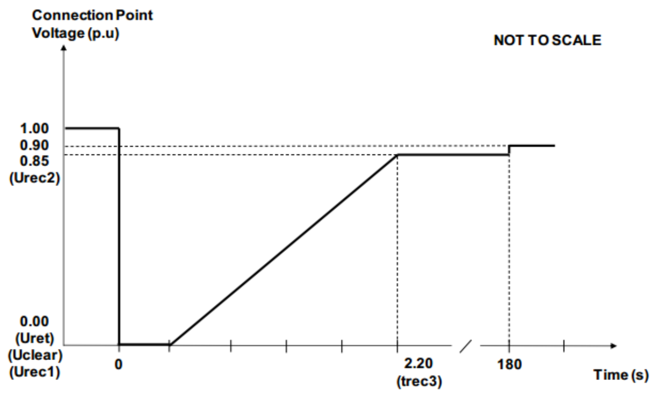

Figure 13.10 - Voltage against time curve applicable to Type D Power Park Modules connected at or above 110 kV

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Clause	Requirement - Test	Result - Remark	Verdict
13.3.1.10	**Table 13.6 Voltage against time parameters applicable to Type D Power Park Modules connected at or above 110 kV**		P
13.3.1.11	In addition to the requirements in 13.3.1.3 to 13.3.1.10: (a) Each Power Generating Module shall be capable of satisfying the above requirements at the Connection Point when operating at Registered Capacity output and maximum leading Power Factor as specified in paragraph 13.5.1.		P
	(b) The pre-fault voltage shall be taken to be 1.0 pu and the post fault voltage shall not be less than 0.9 pu.		P
	(c) The DNO will publish fault level data under maximum demand conditions in the Long Term Development Statements. To allow a Generator to model the Fault Ride Through performance of its Power Generating Modules, the DNO will provide generic fault level values derived from typical cases. Where necessary, on reasonable request the DNO will specify the pre-fault and post fault short circuit capacity (in MVA) at the Connection Point and will provide additional network data as may reasonably be required for the Generator to undertake such study work.		P
	(d) The protection schemes and settings for internal electrical faults shall not jeopardise Fault Ride Through performance as specified in paragraphs 13.3. For the avoidance of doubt where an internal fault on the Power Generating Module occurs during a Fault Ride Through condition, the Power Generating Module's internal protection should trip the module to ensure safety and minimise damage.		P

Table 13.6 (clause 13.3.1.10):

Voltage parameters (pu)		Time parameters (s)	
U_{ret}	0	t_{clear}	0.14
U_{clear}	0	t_{rec1}	0.14
U_{rec1}	0	t_{rec2}	0.14
U_{rec2}	0.85	t_{rec3}	2.2

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Clause	Requirement - Test	Result - Remark	Verdict
	(e) Each Power Generating Module shall be designed such within 0.5 s of restoration of the voltage at the Connection Point to 90% of nominal voltage or greater, Active Power output shall be restored to at least 90% of the level immediately before the fault. Once Active Power output has been restored to the required level, Active Power oscillations shall be acceptable provided that: ● The total active energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant. ● The oscillations are adequately damped. ● In the event of power oscillations, Power Generating Modules shall retain steady state stability when operating at any point on the Generator Performance Chart.		P
13.3.2	In addition to paragraphs 13.3.1.1 – 13.3.1.11 where it has been specifically agreed between the DNO and the Generator that a Power Generating Facility will contribute to the DNO’s Distribution Network security, (eg for compliance with EREC P2) the Power Generating Module(s) may be required to withstand, without tripping, the effects of a close up three phase fault and the Phase (Voltage) Unbalance imposed during the clearance of a close-up phase-to-phase fault, in both cases cleared by the DNO’s main protection. The DNO will advise the Generator in each case of the likely tripping time of the DNO’s protection, and for phase-phase faults, the likely value of Phase (Voltage) Unbalance during the fault clearance time.		P
13.3.3	In the case of phase to phase faults on the DNO’s Distribution Network that are cleared by system back-up protection which will be within the plant short time rating on the DNO’s Distribution Network the DNO, on request during the connection process, will advise the Generator of the expected Phase (Voltage) Unbalance.		P
13.3.4	Other Fault Ride Through Requirements (a) In the case of a Power Park Module, the requirements in paragraph 13.3 do not apply when the Power Park Module is operating at less than 5% of its Registered Capacity or during very high primary energy source conditions when more than 50% of the Generating Units in a Power Park Module have been shut down or disconnected under an emergency shutdown sequence to protect Generator’s plant and apparatus. (b) For the avoidance of doubt the requirements specified in this Section 13.3 do not apply to Power Generating Modules connected to an unhealthy circuit and islanded from the Distribution Network even for delayed auto reclosure times.		P
13.4	**Voltage Limits and Control**		P

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Clause	Requirement - Test	Result - Remark	Verdict
13.4.1	Where a Power Generating Module is remote from a Network voltage control point it may be required to withstand voltages outside the normal statutory limits. In these circumstances, the DNO should agree with the Generator the declared voltage and voltage range at the Connection Point. Immunity of the Power Generating Module to voltage changes of ± 10% of the declared voltage is recommended, but is mandatory for Type D Power Generating Modules, subject to design appraisal of individual installations.		P
13.4.2	The connection of a Power Generating Module to the Distribution Network shall be designed in such a way that operation of the Power Generating Module does not adversely affect the voltage profile of and voltage control employed on the Distribution Network. ETR 126 provides DNOs with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the DNO if requested by the Generator.		P
13.4.3	Synchronous Power Generating Modules Excitation Performance Requirements		N/A
13.4.4	Voltage Control Performance Requirements for Power Park Modules		P
13.4.4.1	Each Power Park Module shall be fitted with a continuously acting automatic control system to provide control of the voltage at the Connection Point without instability over the entire operating range of the Power Park Module. Any plant or apparatus used to provide such voltage control within a Power Park Module may be located at the Generating Unit terminals, an appropriate intermediate busbar or the Connection Point. When operating below 20% Registered Capacity the automatic control system may continue to provide voltage control using any available reactive capability. If voltage control is not being provided the automatic control system shall be designed to ensure a smooth transition between the shaded area below 20% of Active Power output and the non-shaded area above 20% of Active Power output in Figure 13.14.		P
13.4.4.2	The performance requirements for a continuously acting Automatic Voltage Control system that shall be complied with by the Generator in respect of Power Park Modules are defined in Annex C.5. The DNO will agree any site specific requirements with the Generator.		P

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Clause	Requirement - Test	Result - Remark	Verdict
13.4.5	As part of the connection application process the Generator shall agree with the DNO the set points of the control scheme for voltage control, Power Factor control or Reactive Power control as appropriate. These settings, and any changes to these settings, shall be agreed with the DNO and recorded in the Connection Agreement. The information to be provided is detailed in Schedule 5a and Schedule 5b of the Data Registration Code.		P
13.4.6	The final responsibility for control of Distribution Network voltage does however remain with the DNO.		P
13.4.7	Automatic Voltage Control (AVC) schemes employed by the DNO often assume that power flows from parts of the Distribution Network operating at a higher voltage to parts of the Distribution Network operating at lower voltages. Export from Power Generating Modules in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the Low Voltage side may not operate correctly without an import of Reactive power and relay settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of Power Generating Modules becomes significant compared to normal loads, it may be necessary to switch any compounding out of service.		P
13.4.8	Power Generating Modules can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in Active Power and Reactive Power flows. ETR 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.		P
13.5	**Reactive Capability**		P
13.5.1	All Synchronous Power Generating Modules shall be capable of satisfying the Reactive Power capability requirements at the Connection Point as defined in Figure 13.11 when operating at Registered Capacity. In some cases, for example, on large industrial sites etc where the Power Generating Module is embedded in the Generator's Installation, the DNO may specify a performance requirement for the Power Generating Module that fits within the rectangular boundary defined in Figure 13.11, ie an envelope agreed between the DNO and the Generator within the rectangle of Figure 13.11. In such cases the DNO and Generator might agree a different control point, such as the Power Generating Module's terminals. The performance requirements of the control system including Slope (where applicable) shall be agreed between the DNO and the Generator.		N/A

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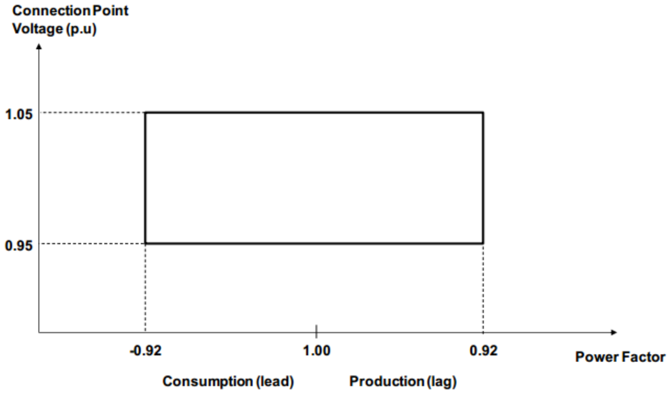
Clause	Requirement - Test	Result - Remark	Verdict
13.5.2	At Active Power output levels other than Registered Capacity all Generating Units within a Synchronous Power Generating Module shall be capable of continuous operation at any point between the Reactive Power capability limit identified on the Generator Performance Chart at least down to the Minimum Stable Operating Level. At reduced Active Power output, Reactive Power supplied at the Connection Point shall correspond to the Generator Performance Chart of the Synchronous Power Generating Module, taking the auxiliary supplies and the Active Power and Reactive Power losses of the Power Generating Module transformer or Station Transformer into account.		N/A
13.5.3	At voltages above 1.05 pu, or below 0.95 pu a Synchronous Power Generating Module shall maintain the Reactive Power output and Power Factor as far as possible recognizing that outside of the envelope of Figure 13.11 it will be necessary for the Reactive Power and/or Power Factor to be constrained by the capability as expressed on the Generator Performance Chart.		N/A
	 **Figure 13.11 Reactive Power capability requirements (Synchronous Power Generating Modules)**		N/A

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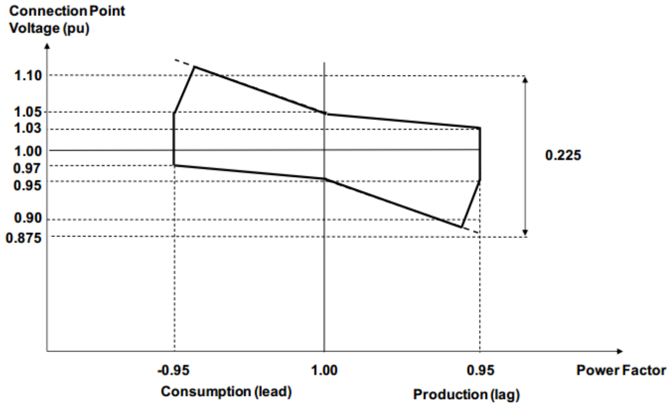
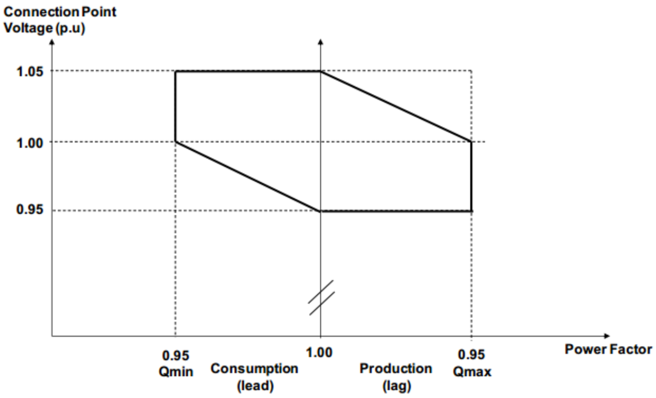
Clause	Requirement - Test	Result - Remark	Verdict
13.5.4	All Power Park Modules with a Connection Point voltage above 33 kV, shall be capable of satisfying the Reactive Power capability requirements at the Connection Point as defined in Figure 13.12 when operating at Registered Capacity.  **Figure 13.12 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage above 33 kV)**		P
13.5.5	All Power Park Modules with a Connection Point voltage at or below 33 kV shall be capable of satisfying the Reactive Power capability requirements at the Connection Point as defined in Figure 13.13 when operating at Registered Capacity.  **Figure 13.13 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage at or below 33 kV)**		P

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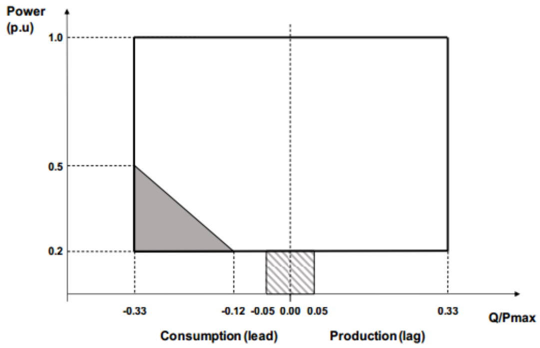
Clause	Requirement - Test	Result - Remark	Verdict
13.5.6	All Power Park Modules, shall be capable of satisfying the Reactive Power capability requirements at the Connection Point as defined in Figure 13.14 when operating below Registered Capacity. With all plant in service, the Reactive Power limits will reduce linearly below 50% Active Power output as shown in Figure 13.14 unless the requirement to maintain the Reactive Power limits defined at Registered Capacity under absorbing Reactive Power conditions down to 20% Active Power output has been specified by the DNO. These Reactive Power limits will be reduced pro rata to the amount of plant in service.  **Figure 13.14 Reactive Power capability requirements (Power Park Modules operating below Registered Capacity)**		P
13.6	**Fast Fault Current Injection**		P
13.6.1	Fast Fault Current injection is necessary to support the Total System during a fault on the Transmission System. The design of Fast Fault Current injection is tailored to this, and does not relate directly to faults on the Distribution Network, not least as these will tend to have longer clearing times than those of the Transmission System for which Fast Fault Current injection is designed. In this Section 13.6 the faults referred to are Transmission System faults which clear within 140 ms and which will be seen in the Distribution Network as a voltage depression. For this section 13.6 voltage and current quantities are assumed to be positive phase sequence values.		P
13.6.2	Each Power Park Module shall be required to satisfy the following requirements.		P

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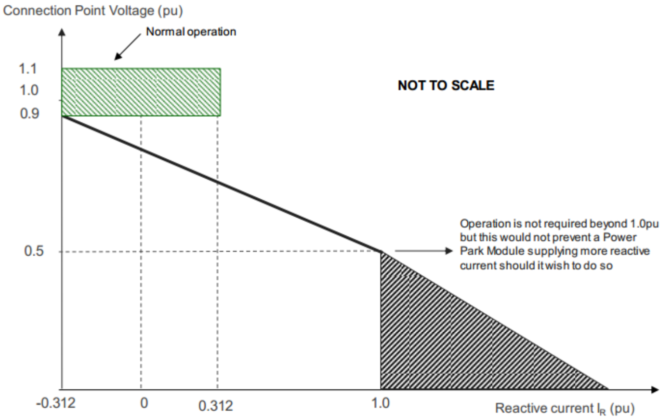
Clause	Requirement - Test	Result - Remark	Verdict
	(a) For any balanced fault on the Transmission System which results in the voltage at the Connection Point falling below 0.9 pu each Power Park Module shall unless otherwise agreed with the DNO, be required to inject reactive current IR that lies above the heavy black line shown in Figure 13.15.  **Figure 13.15 – locus of magnitude of injected reactive current**		P
	(b) Figure 13.15 defines the reactive current IR that is to be supplied during a fault on the Transmission System and which is dependent on the prefault operating conditions, and the voltage retained at the Connection Point. Each Power Park Module shall inject a reactive current I_R which shall not be less than its pre-fault reactive current and which shall as a minimum increase with the fall in retained voltage each time the retained voltage at the Connection Point falls below 0.9 pu, whilst ensuring that the overall rating of the Power Park Module is not exceeded		P
	(c) In addition each Power Park Module shall be required to satisfy the reactive current requirements shown in Figures 13.16 which shows how the reactive current should be injected over time from the fault inception. The injected current shall be above the shaded area shown in Figure 13.16 (a) or Figure 13.16 (b) with priority being given to reactive current injection with any residual capability being supplied as active current. Under any fault condition, where the voltage falls below 0.9 pu, there would be no requirement for any Power Park Module or constituent Generating Unit to exceed its transient or steady state rating.		

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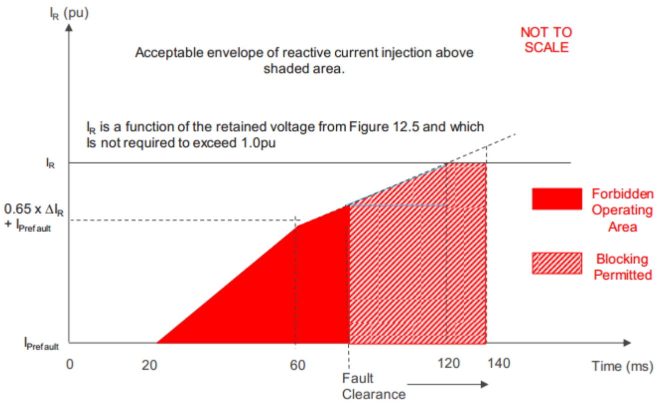
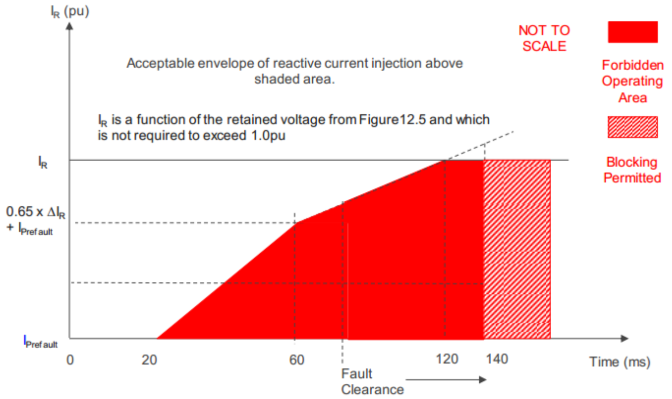
Clause	Requirement - Test	Result - Remark	Verdict
	 **Figure 13.16(a) Chart showing area of Reactive Current injections for voltage depressions of ≤ 140 ms duration**  **Figure 13.16(b) Chart showing area of Reactive Current injections for voltage depressions of > 140 ms duration**		P
	(d) For the purposes of this requirement, the maximum rated current is taken to be the maximum current each Generating Unit can supply when operating at Registered Capacity and 0.95 Power Factor at a nominal voltage of 1.0 pu.		P
	(e) All Power Park Module equipment shall be designed to ensure a smooth transition between any of its voltage, power factor, or reactive power control modes and fault ride through mode in order to prevent the risk of instability which could arise in the transition between the steady state voltage operating range and abnormal conditions where the retained voltage falls below 0.90 pu of nominal voltage. Such a requirement is necessary to ensure adequate performance between the pre-fault operating condition of the Power Park Module and its subsequent behaviour under fault conditions.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	(f) Each Power Park Module shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. Generators shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figures 13.16 (a) and Figure 13.16 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The DNO may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the Connection Agreement. Where the Generator is able to demonstrate to the DNO that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions Generators are required to both advise and agree with the DNO the control strategy, which must also include the approach taken to de-blocking.		P
	(g) To permit additional flexibility for example from Power Park Modules made up of full converter Generating Units, DFIG Generating Units or induction Generating Units, the DNO will permit transient deviations below the shaded area shown in Figure 13.16 (a) or Figure 13.16 (b) provided that the reactive current supplied is greater than the minimum requirement shown in Figures 13.16 (a) or Figure 13.16(b). This agreement will be formalised in the Connection Agreement.		P
	(h) In the case of an unbalanced fault, each Power Park Module or each Generating Unit within a Power Park Module shall be required to inject maximum reactive current without exceeding the transient rating of the Power Park Module.		P
13.7	**Black Start Capability and rapid re-synchronisation**		N/A
13.7.1	The National Electricity Transmission System will be equipped with Black Start Stations. It will be necessary for each Generator to notify the DNO if its Power Generating Module has a restart capability without connection to an external power supply, unless the Generator shall have previously notified the NETSO accordingly under the Grid Code. Such generation may be registered by the NETSO as a Black Start Station.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
13.7.2	In case of disconnection of the Power Generating Module from the Distribution Network, the Power Generating Module shall be capable of quick resynchronisation if required by the NETSO. Where rapid re-synchronisation is required: (a) A Power Generating Module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be capable of houseload operation from any operating point on its Power Generating Module Generator Performance Chart. And b) Power Generating Modules shall be capable of houseload operation, irrespective of any auxiliary connection to the Distribution Network. The minimum operation time shall be specified by the NETSO, taking into consideration the specific characteristics of prime mover technology.		N/A
13.8	**Technical Requirements for Embedded Medium Power Stations**		N/A
13.9	**Operational monitoring**		P
13.9.1	With regard to information exchange: (a) Power Generating Facilities shall be capable of exchanging information with the DNO in real time or periodically with time stamping; (b) the DNO, in coordination with the NETSO, shall specify the content of information exchanges including a precise list of data to be provided by the Power Generating Facility.		P
13.9.2	At each Power Generating Facility the DNO will install its own Telecontrol/SCADA outstation which will generally meet all the DNO's necessary and legal operational data requirements. The DNO will inform the Generator if additional specific data are required at the time of the connection offer.		P
13.9.3	Additionally each Power Generating Facility shall; (a) be fitted with fault recording and dynamic system monitoring facilities which shall be capable of recording System data including voltage, Active Power, Reactive Power and frequency in accordance with Annex C.6. (b) The settings of the fault recording equipment and dynamic system monitoring equipment (which is required to detect poorly damped power oscillations) including triggering criteria shall be agreed between the Generator and the DNO and recorded in the Connection Agreement. (c) The DNO may also specify that Generators shall install power quality monitoring equipment. Any such requirement including the parameters to be monitored would be specified by the DNO in the Connection Agreement. (d) Provisions for the submission of fault recording, dynamic system monitoring and power quality data to the DNO including the communications and protocols shall be specified by the DNO in the Connection Agreement.		P

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Clause	Requirement - Test	Result - Remark	Verdict
13.9.4	The Generator will provide all relevant signals in a format to be agreed between the Generator and the DNO for onsite monitoring. All signals shall be suitably terminated in a single accessible location at the Generators site.		P
13.9.5	The Generator shall provide to the DNO a 230 V power supply adjacent to the signal terminal location.		P
13.9.6	Frequency Sensitive Mode (FSM) monitoring in real time		P
13.9.6.1	Power Generating Modules shall be fitted with facilities to record and monitor the operation of Active Power Frequency Response in real time if the Generator has chosen to enter into an appropriate ancillary services commercial contract with the NETSO.		P
13.9.6.2	Provisions for the submission of Frequency Sensitive Mode data to the DNO including the data to be monitored, communications and protocols shall be specified, if required, by the DNO in the Connection Agreement.		P
13.10	**Steady State Load Inaccuracies**		N/A
	The standard deviation of load error at steady state load over a 30 minute period shall not exceed 2.5% of a Power Generating Modules Registered Capacity. Where a Power Generating Module is instructed to operate in frequency sensitive operation, allowance will be made in determining whether there has been an error according to the governor Droop characteristic registered under the DDRC.		N/A
	For the avoidance of doubt in the case of a Power Park Module allowance will be made for the full variation of mechanical power output.		N/A
14	**INSTALLATION, OPERATION AND CONTROL INTERFACE**		P
14.1	**General**		P
14.2	**Isolation and Safety Labelling**		P
14.2.1	Every Generator’s Installation which includes Power Generating Modules operating in parallel with the Distribution Network must include a means of isolation capable of disconnecting the whole of the Power Generating Module7 infeed to the Distribution Network. This equipment will normally be owned by the Generator, but may by agreement be owned by the DNO.		P
14.2.2	The Generator must grant the DNO rights of access to the means of isolation without undue delay and the DNO must have the right to isolate the Power Generation Modules infeed at any time should such disconnection become necessary for safety reasons and in order to comply with statutory obligations. The isolating device should normally be installed at the Connection Point, but may be positioned elsewhere with the DNO’s agreement.		P

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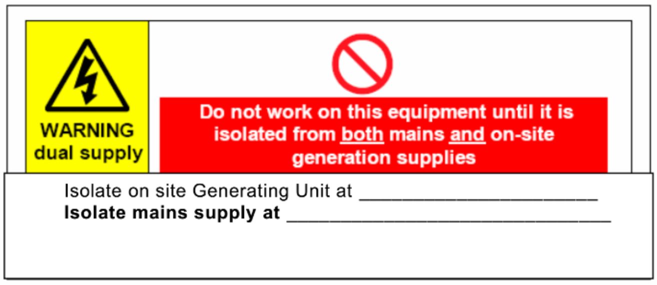
Clause	Requirement - Test	Result - Remark	Verdict
14.2.3	To ensure that DNO staff and that of the Generator and their contractors are aware of the presence of a Power Generating Module, appropriate warning labels should be used.		P
14.2.4	Where the installation is connected to the DNO LV Distribution Network the Generator should generally provide labelling at the Connection Point (Fused Cut-Out), meter position, consumer unit and at all points of isolation within the Generator's premises to indicate the presence of a Power Generating Module. The labelling should be sufficiently robust and if necessary fixed in place to ensure that it remains legible and secure for the lifetime of the installation. The Health and Safety (Safety Signs & Signals) Regulations 1996 stipulates that labels should display the prescribed triangular shape, and size, using black on yellow colouring. A typical label, for both size and content, is shown below in Figure 14.1.  **Figure 14.1 Warning label**		P
14.3	**Site Responsibility Schedule**		Info.
14.4	**Operational and Safety Aspects**		Info.
14.5	**Synchronizing and Operational Control**		P
15	**Common Compliance and Commissioning Requirements for all Power Generating Modules**		N/A
15.1	**Demonstration of Compliance**		N/A
15.2	**Wiring for Type Tested Power Generating Modules**		N/A
15.3	**Commissioning Tests / Checks required at all Power Generating Facilities**		N/A
15.4	**Additional Commissioning requirements for Non Type Tested Interface Protection**		N/A
15.5	**Compliance of Vehicle to Grid Electric Vehicles**		N/A
15.6	**Family approach to Type Testing**		N/A
15.7	**Compliance demonstration for Infrequent Short-Term Parallel Power Generating Modules**		N/A
16	**TYPE A COMPLIANCE TESTING, COMMISSIONING AND OPERATIONAL NOTIFICATION**		P
16.1	**Type Test Certification**		P

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Clause	Requirement - Test	Result - Remark	Verdict
16.1.1	The Power Generating Module can comprise Fully Type Tested equipment or be made up of some Type Tested equipment and require additional site testing prior to operation. The use of Fully Type Tested equipment simplifies the connection process, the protection arrangements and reduces the commissioning test requirements.		P
16.1.2	Type Tested certification is the responsibility of the Manufacturer. The Manufacturer shall submit the Type Test Verification Report confirming that the product has been Type Tested to satisfy the requirements of this EREC G99 to the Energy Networks Association (ENA) Type Test Verification Report Register. The report shall detail the type and model of product tested, the test conditions and results recorded. The report can include reference to Manufacturers' Information.		P
16.1.3	The required Type Test Verification Report and declarations including that for a Fully Type Tested Power Generating Module are shown in Annex A.2:		P
	• Form A2-1 - Compliance Verification Report for Synchronous Power Generating Modules up to and including 50 kW,	Inverter Connected Power Generating Modules.	N/A
	• Form A2-2 Compliance Verification Report for Synchronous Power Generating Modules greater than> 50 kW and also for Synchronous Power Generating Modules ≤ 50 kW where the approach of this form is preferred to that in Form A2-1, or	Inverter Connected Power Generating Modules.	N/A
	• Form A2-3 - Compliance Verification Report for Inverter Connected Power Generating Modules.		N/A

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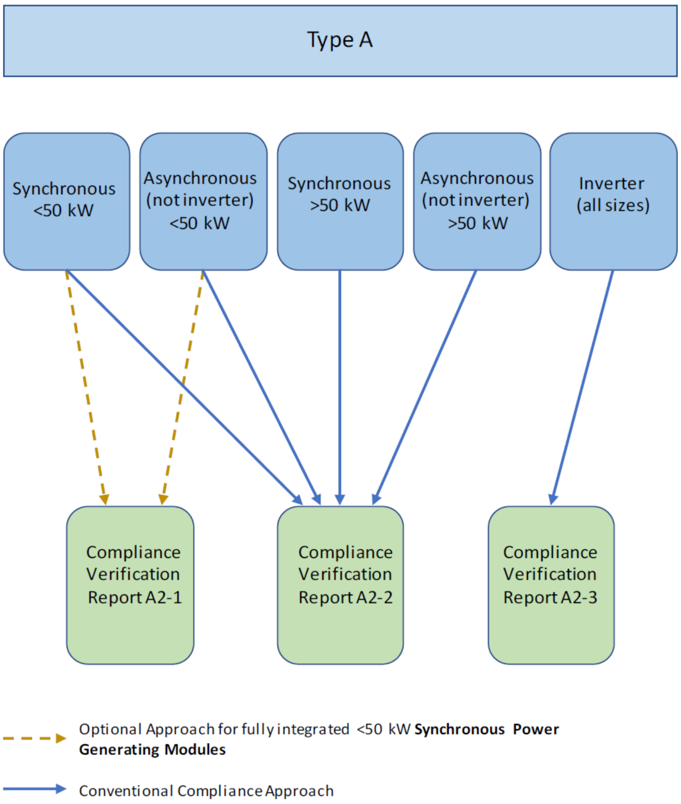
Clause	Requirement - Test	Result - Remark	Verdict
	The choice of compliance route available is shown in Figure 16-1 below.  **Figure 16-1 Illustration of the choice of compliance route**		N/A
	It is intended that the Manufacturers will use the requirements of this EREC G99 to develop type verification certification (ie the Compliance Verification Report as shown in Annex A.2) for each of their Power Generating Module models.		N/A
	Form A2-3 caters for all asynchronous and inverter technologies of any size, with the exception of conventional induction Generating Units. Manufacturers of induction Generating Units may find it more appropriate to use forms A2-2 or A2-1 in preference to Form A2-3 (Annex A.2).		N/A
16.1.4	Guidance for Manufacturers on type testing for Power Generating Modules is included in Annex A.7 of this document.		N/A
16.1.5	Compliance with the requirements detailed in this EREC G99 will ensure that the Power Generating Module is considered to be approved for connection to the DNO's Distribution Network.		P
16.1.6	The Power Generating Module shall comply with all relevant UK and European Directives and should be labelled in accordance with those requirements.		P
16.2	**Connection Process**		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
16.2.1	The Installer shall discuss the installation project with the local DNO at the earliest opportunity. The connection application will need to be in format as shown in Annex A.1 (Form A1) or for Power Generating Modules greater than 50 kW by using the Standard Application Form (generally available from the DNOs website). Where a Power Generating Module is Fully Type Tested and registered with the Energy Networks Association Type Test Verification Report Register, the application should include the Manufacturer's reference number (the Product ID), and the compliance test results do not need to be submitted as part of the application.	Relied on installer.	N/A
16.2.2	On receipt of the application, the DNO will assess: • whether any Distribution Network studies are required; • whether there is a need for work on the Distribution Network before the Tested Power Generating Module can be connected to the Distribution Network; and • whether there is a requirement to witness the commissioning tests and checks.	Fully Type Test.	N/A
16.2.3	Connection of the Power Generating Module is only allowed after the application for connection has been approved by the DNO and any DNO works facilitating the connection have been completed.	It's depended on installer and DNOs.	N/A
16.2.4	Where a Power Generating Module is not Fully Type Tested, the Generator or Installer shall provide the DNO with a Compliance Verification Report as per Annex A.2 (Forms A2-1, A2-2 or A2-3 as applicable) confirming that the Power Generating Module has or will be tested to satisfy the requirements of this EREC G99. This should be provided prior to commencing commissioning.	It's depended on installer and DNOs.	N/A
16.2.5	Where Power Generating Modules require connection to the DNO's Distribution Network in advance of the commissioning date, for the purposes of testing, the Power Generating Facility must comply with the requirements of the Connection Agreement. The Generator shall provide the DNO with a commissioning programme, which will be approved by the DNO if reasonable in the circumstances, to allow commissioning tests to be coordinated.	It's depended on installer and DNOs.	N/A

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict
16.2.6	Where commissioning tests are not witnessed, confirmation of the commissioning of each Power Generating Module will need to be made no later than 28 days after commissioning; the format and content shall be as shown in Annex A.3 (Form A3) Installation Document. The Installer or Generator, as appropriate, shall complete the declaration at the bottom of the Installation Document (Form A3) noting that this declaration also covers the Site Compliance and Commissioning Test Form (Form A2-4). Where the tests are witnessed a copy shall be provided to the DNO at the time of commissioning.	It's depended on installer and DNOs.	N/A
16.2.7	It is the responsibility of the Generator (which may be delegated to the Installer) to ensure that the relevant information is forwarded to the local DNO. The pro forma in Annex A are designed to: (a) simplify the connection procedure for both DNO and Installer; (b) provide the DNO with all the information required to assess the potential impact of the Power Generating Module connection on the operation of the Distribution Network; (c) inform the DNO that the Generator's Installation complies with the requirements of this EREC G99; (d) allow the DNO to accurately record the location of all Power Generating Modules connected to the Distribution Network.	It's depended on installer and DNOs.	N/A
16.3	**Witnessing and Commissioning**		N/A
16.4	**Operational Notification**		N/A
16.4.1	Notification that the Power Generating Module has been connected / commissioned is achieved by completing an Installation Document as per Annex A.3, which also includes the relevant details on the Generator's Installation required by the DNO.		N/A
16.4.2	The Installer, or an agent acting on behalf of the Installer, shall supply separate Installation Documents (Form A3-1 (Annex A.3) for Type A Power Generating Modules or Form A3-2 (Annex A.3) for Integrated Micro Generation and Storage installations) for each Power Generating Facility installed under EREC G99 to the DNO. Documentation shall be supplied either at the time of commissioning (where tests are witnessed) or within 28 days of the commissioning date (where the tests are not witnessed) and may be submitted electronically.	It's depended on installer and DNOs.	N/A
16.4.3	Generators who own Type A Power Generating Modules do not have permanent rights to operate their Power Generating Modules until the commissioning tests have been successfully completed (and witnessed by the DNO if required) and the Installation Document has been fully completed and sent to the DNO	It's depended on installer and DNOs.	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
17	**TYPE B COMPLIANCE TESTING, COMMISSIONING AND OPERATIONAL NOTIFICATION**		P
17.1	**General**		P
17.1.1	Where Power Generating Modules require connection to the DNO's Distribution Network in advance of the commissioning date, for the purposes of testing, the Power Generating Facility shall comply with the requirements of the Connection Agreement. The Generator shall provide the DNO with a commissioning programme, which will be approved by the DNO if reasonable in the circumstances, to allow commissioning tests to be co-ordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.		P
17.1.2	The Generator shall use Type Tested equipment and/or Manufacturers' Information and/or site tests, as well as demonstrating commissioning tests performed on the Power Generating Module in order to discharge the requirements of this document. Examples of the combination of the use of type testing and the provision of Manufacturers' Information are given in Section 22.1. Further information about Manufacturers' Information for Inverter connected Power Park Modules is given in Section 21. Note that the DNO shall charge the Generator for attendance of staff for witness testing in accordance with its charging regime. The Generator shall make arrangements for the DNO to witness the commissioning tests unless otherwise agreed with the DNO.		P
17.1.3	It is the responsibility of the Generator to undertake commissioning tests / checks and to ensure the Power Generating Facility and Power Generating Modules meet all the relevant requirements.		P
17.1.4	In addition to the commissioning tests and checks required under EREC G99, in exceptional circumstances further tests may be required by the DNO from the Manufacturer, Supplier, Generator or Installer of the Power Generating Modules as may be required to satisfy legislation and other standards.		P
17.2	**Connection Process**		N/A
17.2.1	The Generator shall discuss the project with the local DNO at the earliest opportunity. The Generator will need to provide information using the Standard Application Form (generally available from the DNO's website) to allow detailed system studies to be undertaken. Connection of the Power Generating Module is only allowed after the application for connection has been approved by the DNO and any DNO works facilitating the connection have been completed .	It's depended on installer and DNOs.	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
17.2.2	Not less than 28 days, or such shorter period as may be acceptable in the DNO's reasonable opinion, prior to the Generator wishing to synchronise its Power Generating Module for the first time the Generator will submit to the DNO a Power Generating Module Document containing at least but not limited to the items referred to in paragraph 17.2.3.	It's depended on installer and DNOs.	N/A
17.3	**Witnessing and Commissioning**		N/A
17.4	**Final Operational Notification**		N/A
18	**TYPE C COMPLIANCE TESTING, COMMISSIONING AND OPERATIONAL NOTIFICATION**		P
18.1	**General**		P
18.1.1	Where Power Generating Modules require connection to the DNO's Distribution Network in advance of the commissioning date, for the purposes of testing, the Power Generating Facility shall comply with the requirements of the Connection Agreement. The Generator shall provide the DNO with a commissioning programme, which will be approved by the DNO if reasonable in the circumstances, to allow commissioning tests to be co-ordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.		P
18.1.2	The Generator shall use Type Tested equipment and/or Manufacturers' Information and/or site tests as well demonstrating all the commissioning tests performed on the Power Generating Module in order to discharge the requirements of this document. Further information about Manufacturers' Information is given in Section 21. Examples of the combination of the use of type testing and the provision of Manufacturers' Information are given in Section 22.1. Note that the DNO shall charge the Generator for attendance of staff for witness testing in accordance with its charging regime. The Generator shall make arrangements for the DNO to witness the commissioning tests unless otherwise agreed with the DNO.		P
18.1.3	It is the responsibility of the Generator to undertake commissioning tests / checks and to ensure the Power Generating Facility and Power Generating Modules meet all the relevant requirements.		P
18.1.4	In addition to the commissioning tests and checks required under EREC G99, further tests may be required by the Manufacturer, Supplier, Generator or Installer of the Power Generating Modules as may be required to satisfy legislation and other standards.		P

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Clause	Requirement - Test	Result - Remark	Verdict
18.1.5	In the case of a Power Park Module the proportion of the Power Park Module which can be simultaneously synchronised to the Total System shall not exceed 20% of the Registered Capacity of the Power Park Module (or the output of a single Generating Unit where this exceeds 20% of the Power Park Module's Registered Capacity), until the Generator has completed the voltage control tests (detailed in Annex C.9.2) to the DNO's reasonable satisfaction. Following successful completion of this test each additional Generating Unit should be included in the voltage control scheme as soon as is technically possible (unless the DNO agrees otherwise).		P
18.2	**Connection Process**		N/A
18.3	**Witnessing and Commissioning**		N/A
18.4	**Final Operational Notification**		N/A
19	**TYPE D COMPLIANCE TESTING, COMMISSIONING AND OPERATIONAL NOTIFICATION**		P
19.1	**General**		P
19.1.1	A Type D Power Generating Module will be required to obtain an Energisation Operational Notification followed by an Interim Operational Notification and a Final Operational Notification as set out in this Section.		P
19.1.2	The Generator will use Type Tested equipment and or use Manufacturers' Information as well as demonstrating all the commissioning tests performed on the Power Generating Module in order to discharge the requirements of this document. Examples of the combination of the use of type testing and the provision of Manufacturers' Information are given in Section 22.1. Further information about Manufacturers' Information is given in Section 21. It is expected that the DNO will witness the commissioning tests for Power Generating Modules. Note that the DNO shall charge the Generator for attendance of staff for witness testing in accordance with its charging regime. The Generator shall make arrangements for the DNO to witness the commissioning tests unless otherwise agreed with the DNO.		P
19.1.3	It is the responsibility of the Generator to undertake these commissioning tests / checks and to ensure the Power Generating Facility and Power Generating Modules meet all the relevant requirements.		P
19.1.4	In addition to the commissioning tests and checks required under EREC G99, further tests may be required by the Manufacturer, Supplier, Generator or Installer of the Power Generating Modules as may be required to satisfy legislation and other standards.		P
19.2	**Connection Process**		N/A
19.3	**Interim Operational Notification**		N/A
19.4	**Witnessing and Commissioning**		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
19.5	**Final Operational Notification**		N/A
19.6	**Limited Operational Notification**		N/A
19.7	**Processes Relating to Derogations**		N/A
20	**ONGOING OBLIGATIONS**		N/A
20.1	**Periodic Testing for Power Generating Modules**		N/A
20.2	**Operational Incidents affecting Compliance of any Power Generating Module**		N/A
20.3	**Changes to the Power Generating Facility or Power Generating Module**		N/A
20.4	**Notification of Decommissioning**		N/A
21	**MANUFACTURERS' INFORMATION APPLICABLE TO POWER PARK MODULES**		P
21.1	**General**		P
21.1.1	Manufacturers' Information covers such information as type testing details, parameters or data, simulation models and reports on studies run using those models. The guidance in this Section 21 Manufacturers' Information relates to simulation models.		P
21.1.2	In most cases Manufactures' Information is submitted by the Generator to the DNO. However, data and performance characteristics in respect of simulation models may be registered with the DNO by Generating Unit Manufacturers in the form of Manufacturers' Information.		P
21.1.3	A Generator planning to construct a new Power Generating Facility containing the appropriate version of Generating Units in respect of which Manufacturers' Information has been submitted to the DNO may reference the Manufacturers' Information in its submissions to the DNO. Any Generator considering referring to Manufacturers' Information for any aspect of its plant and apparatus may contact the DNO to discuss the suitability of the relevant Manufacturers' Information to its project to determine if, and to what extent, the data included in the Manufacturers' Information contributes towards demonstrating compliance with those aspects of this EREC G99 applicable to the Generator. The DNO will inform the Generator if the reference to the Manufacturers' Information is not appropriate or not sufficient for its project.		P
21.1.4	The process to be followed by Generating Unit Manufacturers submitting Manufacturers' Information must be agreed by the DNO. Paragraph 21.2 below indicates the specific requirement areas in respect of which Manufacturers' Information may be submitted.		P

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Clause	Requirement - Test	Result - Remark	Verdict
21.1.5	The DNO may maintain and publish a register of that Manufacturers' Information which the DNO has received and accepted as being an accurate representation of the performance of the relevant plant and / or apparatus. Such register will clearly identify the Manufacturer, the model(s) of Generating Unit(s) to which the report applies and the provisions of EREC G99 in respect of which the report contributes towards the demonstration of compliance in such a way that these models can easily be identified for appropriate use in other similar projects. The inclusion of any report in the register does not in any way confirm that any Power Park Modules which utilise any Generating Unit(s) covered by a report is or will be compliant with EREC G99.	It's depended on installer and DNOs.	N/A
21.2	Manufacturers' Information in respect of Generating Units may cover one (or part of one) or more of the following provisions: (a) Fault Ride Through capability; (b) Power Park Module mathematical model DDRC 5c.		P
21.3	Reference to a Manufacturer's Data & Performance Report in a Generator's submissions does not by itself constitute compliance with EREC G99.		P
21.4	A Generator referencing Manufacturers' Information should insert the relevant Manufacturers' Information reference in the appropriate place in the submission forms detailed in the Annexes. The DNO will consider the suitability of Manufacturers' Information in place of DDRC data submissions such as a mathematical model suitable for representation of the entire Power Park Module as per Annex B.4.4 or Annex C.7.4.5 as applicable. Site specific parameters will still need to be submitted by the Generator.		P
21.5	It is the responsibility of the Generator to ensure that the correct reference for the Manufacturers' Information is used and the Generator by using that reference accepts responsibility for the accuracy of the information. The Generator shall ensure that the Manufacturer has kept the DNO informed of any relevant variations in plant specification since the submission of the relevant Manufacturers' Information which could affect the validity of the information.		P
21.6	The DNO may contact the Generating Unit Manufacturer directly to verify the relevance of the use of such Manufacturers' Information. If the DNO believes the use some or all of such Manufacturers' Information is incorrect or the referenced data is inappropriate then the reference to the Manufacturers' Information may be declared invalid by the DNO. Where, and to the extent possible, the data included in the Manufacturers' Information is appropriate, the compliance assessment process will be continued using the data included in the Manufacturers' Information.	It's depended on installer and DNOs.	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
22	**TYPE TESTING AND ANNEX INFORMATION**		P
22.1	**Fully Type Tested and Type Tested equipment**		P
	The following matrix demonstrates where Manufacturers' Information and compliance and installation checks on site can be combined to demonstrate compliance for each Power Generating Module.	Fully Type Tested.	P
	(see matrix below)		P

	Manufacturers' Information	**Power Quality Assessment and Site Tests**
Fully Type Tested (**Type A** only ≤ 50 kW)	Registered as **Fully Type Tested** information on ENA website via the Compliance Verification Report (Form A2-1, A2-2 or A2-3 as appropriate)	An assessment of compliance with EREC G5 and EREC P28 is necessary. This will generally allow connection of a **Fully Type Tested** device with no need for mitigation. However, where the fault level is unusually low (eg in remote rural locations) mitigation measures might be needed Only installation checks required – as on the Installation Document (Form A3-1 or A3-2)
Type Tested (**Type A**)	Registered as product or component Type Test information on ENA Website using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3); and/or Supplied by the **Generator** using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3)	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form A3-1 or A3-2) Standard installation checks (Form A3-1 or A3-2). Additional Site Compliance and Commissioning Checks (Form A2-4) may also be required
Type Tested (B, C, D)	Registered as product or component Type Test information on ENA Website; and/or Supplied by the **Generator**	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form B2-1 or Form C2-1) Standard installation checks (Form B3 or Form C3). Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required
One off installation (B, C, D)	To be provided by the **Generator** for those aspects that cannot be demonstrated on site (including simulations etc)	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form B2-1 or Form C2-1) Standard installation checks also required (Form B3 or Form C3). Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required

22.2	**Annex Contents and Form Guidance**		P

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Clause	Requirement - Test	Result - Remark	Verdict

Clause	Requirement - Test	Result - Remark	Verdict
	(nested table below)		P

Annex	Application	Form Title
A.0	Cover Sheet for **Type A Power Generating Facility** Forms	
A.1	Connection Application for **Type A Fully Type Tested** (<50 kW) **Power Generating Modules** Connection Application for **Integrated Micro Generation and Storage** Note for all other **Power Generating Modules** the **DNO**'s Standard Application Form shall be used.	Form A1-1: Application for connection of **Power Generating Module**(s) with Total Aggregate Capacity <50 kW 3-phase or 17 kW single phase Form A1-2: Application for connection of an **Integrated Micro Generation and Storage** installation
A.2	Compliance report for **Type A Type Tested**	Form A2-1: Compliance Verification Report for **Synchronous Power Generating Modules** up to and including 50 kW Form A2-2: Compliance Verification Report for **Synchronous Power Generating Modules** > 50 kW and also for **Synchronous Power Generating Modules** ≤ 50 kW where the approach of this form is preferred to that in Form A2-1 Form A2-3 Compliance Verification Report for **Inverter** Connected **Power Generating Modules**
A.2	Additional Compliance and Commissioning test requirements for **Type A Power Generating Modules**	Form A2-4: Site Compliance and Commissioning test requirements for **Type A Power Generating Modules**

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Clause	Requirement - Test	Result - Remark	Verdict

A.3	Installation and Commissioning a **Power Generating Facility** comprising one or more **Type A Generating Modules**	Form A3-1: Installation Document for **Type A Power Generating Modules** Form A3-2: Installation Document for **Integrated Micro Generation and Storage** installations	P
A.4	Emerging Technologies and other Exceptions		
A.5	Example calculations to determine if unequal generation across different phases is acceptable or not		
A.6	Scenario examples in respect of the application of EREC G59 and EREC G99 to new or modified sites after 27/04/19		
A.7	Requirements for Type Testing **Type A Power Generating Modules**		
B.1	Application	Refer to Standard Application Form	
B.2-1	Compliance documentation for **Type B Power Generating Modules**	Form B2-1: **Power Generating Module Document** for **Type B Power Generating Modules**	
B.2-2	Additional Compliance and Commissioning test requirements for **Type B Power Generating Modules**	Form B2-2 Site Compliance and Commissioning test requirements for **Type B Power Generating Modules**	
B.3	Installation and Commissioning Confirmation Form	Form B2: Installation and Commissioning Confirmation Form for **Type B Power Generating Modules**	
B.4	Simulation Studies for **Type B Power Generating Modules**		
B.5	Compliance Testing of **Type B Synchronous Power Generating Modules**		
B.6	Compliance testing of **Type B Power Park Modules**		
C.1	Application	Refer to Standard Application Form	
C.2-1	Compliance documentation for **Type C** and **Type D Power Generating Modules**	Form C2-1: **Power Generating Module Document** for **Type C and Type D Power Generating Modules**	
C.2-2	Additional Compliance and Commissioning test requirements for **Type C** and **Type D Power Generating Modules**	Form C2-2 Site Compliance and Commissioning test requirements for **Type C** and **Type D Power Generating Modules**	
C.3	Installation and Commissioning Confirmation Form	Form C3: Installation and Commissioning Confirmation Form for **Type C** and **Type D Power Generating Modules**	
C.4	Performance Requirements For Continuously Acting Automatic Excitation Control Systems For **Type C** and **Type D Synchronous Power Generating Modules**		
C.5	Performance Requirements For Continuously Acting Automatic Excitation Control Systems For **Type C** and **Type D Power Park Modules**		
C.6	Functional Specification for Fault Recording and Power Quality Monitoring Equipment Studies for **Type C** and **Type D Power Generating Modules**		
C.7	Simulation Studies for **Type C** and **Type D Power Generating Modules**		

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Clause	Requirement - Test	Result - Remark	Verdict
	(see nested table below)		P

C.8	Compliance Testing of **Type C** and **Type D Synchronous Power Generating Modules**	
C.9	Compliance Testing of **Type C** and **Type D Power Park Modules**	
C.10	Minimum Frequency Response Capabilities for **Type C** and **Type D Power Generating Modules**	
D.0	Decommissioning of any **Power Generating Module**	Form D1**: Decommissioning Confirmation**
D.1	Additional Information Relating to **System Stability** Studies	
D.2	Loss of Mains Protection Analysis	
D.3	Main Statutory and other Obligations	
D.4	Summary of **Reactive Power** and voltage control requirements	

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Clause	Requirement - Test	Result - Remark	Verdict

Appendix 1: Compliance Verification Report – Tests for Type B, C and D Inverter Connected Power Generating Modules

12.2.1/12.2.2 13.2.1/13.2.2	**Operating Range:**	**P**

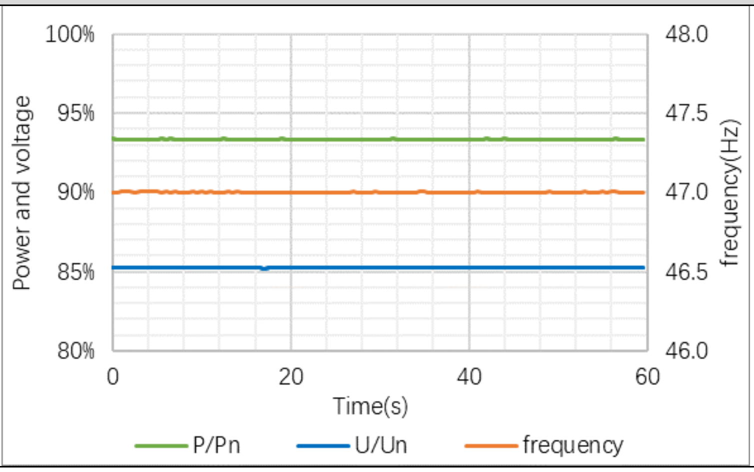
Two tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time.

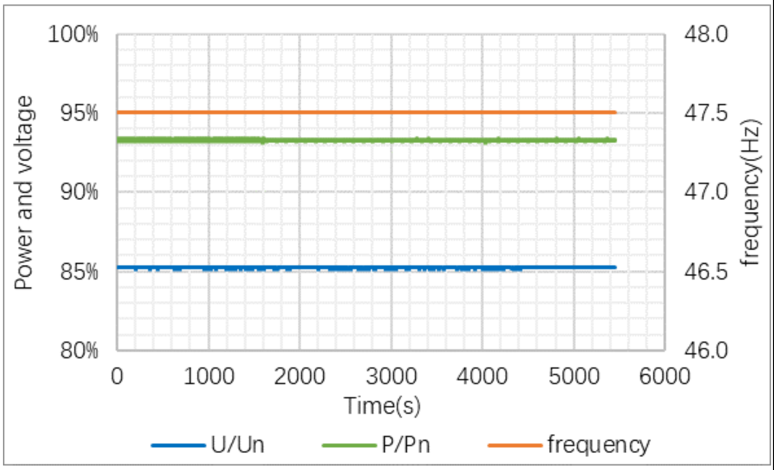
The **Interface Protection** shall be disabled during the tests.
In case of a PV **Power Park Module** the PV primary source may be replaced by a DC source.
In case of a full converter **Power Park Module** (eg wind) the primary source and the prime mover **Inverter**/rectifier may be replaced by a DC source.

Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement "Pass", "No disconnection occurs", etc. Graphical evidence is preferred.
Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

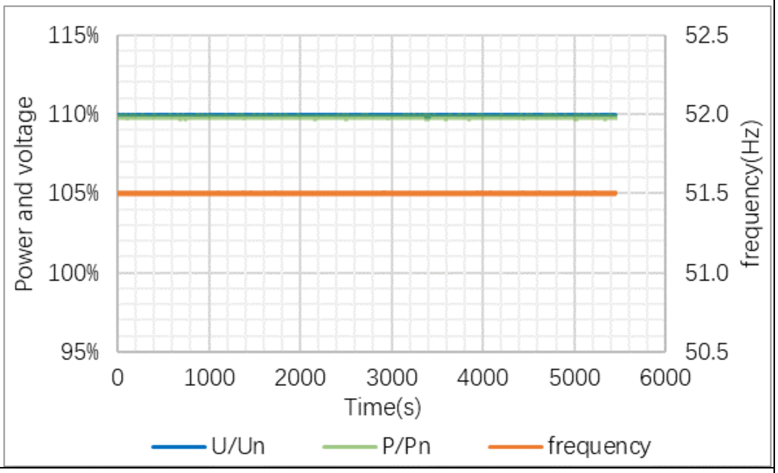
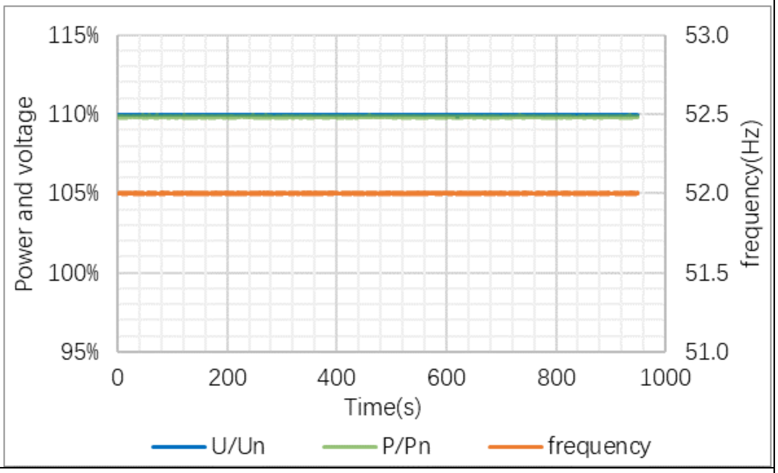
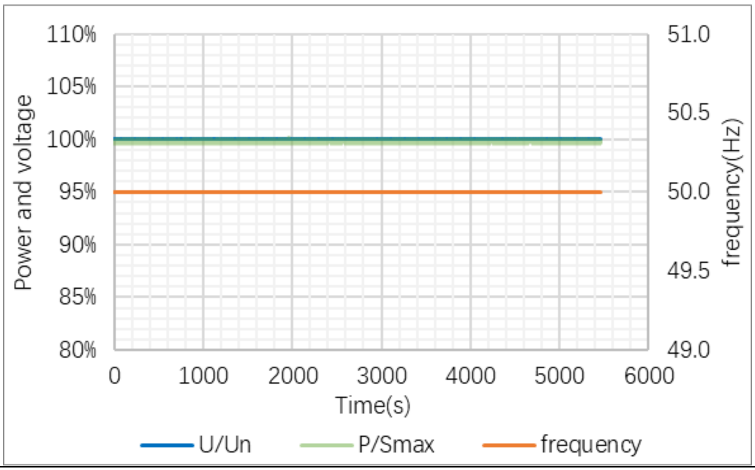
Test 1
Voltage = 85% of nominal (195.5 V),
Frequency = 47 Hz,
Power Factor = 1,
Period of test 20 s



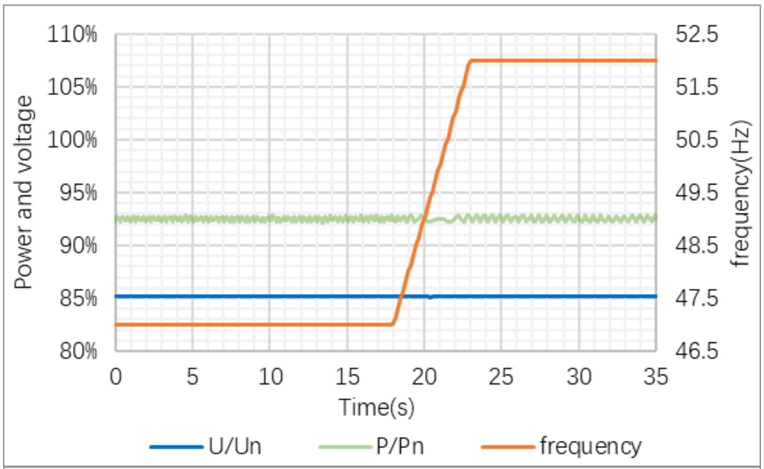
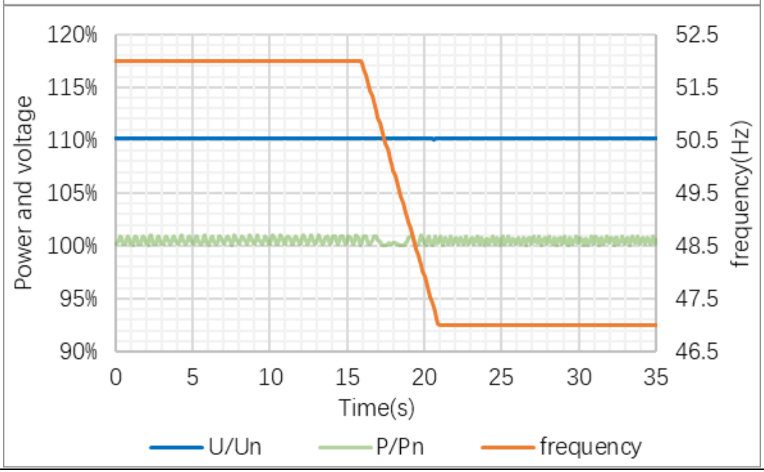
Test 2
Voltage = 85% of nominal (195.5 V),
Frequency = 47.5 Hz,
Power Factor = 1,
Period of test 90 minutes



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test 6 RoCoF withstand Confirm that the **Power Generating Module** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	 

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Model: SG350HX				P
Test 1:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (kW)	Measured Power factor	Test Time (seconds)
681.81	47.00	298.75	1.000	20
Test 2:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (kW)	Measured Power factor	Test Time (Minutes)
681.79	47.50	298.44	1.000	90
Test 3:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (kW)	Measured Power factor	Test Time (Minutes)
879.56	51.50	351.49	1.000	90
Test 4:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (kW)	Measured Power factor	Test Time (Minutes)
879.54	52.00	351.47	1.000	15
Test 5:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (kW)	Measured Power factor	Test Time (Minutes)
800.6	50.00	35135.3	1.000	90
Test 6:				
Measured Voltage (V)	Ramp range	Test frequency ramp	Test Duration	Confirm no trip
680.0	47.0 Hz to 52.0 Hz	+1 Hzs^{-1}	5.0 s	No trip
880.0	52.0 Hz to 47.0 Hz	-1 Hzs^{-1}	5.0 s	No trip

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

9.4.3 Power Quality – Harmonics:	**P**

For **Power Generating Modules** of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5**.** These tests should be carried out as specified in BS EN 61000-3-12, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Modules**, measurements for all phases should be provided.

For **Power Generating Modules** of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Model: SG350HX

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)	117.3	kVA	Harmonic % = Measured Value (A) x 80/rating per phase (kVA)
Single or three phase measurements (for single phase measurements, only complete L1 columns below)	three phase PV inverter		

Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.248	0.219	0.164	0.107	0.095	0.071	8%	8%
3	0.165	0.142	0.281	0.071	0.061	0.122	21.6%	Not stated
4	0.104	0.069	0.116	0.045	0.030	0.050	4%	4%
5	0.124	0.161	0.093	0.054	0.070	0.040	10.7%	10.7%
6	0.046	0.068	0.037	0.020	0.029	0.016	2.67%	2.67%
7	0.086	0.054	0.108	0.037	0.023	0.047	7.2%	7.2%
8	0.047	0.072	0.037	0.020	0.031	0.016	2%	2%
9	0.082	0.027	0.094	0.035	0.012	0.041	3.8%	Not stated
10	0.062	0.041	0.034	0.027	0.018	0.015	1.6%	1.6%
11	0.301	0.405	0.361	0.130	0.175	0.156	3.1%	3.1%
12	0.017	0.015	0.019	0.007	0.006	0.008	1.33%	1.33%
13	0.197	0.222	0.251	0.085	0.096	0.109	2%	2%
THD	-	-	-	0.22	0.25	0.25	23%	13%
PWHD	-	-	-	0.61	0.73	0.73	23%	22%

THD = Total Harmonic Distortion
PWHD = Partial Weighted Harmonic Distortion

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.107	0.269	0.301	0.046	0.116	0.130	8%	8%
3	0.318	0.184	0.475	0.138	0.080	0.205	21.6%	Not stated
4	0.213	0.119	0.190	0.092	0.051	0.082	4%	4%
5	0.164	0.135	0.104	0.071	0.058	0.045	10.7%	10.7%
6	0.194	0.069	0.145	0.084	0.030	0.063	2.67%	2.67%
7	0.189	0.294	0.388	0.082	0.127	0.168	7.2%	7.2%
8	0.073	0.059	0.085	0.032	0.026	0.037	2%	2%
9	0.132	0.055	0.136	0.057	0.024	0.059	3.8%	Not stated
10	0.041	0.048	0.059	0.018	0.021	0.026	1.6%	1.6%
11	0.980	0.908	0.939	0.046	0.393	0.406	3.1%	3.1%
12	0.054	0.053	0.032	0.138	0.023	0.014	1.33%	1.33%
13	0.309	0.283	0.311	0.092	0.122	0.134	2%	2%
THD	-	-	-	0.50	0.46	0.54	23%	13%
PWHD	-	-	-	1.57	1.45	1.59	23%	22%

THD = Total Harmonic Distortion
PWHD = Partial Weighted Harmonic Distortion

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

9.4.3 Power Quality – Voltage fluctuations and Flicker:									**P**
These tests should be undertaken in accordance with Annex A.7.2.5.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable maximum impedance.									
Model:		SG350HX							
Test start date		2022-07-09			Test end date			2022-07-09	
Test location		No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China							
		Starting			Stopping			Running	
		d(max) [%]	d(c) [%]	d(t) [%]	d(max) [%]	d(c) [%]	d(t) [%]	P_{st} [%]	P_{lt} 2 hours [%]
Measured Values at test impedance	L1	0.22	0.03	0	0	0	0	0.09	0.07
	L2	0.25	0.02	0	0	0	0	0.09	0.07
	L3	0.24	0.01	0	0	0	0	0.09	0.07
Normalised to standard impedance	L1	0.22	0.03	0	0	0	0	0.09	0.07
	L2	0.25	0.02	0	0	0	0	0.09	0.07
	L3	0.24	0.01	0	0	0	0	0.09	0.07
Normalised to required maximum impedance	L1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	L2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	L3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set under BS EN 61000-3-11		4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R	0.4	Ω	XI	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	XI	0.15 * 0.25 ^	Ω
Maximum Impedance	R	N/A #	Ω	XI	N/A #	Ω

* Applies to three phase and split single phase **Power Generating Modules.**

^ Applies to single phase **Power Generating Module** and **Power Generating Modules** using two phases on a three phase system. Delete as appropriate.

All the test value and calculated value normalised to standard impedance of dmax test, dc test, d(t) test, Pst test and Plt test were complies with the requirements of IEC 61000-3-11 and therefore is not subject to conditional connection, so the manufacturer no need to declare maximum Impedance.

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the Power Factor of the generation output is 0.98 or above.

Normalised value = Measured value x reference source resistance/measured source resistance at test point.

Single phase units reference source resistance is 0.4 Ω

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Continuous operating L1 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 1
Volt Range 1000V(230V/50Hz) Element1 Judgement: Pass
Un (U1) 0.80056kV Total Judgement: Pass
Freq(U1) 50.002 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.20 Pass	0.38 Pass	0 Pass	0.09 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07 Pass

Update 3600 2022/07/09 08:53:57

Continuous operating L2 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 1
Volt Range 1000V(230V/50Hz) Element1 Judgement: Pass
Un (U1) 0.80056kV Total Judgement: Pass
Freq(U1) 50.002 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.20 Pass	0.38 Pass	0 Pass	0.09 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07 Pass

Update 3600 2022/07/09 08:53:57

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Continuous operating L3 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 3
Volt Range 1000V(230V/50Hz) Element3 Judgement: Pass
Un (U3) 0.79984kV Total Judgement: Pass
Freq(U3) 50.002 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
2	0.23 Pass	0.40 Pass	0 Pass	0.09 Pass	
3	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
5	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
6	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
7	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
9	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
Result	Pass	Pass	Pass	Pass	0.07 Pass

Update 3600 2022/07/09 09:15:50

Switch on and switch off operating L1 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 0:20:00

Count 2/2
Interval 10m00s/10m00s
Element 3
Volt Range 1000V(230V/50Hz) Element3 Judgement: Pass
Un (U3) 0.80010kV Total Judgement: Pass
Freq(U3) 50.002 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.01 Pass	0.24 Pass	0 Pass	0.08 Pass	
2	0.00 Pass	0.00 Pass	0 Pass	0.08 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Update 600 2022/07/09 09:40:01

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Switch on and switch off operating L2 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 0:20:00

Count 2/2
Interval 10m00s/10m00s
Element 2
Volt Range 1000V(230V/50Hz) Element2 Judgement: Pass
Un (U2) 0.79924kV Total Judgement: Pass
Freq(U2) 50.002 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.02 Pass	0.25 Pass	0 Pass	0.08 Pass	
2	0.00 Pass	0.00 Pass	0 Pass	0.08 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Update 600 2022/07/09 09:40:10

Switch on and switch off operating L3 phase

Flicker Mode Uover:■ ■ ■ ■ YOKOGAWA ◆
IEC61000-4-15 Ed2.0 Iover:■ ■ ■ ■ Flicker:Complete 0:20:00

Count 2/2
Interval 10m00s/10m00s
Element 1
Volt Range 1000V(230V/50Hz) Element1 Judgement: Pass
Un (U1) 0.80023kV Total Judgement: Pass
Freq(U1) 50.001 Hz (Element1,2,3,4)

	dc[%]	dmax[%]	Tmax[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.03 Pass	0.22 Pass	0 Pass	0.08 Pass	
2	0.00 Pass	0.00 Pass	0 Pass	0.08 Pass	
Result	Pass	Pass	Pass	Pass	0.04 Pass

Update 600 2022/07/09 09:40:17

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

9.4.6 Power quality – DC injection:	**P**

The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

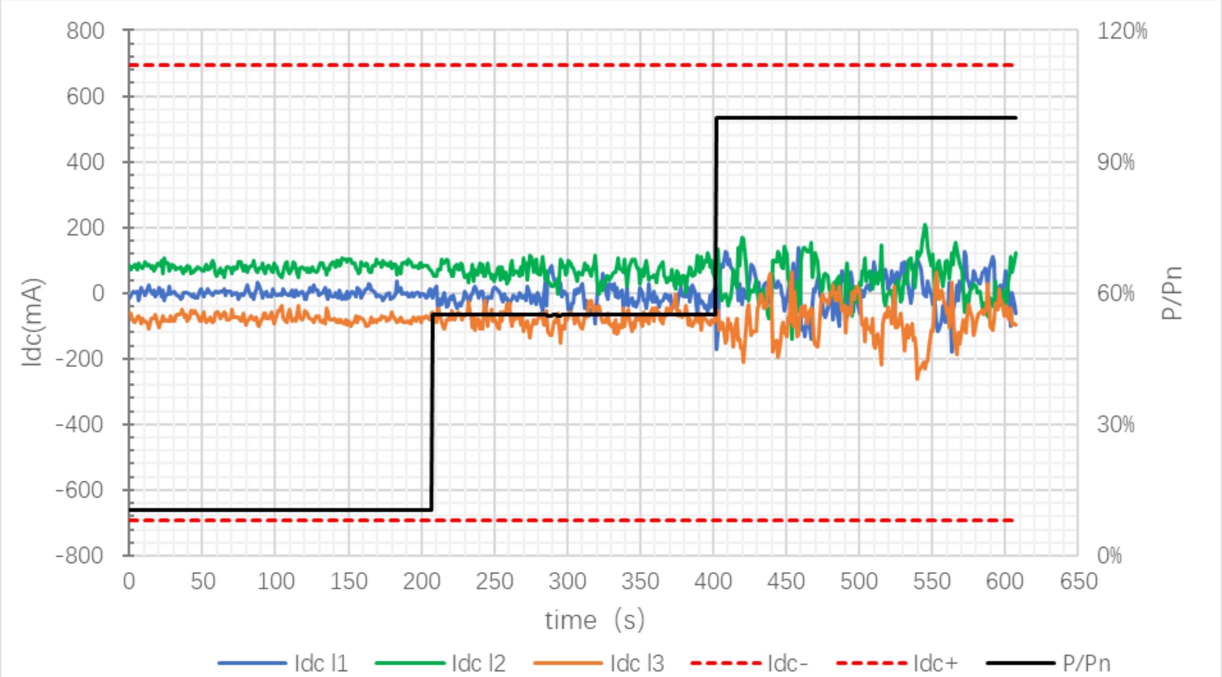
The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / Vphase. The % DC injection should not be greater than 0.25%.

Model: SG350HX

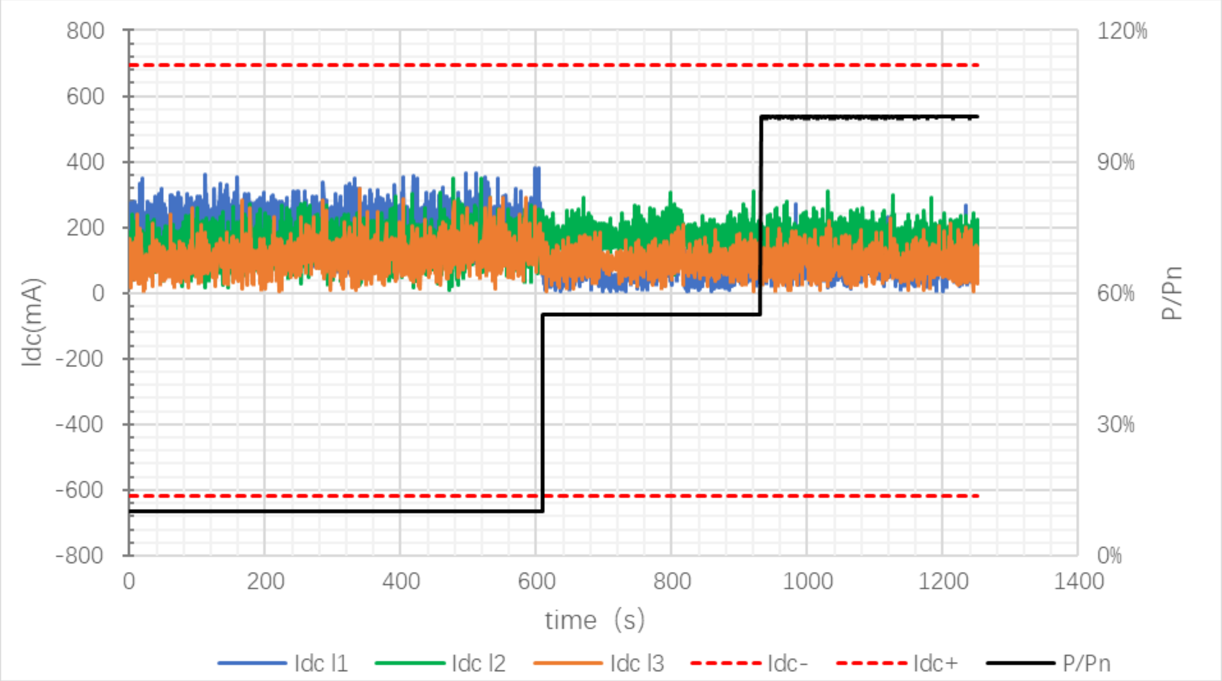
Test power level	10%			55%			100%		
	L1	L2	L3	L1	L2	L3	L1	L2	L3
Recorded DC injection value (mA)	35.1	108.1	109.3	93	121	150.0	180	209	261
as % of rated AC current	0.015	0.047	0.047	0.040	0.052	0.065	0.078	0.091	0.113
Limit	0.25%			0.25%			0.25%		



Model: SG285HX

Test power level	10%			55%			100%		
	L1	L2	L3	L1	L2	L3	L1	L2	L3
Recorded DC injection value (mA)	379.8	348.9	290.4	154.3	310.4	192.9	265.6	288.7	212.0
as % of rated AC current	0.184	0.169	0.141	0.075	0.151	0.094	0.129	0.140	0.103
Limit	0.25%			0.25%			0.25%		

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict



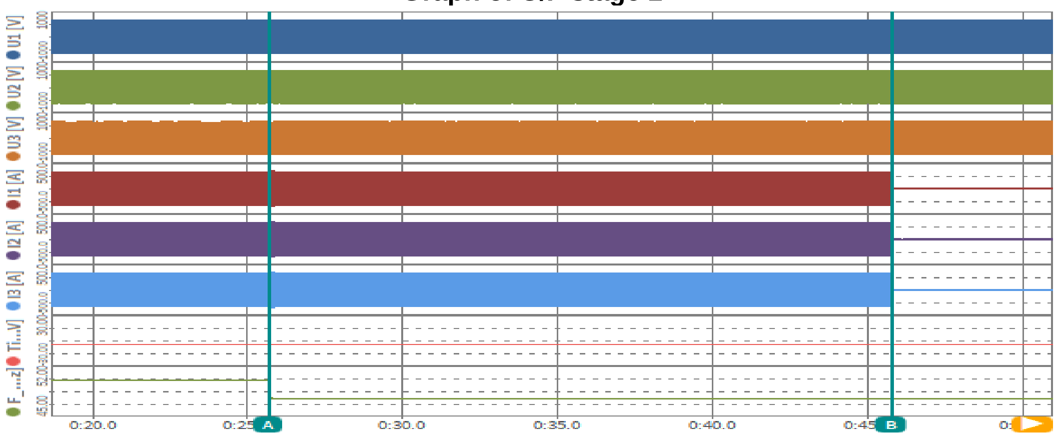
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

9.4.5 Power Factor:			**P**
The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2 Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.			
Model: SG350HX			
Voltage	0.94 pu (752 V)	1 pu (800 V)	1.1 pu (880 V)
Measured value	0.9999	0.9999	0.9999
Power Factor Limit	>0.95	>0.95	>0.95
Model: SG285HX			
Voltage	0.94 pu (752 V)	1 pu (800 V)	1.1 pu (880 V)
Measured value	0.9997	0.9998	0.9999
Power Factor Limit	>0.95	>0.95	>0.95

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

10.6.7.1 Protection – Frequency tests:						**P**
These tests should be carried out in accordance with the Annex A.7.1.2.3. For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.						
Model: SG350HX						
Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.49 Hz	20.03 s	47.7 Hz 30 s	No trip
U/F stage 2	47.0 Hz	0.5 s	46.99 Hz	0.521 s	47.2 Hz 19.5 s	No trip
					46.8 Hz 0.45 s	No trip
O/F	52.0 Hz	0.5 s	52.01 Hz	0.529 s	51.8 Hz 120.0 s	No trip
					52.2 Hz 0.45 s	No trip
Note: For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						

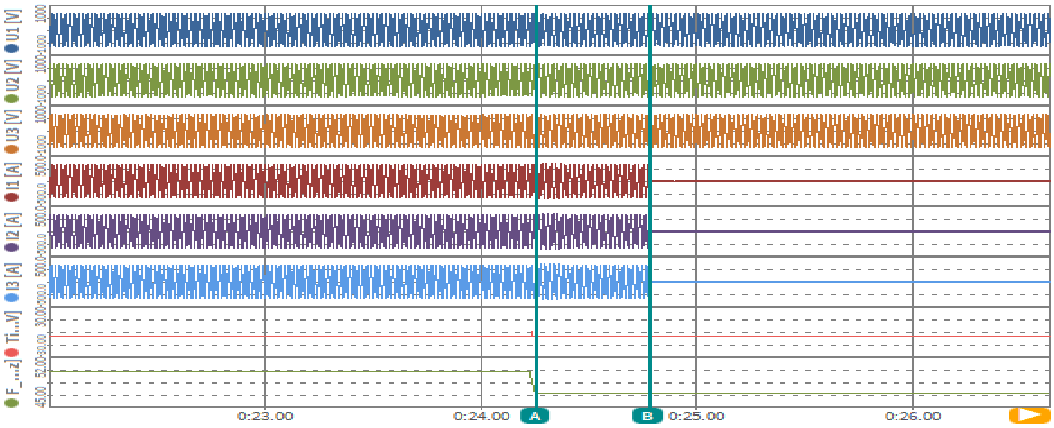
Graph of U/F stage 1



	A	B	间隔	有效值
时间 [s]	0:25.71428	0:45.73949	0:20.02520	
U1 [V]	654.5957	468.6384	-185.9572	462.2869
U2 [V]	-335.2772	168.4982	503.7754	461.3729
U3 [V]	-320.5468	-629.6775	-309.1307	461.6311
I1 [A]	328.9670	234.6068	-94.36024	232.9618
I2 [A]	-164.5132	82.68130	247.1945	232.1273
I3 [A]	-163.8622	-318.5445	-154.6823	232.2332
Tirgger [V]	-4.983849	-4.958250	0.025599	4.978052
F_fun...320HX	50.00188	47.49497	-2.506912	47.50016

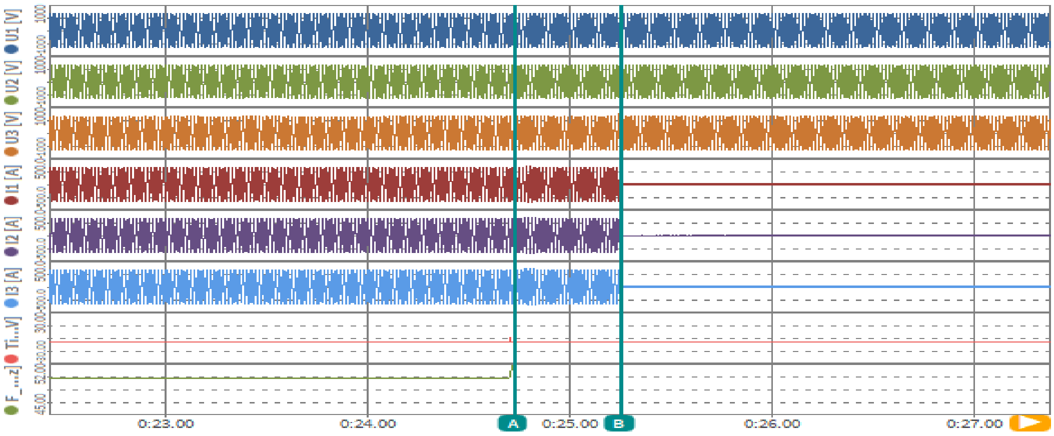
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/F stage 2



时间 [s]	A 0:24.258368	B 0:24.779452	间隔 0.521084	有效值
U1 [V]	-205.3839	251.1172	456.5012	462.3056
U2 [V]	-444.5392	401.6959	846.2351	461.3936
U3 [V]	644.6456	-642.9915	-1287.637	461.5481
I1 [A]	-57.89245	125.5847	183.4772	233.4049
I2 [A]	-188.0441	204.5012	392.5452	232.4962
I3 [A]	243.6867	-325.9421	-569.6287	232.5654
Tirgger [V]	-4.975891	-4.980229	-4.338e-3	4.978258
F_fun...320HX	49.98359	47.01119	-2.972401	47.11341

Graph of O/F



时间 [s]	A 0:24.723517	B 0:25.252721	间隔 0.529204	有效值
U1 [V]	-633.7761	648.6529	1282.429	462.4783
U2 [V]	441.7238	-370.3757	-812.0995	461.3545
U3 [V]	197.7564	-283.4063	-481.1627	461.3433
I1 [A]	-282.9809	0.276327	283.2573	232.0466
I2 [A]	204.8242	-1.480699	-206.3049	230.2792
I3 [A]	78.96412	0.259519	-78.70460	231.0223
Tirgger [V]	-4.979264	-4.974411	4.853e-3	4.978324
F_fun...320HX	50.01267	51.92933	1.916660	51.94003

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

10.6.7.1 Protection – Voltage tests (LV Protection) — **P**

These tests should be carried out in accordance with Annex A.7.1.2.2. For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Note that the value of voltage stated below assumes a **LV** connection This should be adjusted for **HV** taking account of the VT ratio as required.

Model: SG350HX

L1L2L3 Phase

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	0.8 pu	2.5 s	639.45 V	2.510 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.14 pu	1.0 s	912.42 V	1.056 s	898 V 5.0 s	No trip
O/V stage 2	1.19 pu	0.5 s	952.01 V	0.532 s	938 V 0.95 s	No trip
					966 V 0.45 s	No trip

L1-L2 Phase

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	0.8 pu	2.5 s	639.47 V	2.504 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.14 pu	1.0 s	912.62 V	1.048 s	898 V 5.0 s	No trip
O/V stage 2	1.19 pu	0.5 s	952.28 V	0.523 s	938 V 0.95 s	No trip
					966 V 0.45 s	No trip

L2-L3 Phase

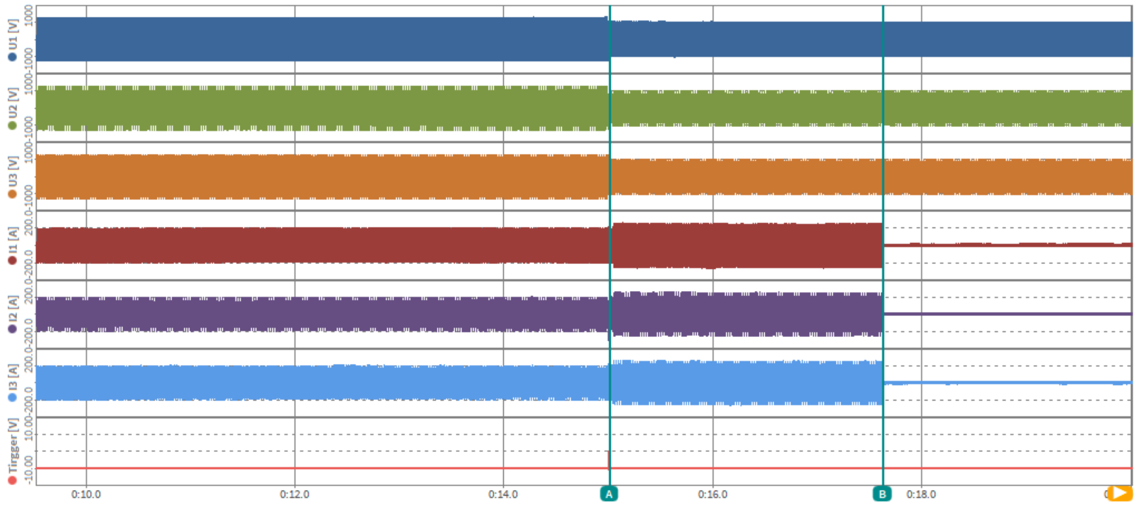
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	0.8 pu	2.5 s	639.62 V	2.540 s	654 V 5.0 s	No trip
					625.5 V 2.45 s	No trip
O/V stage 1	1.14 pu	1.0 s	912.94 V	1.027 s	898 V 5.0 s	No trip

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

O/V stage 2	1.19 pu	0.5 s	952.30 V	0.536 s	938 V 0.95 s	No trip
					966 V 0.45 s	No trip
L3-L1 Phase						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	0.8 pu	2.5 s	639.47 V	2.510 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.14 pu	1.0 s	912.37 V	1.047 s	898 V 5.0 s	No trip
O/V stage 2	1.19 pu	0.5 s	952.76 V	0.555 s	938 V 0.95 s	No trip
					966 V 0.45 s	No trip
Note: For Voltage tests the Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.						

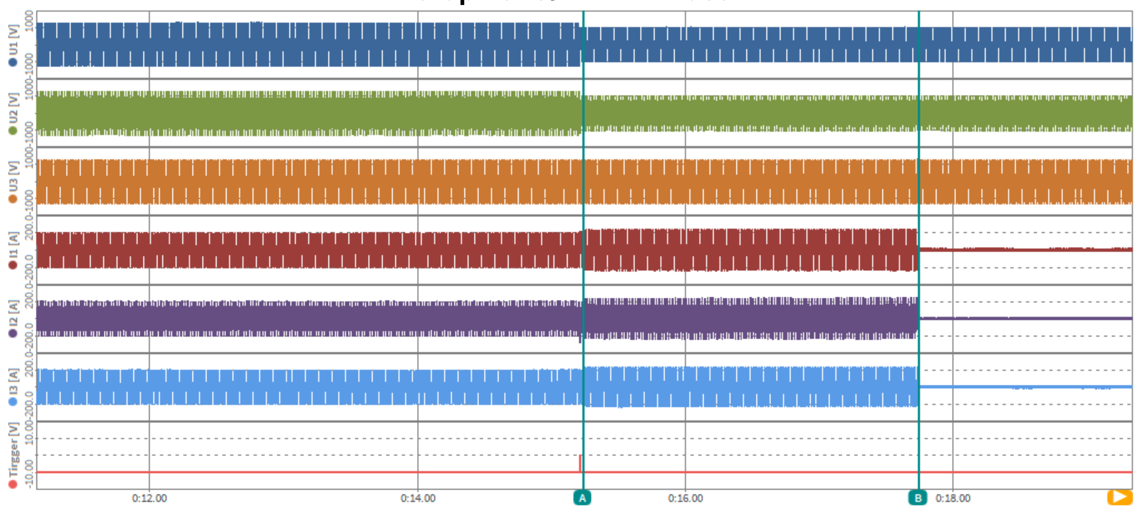
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/V L1L2L3 Phase



时间 [s]	A 0:15.116666	B 0:17.627216	间隔 2.510549	有效值
U1 [V]	241.4601	-327.2114	-568.6715	369.5920
U2 [V]	-520.4635	511.7405	1032.204	369.2998
U3 [V]	280.7248	-188.4940	-469.2188	369.2895
I1 [A]	43.25891	1.645088	-41.61382	87.54144
I2 [A]	-93.73308	0.644326	94.37740	87.25896
I3 [A]	48.77508	0.538111	-48.23697	87.00981
Tirgger [V]	-4.981470	-4.993769	-0.012299	4.982921

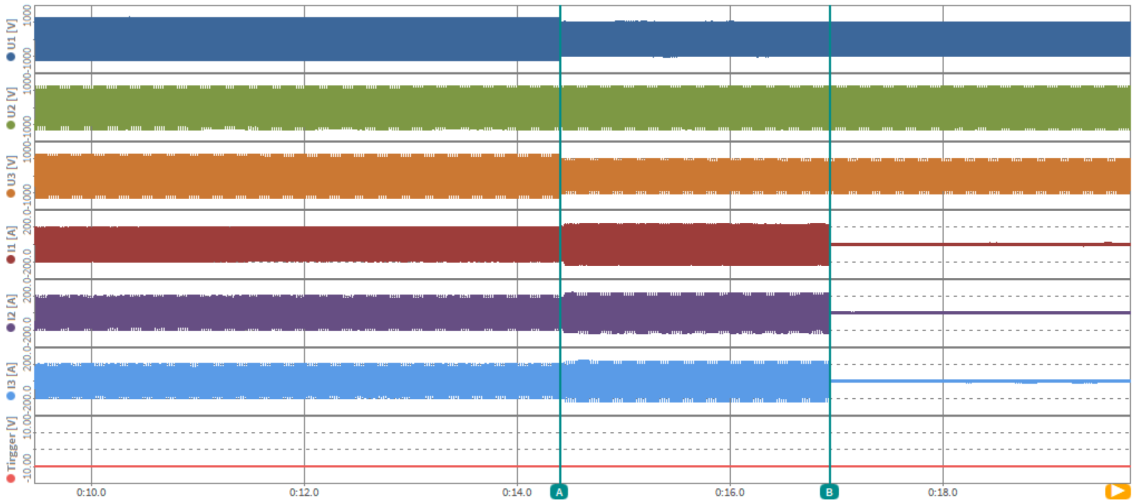
Graph of U/V L1L2 Phase



时间 [s]	A 0:15.240349	B 0:17.744420	间隔 2.504071	有效值
U1 [V]	175.0411	-433.8244	-608.8655	369.3610
U2 [V]	347.4775	463.4284	115.9509	369.3886
U3 [V]	-639.6462	-38.70774	600.9385	461.5549
I1 [A]	34.02055	6.571412	-27.44913	81.64870
I2 [A]	71.01596	4.393220	-66.62274	81.91891
I3 [A]	-111.4669	5.113483	116.5804	81.49743
Tirgger [V]	-4.934210	-5.007427	-0.073217	4.982833

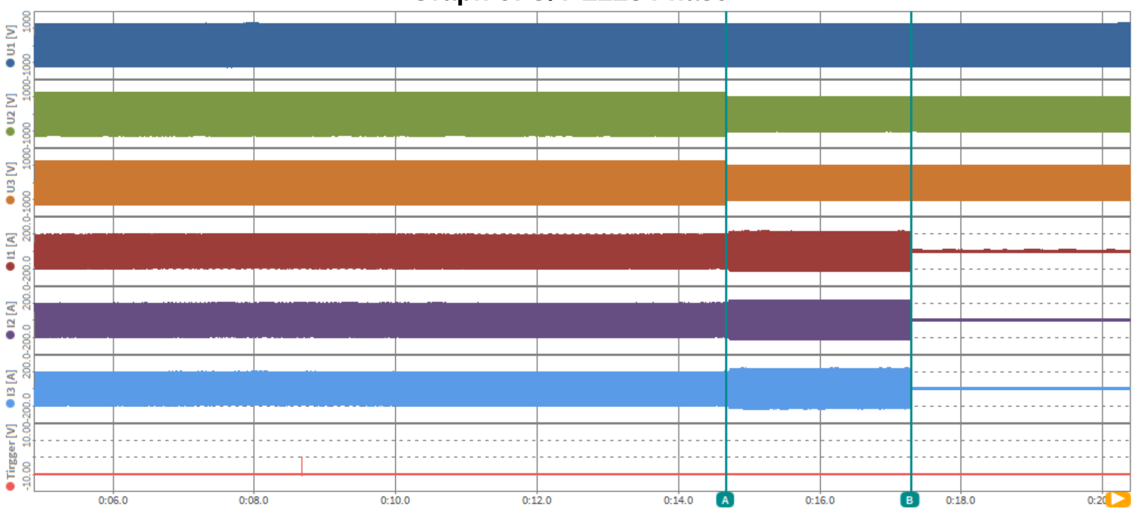
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/V L1L3 Phase



时间 [s]	A 0:14.403131	B 0:16.943924	间隔 2.540793	有效值
U1 [V]	160.6605	286.7054	126.0449	369.5808
U2 [V]	-628.9871	-645.2740	-16.28685	461.4387
U3 [V]	351.3009	235.6357	-115.6652	369.3140
I1 [A]	30.31731	-4.688263	-35.00557	82.20784
I2 [A]	-104.7059	-3.761530	100.9444	81.66354
I3 [A]	70.20808	-3.159166	-73.36724	81.26193
Tirgger [V]	-0.142025	-4.967662	-4.825638	4.981949

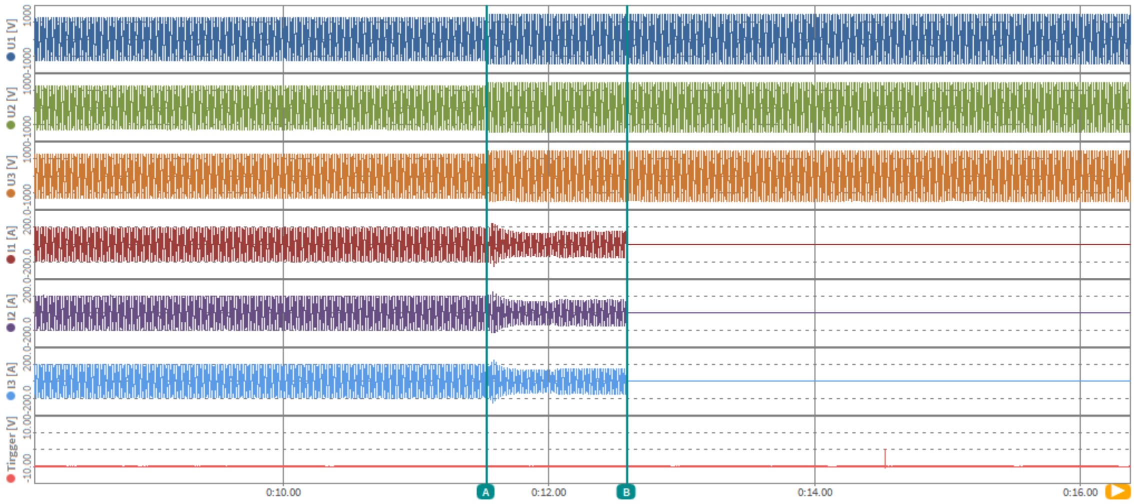
Graph of U/V L2L3 Phase



时间 [s]	A 0:14.672481	B 0:17.183068	间隔 2.510587	有效值
U1 [V]	-347.2618	458.6932	805.9550	461.7507
U2 [V]	520.2223	-499.6816	-1019.904	369.2566
U3 [V]	-245.6857	138.0843	383.7700	369.3079
I1 [A]	-43.55395	-7.872940	35.68101	80.72179
I2 [A]	91.65598	-0.462890	-92.11886	80.23330
I3 [A]	-55.08864	5.584240	60.67288	80.60843
Tirgger [V]	-4.970924	-4.966100	4.824e-3	4.982825

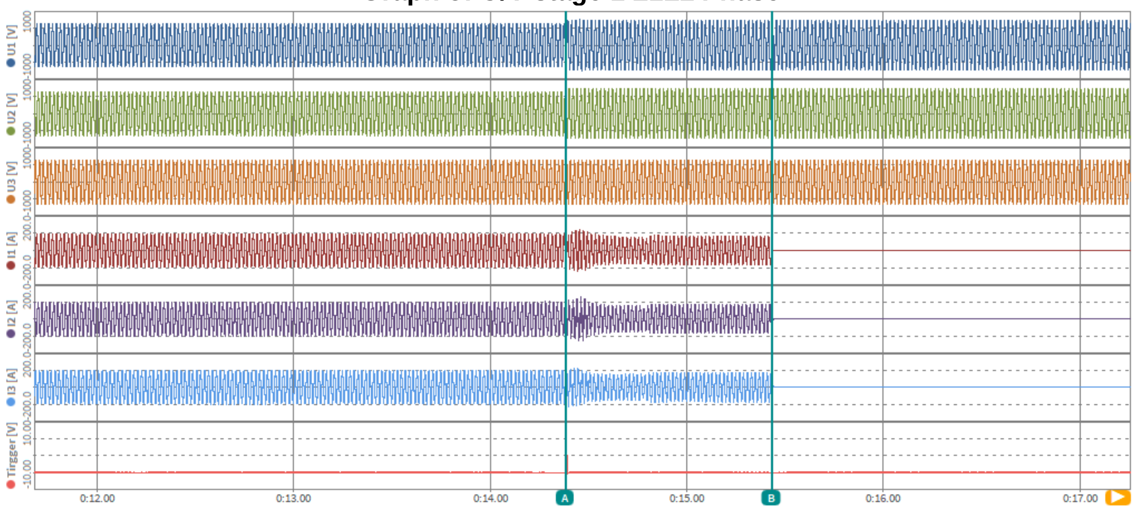
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 1 L1L2L3 Phase



时间 [s]	A 0:11.531987	B 0:12.588945	间隔 1.056958	有效值
U1 [V]	383.9741	-288.5997	-672.5738	527.6715
U2 [V]	-739.6055	-452.7494	286.8561	526.3844
U3 [V]	364.5988	734.7211	370.1223	526.6784
I1 [A]	-5.291581	0.617623	5.909205	51.16420
I2 [A]	8.297921	0.641823	-7.656098	51.14435
I3 [A]	-1.367927	1.019955	2.387881	50.87433
Tirgger [V]	-4.822573	-4.979099	-0.156527	4.982485

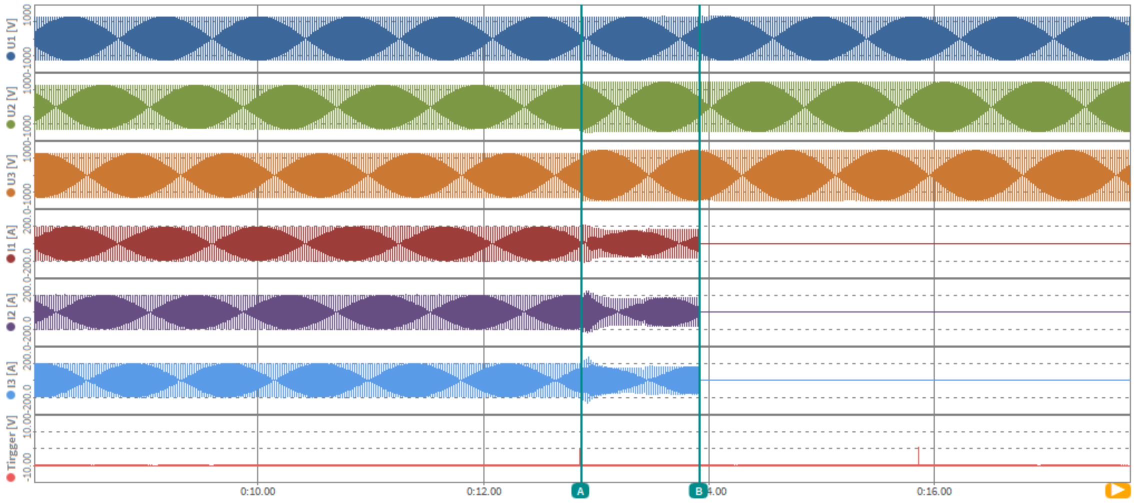
Graph of O/V stage 1 L1L2 Phase



时间 [s]	A 0:14.384379	B 0:15.432714	间隔 1.048335	有效值
U1 [V]	-3.057480	-346.9368	-343.8794	526.7667
U2 [V]	565.7059	-402.0173	-967.7232	526.0811
U3 [V]	-565.7091	648.7447	1214.454	461.2283
I1 [A]	0.742555	-40.68065	-41.42320	59.56080
I2 [A]	85.42538	-46.24152	-131.6669	59.15735
I3 [A]	-84.58651	87.69119	172.2777	58.44129
Tirgger [V]	-4.989649	-4.982822	6.827e-3	4.979330

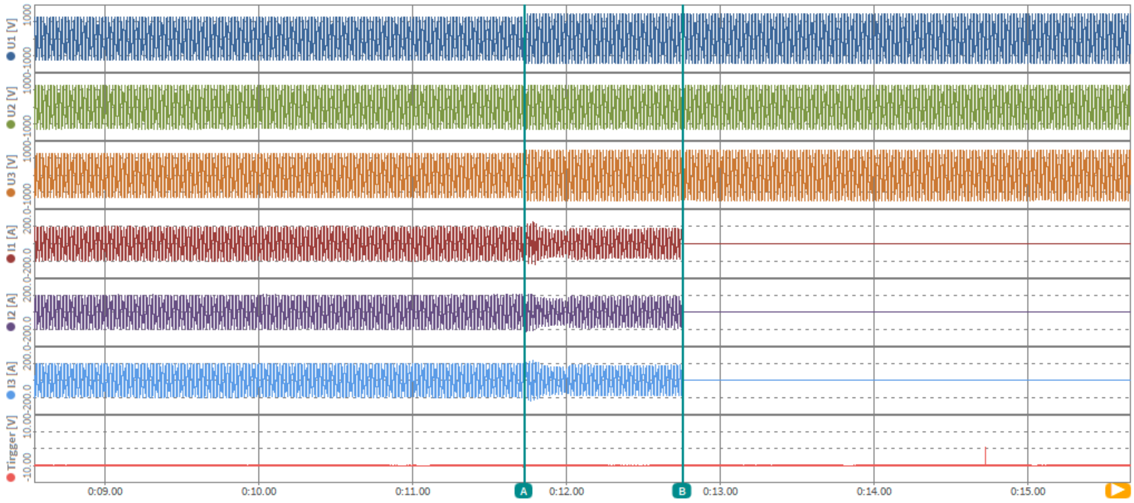
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 1 L2L3 Phase



时间 [s]	A 0:12.870129	B 0:13.917455	间隔 1.047326	有效值
U1 [V]	222.8320	311.7349	88.90296	462.1497
U2 [V]	-725.8968	393.9160	1119.813	526.5805
U3 [V]	477.8121	-743.4693	-1221.281	526.5464
I1 [A]	-7.187605	37.54378	44.73138	56.87201
I2 [A]	-5.647183	40.68494	46.33212	57.82255
I3 [A]	15.88440	-77.76416	-93.64856	57.22458
Tirgger [V]	-0.201151	-4.994706	-4.793555	4.981142

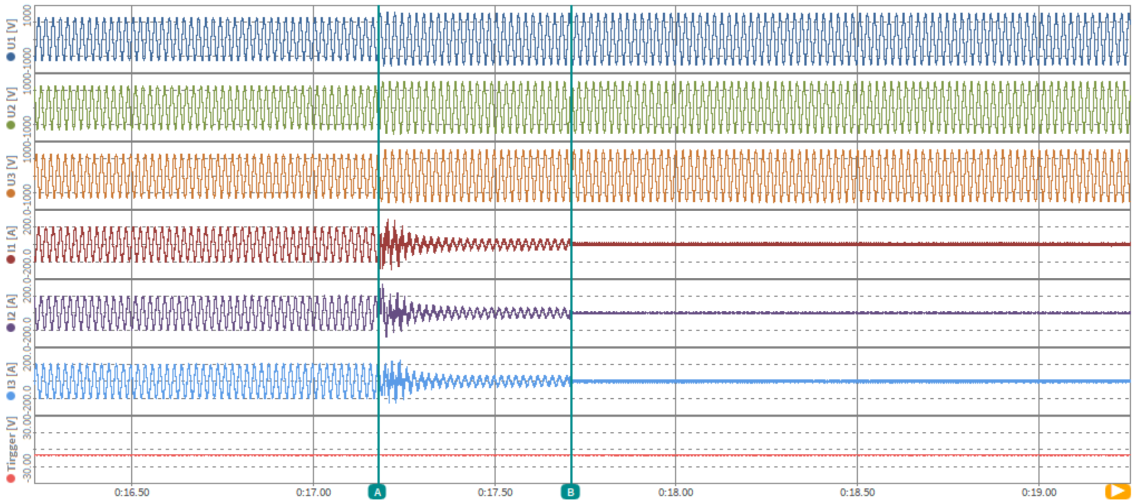
Graph of O/V stage 1 L1L3 Phase



时间 [s]	A 0:11.731896	B 0:12.759744	间隔 1.027848	有效值
U1 [V]	662.5375	-735.9698	-1398.507	526.6200
U2 [V]	-28.19407	410.4526	438.6467	461.6762
U3 [V]	-632.8940	270.8868	903.7808	527.0169
I1 [A]	29.40834	-87.39627	-116.8046	61.87115
I2 [A]	20.43951	57.99592	37.55641	61.53006
I3 [A]	-47.08779	32.05991	79.14770	61.99381
Tirgger [V]	-4.983051	-5.005921	-0.022870	4.982405

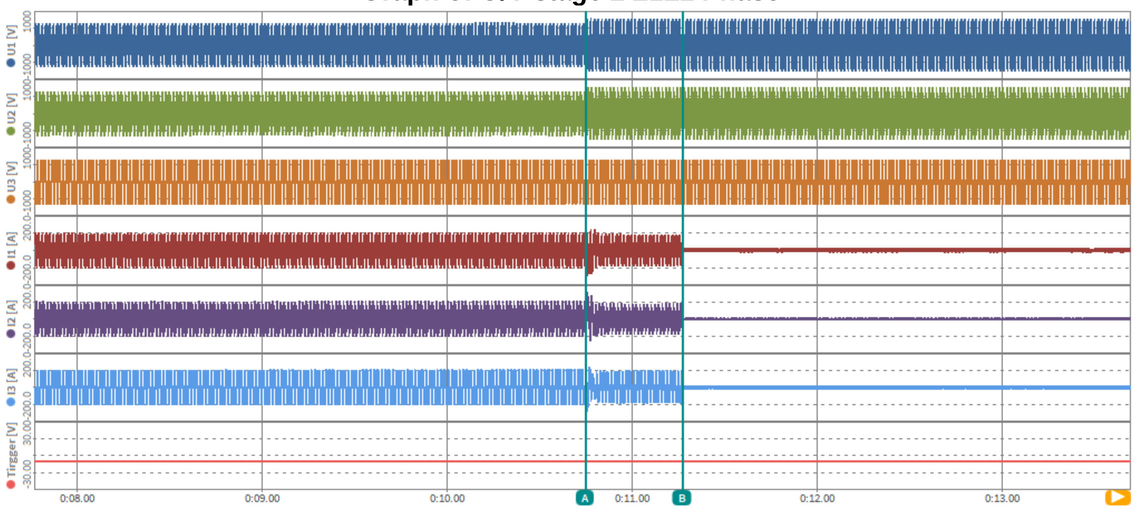
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 2 L1L2L3 Phase



时间 [s]	A 0:17.18003	B 0:17.71212	间隔 0.53209	有效值
U1 [V]	-561.4558	277.4321	838.8879	548.3293
U2 [V]	-12.18426	490.8207	503.0049	547.3059
U3 [V]	570.9375	-766.2161	-1337.154	548.7814
I1 [A]	-85.61564	11.40678	97.02242	31.50342
I2 [A]	-0.035882	-3.384114	-3.348232	31.25010
I3 [A]	85.15478	3.809214	-81.34556	29.63271
Tirgger [V]	-4.986792	-5.020759	-0.033967	4.976690

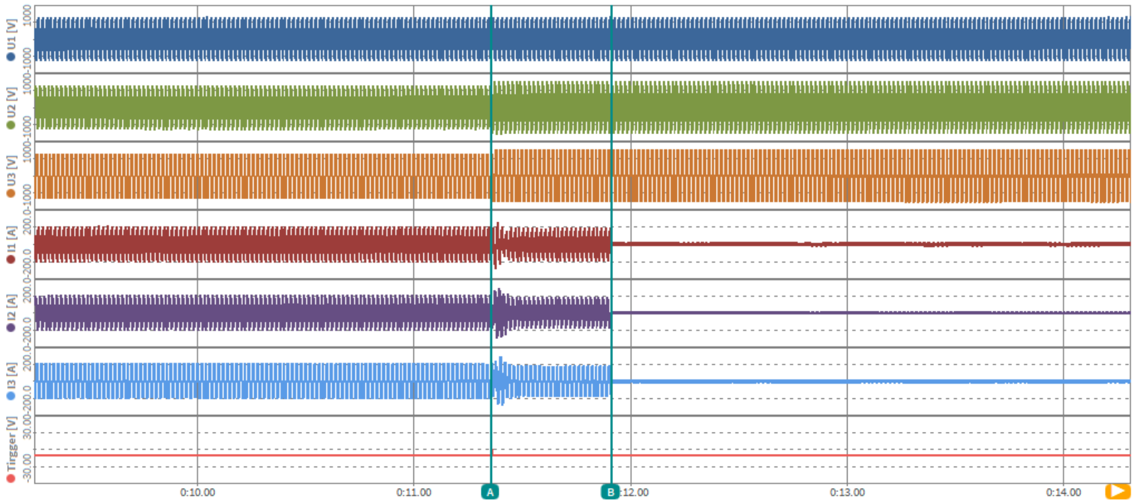
Graph of O/V stage 2 L1L2 Phase



时间 [s]	A 0:10.750349	B 0:11.273761	间隔 0.523412	有效值
U1 [V]	-238.7009	510.3320	749.0329	547.5858
U2 [V]	-408.5059	-758.6068	-350.1009	549.3554
U3 [V]	642.7095	213.1407	-429.5688	461.7280
I1 [A]	-36.76939	-4.315019	32.45437	63.43285
I2 [A]	-62.07884	-1.369000	60.70984	62.86430
I3 [A]	97.62383	5.140066	-92.48376	61.39544
Tirgger [V]	-4.964154	-4.969991	-5.836e-3	4.976390

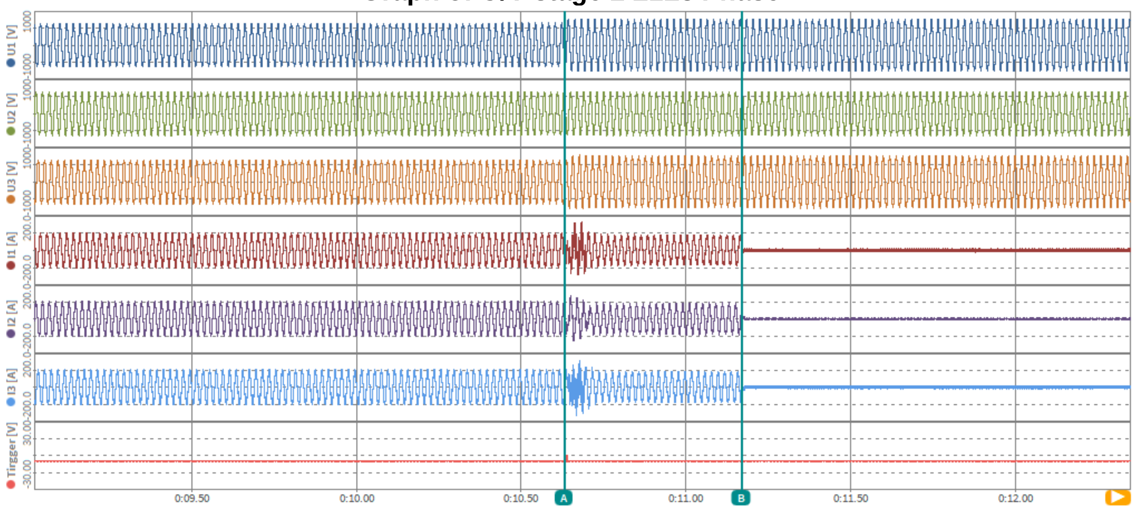
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 2 L2L3 Phase



时间 [s]	A 0:11.356639	B 0:11.912065	间隔 0.555426	有效值
U1 [V]	-540.5039	-435.0839	105.4200	460.3995
U2 [V]	-51.12350	757.6874	808.8109	548.8027
U3 [V]	587.9010	-238.5962	-826.4972	549.0604
I1 [A]	-83.80628	5.283952	89.09023	61.82530
I2 [A]	-7.453561	2.210736	9.664298	63.62749
I3 [A]	91.13253	3.572107	-87.56042	62.71742
Tirgger [V]	-4.983895	-5.018027	-0.034132	4.976761

Graph of O/V stage 2 L1L3 Phase



时间 [s]	A 0:10.632006	B 0:11.168922	间隔 0.536916	有效值
U1 [V]	-148.7268	530.1576	678.8844	548.6996
U2 [V]	623.5787	197.5627	-426.0160	461.3462
U3 [V]	-481.9089	-756.9280	-275.0191	546.3091
I1 [A]	-23.74947	59.13055	82.88003	64.60406
I2 [A]	93.05537	24.37306	-68.68232	62.39103
I3 [A]	-72.40761	-88.29809	-15.89048	64.87225
Tirgger [V]	-4.956504	-4.939474	0.017030	4.976415

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

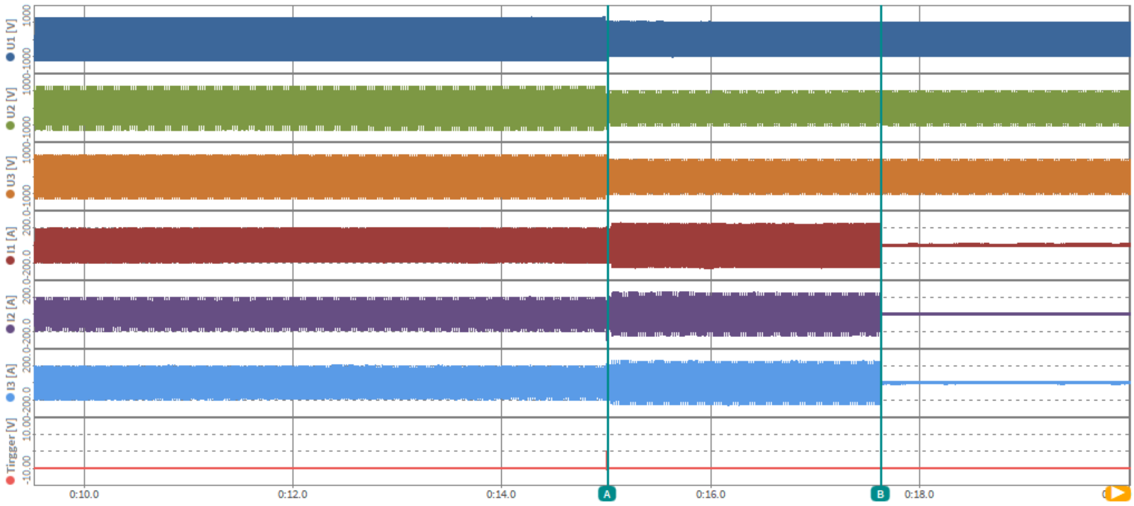
10.6.7.1 Protection – Voltage tests (HV Protection)						P
Model: SG350HX						
L1L2L3 Phase						
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu	2.5 s	639.62 V	2.510 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.10 pu	1.0 s	886.80 V	1.015 s	865.5 V 5.0 s	No trip
O/V stage 2	1.13 pu	0.5 s	903.08 V	0.550 s	889.5V 0.95 s	No trip
					918.5 V 0.45 s	No trip
L1-L2 Phase						
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu	2.5 s	639.51 V	2.504 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.10 pu	1.0 s	887.10 V	1.065 s	865.5 V 5.0 s	No trip
O/V stage 2	1.13 pu	0.5 s	906.72 V	0.539 s	889.5V 0.95 s	No trip
					918.5 V 0.45 s	No trip
L2-L3 Phase						
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu	2.5 s	639.28 V	2.510 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.10 pu	1.0 s	886.90 V	1.056 s	865.5 V 5.0 s	No trip
O/V stage 2	1.13 pu	0.5 s	906.85 V	0.581 s	889.5V 0.95 s	No trip

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

					918.5 V 0.45 s	No trip
L3-L1 Phase						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu	2.5 s	639.63 V	2.540 s	654 V 5.0 s	No trip
					626 V 2.45 s	No trip
O/V stage 1	1.10 pu	1.0 s	887.06 V	1.039 s	865.5 V 5.0 s	No trip
O/V stage 2	1.13 pu	0.5 s	903.22 V	0.553 s	889.5V 0.95 s	No trip
					918.5 V 0.45 s	No trip

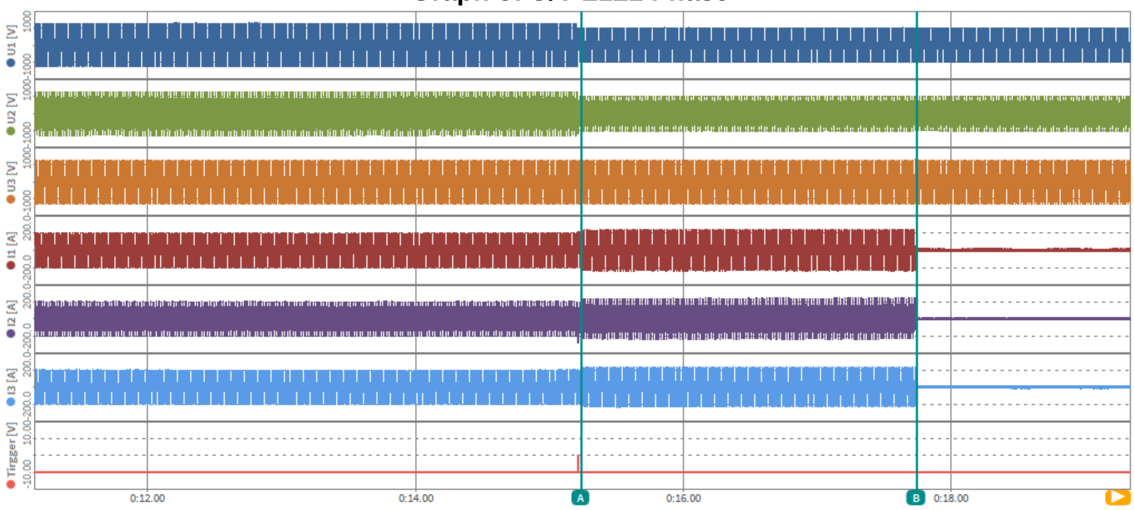
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/V L1L2L3 Phase



时间 [s]	A 0:15.116666	B 0:17.627216	间隔 2.510549	有效值
U1 [V]	241.4601	-327.2114	-568.6715	369.5920
U2 [V]	-520.4635	511.7405	1032.204	369.2998
U3 [V]	280.7248	-188.4940	-469.2188	369.2895
I1 [A]	43.25891	1.645088	-41.61382	87.54144
I2 [A]	-93.73308	0.644326	94.37740	87.25896
I3 [A]	48.77508	0.538111	-48.23697	87.00981
Tirgger [V]	-4.981470	-4.993769	-0.012299	4.982921

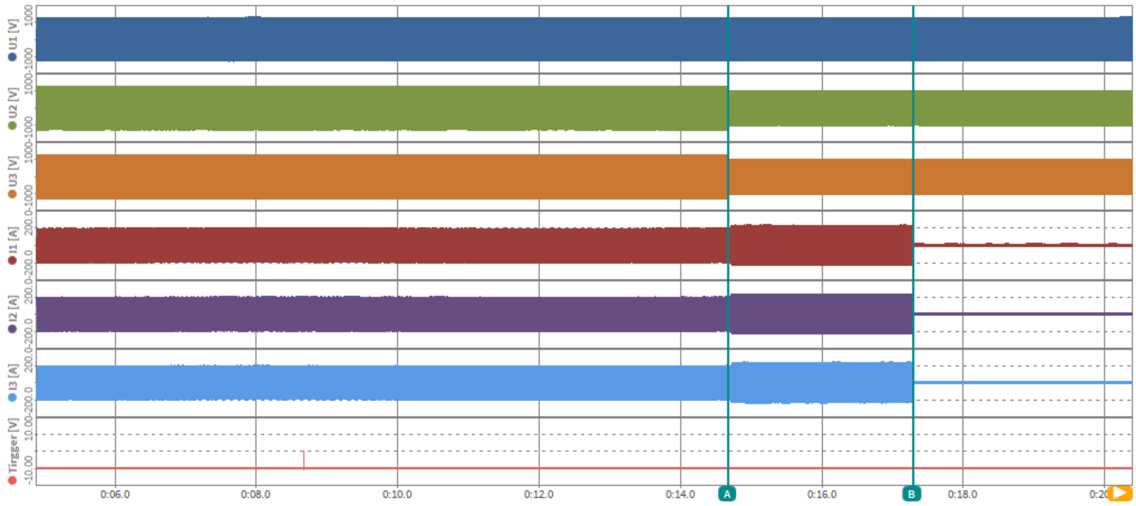
Graph of U/V L1L2 Phase



时间 [s]	A 0:15.240349	B 0:17.744420	间隔 2.504071	有效值
U1 [V]	175.0411	-433.8244	-608.8655	369.3610
U2 [V]	347.4775	463.4284	115.9509	369.3886
U3 [V]	-639.6462	-38.70774	600.9385	461.5549
I1 [A]	34.02055	6.571412	-27.44913	81.64870
I2 [A]	71.01596	4.393220	-66.62274	81.91891
I3 [A]	-111.4669	5.113483	116.5804	81.49743
Tirgger [V]	-4.934210	-5.007427	-0.073217	4.982833

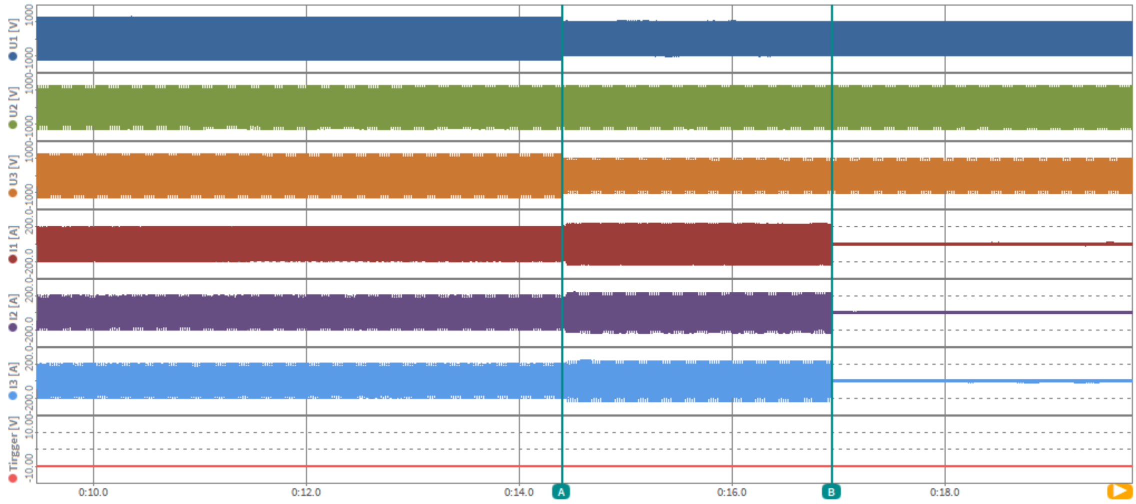
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/V L2L3 Phase



时间 [s]	A 0:14.672481	B 0:17.183068	间隔 2.510587	有效值
U1 [V]	-347.2618	458.6932	805.9550	461.7507
U2 [V]	520.2223	-499.6816	-1019.904	369.2566
U3 [V]	-245.6857	138.0843	383.7700	369.3079
I1 [A]	-43.55395	-7.872940	35.68101	80.72179
I2 [A]	91.65598	-0.462890	-92.11886	80.23330
I3 [A]	-55.08864	5.584240	60.67288	80.60843
Tirgger [V]	-4.970924	-4.966100	4.824e-3	4.982825

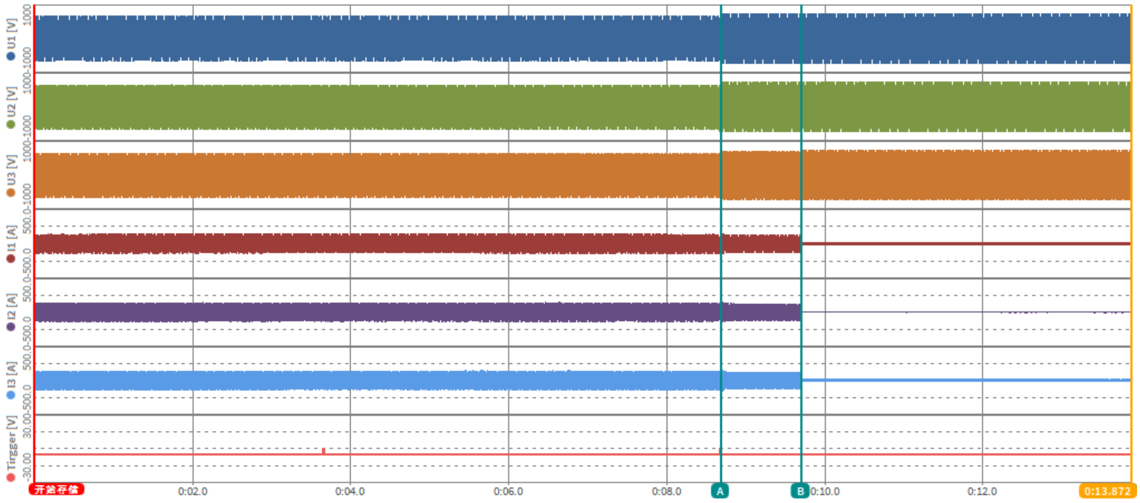
Graph of U/V L1L3 Phase



时间 [s]	A 0:14.403131	B 0:16.943924	间隔 2.540793	有效值
U1 [V]	160.6605	286.7054	126.0449	369.5808
U2 [V]	-628.9871	-645.2740	-16.28685	461.4387
U3 [V]	351.3009	235.6357	-115.6652	369.3140
I1 [A]	30.31731	-4.688263	-35.00557	82.20784
I2 [A]	-104.7059	-3.761530	100.9444	81.66354
I3 [A]	70.20808	-3.159166	-73.36724	81.26193
Tirgger [V]	-0.142025	-4.967662	-4.825638	4.981949

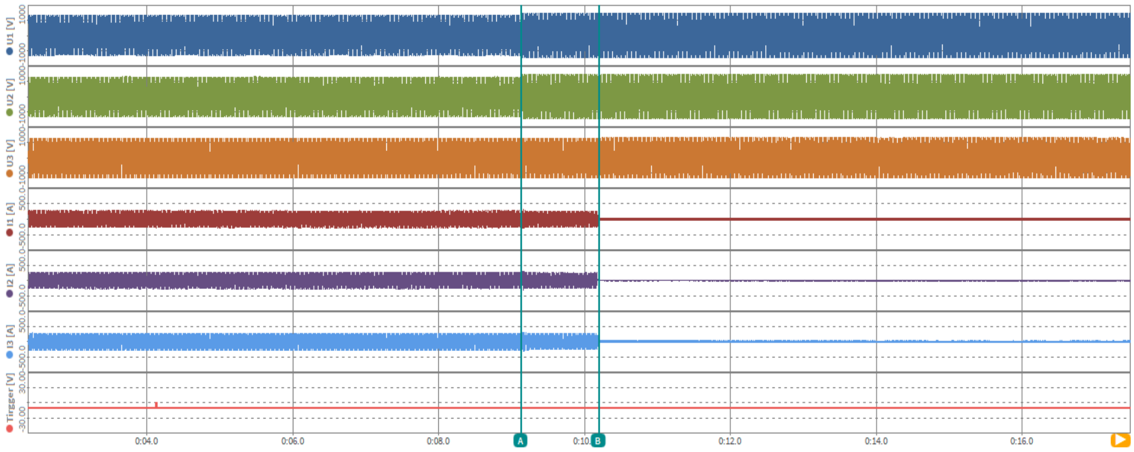
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 1 L1L2L3 Phase



时间 [s]	A	B	间隔	有效值
	8.68396	9.69897	1.01501	
U1 [V]	44.91198	-722.2010	-767.1130	512.5679
U2 [V]	-638.4755	310.6426	949.1181	512.5544
U3 [V]	592.8680	411.4797	-181.3883	511.4049
I1 [A]	6.458521	5.104423	-1.354098	84.63003
I2 [A]	-155.4312	12.34007	167.7712	84.53215
I3 [A]	141.4969	0.767708	-140.7292	84.35192
Tirgger [V]	-4.937918	-4.982229	-0.044310	4.979574

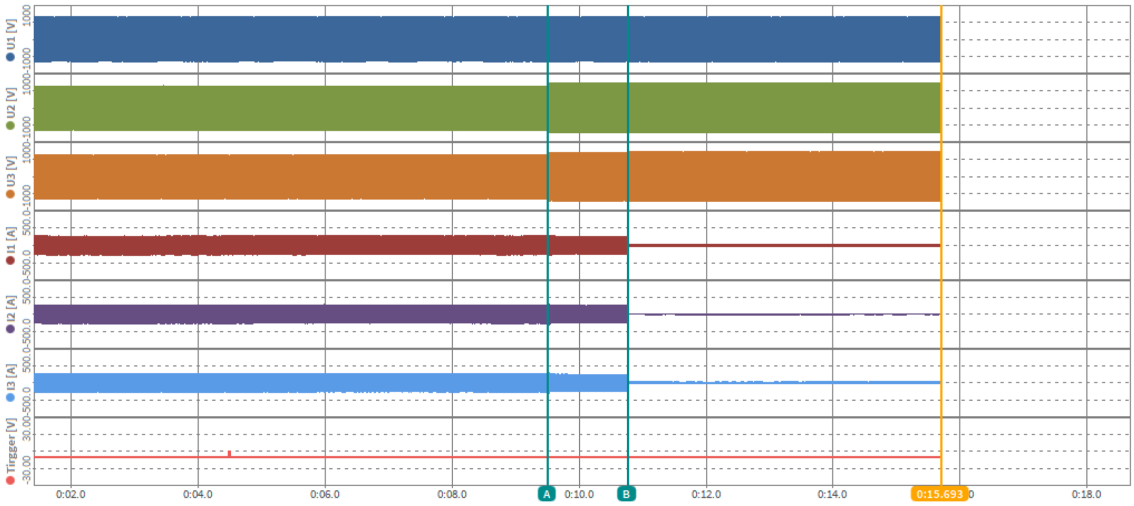
Graph of O/V stage 1 L1L2 Phase



时间 [s]	A	B	间隔	有效值
	9.13219	0:10.19725	1.06506	
U1 [V]	659.7411	248.2897	-411.4514	512.9063
U2 [V]	-560.0851	447.0521	1007.137	511.1080
U3 [V]	-90.45554	-626.2285	-535.7730	461.6187
I1 [A]	96.66288	0.990152	-95.67273	85.96642
I2 [A]	-77.61205	1.024365	78.63641	85.39972
I3 [A]	-7.358432	-0.574231	6.784201	85.44848
Tirgger [V]	-5.019225	-4.973041	0.046184	4.979563

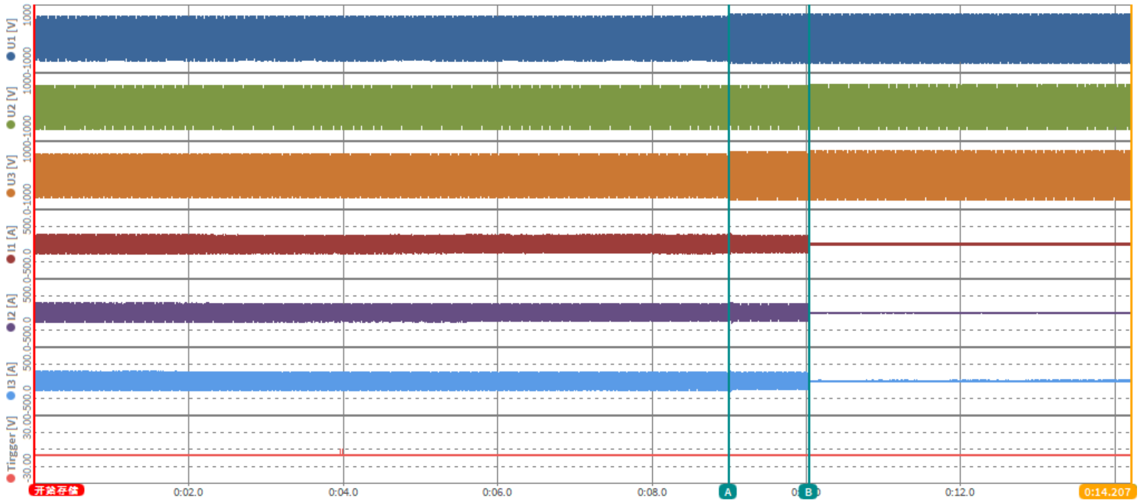
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 1 L2L3 Phase



	A	B	间隔	有效值
时间 [s]	9.50910	0:10.56562	1.05652	
U1 [V]	291.1568	-389.7928	-680.9496	462.2899
U2 [V]	-723.4282	-303.9234	419.5048	511.7485
U3 [V]	405.7472	731.2623	325.5151	511.7469
I1 [A]	23.82708	-2.885223	-26.71230	86.64922
I2 [A]	-48.61486	0.493646	49.10851	86.49298
I3 [A]	26.36993	-3.849626	-30.21956	86.02002
Tirgger [V]	-0.069537	-4.948283	-4.878745	4.979212

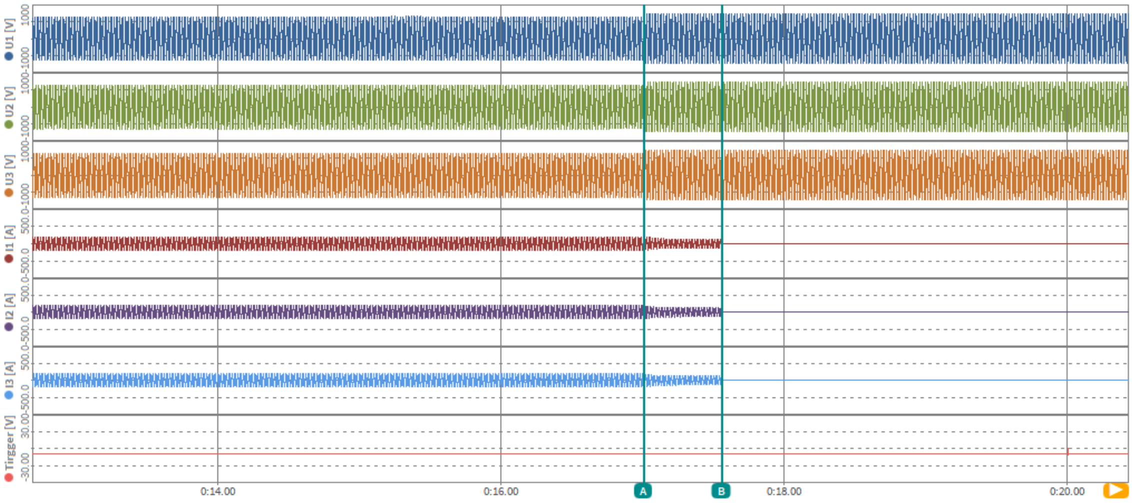
Graph of O/V stage 1 L1L3 Phase



	A	B	间隔	有效值
时间 [s]	8.99492	0:10.03446	1.03954	
U1 [V]	246.3278	145.7567	-100.5710	512.4903
U2 [V]	-637.3735	-599.7523	37.62114	461.1249
U3 [V]	467.0847	525.7136	58.62892	512.1278
I1 [A]	52.32442	-5.612731	-57.93715	86.14257
I2 [A]	-142.5500	-3.547907	139.0021	86.01929
I3 [A]	95.36422	-4.449010	-99.81323	86.09040
Tirgger [V]	-5.010435	-4.915206	0.095229	4.979515

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 2 L1L2L3 Phase



	A	B	间隔	有效值
时间 [s]	0:17.012251	0:17.563048	0.550798	
U1 [V]	736.4573	-714.6212	-1451.079	521.8597
U2 [V]	-379.0870	205.2425	584.3295	520.8834
U3 [V]	-358.8160	511.3757	870.1917	521.2301
I1 [A]	35.23576	0.969052	-34.26671	50.16564
I2 [A]	-17.72523	6.445647	24.17088	50.28838
I3 [A]	-15.01358	-4.954219	10.05936	49.83315
Tirgger [V]	-4.999008	-4.991727	7.281e-3	4.982582

Graph of O/V stage 2 L1L2 Phase

	A	B	间隔	有效值
时间 [s]	0:11.891620	0:12.430661	0.539041	
U1 [V]	68.90023	-151.0052	-219.9054	524.1650
U2 [V]	-596.5866	-551.6150	44.97159	523.1467
U3 [V]	523.3988	615.4567	92.05795	461.3096
I1 [A]	14.11736	0.906110	-13.21125	60.65144
I2 [A]	-93.44161	-0.143766	93.29784	60.52879
I3 [A]	79.45014	1.374245	-78.07589	59.49376
Tirgger [V]	0.101895	-5.002209	-5.104105	4.976645

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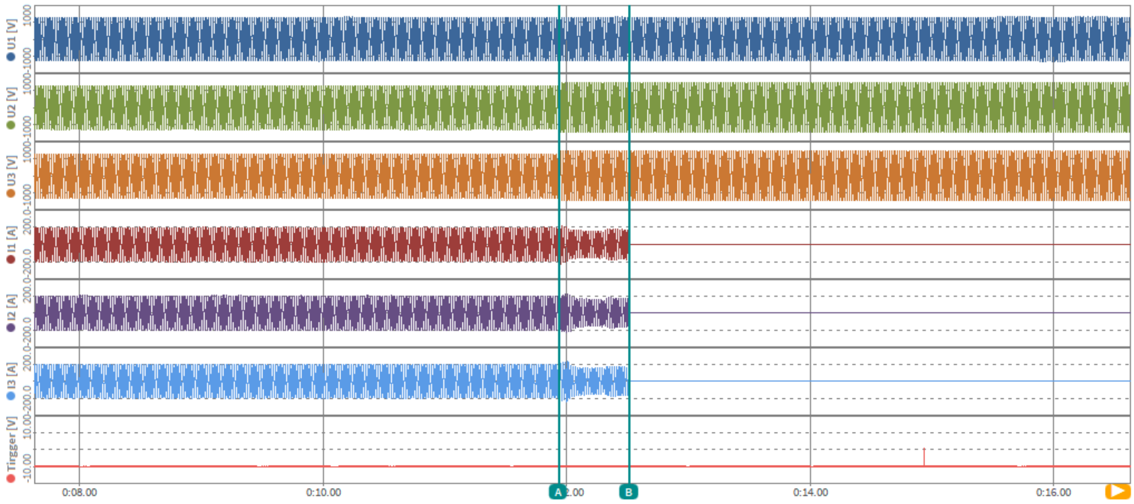
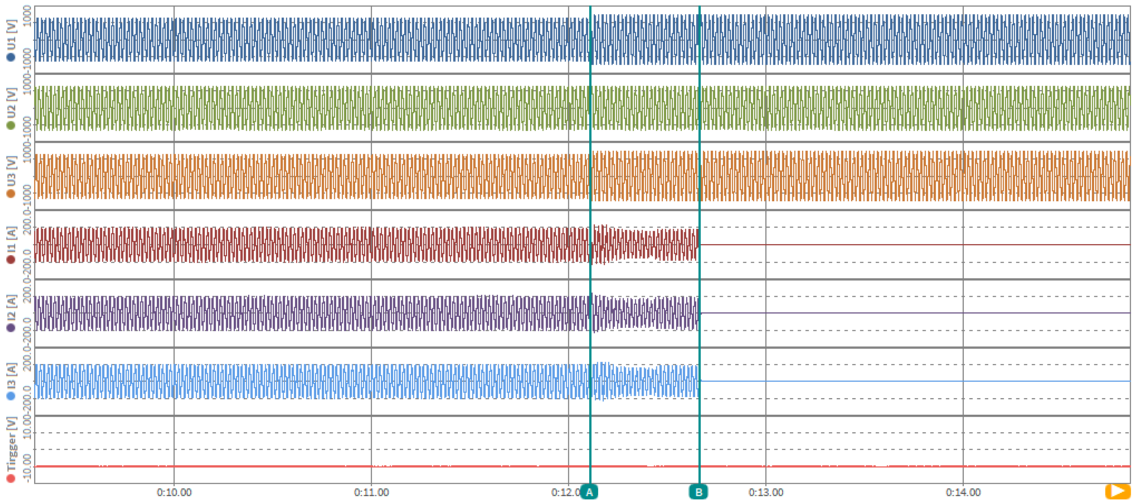
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 2 L2L3 Phase



时间 [s]	A	B	间隔	有效值
	0:11.937771	0:12.519650	0.581879	
U1 [V]	-650.3343	-549.3763	100.9580	462.2873
U2 [V]	349.4389	-39.39152	-388.8304	522.4550
U3 [V]	308.8050	657.3397	348.5347	522.7561
I1 [A]	-99.48815	-74.13662	25.35153	58.98442
I2 [A]	53.47240	-7.081271	-60.55367	59.58497
I3 [A]	45.40193	76.20812	30.80619	59.14222
Tirgger [V]	-4.972591	-4.974565	-1.974e-3	4.976934

Graph of O/V stage 2 L1L3 Phase



时间 [s]	A	B	间隔	有效值
	0:12.110338	0:12.663381	0.553043	
U1 [V]	-186.0108	-457.7694	-271.7586	520.3677
U2 [V]	-453.5427	647.7782	1101.321	462.1322
U3 [V]	634.4005	-276.4830	-910.8835	521.3944
I1 [A]	-30.26080	-55.45724	-25.19643	62.11393
I2 [A]	-67.18982	91.12537	158.3152	61.99654
I3 [A]	96.76529	-33.68163	-130.4469	62.42613
Tirgger [V]	-4.987121	-5.005946	-0.018826	4.976678

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Clause	Requirement - Test	Result - Remark	Verdict

9.6 Protection – Loss of Mains test — **P**

These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.

For test condition A, EUT output = 100 % P_n, test condition B, EUT output = 50 % to 66 % P_n, and test condition C, EUT output = 25 % to 33 % P_n.

Model: SG350HX

The following sub set of tests should be recorded in the following table.

Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. **Limit is 0.5s**	89 ms	99 ms	184 ms	92 ms	100 ms	179 ms

No.	P_{EUT} a) (% of EUT rating)	Reactive load (% of Q_L)	P_{AC} b) (% of nominal)	Q_{AC} c) (% of nominal)	Run-on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC} d)	Remarks e)
1	100	100	0	0	189	320	1	1280	/
2	66	66	0	0	147	212	1.00	1100	/
3	33	33	0	0	122	106	1.00	900	/
4	100	100	-5	-5	125	320	1.03	1280	Test A at IB
5	100	100	-5	0	169	320	1.05	1280	Test A at IB
6	100	100	-5	+5	119	320	1.08	1280	Test A at IB
7	100	100	0	-5	184	320	0.98	1280	Test A at IB
8	100	100	0	+5	179	320	1.02	1280	Test A at IB
9	100	100	+5	-5	129	320	0.93	1280	Test A at IB
10	100	100	+5	0	146	320	0.95	1280	Test A at IB
11	100	100	+5	+5	111	320	0.95	1280	Test A at IB
12	66	66	0	-5	99	212	0.98	1100	Test B at IB
13	66	66	0	-4	107	212	0.98	1100	Test B at IB
14	66	66	0	-3	114	212	0.99	1100	Test B at IB
15	66	66	0	-2	129	212	0.99	1100	Test B at IB
16	66	66	0	-1	134	212	1.01	1100	Test B at IB
17	66	66	0	+1	143	212	1.01	1100	Test B at IB
18	66	66	0	+2	129	212	1.01	1100	Test B at IB
19	66	66	0	+3	118	212	1.02	1100	Test B at IB
20	66	66	0	+4	111	212	1.02	1100	Test B at IB
21	66	66	0	+5	100	212	1.03	1100	Test B at IB
22	33	33	0	-5	89	106	0.97	900	Test B at IB
23	33	33	0	-4	98	106	0.98	900	Test C at IB
24	33	33	0	-3	105	106	0.99	900	Test C at IB

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Clause	Requirement - Test	Result - Remark	Verdict

25	33	33	0	-2	114	106	0.99	900	Test C at IB
26	33	33	0	-1	117	106	1.00	900	Test C at IB
27	33	33	0	+1	118	106	1.01	900	Test C at IB
28	33	33	0	+2	109	106	1.01	900	Test C at IB
29	33	33	0	+3	106	106	1.02	900	Test C at IB
30	33	33	0	+4	98	106	1.03	900	Test C at IB
31	33	33	0	+5	92	106	1.03	900	Test C at IB

Note:

a)PEUT: EUT output power.

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

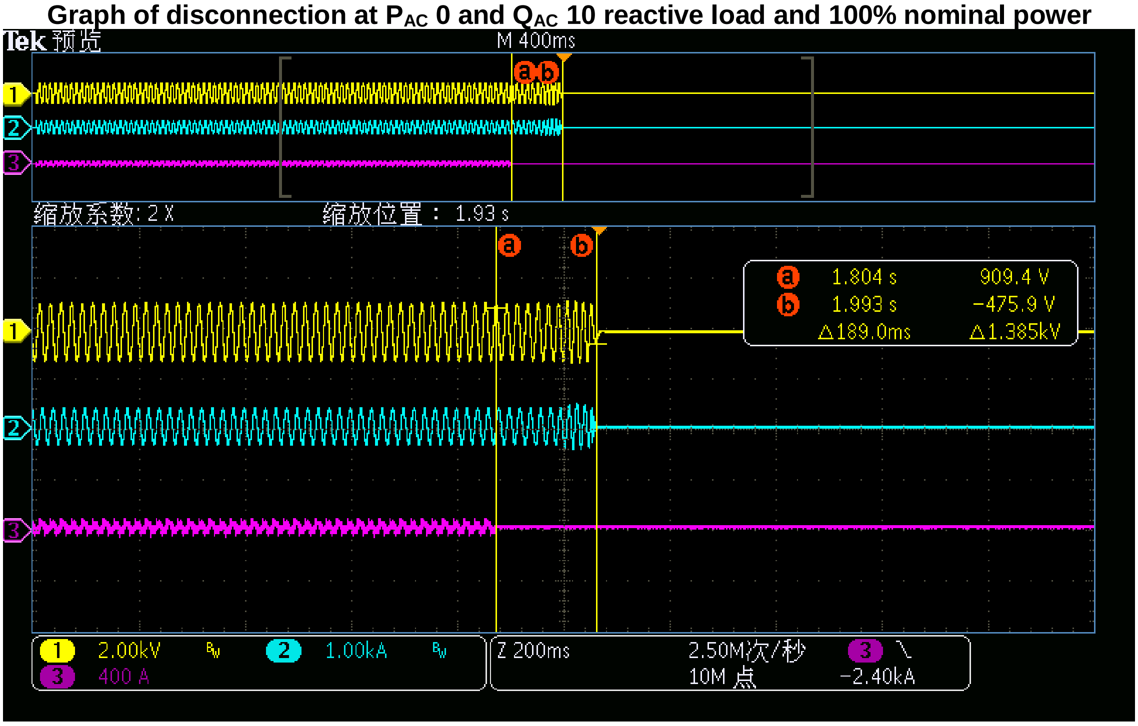
c)Q_{ac}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

d)For test condition A, > 75 % of rated input voltage range used, for test condition B, 50 % of rated input voltage range, ±10 % used, for test condition C, < 20 % of rated input voltage range used. Based on EUT rated input operating range. For example, if range is between X volts and Y volts, 75 % of range = X + 0,75 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

e)BL: Balance condition, IB: Imbalance condition.

If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

Graph of disconnection at P_{AC} 0 and Q_{AC} 10 reactive load and 100% nominal power



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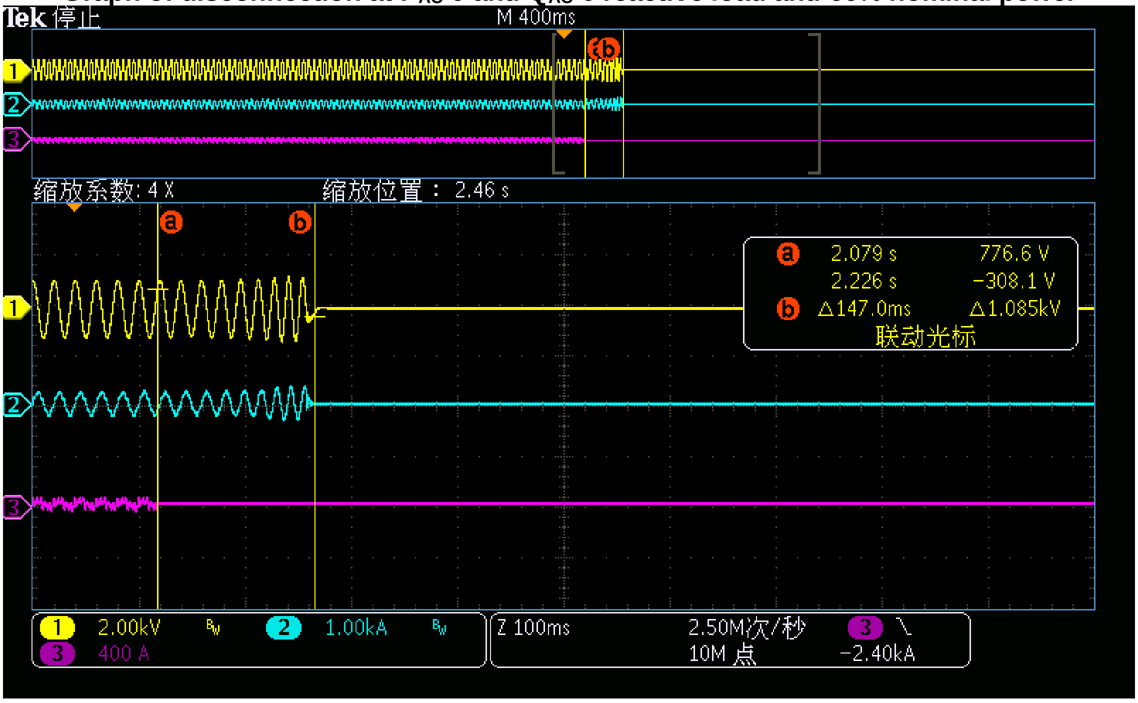
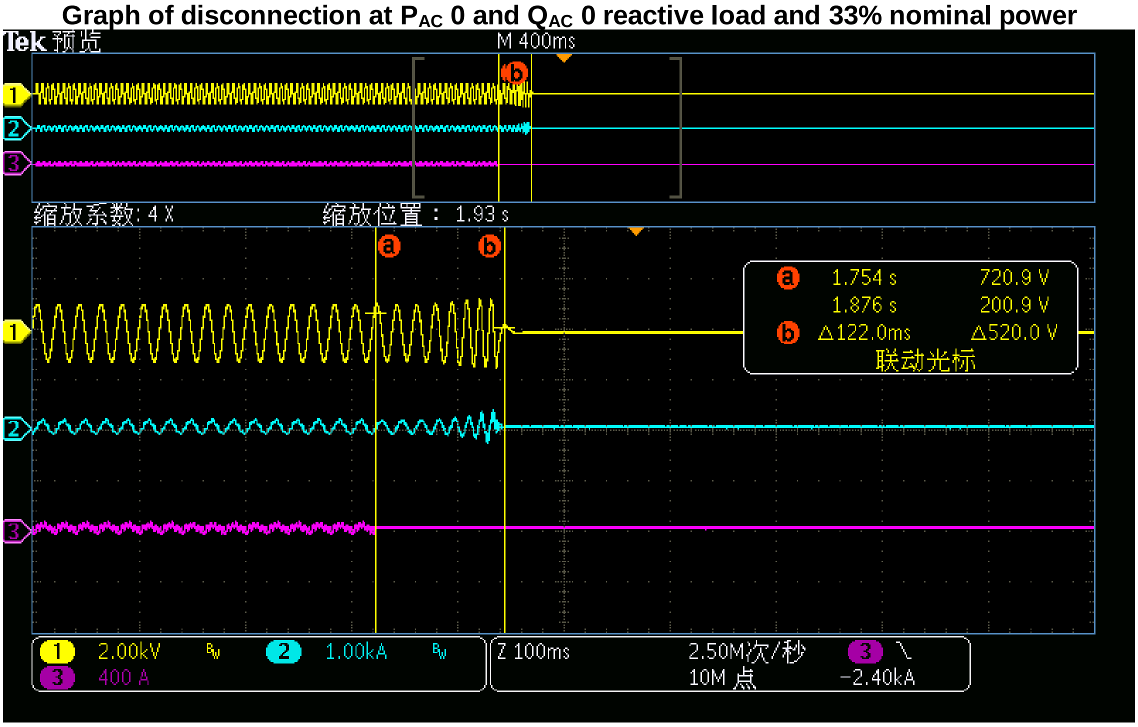
Clause	Requirement - Test	Result - Remark	Verdict

Graph of disconnection at P_{AC} 0 and Q_{AC} 0 reactive load and 66% nominal power



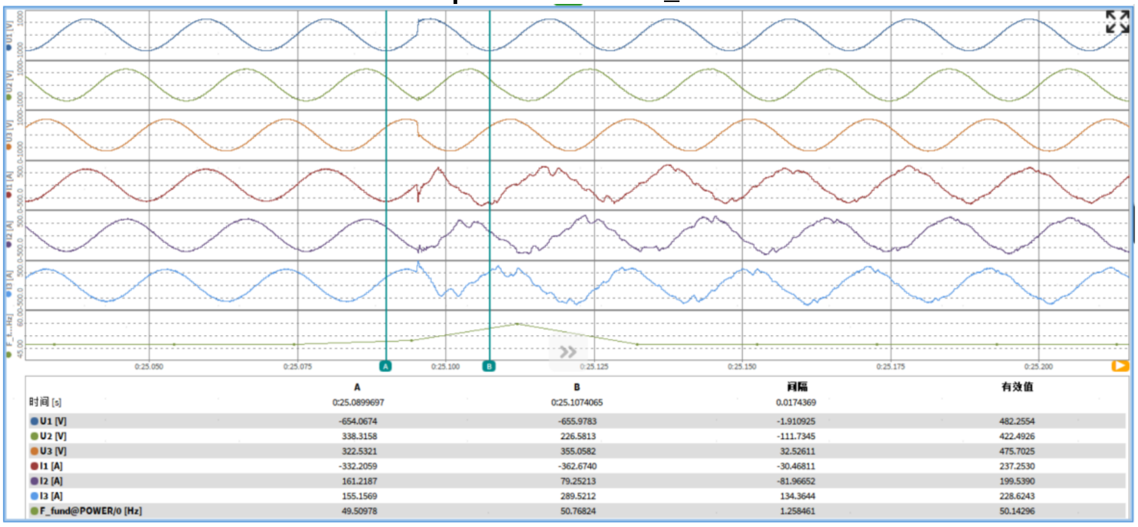
Graph of disconnection at P_{AC} 0 and Q_{AC} 0 reactive load and 33% nominal power



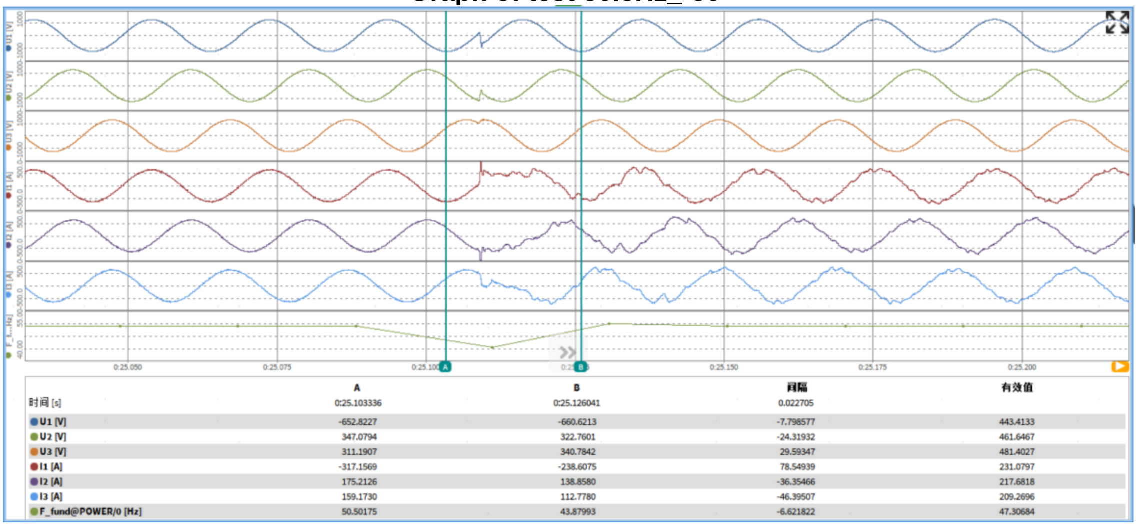
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

10.6.2 Loss of Mains Protection, Vector Shift Stability test			P
This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.			
Model: SG350HX			
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	No trip
Negative Vector Shift	50.5 Hz	- 50 degrees	No trip

Graph of test 49.5Hz_+50°



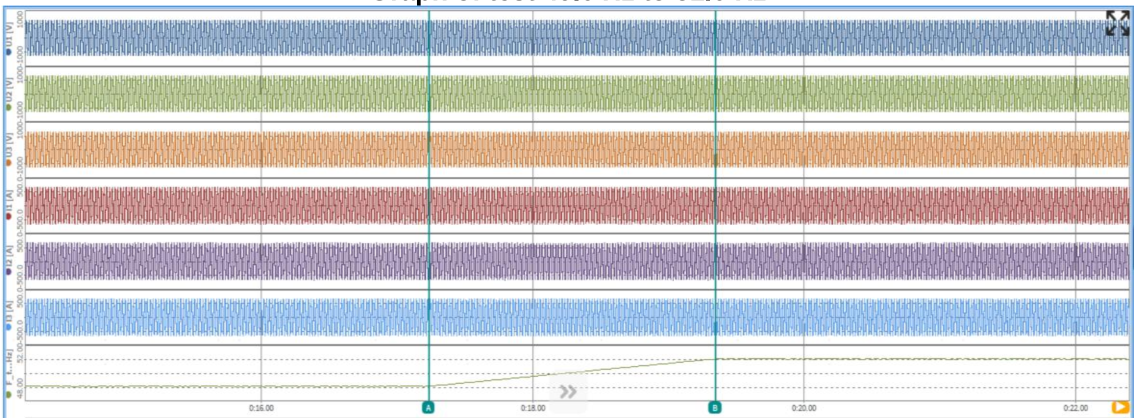
Graph of test 50.5Hz_-50°



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

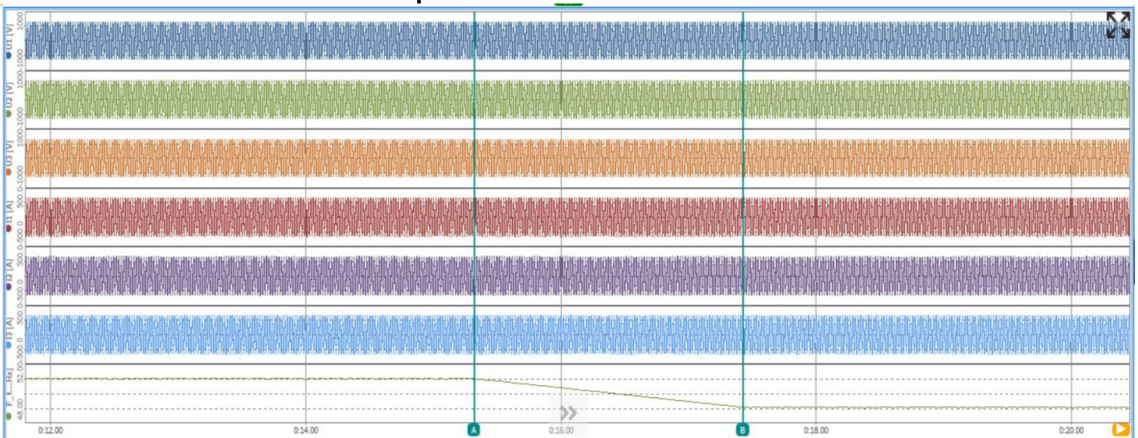
10.6.2 Loss of Mains Protection, RoCoF Stability test			**P**
This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.			
Model: SG350HX			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	No trip
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	No trip

Graph of test 49.0 Hz to 51.0 Hz



	A	B	间隔	有效值
时间 [s]	0:17.237843	0:19.347189	2.109346	
U1 [V]	570.8042	-579.1144	-1149.919	463.0003
U2 [V]	-3.564501	26.47424	30.03874	462.2268
U3 [V]	-564.1368	553.9623	1118.099	462.4753
I1 [A]	287.4899	-297.0386	-584.5285	231.4772
I2 [A]	-6.546379	11.11150	17.65788	232.0974
I3 [A]	-284.5806	266.8244	551.4050	232.1006
F_fund@POWER/0 [Hz]	49.00277	50.98892	1.986149	50.00337

Graph of test 51.0 Hz to 49.0 Hz



	A	B	间隔	有效值
时间 [s]	0:15.323027	0:17.429067	2.106040	
U1 [V]	-76.72673	-555.7961	-479.0694	463.2041
U2 [V]	597.1469	-18.05048	-615.1974	462.3693
U3 [V]	-524.9523	576.8871	1101.839	462.1346
I1 [A]	-32.19366	-275.6167	-243.4230	232.5456
I2 [A]	294.9572	-3.227592	-298.1848	232.0702
I3 [A]	-263.2821	296.4378	559.7198	231.0643
F_fund@POWER/0 [Hz]	51.00724	49.02649	-1.980751	50.04190

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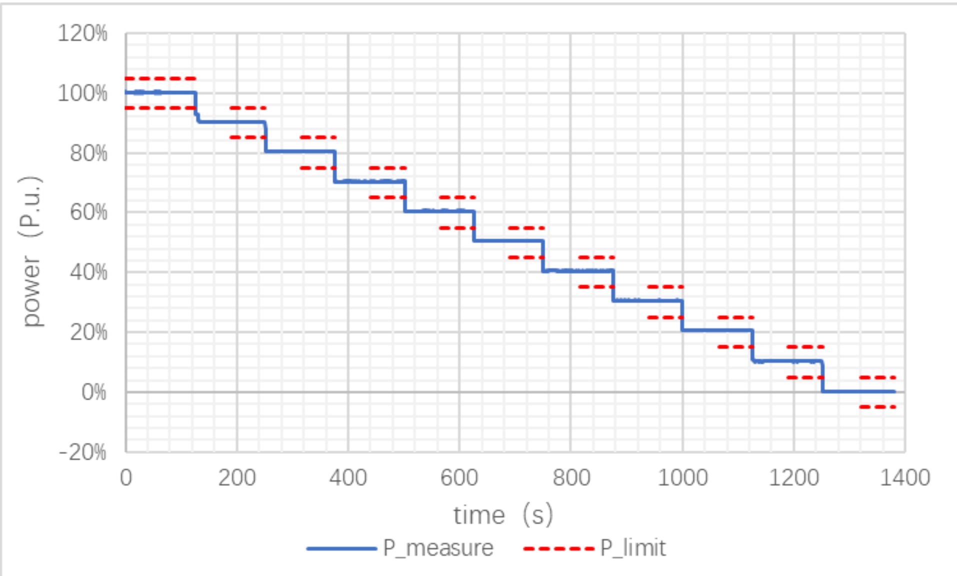
Clause	Requirement - Test	Result - Remark	Verdict

12.1.3 **13.1.3**	**TABLE: Reduction of active power on setpoint (for Type B, Type C, Type D)**										**P**
Model	SG350HX										
1-min mean value, P/P_n [%]	100	90	80	70	60	50	40	30	20	10	0
$P_{Setpoint}$[kW]:	320	288	256	224	192	160	128	96	64	32	0
P_{E60} [kW]:	321.8	290.0	258.5	225.6	193.9	162.3	129.4	97.6	65.8	33.7	2.4
$\Delta P_{E60}/P_{Emax}$ [%]:	0.64	0.69	0.78	0.49	0.61	0.73	0.46	0.48	0.55	0.53	0.71
Limit reduce time [s]	5 s										

Graph of the setting accuracy



Note:
The **Active Power** reduction will be either between 1.0 p.u. of **Registered Capacity Active Power** and zero, or between 1.0 pu of **Registered Capacity Active Power** and **Minimum Stable Operating Level**. In the latter case the **Generator** will agree with the **DNO** how zero output can be achieved, including the option of using the logic interface as described in paragraph 11.1.3.1.

11.1.3.1 By default the **DNO** logic interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the **Power Generating Module** can operate normally. When the switch is opened the **Power Generating Module** will reduce its **Active Power** to zero within 5 s. The signal from the **Power Generating Module** that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V). If the **DNO** wishes to make use of the facility to cease **Active Power** output the **DNO** will agree with the **Generator** how the communication path is to be achieved.

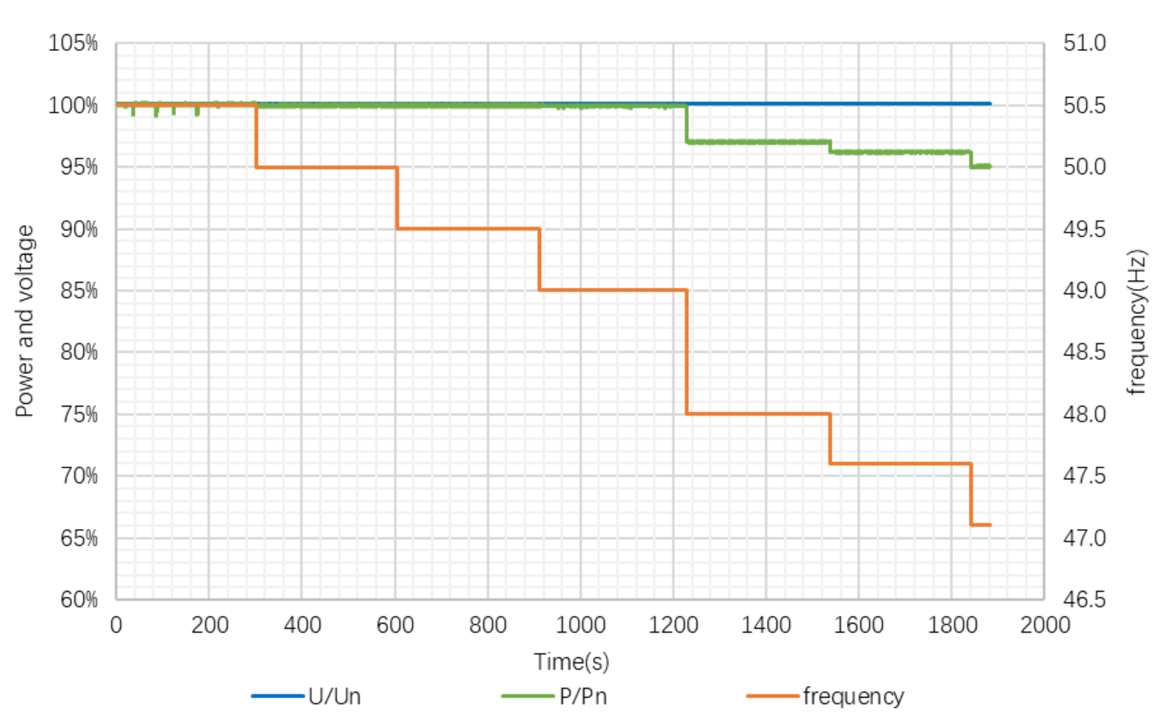
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

12.2.3 13.2.3	**TABLE: Output power with falling frequency**			P
Model	SG350HX			
Voltage	Un=800Vac			
Test sequence	Measured **Active Power** Output (W)	Acceptable **Active Power**	Frequency (Hz)	Primary power source
50.5 Hz for 5 minutes	320185.3	100% **Registered Capacity**	50.50	Photovoltaic array simulator
50.0 Hz for 5 minutes	319953.8	100% **Registered Capacity**	50.00	Photovoltaic array simulator
49.5 Hz for 5 minutes	319970.2	100% **Registered Capacity**	49.50	Photovoltaic array simulator
49.0 Hz for 5 minutes	319825.3	99% **Registered Capacity**	49.00	Photovoltaic array simulator
48.0 Hz for 5 minutes	310414.3	97% **Registered Capacity**	48.00	Photovoltaic array simulator
47.6 Hz for 5 minutes	307876.0	96.2% **Registered Capacity**	47.60	Photovoltaic array simulator
47.1 Hz for 20 s	304089.4	95% **Registered Capacity**	47.10	Photovoltaic array simulator

Notes:
Each **Power Generating Module**, shall be capable of:
(a) continuously maintaining constant **Active Power** output for system frequency changes within the range 50.5 to 49.5 Hz; and

(b) (subject to the provisions of paragraph 12.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 12.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%.

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

12.2.4 13.2.4 B.4.5	**TABEL Lmited Frequency Sensitive Mode – Over frequency test:**	**P**
The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.		
Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex B.6.2		Y
Model: SG350HX		
Alternatively, simulation results should be noted below:		

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output (kW)	Frequency (Hz)	Calculated droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	319.75	50	--	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	316.51	50.45	9.2		-
Step c) 50.70 Hz ±0.10 Hz	299.16	50.7	9.2		-
Step d) 51.15 Hz ±0.05 Hz	270.66	51.15	9.7		-
Step e) 50.70 Hz ±0.10 Hz	299.21	50.7	9.2		-
Step f) 50.45 Hz ±0.05 Hz	316.55	50.45	9.3		-
Step g) 50.00 Hz ±0.01 Hz	319.79	50	--		-
Test sequence at **Registered Capacity** 40-60%	Measured **Active Power** Output (kW)	Frequency (Hz)	Calculated droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	161.45	50.00	-	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	158.75	50.45	11.9		-
Step c) 50.70 Hz ±0.10 Hz	142.89	50.70	10.3		-
Step d) 51.15 Hz ±0.05 Hz	114.27	51.15	10.2		-
Step e) 50.70 Hz ±0.10 Hz	142.65	50.70	10.2		-
Step f) 50.45 Hz ±0.05 Hz	158.58	50.45	11.1		-
Step g) 50.00 Hz ±0.01 Hz	161.46	59	-		-

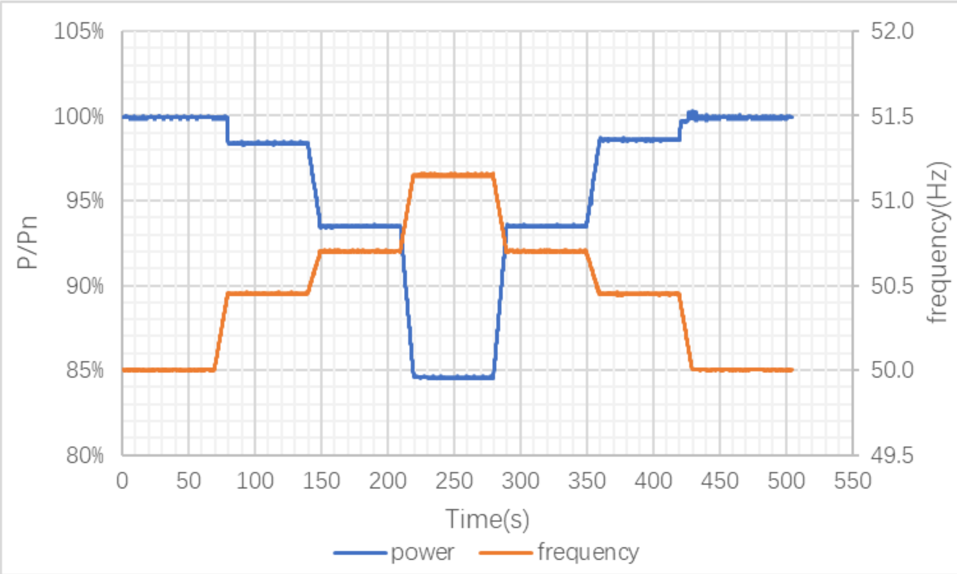
Note:
The simulation study event shall be equivalent to:
(i) a sufficiently large increase in the measured system frequency ramped over 10 s to cause a decrease in **Active Power** output in accordance with the **Droop** setting followed by
(ii) 60 s of steady state with the measured system frequency increased to the same level as in B.4.5.4 (i) as illustrated in Figure B.4.1 below
(iii) then decrease of the measured system frequency ramped over 10 s to cause an increase in **Active Power** output back to the maximum **Active Power** level followed by at least 60 s of steady output.

The allowed tolerance for the frequency measurement shall be ± 0.05 Hz. The allowed tolerance for Active Power output measurement shall be ±10% of the required change in Active Power.

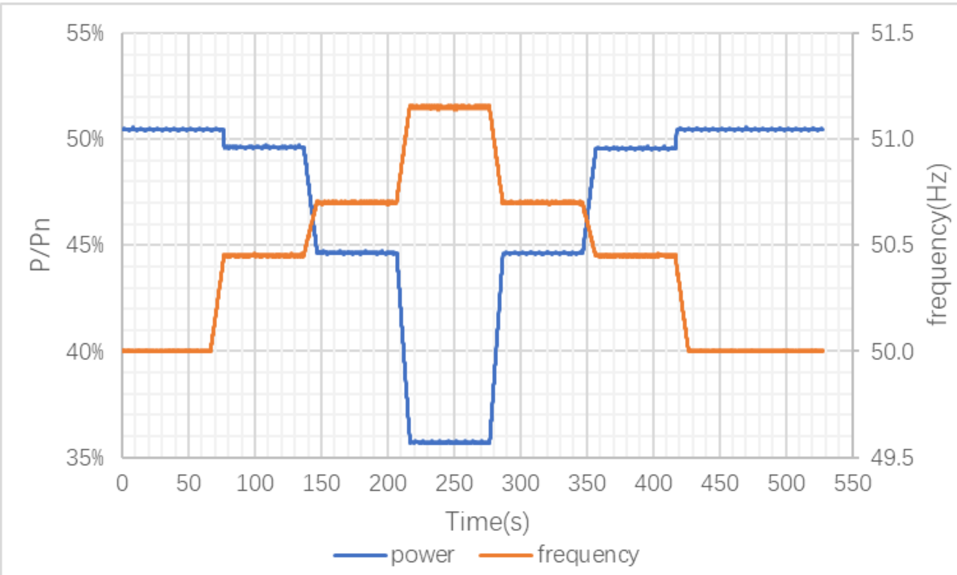
The resulting overall tolerance range for a nominal 10% Droop is +2.8% and – 1.5%, ie a Droop less than 12.8% and greater than 8.5%.

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Limited Frequency Sensitive Mode – Over frequency test (100%Pn)



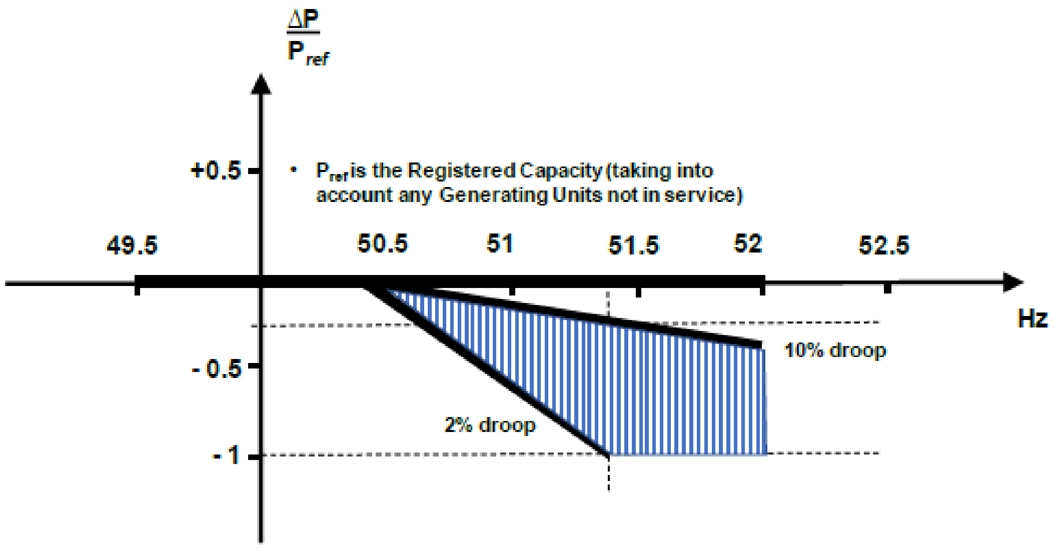
Limited Frequency Sensitive Mode – Over frequency test (50%Pn)



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

B.6.2	**Frequency Response Tests** **Active Power** response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex B.6.2. **(for Type B, Type C, Type D)**	**P**

Test sequence at **Registered Capacity** >65%	Measured **Active Power** Output (kW)	Frequency (Hz)	Calculate droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	321.44	50.00	-	Photovoltaic array simulator	-
Step b) 52.00 Hz ±0.01 Hz	219.25	52.00	10.0		P
Step c) 50.00 Hz ±0.01 Hz	321.29	50.00			-



P_{ref} is the reference Active Power to which ΔP is related and. ΔP is the change in Active Power output from the Power Generating Module.

Figure 13.2 Active Power Frequency Response capability when operating in LFSM-O

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

1. The frequency input and the expected Active Power response which are illustrated for different time periods from 0 s to 130 s in Figures B.6.1 for a step change in frequency.

2. The response should commence within 2 s and the response shall be to the left of the red line (ie between the green and red lines), and as close to the green line as possible when following the frequency step or ramp. Note that the red line represents the 0.5% s-1 specified in paragraph 12.2.4.

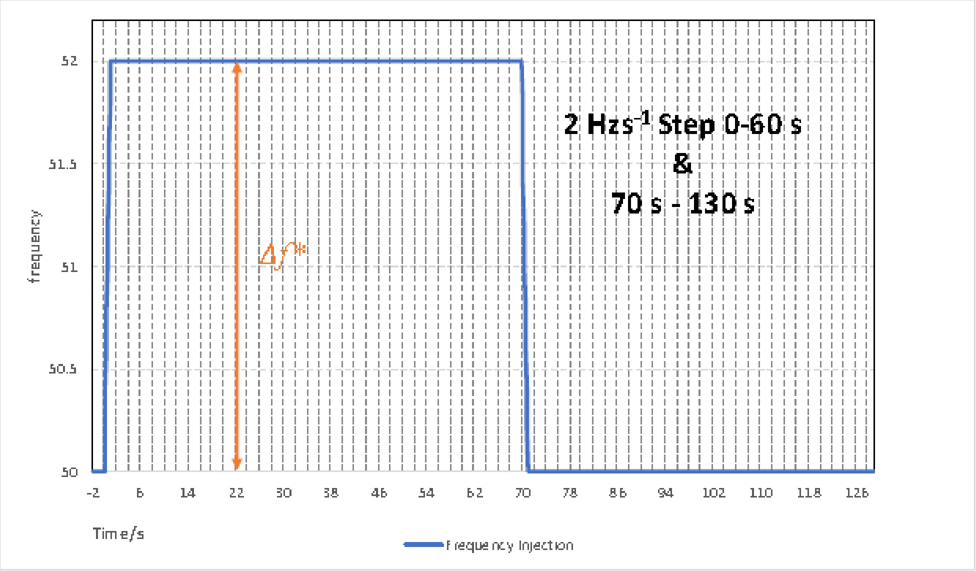
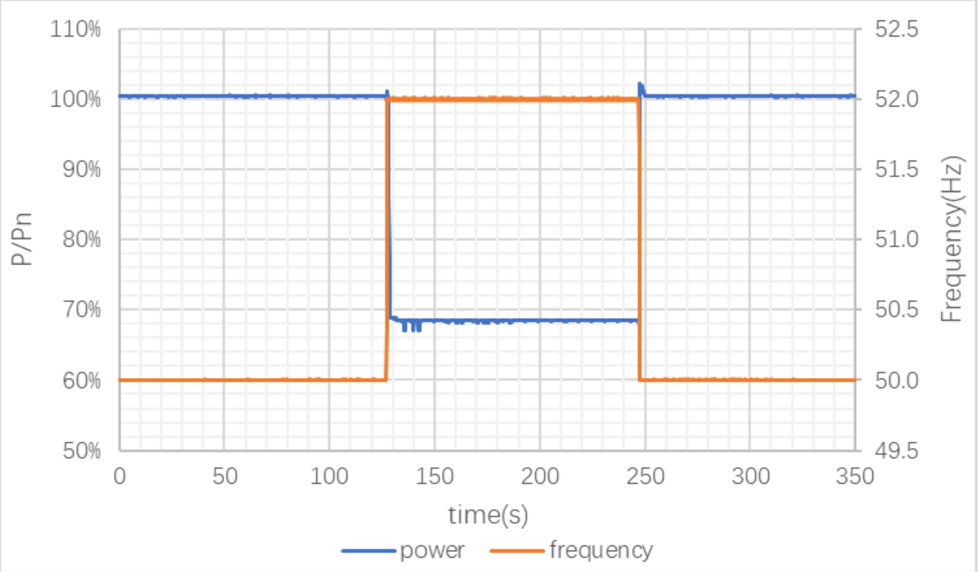


Figure B.6.1(i): LFSM-O step response test – frequency injection

Graph of Frequency response Test



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output (kW)	Frequency (Hz)	$\Delta P_{E60}/Pn$ (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	321.53	50.00	-	Photovoltaic array simulator	-
Step b) 50.60 Hz ±0.01 Hz	308.66	50.60	9.9		P
Step c) 50.00 Hz ±0.01 Hz	321.37	50.00	-		-

1.Initial output is 100%, droop is 10%. (20%Pn/Hz)

2.Ramp of frequency change is 0.02 Hz/s.

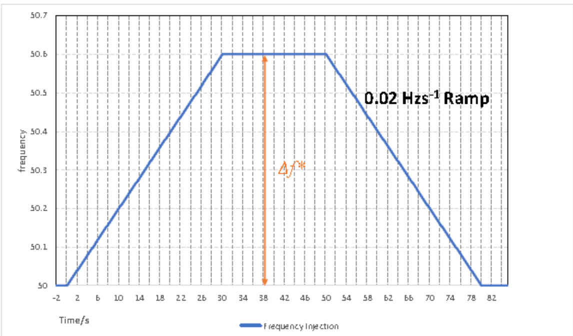


Figure B.6.2(i): LFSM-O BC2 ramp response test – frequency injection

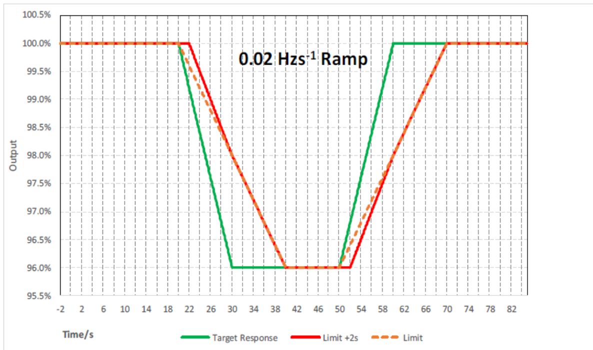
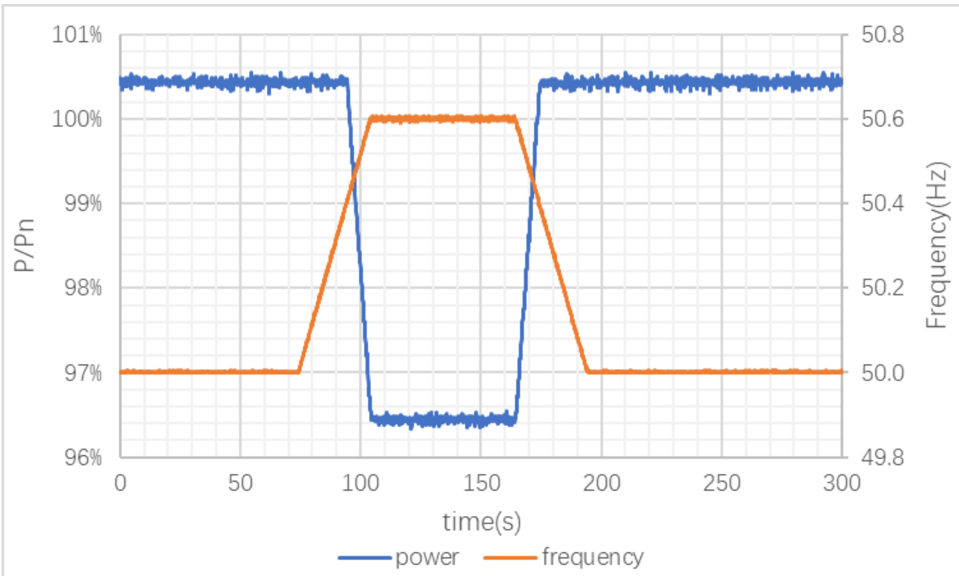


Figure B.6.2(ii): LFSM-O BC2 ramp response test – target response and limits

Graph of Frequency response Test

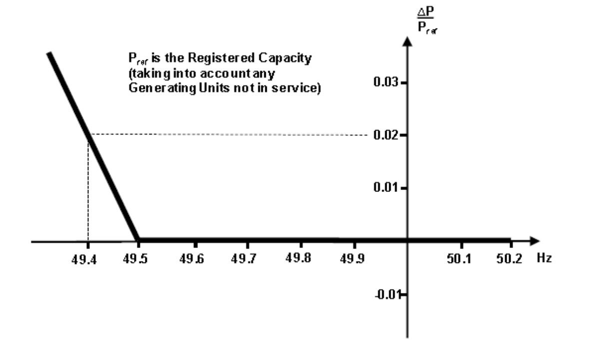


G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.2.5 Limited Frequency Sensitive Mode – Under frequency (LFSM-U) Shall be capable of increasing active power output in response to system when this falls below 49.5Hz. Droop of 10%. Annex C.7.8					**P**
Test sequence at **Registered Capacity** 80% Pn	Measured **Active Power** Output (kW)	Frequency (Hz)	Calculate droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	258.37	50.00	-	Photovoltaic array simulator	-
Step b) 49.50 Hz ±0.01 Hz	259.05	49.50	-		-
Step c) 49.40 Hz ±0.01 Hz	265.21	49.40	9.4		-
Step d) 48.50 Hz ±0.01 Hz	321.87	48.50	10.1		-
Step e) 49.40 Hz ±0.01 Hz	265.03	49.40	9.6		-
Step f) 49.50 Hz ±0.01 Hz	258.76	49.50	-		-
Step g) 50.00 Hz ±0.01 Hz	258.27	50.00	-		-

Notes:

1. Droop is 10%.
2. In LFSM-U Mode the inverter shall be capable of providing a power increase up to its Registered Capacity.
3. A sufficiently large reduction in the measured system frequency ramped over 10 s.
4. Then increase of the measured system frequency ramped over 10 s to cause a reduction in Active Power output back to the original Active Power level followed by at least 60 s of steady output.



Pref is the **Registered Capacity**, taking into account any **Interface Protections** not in service to which ΔP is related and ΔP is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide a positive **Active Power** output change with a **Droop** of 10% or less based on Pref.

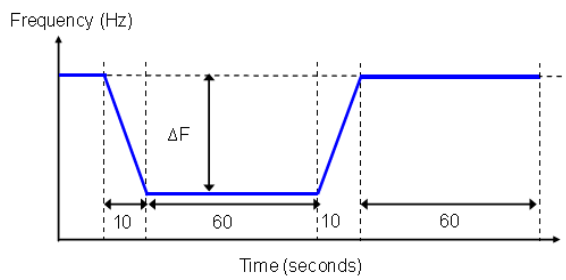
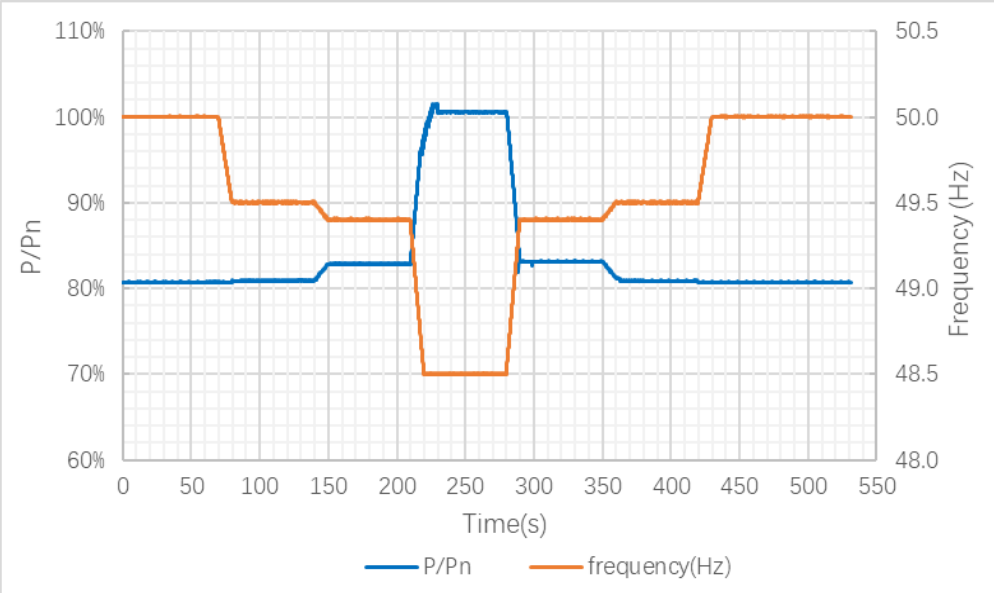


Figure C.7.3 LFSM-U step response simulation

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Diagram



G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.2.6 Frequency Sensitive Mode – (FSM) (for Type C, Type D) The test should be carried out using the specific threshold frequency of 50Hz and **Droop** of 4%. (50%Pn/Hz)					**P**
Test sequence **start at 80% Registered Capacity**	Measured **Active Power** Output (kW)	Frequency (Hz)	Calculate droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	257.25	50.00	-	Photovoltaic array simulator	-
Step b) 50.10 Hz ±0.01 Hz	243.11	50.10	4.5		P
Step c) 50.20 Hz ±0.01 Hz	224.94	50.20	4.0		P
Step d) 50.30 Hz ±0.01 Hz	224.89	50.30	-		-
Step e) 50.40 Hz ±0.01 Hz	224.90	50.40	-		-
Step f) 50.30 Hz ±0.01 Hz	224.98	50.30	-		-
Step g) 50.20 Hz ±0.01 Hz	224.95	50.20	4.0		P
Step h) 50.10 Hz ±0.01 Hz	242.20	50.10	4.3		P
Step i) 50.00 Hz ±0.01 Hz	259.49	50.00	-		-
Step j) 49.90 Hz ±0.01 Hz	273.15	49.90	4.0		P
Step k) 49.80 Hz ±0.01 Hz	290.56	49.80	3.8		P
Step l) 49.70 Hz ±0.01 Hz	291.19	49.70	-		-
Step m) 49.60 Hz ±0.01 Hz	291.24	49.60	-		-
Step n) 49.70 Hz ±0.01 Hz	291.13	49.70	-		-
Step o) 49.80 Hz ±0.01 Hz	290.71	49.80	3.8		P
Step p) 49.90 Hz ±0.01 Hz	273.22	49.90	4.0		P
Step q) 50.00 Hz ±0.01 Hz	259.49	50.00	-		-

1. Power Generating Modules shall be capable of providing Active Power Frequency Response in accordance with the performance characteristic shown in Figure 13.4 and parameters in Table 13.1.

2. In satisfying the performance requirements specified in paragraph 13.2.6.1 Generators in respect of each Power Generating Module should be aware: -

i. in the case of over frequency, the Active Power Frequency Response is limited by the Minimum Stable Operating Level,

ii. in the case of under frequency, the Active Power Frequency Response is limited by the Registered Capacity,

ii.the actual delivery of Active Power Frequency Response depends on the operating and ambient conditions of the Power Generating Module when this response is triggered, in particular limitations

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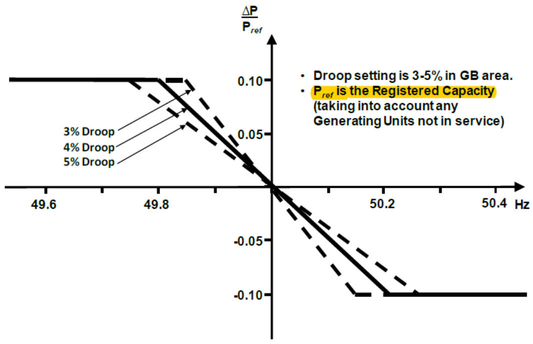
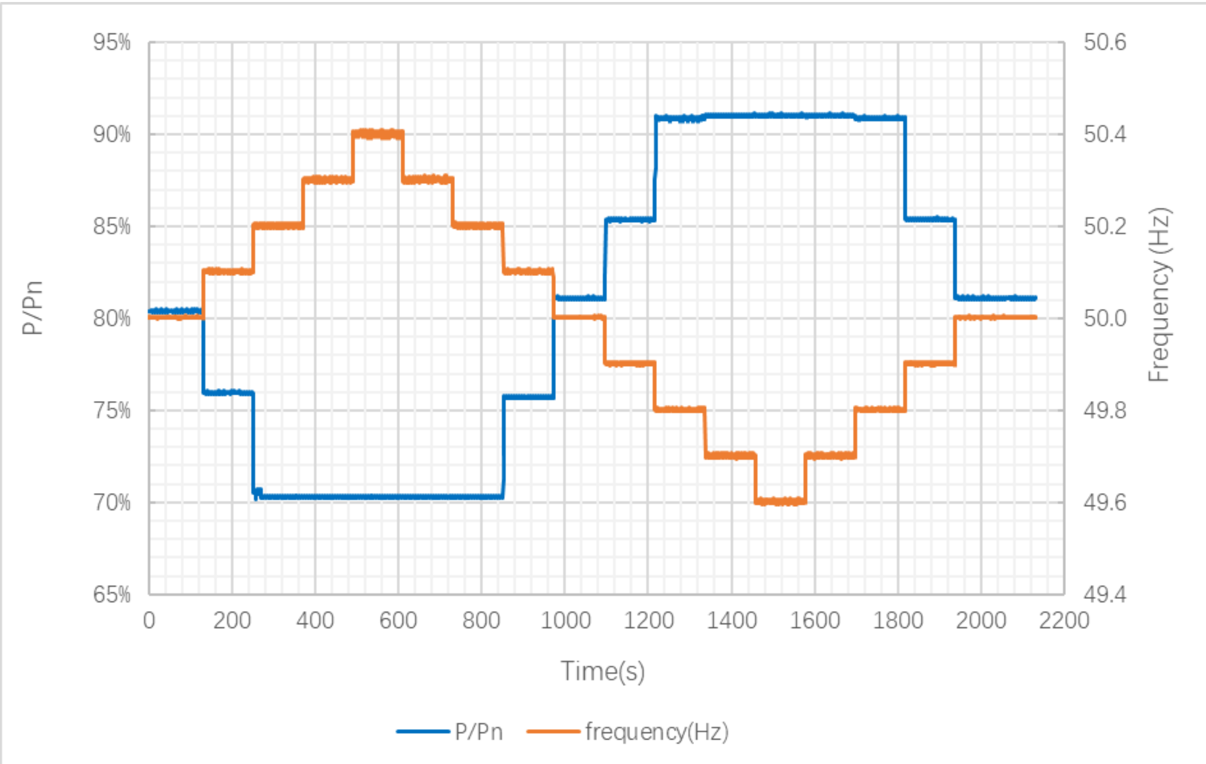
Clause	Requirement - Test	Result - Remark	Verdict

on operation near Registered Capacity at low frequencies as specified in 13.2.5 and available primary energy sources.
iv. The frequency control device (or speed governor) shall also be capable of being set so that it operates with an overall speed Droop of between 3 – 5%. The Frequency Response Dead band and Droop shall be able to be reset at any time and as required by the DNO. For the avoidance of doubt, in the case of a Power Park Module the speed Droop should be equivalent of a fixed setting between 3% and 5% applied to each Generating Unit in service.



iii. Figure 13.4 – Frequency Sensitive Mode capability of Power Generating Modules and Power Park Modules

Diagram



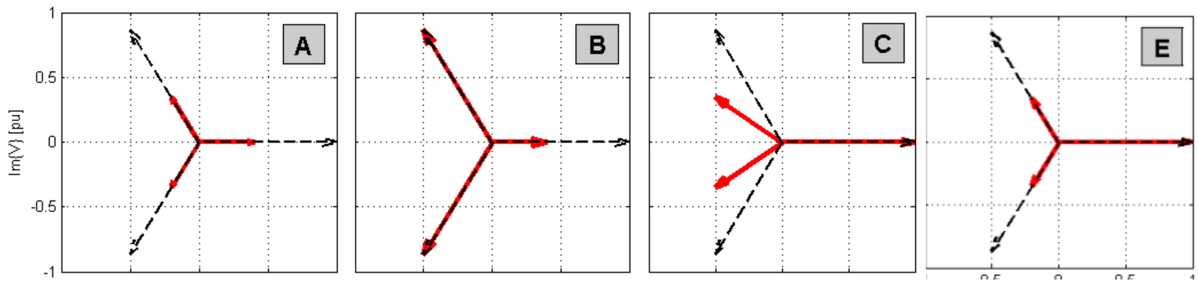
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

12.3, 12.6 13.3, 13.6 C.7.5	**Fault Ride Through and Fast Fault Injection (For Type B, Type C, Type D)**						**P**
Test no.	U/Un [pu]	No. of phases shorted	Output power level	Fault duration (ms)	Set Q before fault [Q/Pn]	Limit Percent of Injected current after 60 ms [pu]	Limit Percent of Injected current after 120 ms [pu]
1.1.0	*0 * Type D (>110 kV)*	Three phase symetric fault	*P=0*	140	0	N/A	N/A
1.1.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	140	0	≥0.65	≥1.0
1.1.2			$P \geq 0{,}9P_n$	140	0	≥0.65	≥1.0
1.2.0		One phase asymetric fault	*P=0*	140	0	N/A	N/A
1.2.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	140	0	≥0.65	≥1.0
1.2.2			$P \geq 0{,}9P_n$	140	0	≥0.65	≥1.0
1.3.0		Phase to phase fault	*P=0*	140	0	N/A	N/A
1.3.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	140	0	≥0.65	≥1.0
1.3.2			$P \geq 0{,}9P_n$	140	0	≥0.65	≥1.0
1.4.0		Two phase to earth fault	*P=0*	140	0	N/A	N/A
1.4.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	140	0	≥0.65	≥1.0
1.4.2			$P \geq 0{,}9P_n$	140	0	≥0.65	≥1.0
2.1.0	*0.10*	Three phase symetric fault	*P=0*	383	0	N/A	N/A
2.1.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	383	0	≥0.65	≥1.0
2.1.2			$P \geq 0{,}9P_n$	383	0	≥0.65	≥1.0
2.2.0		One phase asymetric fault	*P=0*	383	0	N/A	N/A
2.2.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	383	0	≥0.65	≥1.0
2.2.2			$P \geq 0{,}9P_n$	383	0	≥0.65	≥1.0
2.3.0		Phase to phase fault	*P=0*	383	0	N/A	N/A
2.3.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	383	0	≥0.65	≥1.0
2.3.2			$P \geq 0{,}9P_n$	383	0	≥0.65	≥1.0
2.4.0		Two phase to earth fault	*P=0*	383	0	N/A	N/A
2.4.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	383	0	≥0.65	≥1.0
2.4.2			$P \geq 0{,}9P_n$	383	0	≥0.65	≥1.0
3.1.0	0.50	Three phase symetric fault	*P=0*	1352	0	N/A	N/A
3.1.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	1352	0	≥0.65	≥1.0
3.1.2			$P \geq 0{,}9P_n$	1352	0	≥0.65	≥1.0
3.2.0		One phase asymetric fault	*P=0*	1352	0	N/A	N/A
3.2.1			$0{,}1P_n \leq P \leq 0{,}3P_n$	1352	0	≥0.65	≥1.0
3.2.2			$P \geq 0{,}9P_n$	1352	0	≥0.65	≥1.0

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

12.3, 12.6 13.3, 13.6 C.7.5	**Fault Ride Through and Fast Fault Injection (For Type B, Type C, Type D)**							**P**
3.3.0		Phase to phase fault	*P=0*	1352	0	N/A	N/A	
3.3.1			$0,1P_n \leq P \leq 0,3P_n$	1352	0	≥0.65	≥1.0	
3.3.2			$P \geq 0,9P_n$	1352	0	≥0.65	≥1.0	
3.4.0		Two phase to earth fault	*P=0*	1352	0	N/A	N/A	
3.4.1			$0,1P_n \leq P \leq 0,3P_n$	1352	0	≥0.65	≥1.0	
3.4.2			$P \geq 0,9P_n$	1352	0	≥0.65	≥1.0	
4.1.0	0.85	Three phase symetric fault	*P=0*	2200	0	N/A	N/A	
4.1.1			$0,1P_n \leq P \leq 0,3P_n$	2200	0	≥0.65	≥1.0	
4.1.2			$P \geq 0,9P_n$	2200	0	≥0.65	≥1.0	
4.2.0		One phase asymetric fault	*P=0*	2200	0	N/A	N/A	
4.2.1			$0,1P_n \leq P \leq 0,3P_n$	2200	0	≥0.65	≥1.0	
4.2.2			$P \geq 0,9P_n$	2200	0	≥0.65	≥1.0	
4.3.0		Phase to phase fault	*P=0*	2200	0	N/A	N/A	
4.3.1			$0,1P_n \leq P \leq 0,3P_n$	2200	0	≥0.65	≥1.0	
4.3.2			$P \geq 0,9P_n$	2200	0	≥0.65	≥1.0	
4.4.0		Two phase to earth fault	*P=0*	2200	0	N/A	N/A	
4.4.1			$0,1P_n \leq P \leq 0,3P_n$	2200	0	≥0.65	≥1.0	
4.4.2			$P \geq 0,9P_n$	2200	0	≥0.65	≥1.0	

Note:
*Addtional test condition only for Type D Power Generating Modules above 110 kV.



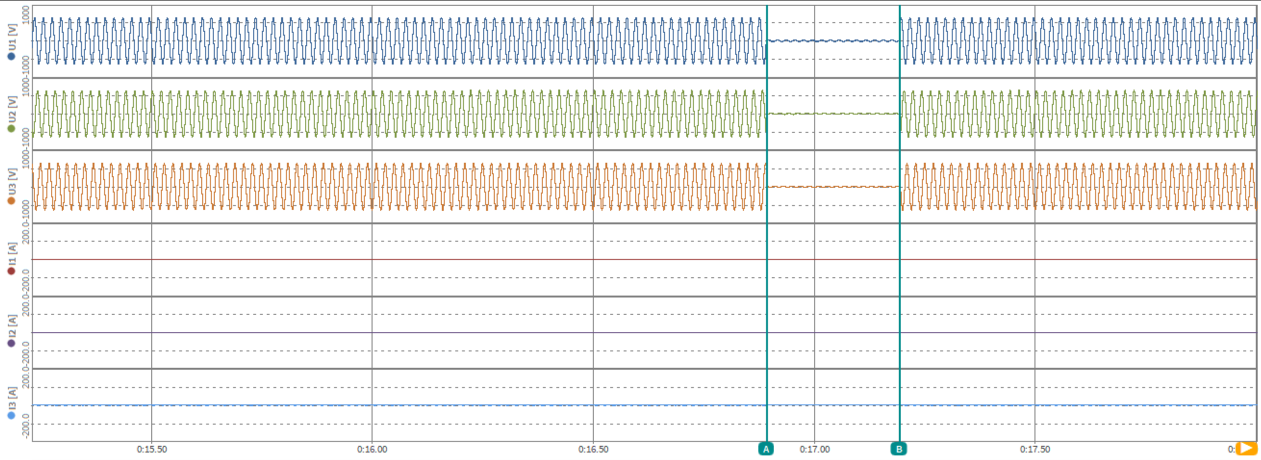
A: three-pole short circuit
B: single-pole short circuit with earth contact
C: two-pole short circuit without earth contact
E: two-phase short circuit to earth

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

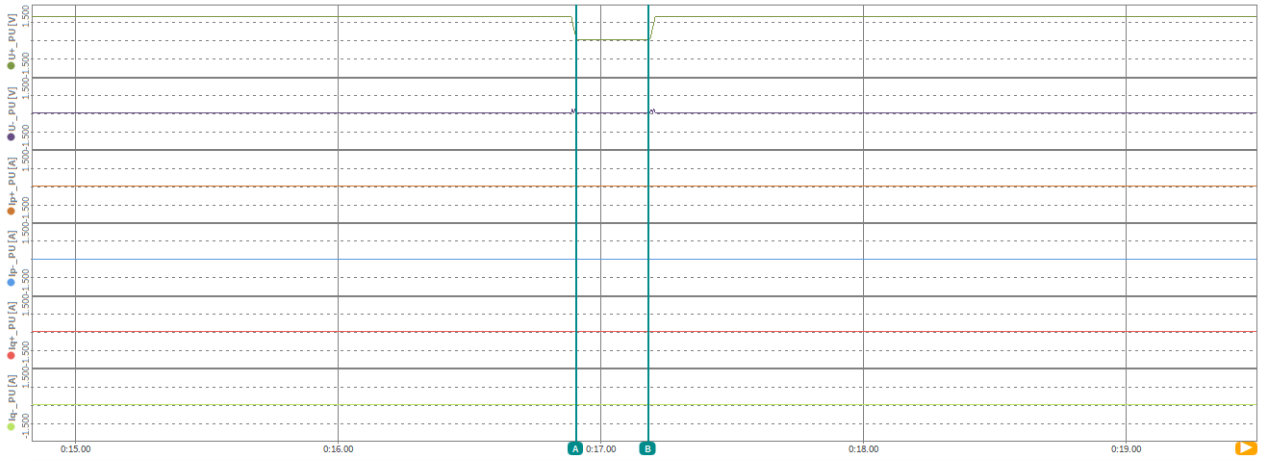
Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	1.1.1	1.1.2
	1	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	462.7	463.9
	2		Phase 2			460.3	460.3
	3		Phase 3			462.1	461.2
	4	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	47.1	233.7
	5		Phase 2			46.8	231.5
	6		Phase 3			47.0	232.0
	7	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.20	1.0
	8		total		W	65008	322003
	9	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.01	0.01
	10		total		var	2341	5197
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	18.1	18.3
	12		Phase 2			19.4	19.5
	13		Phase 3			18.6	18.6
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	240.4	239.4
	15		Phase 2			241.3	241.4
	16		Phase 3			239.6	240.0
	17	Total fault duration	All phase	t_1 to t_2	ms	363.9	362
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.038	0.038
	19		total		var	13277.5	13303
	20	Reactive current	Positive sequence		p.u.	1.2	1.005
	21	Active power	Positive sequence		p.u.	0.006	0.01
	22		total		W	2004	3110
	23	Active current	Positive sequence		p.u.	0.17	0.25
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.97	0.97
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	1.00	1.00
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	462.8	461.2
	27		Phase 2			462.8	461.5
	28		Phase 3			460.0	462.9
	29	Current	Phase 1	t_2+1s	Arms	45.7	232.3
	30		Phase 2			45.9	232.1
	31		Phase 3			45.5	232.8
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.0
	33		total		W	65036	321980
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	35		total		Var	2570	7164.8
	36	Active power recovery time	Positive sequence	--	ms	98.7	499.2

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.1.0 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=0, Fault Duration



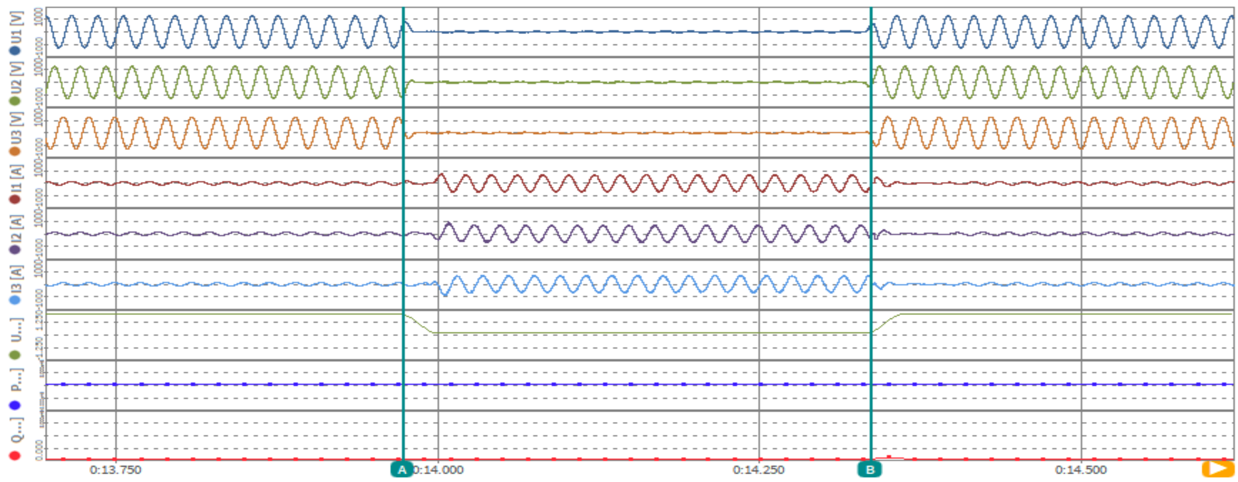
时间 [s]	A 0:16.892757	B 0:17.193044	间隔 0.300287	有效值
U1 [V]	63.13432	224.2019	161.0676	15.36952
U2 [V]	-173.1341	-521.2363	-348.1022	22.98239
U3 [V]	115.3557	300.7140	185.3583	17.80174
I1 [A]	-0.166535	0.438213	0.604749	0.478562
I2 [A]	-0.802875	0.504971	1.307845	0.315766
I3 [A]	0.485897	-0.044584	-0.530481	0.427684



时间 [s]	A 0:16.907646	B 0:17.182278	间隔 0.274632
U+_PU [V]	0.276995	0.029106	-0.247890
U-_PU [V]	0.154742	4.447e-4	-0.154297
Ip+_PU [A]	1.114e-4	2.103e-5	-9.036e-5
Ip-_PU [A]	-4.300e-5	4.836e-5	9.136e-5
Iq+_PU [A]	2.165e-4	5.806e-5	-1.584e-4
Iq-_PU [A]	7.173e-5	1.022e-5	-6.150e-5

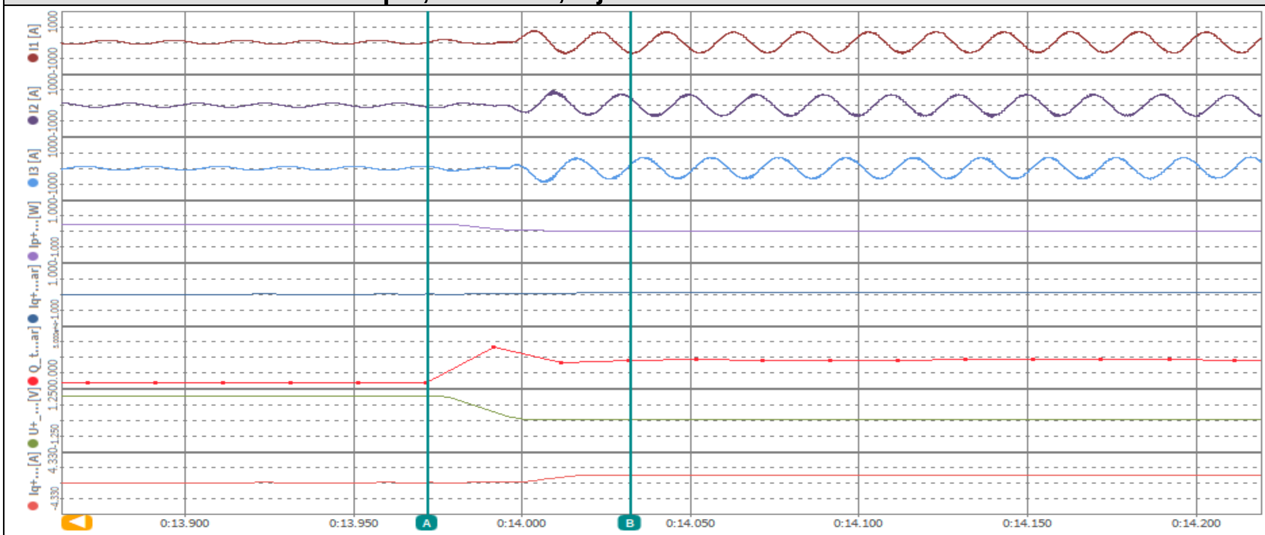
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.1.1 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=20%Pn, fault duration



	A	B	Delta	RMS
Time [s]	0:13.973581	0:14.336568	0.362987	
U1 [V]	234.7514	227.0866	-7.664800	50.07581
U2 [V]	-600.1517	-161.1672	438.9845	51.91621
U3 [V]	371.8771	-71.17808	-443.0552	34.24030
I1 [A]	27.43161	-144.2442	-171.6758	233.9444
I2 [A]	-76.95854	-202.8426	-125.8841	232.1188
I3 [A]	48.52581	349.2528	300.7270	233.4456
U+_PU [V]	0.999179	0.053007	-0.946172	0.186727
P_t@SG320HX [W]	65066.07	-2053.112	-67119.18	16080.69
Q_t@SG320HX [var]	2168.750	13284.76	11116.01	13348.52

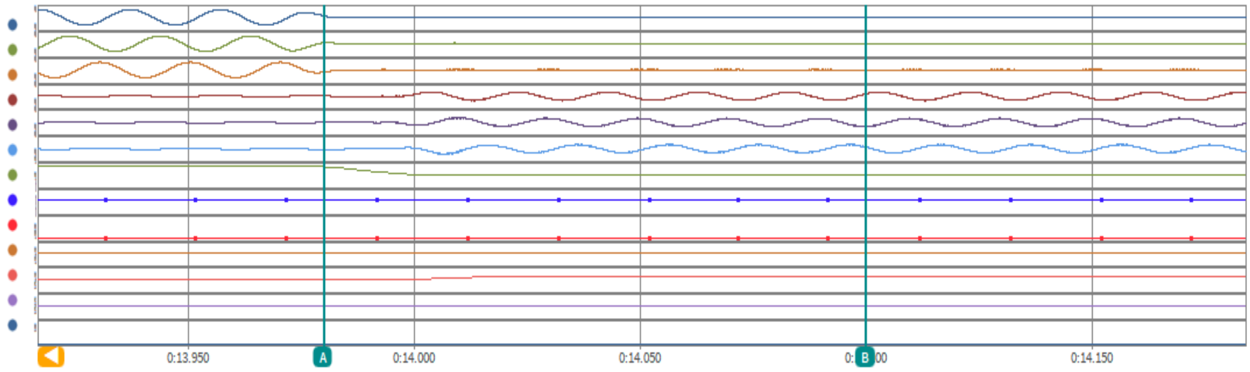
Test no. 1.1.1 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	RMS
Time [s]	0:13.972134	0:14.032242	0.060108	
I1 [A]	-3.021836	-361.4919	-358.4701	185.2603
I2 [A]	-56.55098	267.0741	323.6251	189.8124
I3 [A]	58.53808	92.75950	34.22141	187.3874
Ip+_PU [W]	0.203328	-6.961e-3	-0.210289	0.101173
Iq+_PU [var]	-4.899e-5	0.037241	0.037290	0.022435
Q_t@SG320HX [var]	2227.662	12130.44	9902.778	11623.72
U+_PU [V]	0.999166	0.037042	-0.962124	0.466254
Iq+_PU [A]	-4.903e-5	1.005318	1.005367	0.610983

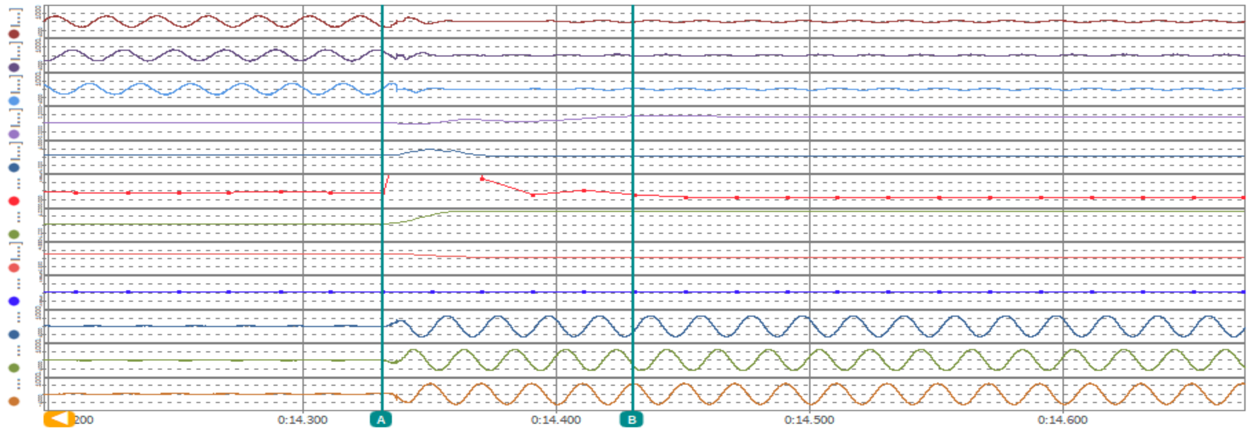
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.1.1 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.9799533	0:14.0999382	0.1199849		
U1 [V]	143.1452	23.08953	-120.0557	1.823508	20.01887
U2 [V]	65.83023	1.866698	-63.96354	2.267765	21.91585
U3 [V]	-205.2943	-17.07482	188.2194	-3.492021	26.92499
I1 [A]	55.46356	201.2627	145.7992	-2.953386	222.0463
I2 [A]	24.41538	-347.5838	-371.9992	8.263133	222.9602
I3 [A]	-79.80276	143.6664	223.4692	-4.626633	226.1721
U+_PU [V]	0.887335	0.037345	-0.849990	0.107122	0.218149
P_t@SG320HX [W]	65066.07	-2029.339	-67095.41	11461.50	26358.41
Q_t@SG320HX [var]	2168.750	13253.85	11085.10	12434.26	13319.56
Ip+_PU [A]	0.227601	-0.176792	-0.404393	-0.094778	0.177474
Iq+_PU [A]	-9.587e-4	1.024033	1.024991	0.786873	0.883863

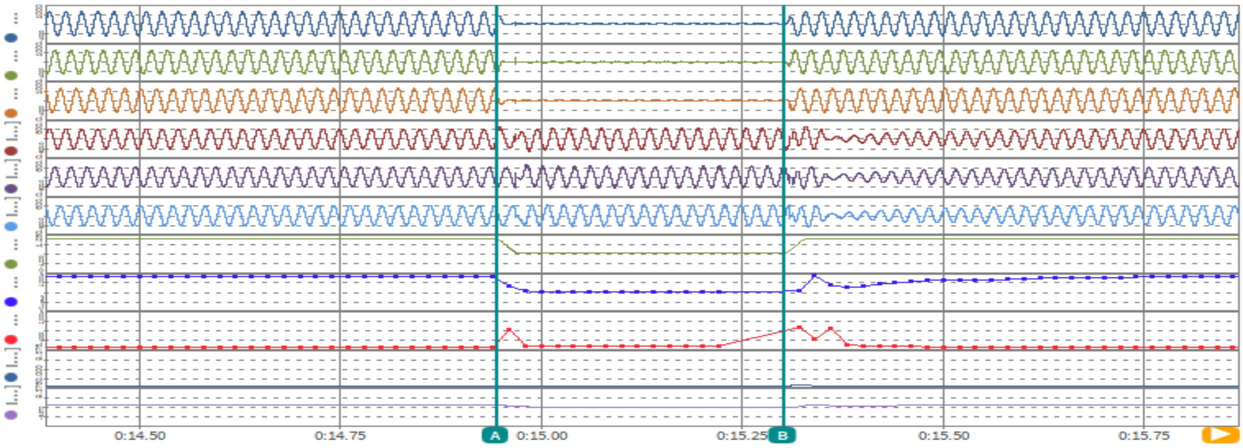
Test no. 1.1.1 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:14.331561	0:14.430301	0.098740		
I1 [A]	-289.5541	-36.00323	253.5509	-11.73838	91.43425
I2 [A]	278.6812	-27.22347	-305.9046	2.628135	65.05675
I3 [A]	14.87959	63.98988	49.11030	9.144695	78.93098
Ip+_PU [W]	-6.552e-3	0.196907	0.203459	0.068015	0.095550
Iq+_PU [var]	0.038640	0.027325	-0.011315	0.106051	0.164870
Q_t@SG320HX [var]	13180.65	14666.71	1486.063	41315.92	71286.39
U+_PU [V]	0.037698	1.000439	0.962741	0.827826	0.886937
Iq+_PU [A]	1.024944	0.027312	-0.997632	0.256773	0.431524
P_t@SG320HX [W]	-2079.498	42367.81	44447.31	14396.62	21534.98
U1 [V]	-4.083276	-375.5180	-371.4347	-20.83410	445.5474
U2 [V]	-17.16185	-281.2574	-264.0956	30.33394	440.2088
U3 [V]	11.47211	645.5095	634.0374	-9.900525	440.9851

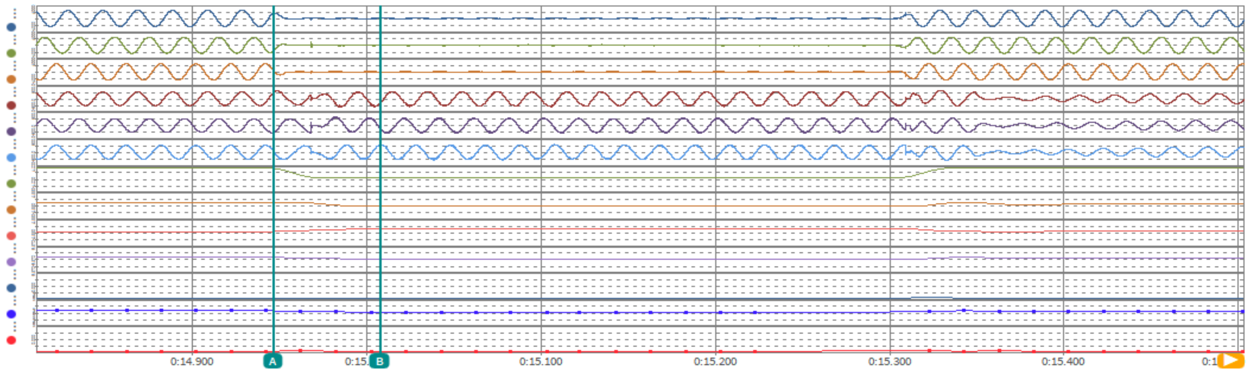
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.1.2 Three phase symmetrical fault type A）
U/Un = 0 p.u, P=100%Pn, fault duration



Time [s]	A	B	Delta	RMS
	0:14.944330	0:15.301242	0.356912	
U1 [V]	100.3681	-23.70405	-124.0722	49.60590
U2 [V]	-609.1941	3.386021	612.5801	58.12070
U3 [V]	512.8256	18.60464	-494.2210	40.34894
I1 [A]	49.81196	-131.9903	-181.8023	237.4981
I2 [A]	-304.7909	304.7893	609.5802	238.0825
I3 [A]	256.2074	-174.7468	-430.9541	238.0443
U+_PU [V]	0.999660	0.037355	-0.962304	0.187982
P_t@SG320HX [W]	321976.5	-2991.879	-324968.4	87536.21
Q_t@SG320HX [var]	4909.981	13172.20	8262.219	28838.98
Iq+_PU [var]	-5.139e-4	0.037707	0.038221	0.037929
Ip+_PU [W]	1.006042	-9.262e-3	-1.015304	0.188656

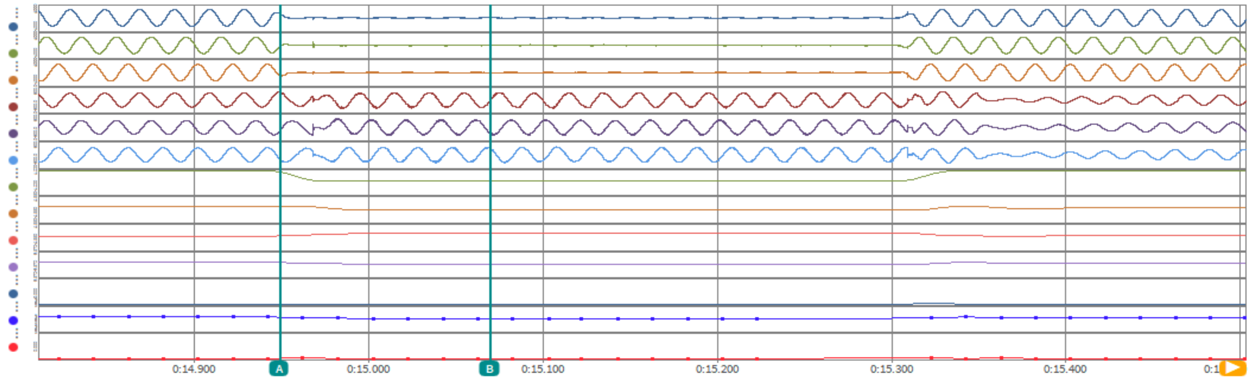
Test no. 1.1.2 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 60ms



Time [s]	A	B	Delta	Avg	RMS
	0:14.9469642	0:15.0079480	0.0609838		
U1 [V]	408.6880	30.74515	-377.9428	24.90554	94.48495
U2 [V]	-443.3900	-12.91359	430.4765	-8.197850	66.92044
U3 [V]	41.82661	-15.89453	-57.72114	-16.28727	60.25056
I1 [A]	311.7509	-206.6380	-518.3889	-20.21695	229.0508
I2 [A]	-319.7854	-140.9805	178.8049	50.34893	220.2983
I3 [A]	11.37841	348.2779	336.8995	-29.89309	225.9938
U+_PU [V]	0.991614	0.038887	-0.952727	0.248113	0.406382
Ip+_PU [A]	1.009794	-0.288655	-1.298449	0.382524	0.674224
Iq+_PU [A]	7.079e-5	0.974194	0.974123	0.513723	0.622483
Ip+_PU [W]	1.001369	-0.011226	-1.012594	0.228536	0.415258
Iq+_PU [var]	7.020e-5	0.037885	0.037815	0.033480	0.038895
P_t@SG320HX [W]	321976.5	-4044.360	-326020.9	106113.2	169433.3
Q_t@SG320HX [var]	4909.981	13727.29	8817.310	33180.25	51259.24

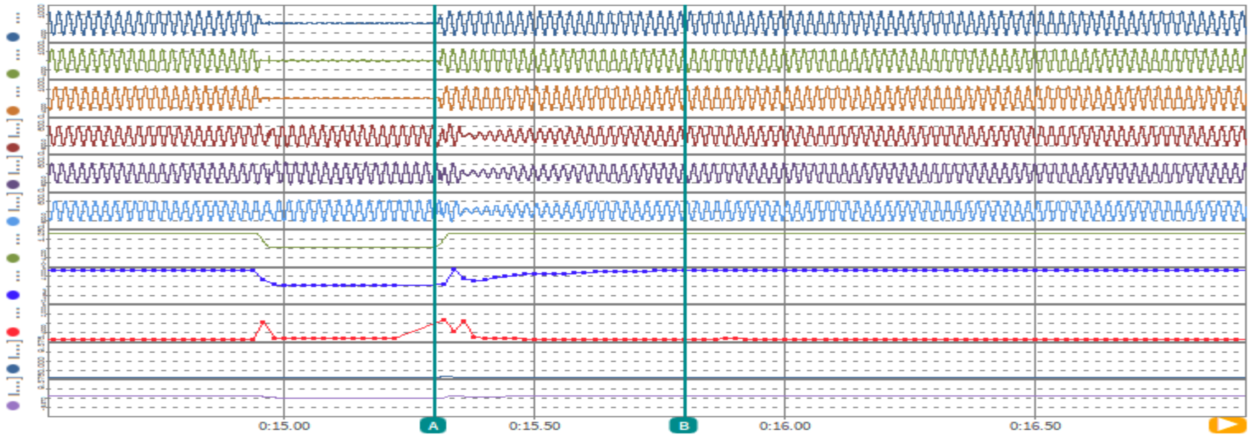
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.1.2 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.949161	0:15.069865	0.120703		
U1 [V]	353.8392	20.92302	-332.9162	5.659303	41.81121
U2 [V]	-148.0452	1.375794	149.4210	1.904197	25.80724
U3 [V]	-209.7705	-29.90484	179.8656	-7.111954	41.80054
I1 [A]	384.5059	-9.595156	-394.1010	-18.84290	230.9490
I2 [A]	-168.2019	-302.2311	-134.0292	27.35519	229.9869
I3 [A]	-218.8839	314.6970	533.5809	-8.345580	236.7236
U+_PU [V]	0.964384	0.038063	-0.926321	0.129442	0.262177
Ip+_PU [A]	1.021409	-0.265599	-1.287007	0.042672	0.500162
Iq+_PU [A]	2.640e-3	1.006431	1.003791	0.771989	0.842967
Ip+_PU [W]	0.985073	-0.010110	-0.995182	0.094587	0.267117
Iq+_PU [var]	2.546e-3	0.038309	0.035764	0.036639	0.039069
P_t@SG320HX [W]	321976.5	-3160.934	-325137.5	59249.15	128097.1
Q_t@SG320HX [var]	4909.981	13463.56	8553.579	24827.63	39771.66

Test no. 1.1.2 Three phase symmetrical fault（type A）
U/Un = 0 p.u, P=100%Pn, Active power recovery time



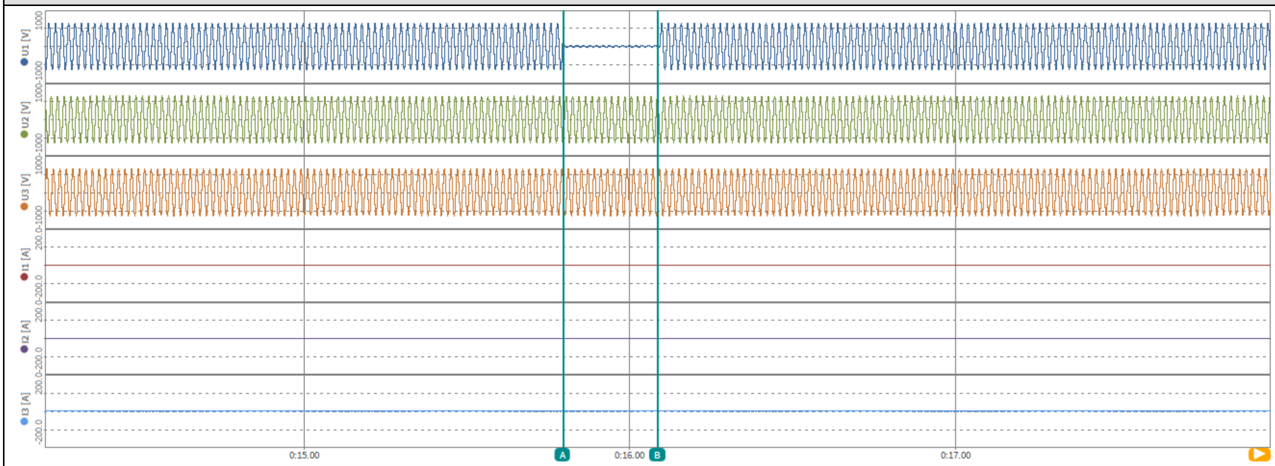
	A	B	Delta	RMS
Time [s]	0:15.301889	0:15.801154	0.499264	
U1 [V]	-14.54353	-488.9260	-474.3824	458.4596
U2 [V]	-18.26573	-137.0843	-118.8185	456.9620
U3 [V]	25.67828	616.1045	590.4262	456.5684
I1 [A]	-190.7289	-239.5268	-48.79785	192.0146
I2 [A]	319.5602	-72.61539	-392.1756	188.9360
I3 [A]	-129.4433	311.8540	441.2973	188.0780
U+_PU [V]	0.037355	0.999540	0.962184	0.976895
P_t@SG320HX [W]	-2991.879	314428.3	317420.2	249025.8
Q_t@SG320HX [var]	13172.20	6199.977	-6972.223	33781.76
Iq+_PU [var]	0.037707	6.007e-3	-0.031700	0.072329
Ip+_PU [W]	-9.262e-3	0.985925	0.995188	0.786617

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	1.2.1	1.2.1
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	461.1	462
	2		Phase 2			460.3	460
	3		Phase 3			463.1	462
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.0	233
	5		Phase 2			46.9	232
	6		Phase 3			47.1	232
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.0
	8		total		W	65010	3212948
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.02	0.01
	10		total		var	2542	6273
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	23.2	19.2
	12		Phase 2			463.0	460.1
	13		Phase 3			460.7	462.1
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	241.2	240.1
	15		Phase 2			114.6	117.0
	16		Phase 3			127.6	123.9
	17	Total fault duration	All phase	t_1 to t_2	ms	296	300
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.37	0.03
	19		total		var	117790	7368
	20	Reactive current	Positive sequence		p.u.	0.54	0.04
	21				p.u.	0.04	0.36
	22				W	10800	117153
	23	Active current	Positive sequence		p.u.	0.06	0.53
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.52	0.52
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.54	0.52
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	460.3	461.6
	27		Phase 2			461.9	462.8
	28		Phase 3			463.0	460.9
	29	Current	Phase 1	t_2+1s	Arms	45.5	232.9
	30		Phase 2			45.7	233.2
	31		Phase 3			45.7	232.1
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.0
	33		total		W	61848	322354
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.02	0.01
	35		total		Var	8960	7059
	36	Active power recovery time	Positive sequence	--	ms	959	310

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.2.0 single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=0, Fault Duration

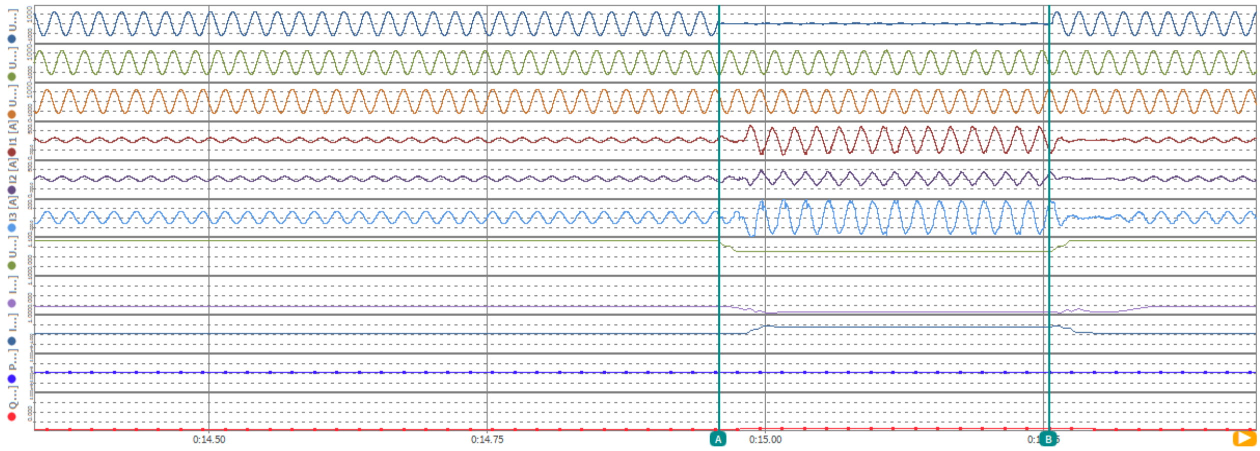


时间 [s]	A 0:15.796169	B 0:16.087704	间隔 0.291535	有效值
U1 [V]	14.92608	-17.81523	-32.74131	13.67046
U2 [V]	-625.7248	458.7238	1084.449	462.1366
U3 [V]	157.9059	177.6400	19.73403	460.1880
I1 [A]	-0.160456	-0.536203	-0.375748	0.479588
I2 [A]	-0.597119	-0.360727	0.236392	0.350213
I3 [A]	0.059962	-0.917792	-0.977755	0.489087

时间 [s]	A 0:15.813250	B 0:16.084679	间隔 0.271429
U+_PU [V]	0.671671	0.675836	4.165e-3
U-_PU [V]	0.313521	0.322938	9.417e-3
Ip+_PU [A]	1.934e-5	1.953e-5	1.943e-7
Ip-_PU [A]	1.431e-4	1.371e-4	-6.084e-6
Iq+_PU [A]	4.856e-4	4.822e-4	-3.479e-6
Iq-_PU [A]	4.164e-4	4.099e-4	-6.571e-6

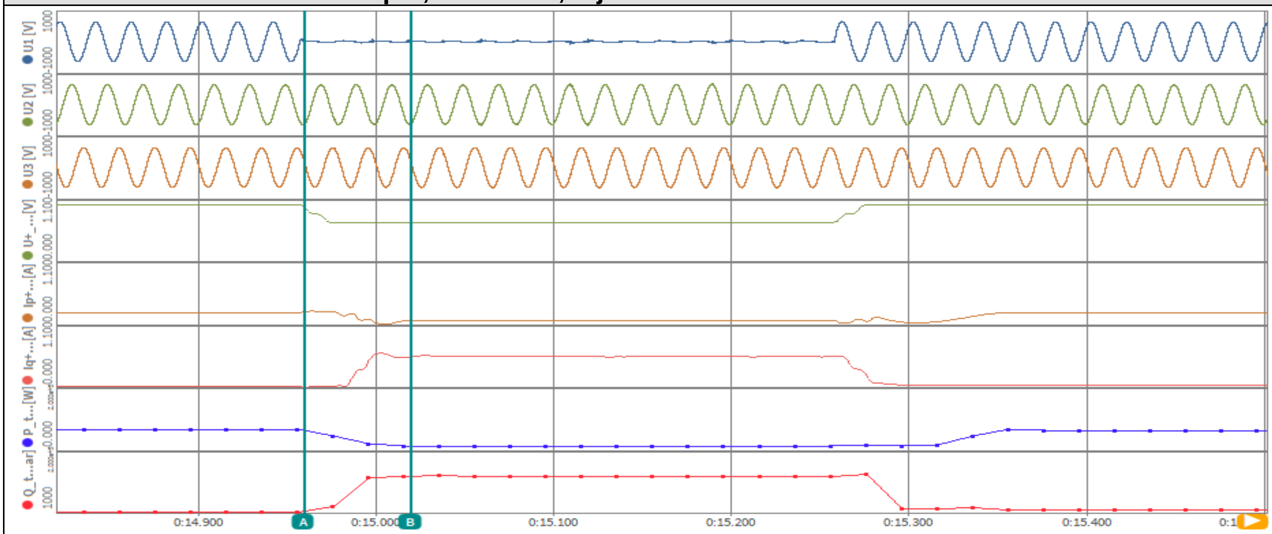
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.2.1 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.958686	0:15.255076	0.296391		
U1 [V]	10.07712	-20.33079	-30.40791	1.655219	22.90042
U2 [V]	-646.1388	-232.3297	413.8091	6.071792	461.7400
U3 [V]	371.0767	643.9377	272.8610	-6.896776	461.0743
I1 [A]	63.83837	-300.1658	-364.0042	4.990005	233.7554
I2 [A]	-87.07595	148.6709	235.7469	-0.611335	111.5558
I3 [A]	20.95199	152.1286	131.1766	-3.959769	124.5676
U+_PU [V]	0.998482	0.683576	-0.314906	0.692964	0.694428
Ip+_PU [W]	0.203461	0.042490	-0.160971	0.051673	0.065306
Iq+_PU [var]	-1.595e-3	0.363060	0.364655	0.326875	0.345735
P_t@SG320HX [W]	65035.82	10663.15	-54372.67	16941.35	22950.65
Q_t@SG320HX [var]	2596.953	117728.6	115131.6	103247.4	109559.4

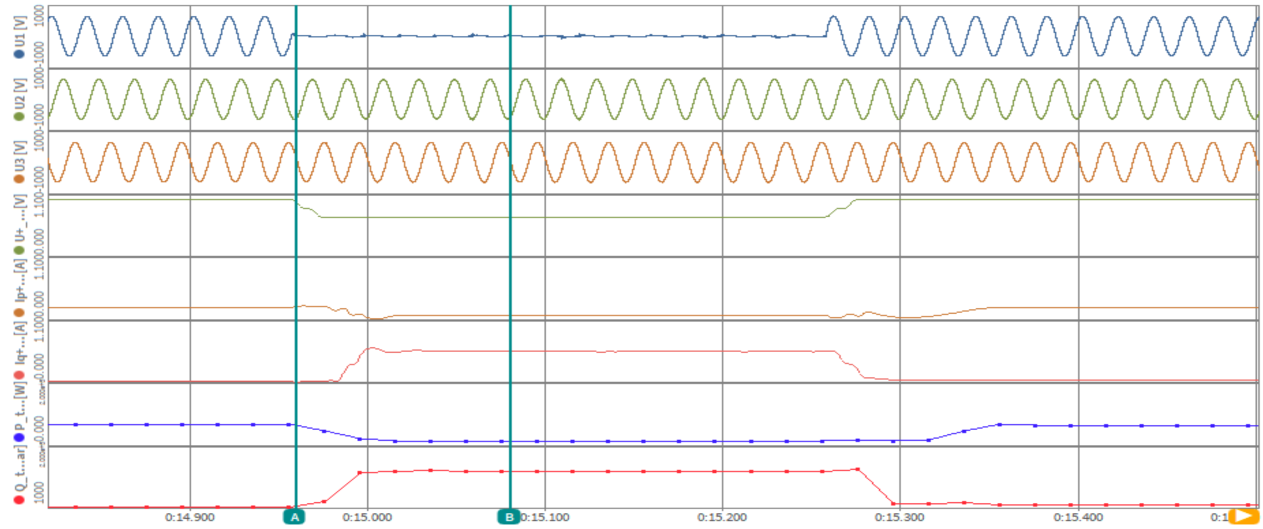
Test no. 1.2.1 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.959385	0:15.019688	0.060302		
U1 [V]	18.93747	21.53409	2.596617	1.812604	22.03877
U2 [V]	-642.9518	-629.8097	13.14211	-3.943524	462.5489
U3 [V]	247.6314	185.3258	-62.30569	1.249104	460.9159
U+_PU [V]	0.991021	0.682942	-0.308080	0.724442	0.729271
Ip+_PU [A]	0.206106	0.058508	-0.147599	0.121697	0.149928
Iq+_PU [A]	-7.994e-3	0.528305	0.536298	0.252392	0.355411
P_t@SG320HX [W]	65035.82	9309.901	-55725.92	34123.42	40748.88
Q_t@SG320HX [var]	2596.953	116629.1	114032.2	62820.48	82180.85

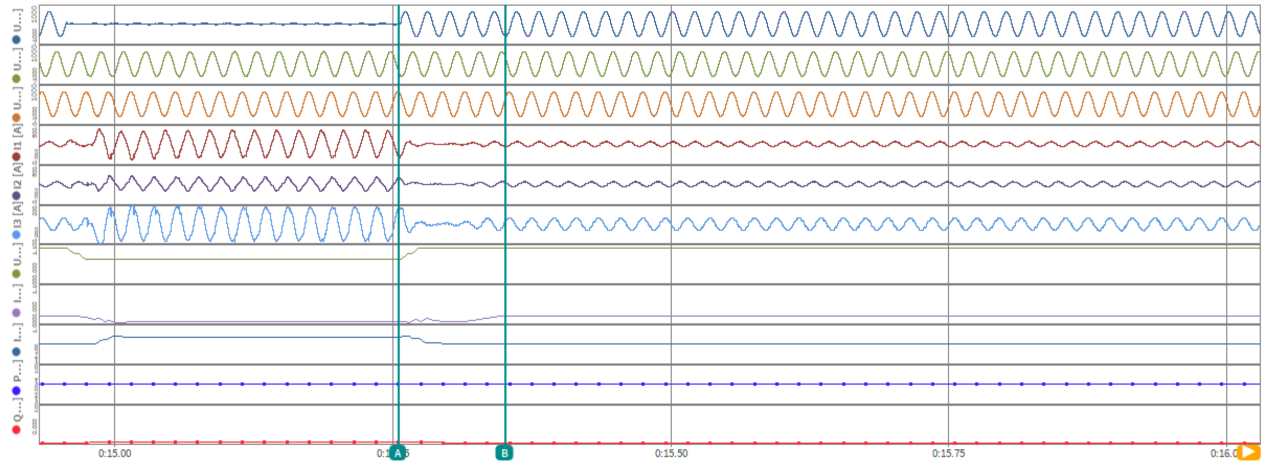
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.2.1 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.959385	0:15.080279	0.120894		
U1 [V]	18.93747	29.12688	10.18941	1.863805	22.53992
U2 [V]	-642.9518	-599.1007	43.85102	-4.879708	463.1921
U3 [V]	247.6314	62.80077	-184.8307	1.077908	460.5965
U+_PU [V]	0.991021	0.683237	-0.307785	0.703598	0.706396
Ip+_PU [A]	0.206106	0.060051	-0.146055	0.090602	0.114086
Iq+_PU [A]	-7.994e-3	0.535964	0.543957	0.397389	0.458553
P_t@SG320HX [W]	65035.82	10686.46	-54349.37	23956.26	31548.13
Q_t@SG320HX [var]	2596.953	118228.4	115631.4	86568.35	99250.75

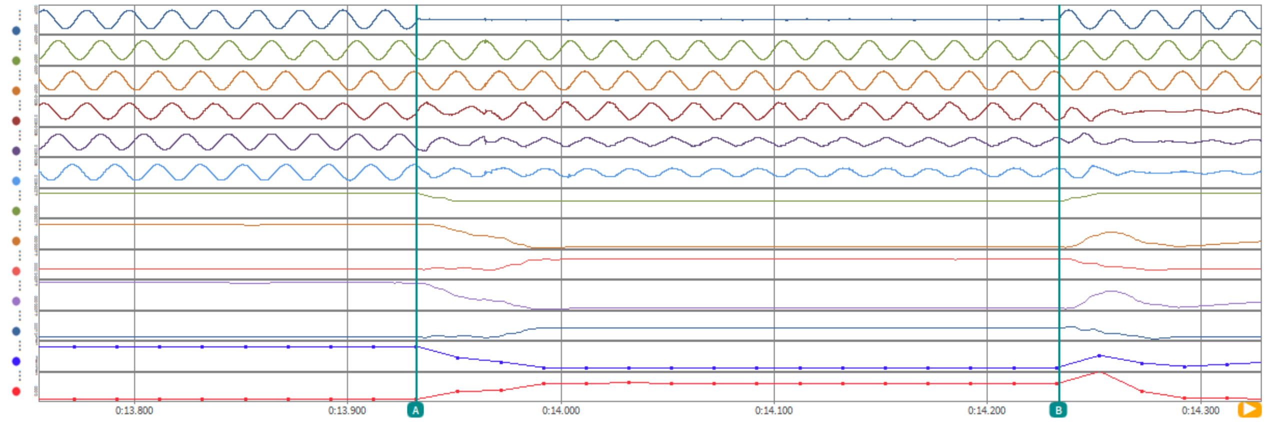
Test no. 1.2.1 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:15.2554693	0:15.3513520	0.0958827		
U1 [V]	-14.92465	-630.2538	-615.3292	23.06902	455.2975
U2 [V]	-305.5126	470.2561	775.7687	-3.413452	469.3046
U3 [V]	651.9095	164.4816	-487.4279	-19.81764	460.1798
I1 [A]	-330.4926	-65.36746	265.1252	-16.52440	78.89976
I2 [A]	167.7718	44.78979	-122.9820	11.54977	44.02640
I3 [A]	164.7564	18.36634	-146.3901	4.750023	50.08828
U+_PU [V]	0.684285	1.001265	0.316980	0.958776	0.963041
Ip+_PU [W]	0.042921	0.193106	0.150185	0.072410	0.088835
Iq+_PU [var]	0.364954	0.026352	-0.338603	0.104746	0.172394
P_t@SG320HX [W]	10663.15	43853.64	33190.49	17195.87	20981.40
Q_t@SG320HX [var]	117728.6	14568.32	-103160.2	65758.25	84878.05

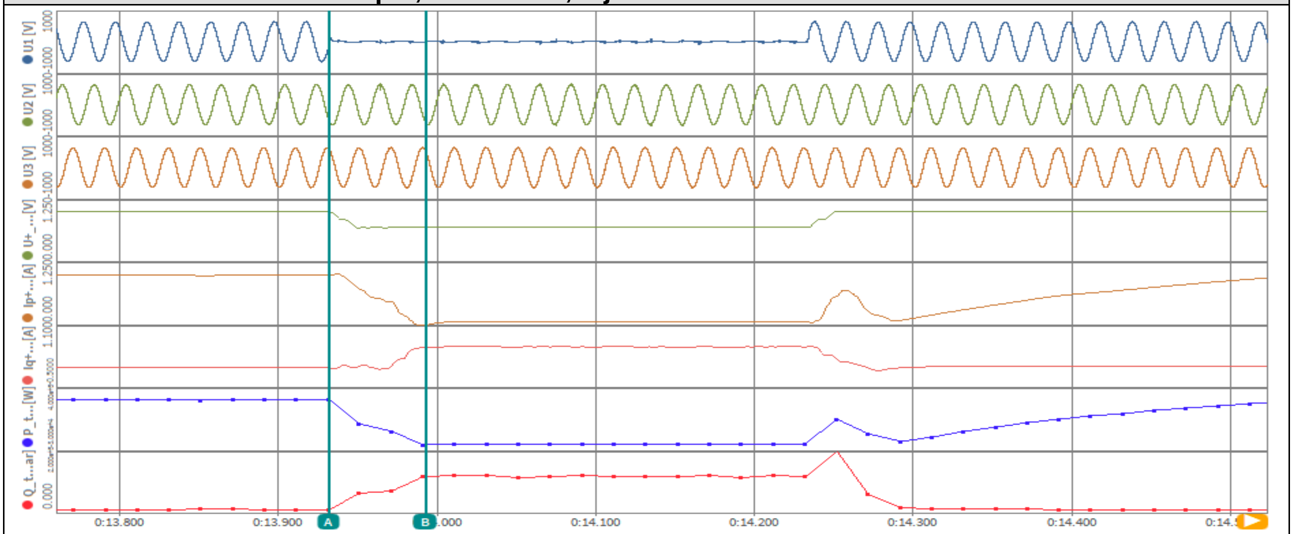
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.2.2 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=100%Pn, fault duration



	A	B	Delta	RMS
Time [s]	0:13.93237	0:14.23346	0.30110	
U1 [V]	-178.3502	4.440546	182.7908	20.40179
U2 [V]	-458.2339	-589.9803	-131.7464	462.4520
U3 [V]	629.6906	538.0340	-91.65657	463.2812
I1 [A]	-93.42778	-330.4472	-237.0194	234.0194
I2 [A]	-231.0881	173.0009	404.0890	125.7868
I3 [A]	321.1603	160.4796	-160.6808	127.4360
U+_PU [V]	0.999639	0.679904	-0.319735	0.693707
Ip+_PU [A]	0.993550	0.042616	-0.950934	0.292393
Iq+_PU [A]	-1.429e-3	0.530904	0.532333	0.485242
Ip+_PU [W]	0.993234	0.028976	-0.964258	0.241281
Iq+_PU [var]	-1.429e-3	0.360979	0.362408	0.330003
P_t@SG320HX [W]	318938.6	7211.922	-311726.7	117352.8
Q_t@SG320HX [var]	5995.103	117060.6	111065.5	104915.8

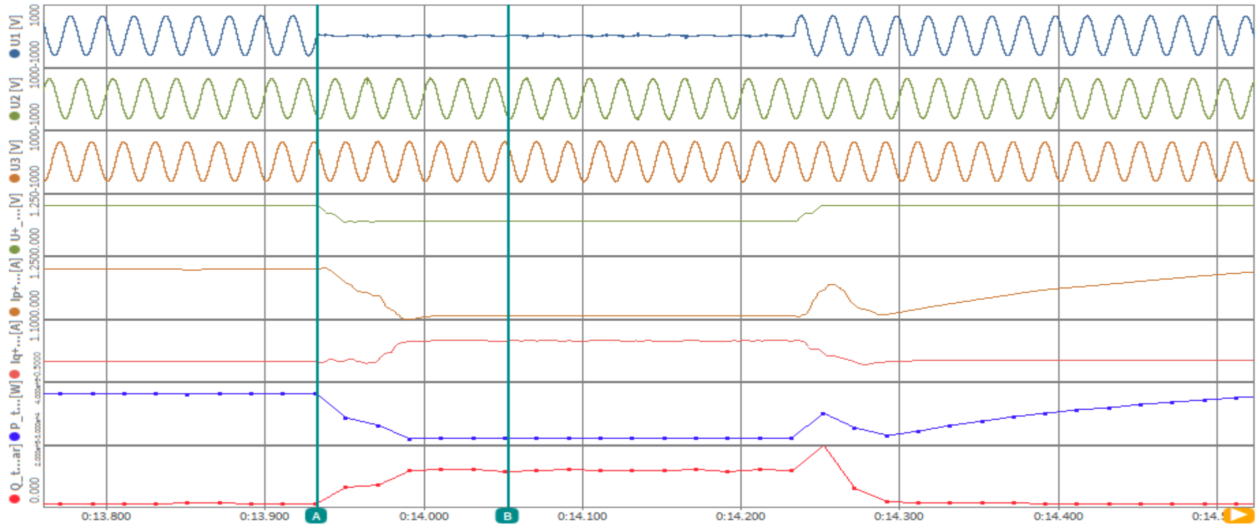
Test no. 1.2.2 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.93266	0:13.99324	0.06057		
U1 [V]	-115.8328	4.909516	120.7423	2.795764	22.17476
U2 [V]	-498.9128	-565.5338	-66.62095	-6.231746	461.2059
U3 [V]	609.6483	562.3238	-47.32442	6.849620	463.3218
U+_PU [V]	0.999680	0.676319	-0.323361	0.732086	0.739057
Ip+_PU [A]	0.993497	-0.017905	-1.011402	0.534052	0.632517
Iq+_PU [A]	-1.234e-3	0.518453	0.519687	0.113297	0.214223
P_t@SG320HX [W]	318938.6	-1518.058	-320456.7	175338.8	216090.8
Q_t@SG320HX [var]	5995.103	115461.2	109466.1	51854.25	66273.58

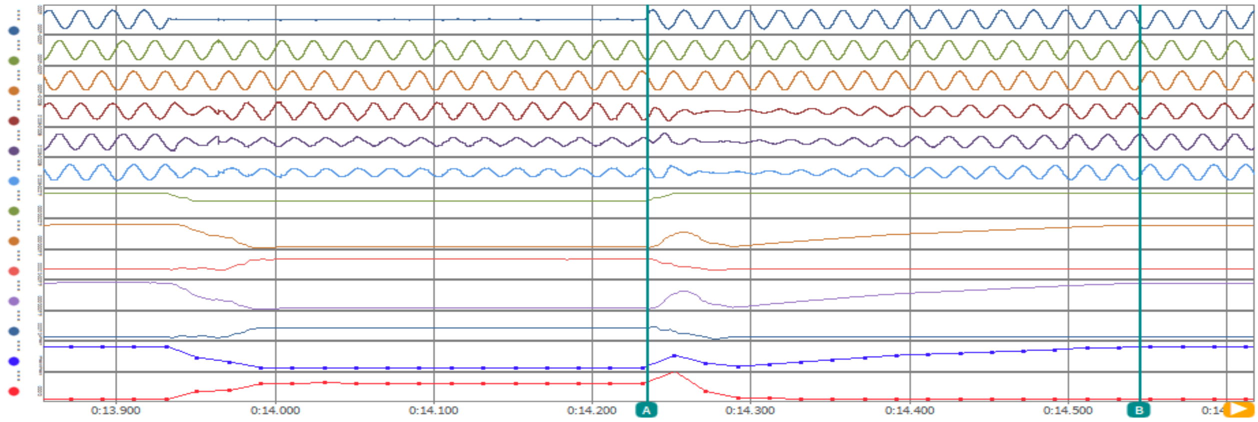
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.2.2 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.933117	0:14.053358	0.120241		
U1 [V]	-12.80701	2.939940	15.74695	2.831584	19.86749
U2 [V]	-556.8287	-576.9165	-20.08784	-1.489623	461.2961
U3 [V]	568.7038	551.3990	-17.30478	1.560856	462.4446
U+_PU [V]	0.999680	0.679219	-0.320461	0.705759	0.709910
Ip+_PU [A]	0.993497	0.053820	-0.939677	0.286356	0.449940
Iq+_PU [A]	-1.234e-3	0.520426	0.521659	0.321362	0.404991
P_t@SG320HX [W]	318938.6	8381.084	-310557.5	112398.2	170897.0
Q_t@SG320HX [var]	5995.103	114267.1	108272.0	76467.95	89014.94

Test no. 1.2.2 Single-pole short circuit with earth (type B)
U/Un = 0 p.u, P=100%Pn, Active power recovery time



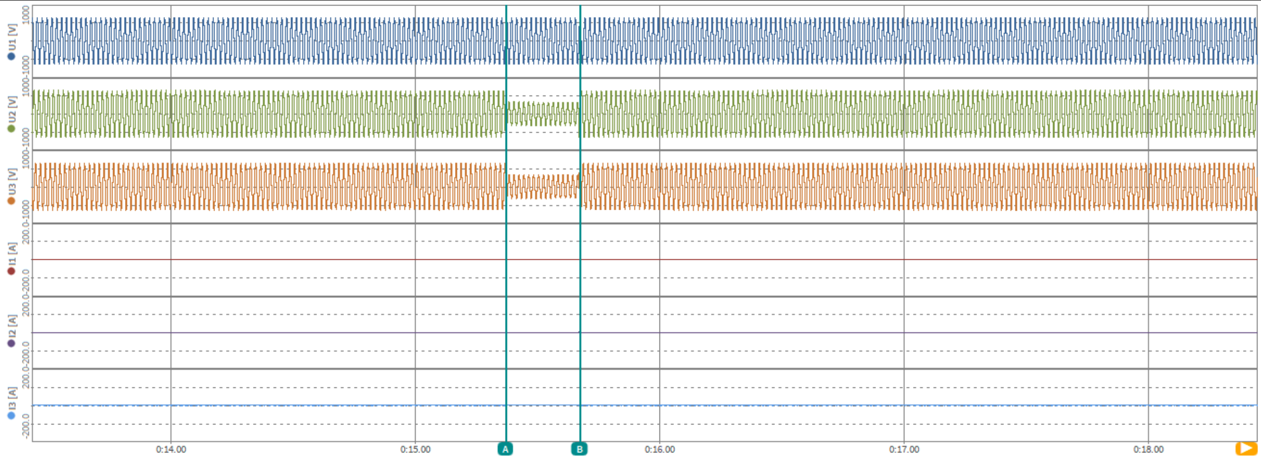
	A	B	Delta	Avg	RMS
Time [s]	0:14.234953	0:14.544779	0.309826		
U1 [V]	340.3774	-311.7315	-652.1088	9.627763	462.5983
U2 [V]	-652.4040	652.1863	1304.590	0.511601	462.0561
U3 [V]	320.0264	-345.6609	-665.6874	-11.71712	461.9396
I1 [A]	-305.1975	-147.8013	157.3962	-3.528650	153.4679
I2 [A]	135.8647	316.8557	180.9909	6.921266	151.3516
I3 [A]	164.6422	-165.0508	-329.6930	-3.710432	151.8943
U+_PU [V]	0.682043	0.999551	0.317508	0.991019	0.992011
Ip+_PU [A]	0.041060	0.973279	0.932219	0.550175	0.617768
Iq+_PU [A]	0.534012	0.010902	-0.523109	0.036685	0.108761
Ip+_PU [W]	0.028006	0.972883	0.944878	0.549390	0.617549
Iq+_PU [var]	0.364234	0.010898	-0.353336	0.032292	0.089840
P_t@SG320HX [W]	7211.922	306901.6	299689.6	168993.3	193069.8
Q_t@SG320HX [var]	117060.6	7019.143	-110041.4	30732.45	60078.60

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
	0	Test number	--	--	--	1.3.1	1.3.2
Before dip < t_1	1	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	460.5	469
	2		Phase 2			463.3	461
	3		Phase 3			460.9	463
	4	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	46.9	232
	5		Phase 2			47.2	232
	6		Phase 3			46.8	233
	7	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.2	1.00
	8		total		W	65052	322277
	9	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.001	0.01
	10		total		var	2850	6960
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	457.8	460
	12		Phase 2			229.8	231
	13		Phase 3			229.9	231
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	15.2	13
	15		Phase 2			210.0	209
	16		Phase 3			201.2	204
	17	Total fault duration	All phase	t_1 to t_2	ms	302	302
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.27	0.27
	19		total		var	102978	10265
	20	Reactive current	Positive sequence		p.u.	0.52	0.53
	21	Active power	Positive sequence		p.u.	0.025	0.02
	22		total		W	6816	3942
	23	Active current	Positive sequence		p.u.	0.05	0.03
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.56	0.52
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.53	0.52
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	461	463
	27		Phase 2			462	460
	28		Phase 3			460	461
	29	Current	Phase 1	t_2+1s	Arms	47	233
	30		Phase 2			47.1	231
	31		Phase 3			46.8	230
	32	Active power	Positive sequence	t_2+1s	p.u.	0.2	1.00
	33		total		W	65052	322277
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.001	0.01
	35		total		Var	2850	6960
	36	Active power recovery time	Positive sequence	--	ms	979	730

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.3.0 two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=0, Fault Duration

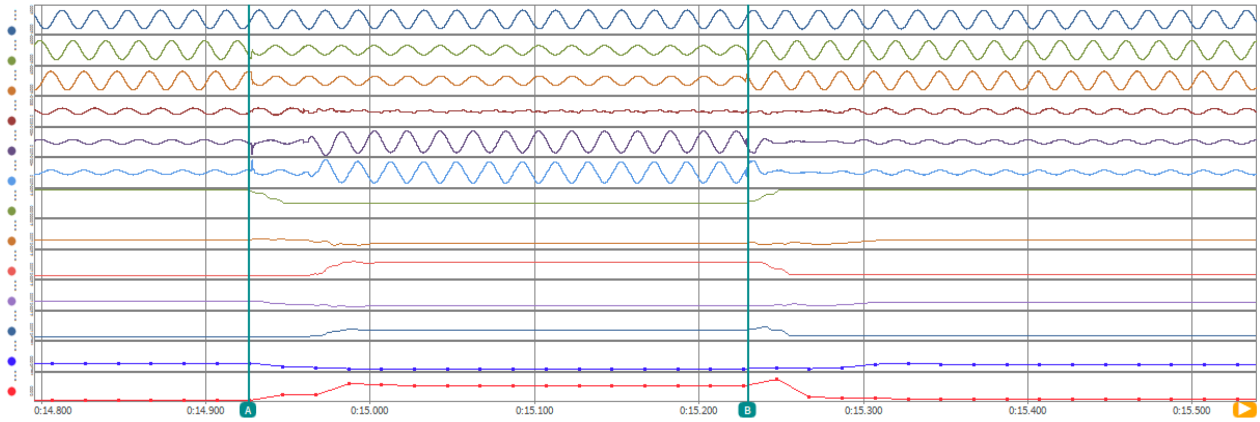


	A	B	间隔	有效值
时间 [s]	0:15.371619	0:15.674552	0.302932	
U1 [V]	331.8721	645.4275	313.5554	462.2694
U2 [V]	-185.1864	-390.9205	-205.7341	239.6224
U3 [V]	-154.1152	-255.8355	-101.7203	232.5854
I1 [A]	0.252485	0.107646	-0.144839	0.489766
I2 [A]	0.208974	-0.434637	-0.643611	0.282091
I3 [A]	0.345588	0.294685	-0.050902	0.417774

	A	B	间隔
时间 [s]	0:15.391238	0:15.667822	0.276584
U+_PU [V]	0.516601	0.514509	-2.092e-3
U-_PU [V]	0.485729	0.484628	-1.101e-3
Ip+_PU [A]	1.039e-4	8.698e-5	-1.689e-5
Ip-_PU [A]	-3.844e-5	-1.789e-5	2.055e-5
Iq+_PU [A]	2.610e-4	2.494e-4	-1.159e-5
Iq-_PU [A]	1.477e-4	1.477e-4	3.774e-9

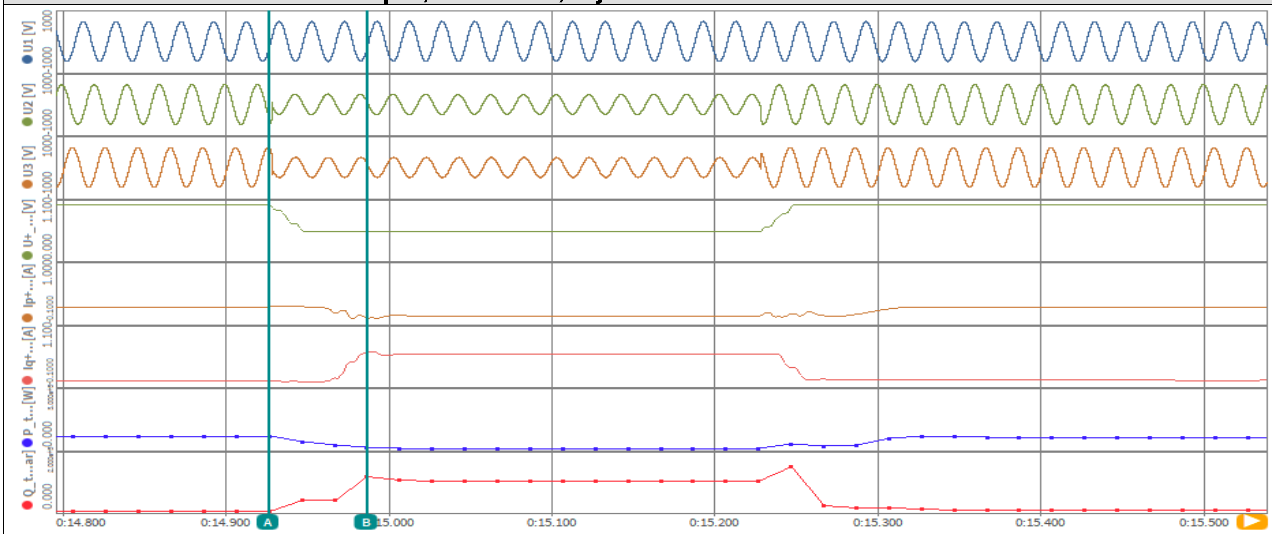
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.3.1 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=20%Pn, fault duration



	A	B	Delta	RMS
Time [s]	0:14.9264138	0:15.2297992	0.3033854	
U1 [V]	-370.6607	276.3289	646.9896	459.1091
U2 [V]	-285.8259	-644.3942	-358.5683	236.3904
U3 [V]	652.2165	369.8113	-282.4052	237.8909
I1 [A]	-36.47983	-4.277110	32.20272	22.71832
I2 [A]	-31.18873	-142.1415	-110.9527	198.9637
I3 [A]	64.60870	144.7314	80.12271	190.2907
U+_PU [V]	0.999199	0.524290	-0.474909	0.546793
Ip+_PU [A]	0.203758	0.045749	-0.158009	0.089757
Iq+_PU [A]	-1.953e-4	0.527504	0.527699	0.482856
Ip+_PU [W]	0.203603	0.023987	-0.179616	0.059806
Iq+_PU [var]	-1.952e-4	0.276577	0.276772	0.250695
P_t@SG320HX [W]	65041.66	6793.222	-58248.44	25556.87
Q_t@SG320HX [var]	2398.351	102686.6	100288.2	91974.60

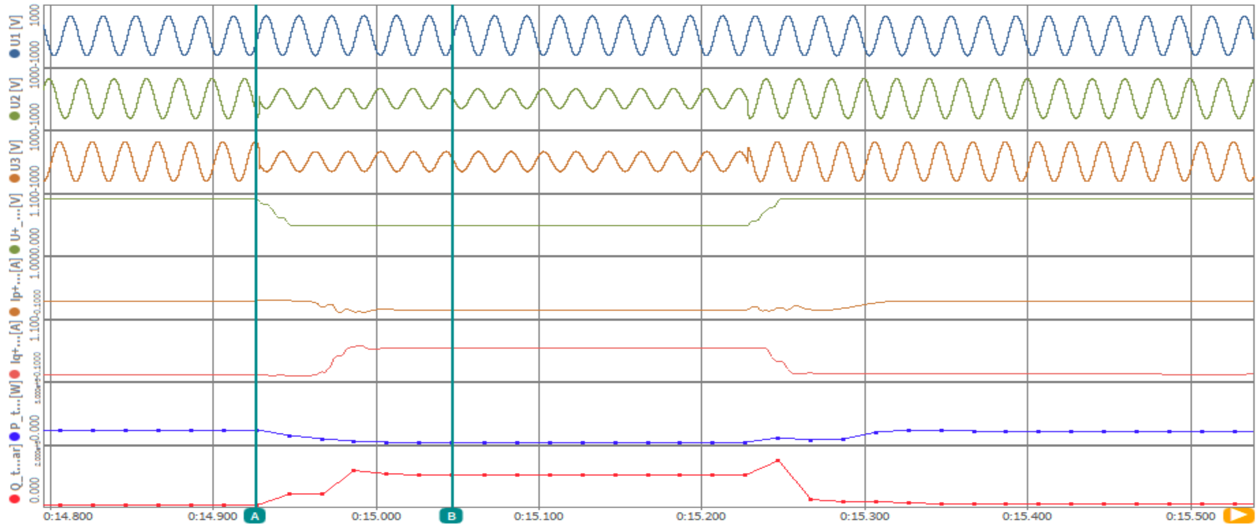
Test no. 1.3.1 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.926380	0:14.986624	0.060244		
U1 [V]	-382.9055	-333.7724	49.13307	-1.965542	460.5430
U2 [V]	-272.3102	151.2597	423.5698	-19.68395	250.3994
U3 [V]	647.7716	189.0025	-458.7691	21.43727	263.2513
U+_PU [V]	0.999199	0.519647	-0.479552	0.624100	0.645191
Ip+_PU [A]	0.203758	0.020762	-0.182996	0.160442	0.175950
Iq+_PU [A]	-1.953e-4	0.560549	0.560744	0.100313	0.202526
P_t@SG320HX [W]	65041.66	22289.34	-42752.32	47713.85	51091.91
Q_t@SG320HX [var]	2398.351	39621.40	37223.05	20937.81	27874.67

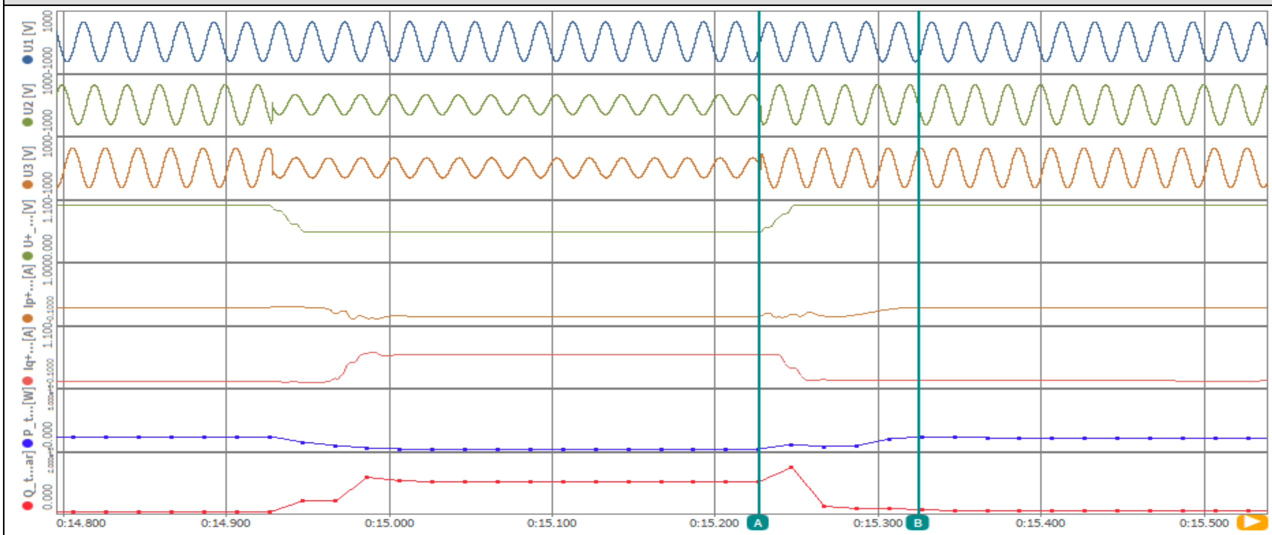
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.3.1 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.926380	0:15.046868	0.120488		
U1 [V]	-382.9055	-298.7737	84.13184	-1.402640	460.4278
U2 [V]	-272.3102	130.1241	402.4343	-9.590140	241.5478
U3 [V]	647.7716	167.8760	-479.8956	10.97175	248.1581
U+_PU [V]	0.999199	0.519146	-0.480053	0.572163	0.586182
Ip+_PU [A]	0.203758	0.048961	-0.154797	0.101479	0.128793
Iq+_PU [A]	-1.953e-4	0.529220	0.529415	0.315067	0.402322
P_t@SG320HX [W]	65041.66	6616.628	-58425.03	30801.93	39010.25
Q_t@SG320HX [var]	2398.351	102797.6	100399.3	58252.88	73879.83

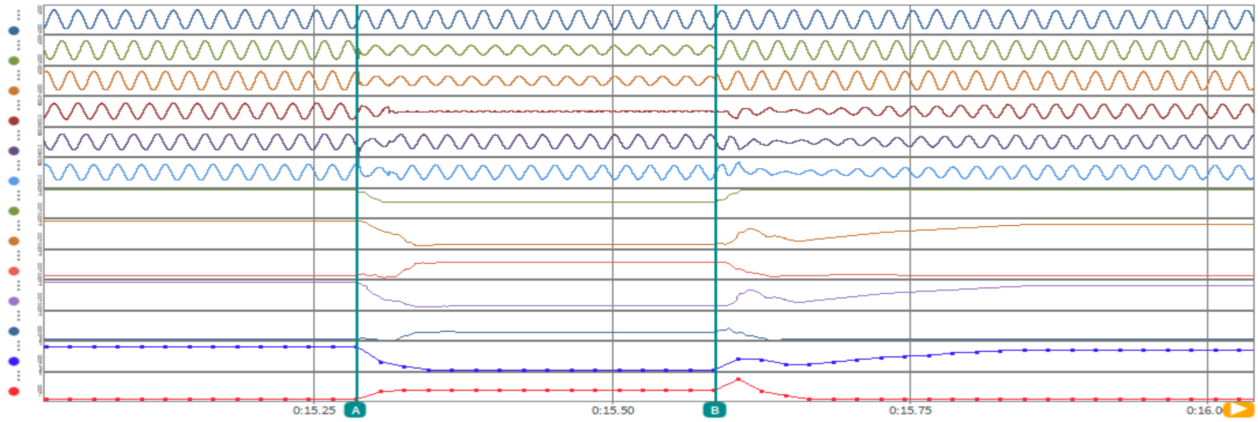
Test no. 1.3.1 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:15.226763	0:15.324660	0.097897		
U1 [V]	-315.6021	-596.8877	-281.2857	9.078287	461.6750
U2 [V]	139.6800	68.22658	-71.45346	14.57180	456.4277
U3 [V]	178.7778	525.5943	346.8164	-23.62333	447.6954
U+_PU [V]	0.519005	0.998258	0.479253	0.929213	0.939835
Ip+_PU [A]	0.049310	0.199810	0.150501	0.093471	0.108990
Iq+_PU [A]	0.529399	0.029229	-0.500170	0.145852	0.240803
P_t@SG320HX [W]	6820.528	55250.65	48430.12	22365.79	27767.71
Q_t@SG320HX [var]	102761.1	14513.83	-88247.28	67365.45	85908.02

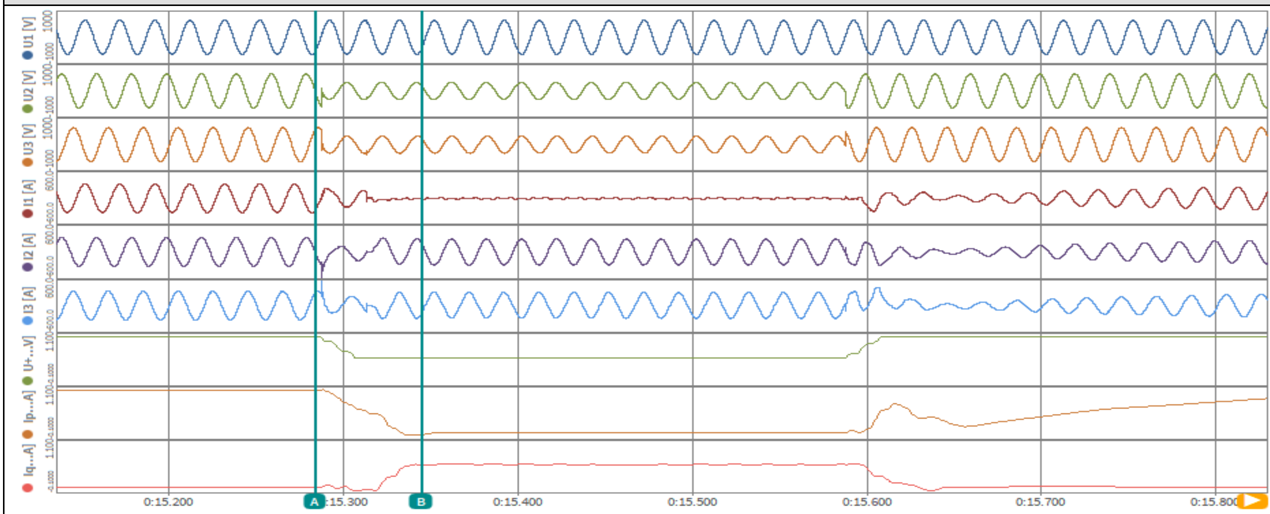
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.3.2 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:15.285320	0:15.586832	0.301513		
U1 [V]	-452.4046	-197.4300	254.9746	-2.404742	460.6503
U2 [V]	-187.4197	76.22219	263.6418	-3.369235	235.6116
U3 [V]	630.8979	117.9323	-512.9656	5.295567	239.6914
I1 [A]	-225.3368	-26.22485	199.1120	-3.238956	47.86897
I2 [A]	-93.80651	77.34299	171.1495	-0.845332	204.5774
I3 [A]	318.2370	-52.96934	-371.2063	3.490122	200.4047
U+_PU [V]	0.999630	0.519365	-0.480265	0.541604	0.548531
Ip+_PU [A]	1.006275	0.032828	-0.973447	0.123942	0.273147
Iq+_PU [A]	-1.293e-3	0.525683	0.526976	0.445905	0.482443
Ip+_PU [W]	1.005945	0.017050	-0.988895	0.084964	0.218623
Iq+_PU [var]	-1.293e-3	0.273033	0.274326	0.232047	0.250758
P_t@SG320HX [W]	321934.8	4029.733	-317905.1	52716.13	117798.9
Q_t@SG320HX [var]	5611.179	101642.0	96030.87	90255.36	95768.70

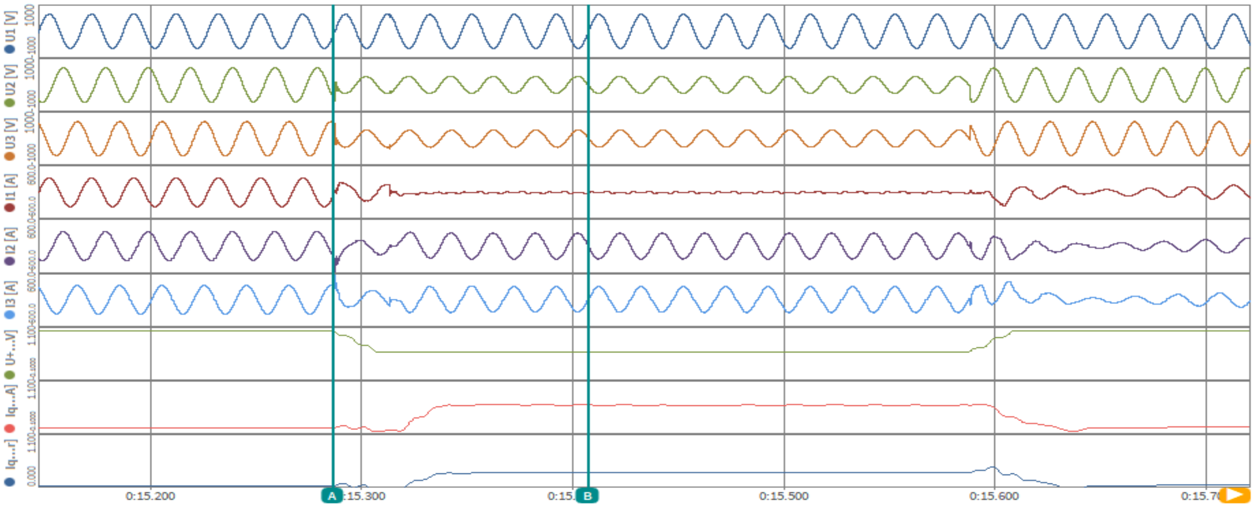
Test no. 1.3.2 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.284423	0:15.345068	0.060645		
U1 [V]	-568.4021	-496.8977	71.50436	-6.433062	461.2255
U2 [V]	4.788041	236.3244	231.5364	-25.01988	248.8470
U3 [V]	563.7092	263.7974	-299.9118	30.52402	276.5636
I1 [A]	-288.3121	-19.12105	269.1910	-4.689104	108.1000
I2 [A]	-8.379460	223.2292	231.6086	-1.966976	181.1233
I3 [A]	292.8111	-206.5780	-499.3891	6.266738	184.6705
U+_PU [V]	0.999647	0.519392	-0.480255	0.634258	0.657266
Ip+_PU [A]	1.006219	-0.029931	-1.036150	0.497066	0.612945
Iq+_PU [A]	-1.360e-3	0.516328	0.517688	0.129967	0.246883

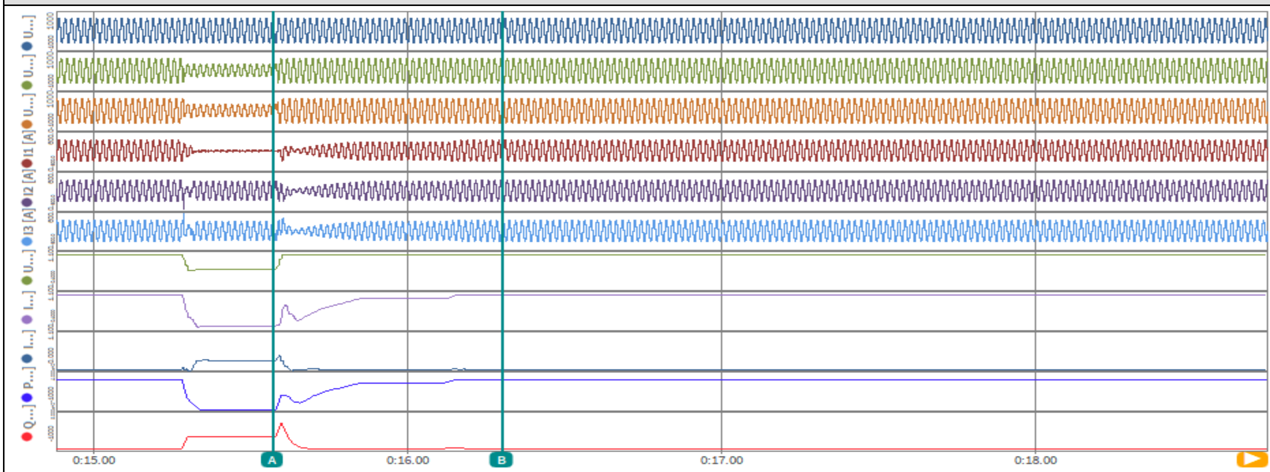
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.3.2 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 120ms



Time [s]	A 0:15.286946	B 0:15.407466	Delta 0.120520	Avg	RMS
U1 [V]	-175.1695	-70.43791	104.7316	-1.332320	459.4901
U2 [V]	-461.8569	16.47461	478.3315	-4.726566	238.8420
U3 [V]	628.0464	57.07920	-570.9672	5.458380	240.6728
I1 [A]	-83.45867	-20.40327	63.05540	-1.778198	71.45028
I2 [A]	-230.3515	9.857894	240.2094	2.801290	196.2929
I3 [A]	316.2704	9.179831	-307.0905	-1.421140	190.8108
U+_PU [V]	0.999653	0.519753	-0.479900	0.570012	0.583419
Iq+_PU [A]	-1.201e-3	0.525877	0.527078	0.333009	0.413781
Iq+_PU [var]	-1.201e-3	0.273338	0.274539	0.173833	0.215133

Test no. 1.3.2 Two-pole short circuit without earth (type C)
U/Un = 0 p.u, P=100%Pn, Active power recovery time



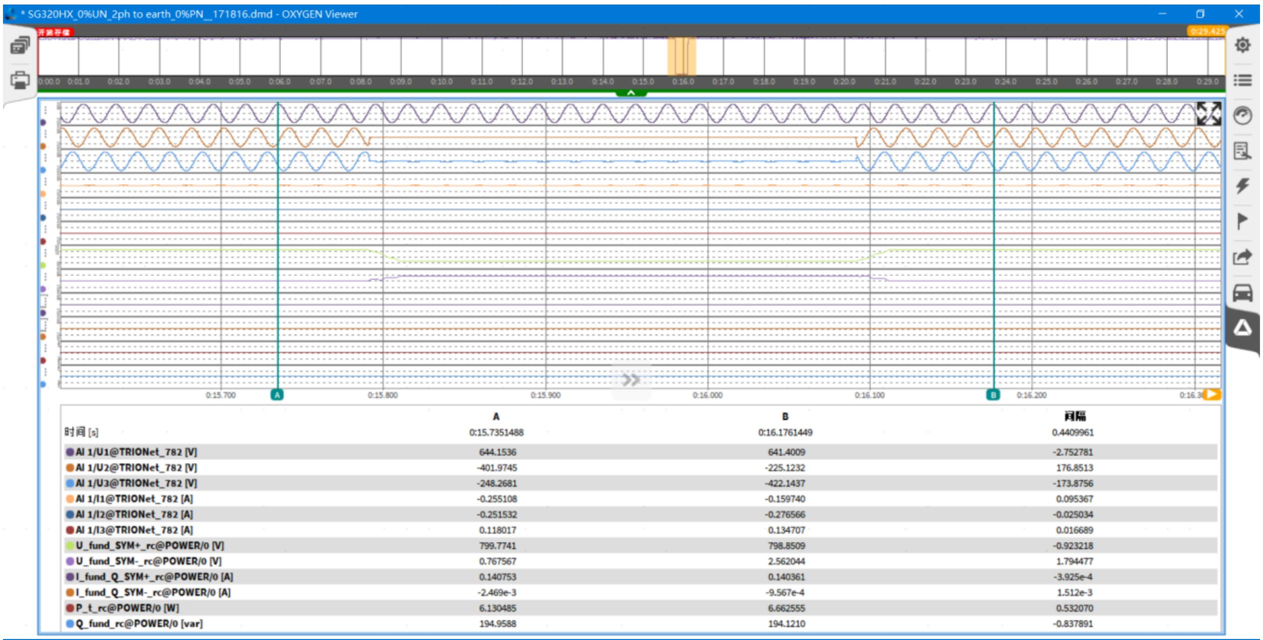
Time [s]	A 0:15.574102	B 0:16.303846	Delta 0.729744	Avg	RMS
U1 [V]	596.2484	-610.8883	-1207.137	-2.222786	462.2183
U2 [V]	-286.2631	113.0061	399.2692	3.295051	457.7641
U3 [V]	-305.9145	500.4511	806.3657	-0.831410	456.6860
I1 [A]	1.299501	-310.0861	-311.3857	-2.859409	188.2573
I2 [A]	-265.6276	63.15232	328.7800	-0.343108	191.5146
I3 [A]	260.4901	242.0080	-18.48209	1.476741	191.7827
U+_PU [V]	0.519395	0.999934	0.480539	0.982245	0.985640
Ip+_PU [W]	0.017387	1.004568	0.987180	0.755264	0.799957
Iq+_PU [var]	0.272640	0.013763	-0.258877	0.026404	0.071615
P_t@SG320HX [W]	4029.733	321164.2	317134.5	236211.5	252411.6
Q_t@SG320HX [var]	101642.0	9158.489	-92483.56	21868.56	46351.19

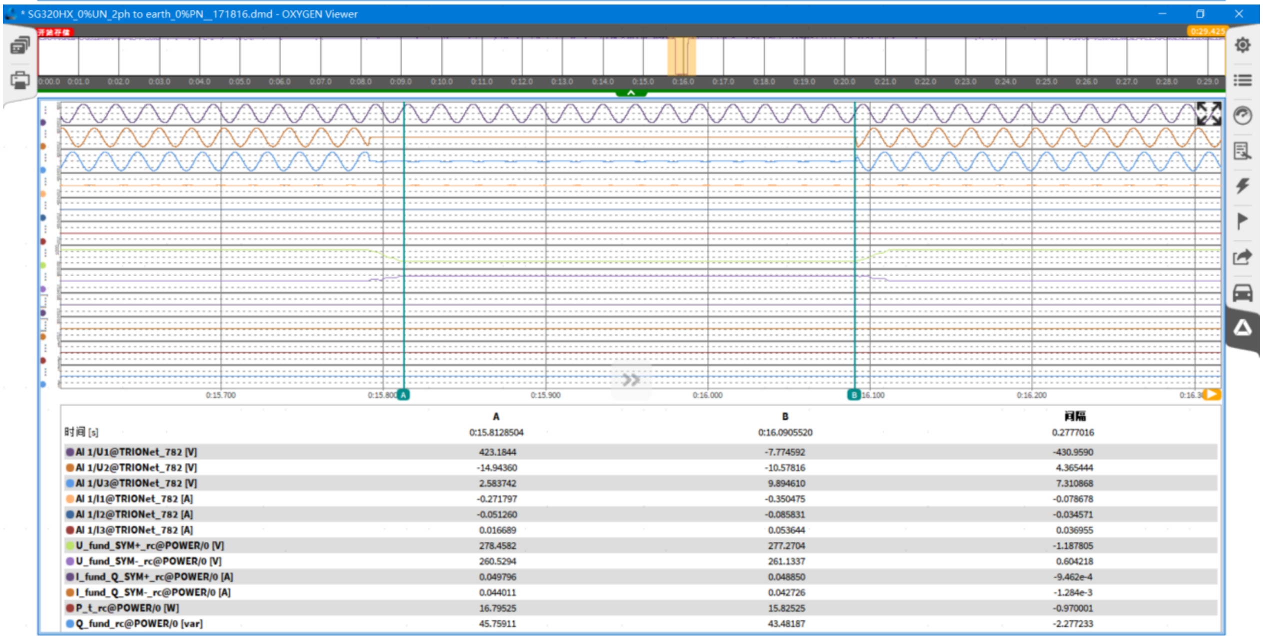
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
	37	Test number	--	--	--	1.4.1	1.4.2
Before dip < t_1	38	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	461.9	462.6
	39		Phase 2			461.9	461.8
	40		Phase 3			461.8	462.2
	41	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	48.3	230.8
	42		Phase 2			46.5	230.0
	43		Phase 3			46.4	230.4
	44	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.21	1.00
	45		total		W	65618	319740
	46	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	-0.02	0.00
	47		total		var	-5521	157
During dip t_1 to t_2	48	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	463.0	462.7
	49		Phase 2			13.5	13.6
	50		Phase 3			12.7	14.2
	51	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	84.8	85.4
	52		Phase 2			213.9	215.5
	53		Phase 3			206.8	205.5
	54	Total fault duration	All phase	t_1 to t_2	ms	269	252
	55	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.14	0.14
	56		total		var	43452	43982
	57	Reactive current	Positive sequence		p.u.	0.63	0.63
	58	Active power	Positive sequence		p.u.	0.03	0.02
	59		total		W	8054	5911
	60	Active current	Positive sequence		p.u.	0.03	0.02
	61	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.63	0.63
	62	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.63	0.63
After dip > t_2	63	Voltage	Phase 1	t_2+1s	Vrms	462.1	462.6
	64		Phase 2			461.9	461.9
	65		Phase 3			461.6	462.1
	66	Current	Phase 1	t_2+1s	Arms	48.0	230.7
	67		Phase 2			47.5	230.1
	68		Phase 3			48.0	230.1
	69	Active power	Positive sequence	t_2+1s	p.u.	0.21	1.00
	70		total		W	66792	318511
	71	Reactive power	Positive sequence	t_2+1s	p.u.	0.00	0.00
	72		total		Var	1268	1066
	73	Active power recovery time	Positive sequence	--	ms	79	523

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

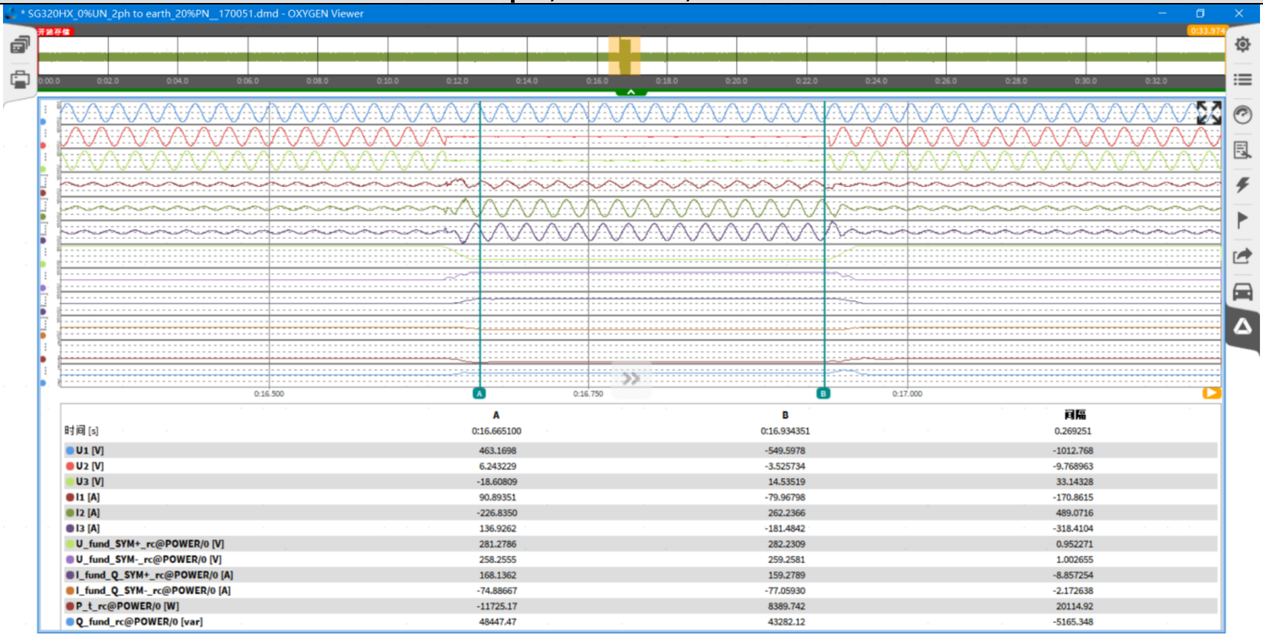
Test no. 1.4.0 Two phase to earth fault (type E)
U/Un = 0 p.u, P=0, Fault Duration





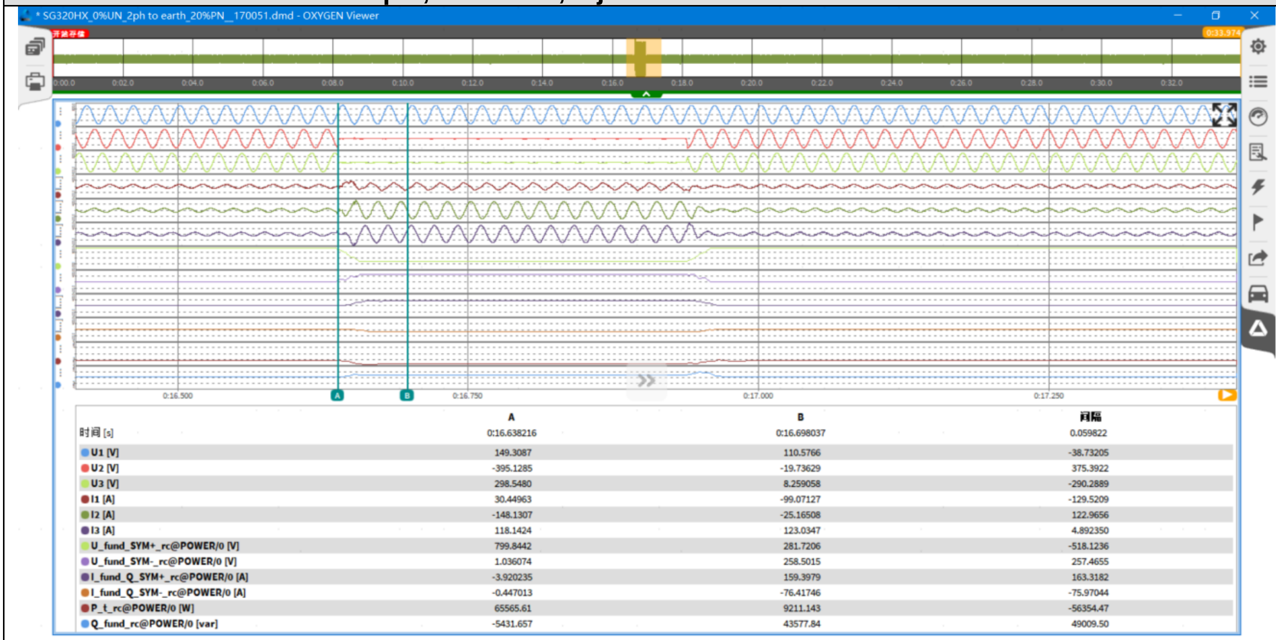
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.4.1 Two phase to earth fault (type E)
U/Un = 0 p.u, P=20%Pn, fault duration



时间 [s]	A 0:16.665100	B 0:16.934351	间隔 0.269251
U1 [V]	463.1698	-549.5978	-1012.768
U2 [V]	6.243229	-3.525734	-9.768963
U3 [V]	-18.60809	14.53519	33.14328
I1 [A]	90.89351	-79.96798	-170.8615
I2 [A]	-226.8350	262.2366	489.0716
I3 [A]	136.9262	-181.4842	-318.4104
U_fund_SYM+_rc@POWER/0 [V]	281.2786	282.2309	0.952271
U_fund_SYM-_rc@POWER/0 [V]	258.2555	259.2581	1.002655
I_fund_Q_SYM+_rc@POWER/0 [A]	168.1362	159.2789	-8.857254
I_fund_Q_SYM-_rc@POWER/0 [A]	-74.88667	-77.05930	-2.172638
P_t_rc@POWER/0 [W]	-11725.17	8389.742	20114.92
Q_fund_rc@POWER/0 [var]	48447.47	43282.12	-5165.348

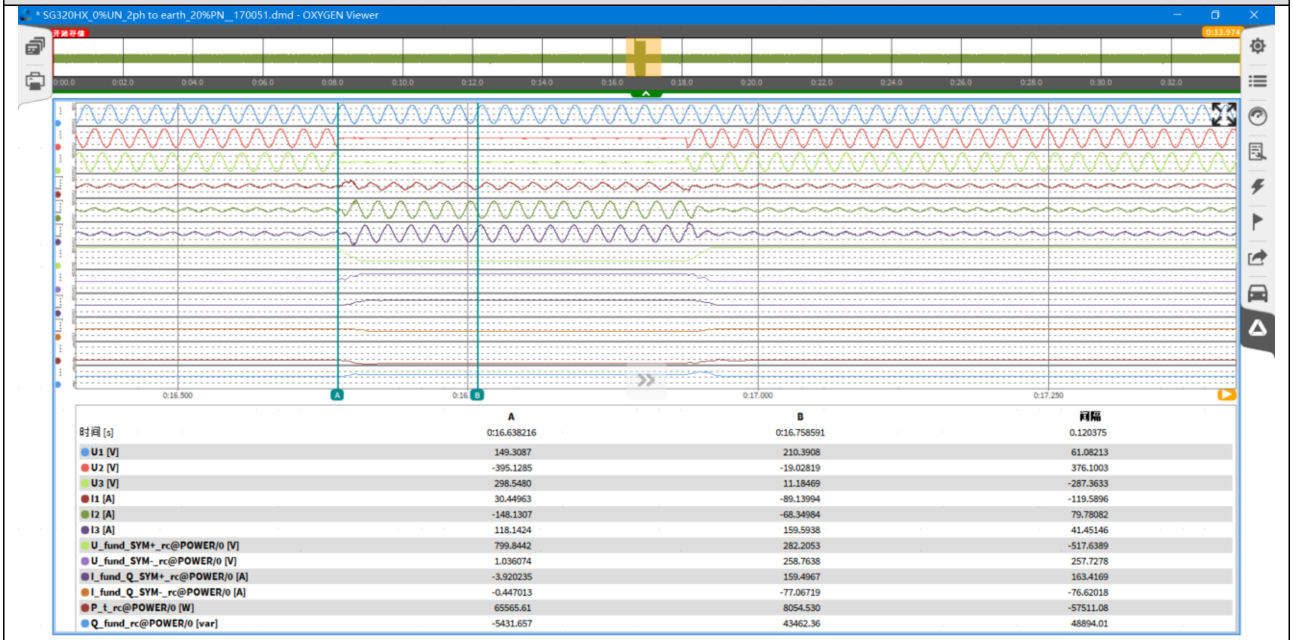
Test no. 1.4.1 Two phase to earth fault (type E)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 60ms



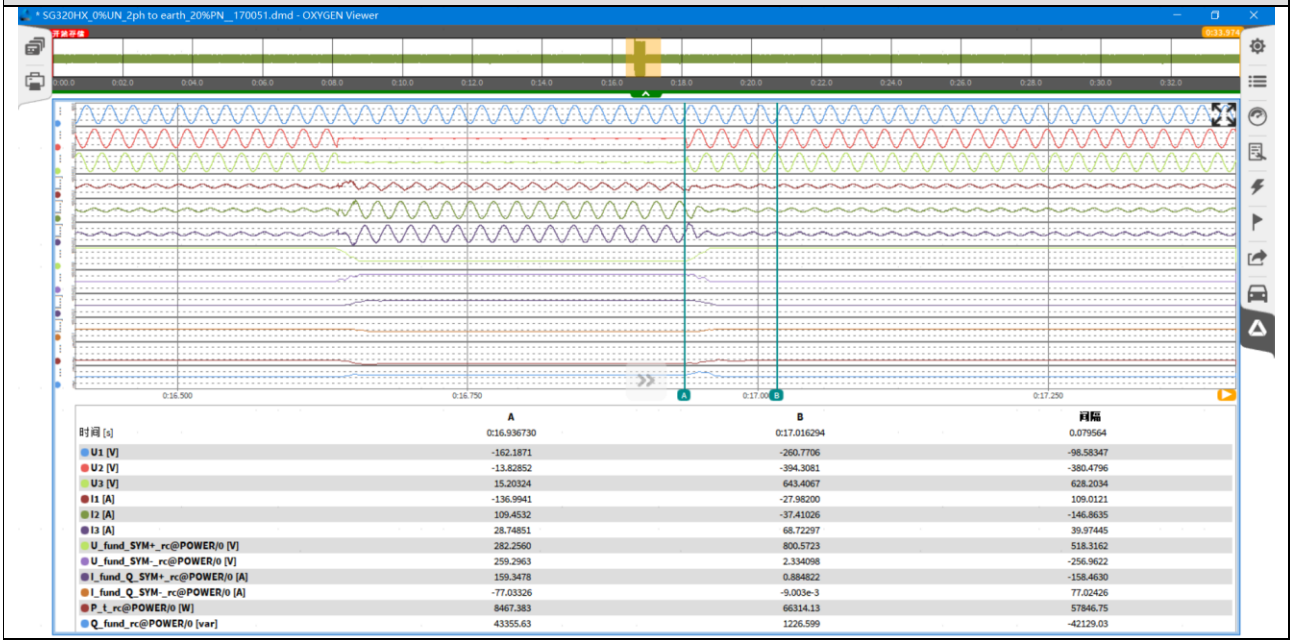
时间 [s]	A 0:16.638216	B 0:16.698037	间隔 0.059822
U1 [V]	149.3087	110.5766	-38.73205
U2 [V]	-395.1285	-19.73629	375.3922
U3 [V]	298.5480	8.259058	-290.2889
I1 [A]	30.44963	-99.07127	-129.5209
I2 [A]	-148.1307	-25.16508	122.9656
I3 [A]	118.1424	123.0347	4.892350
U_fund_SYM+_rc@POWER/0 [V]	799.8442	281.7206	-518.1236
U_fund_SYM-_rc@POWER/0 [V]	1.036074	258.5015	257.4655
I_fund_Q_SYM+_rc@POWER/0 [A]	-3.920235	159.3979	163.3182
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.447013	-76.41746	-75.97044
P_t_rc@POWER/0 [W]	65565.61	9211.143	-56354.47
Q_fund_rc@POWER/0 [var]	-5431.657	43577.84	49009.50

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.4.1 Two phase to earth fault (type E)
U/Un = 0 p.u, P=20%Pn, Injected reactive Current after 120ms

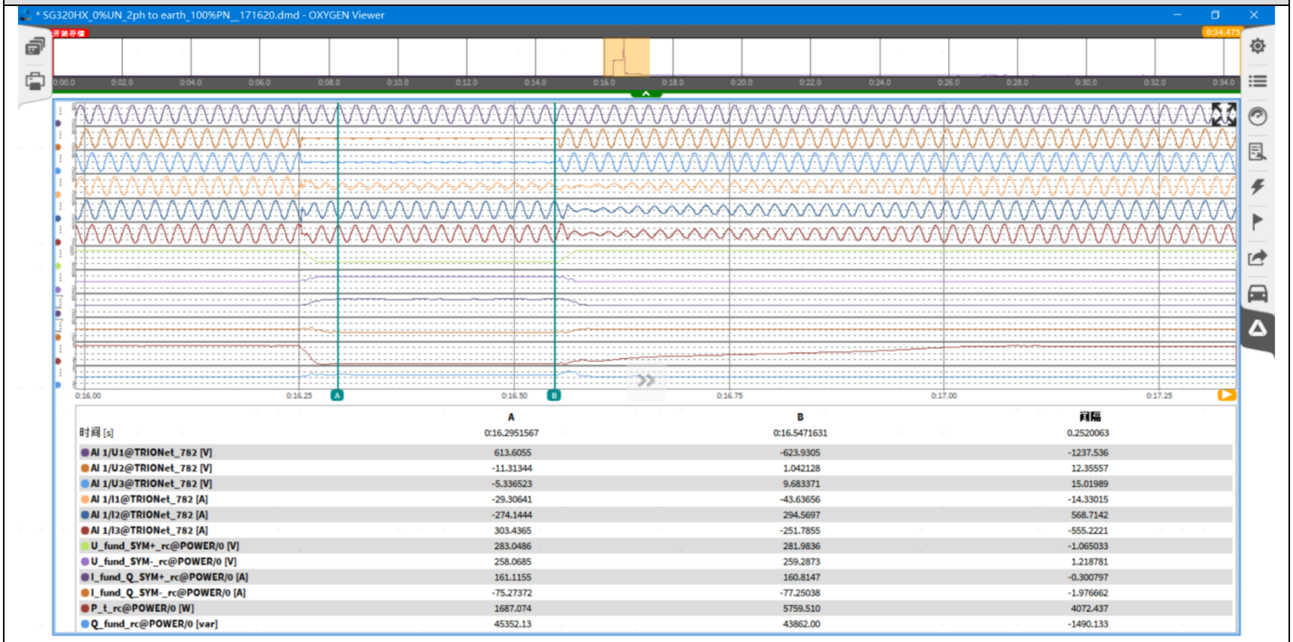


Test no. 1.4.1 Two phase to earth fault (type E)
U/Un = 0 p.u, P=20%Pn, Active power recovery time



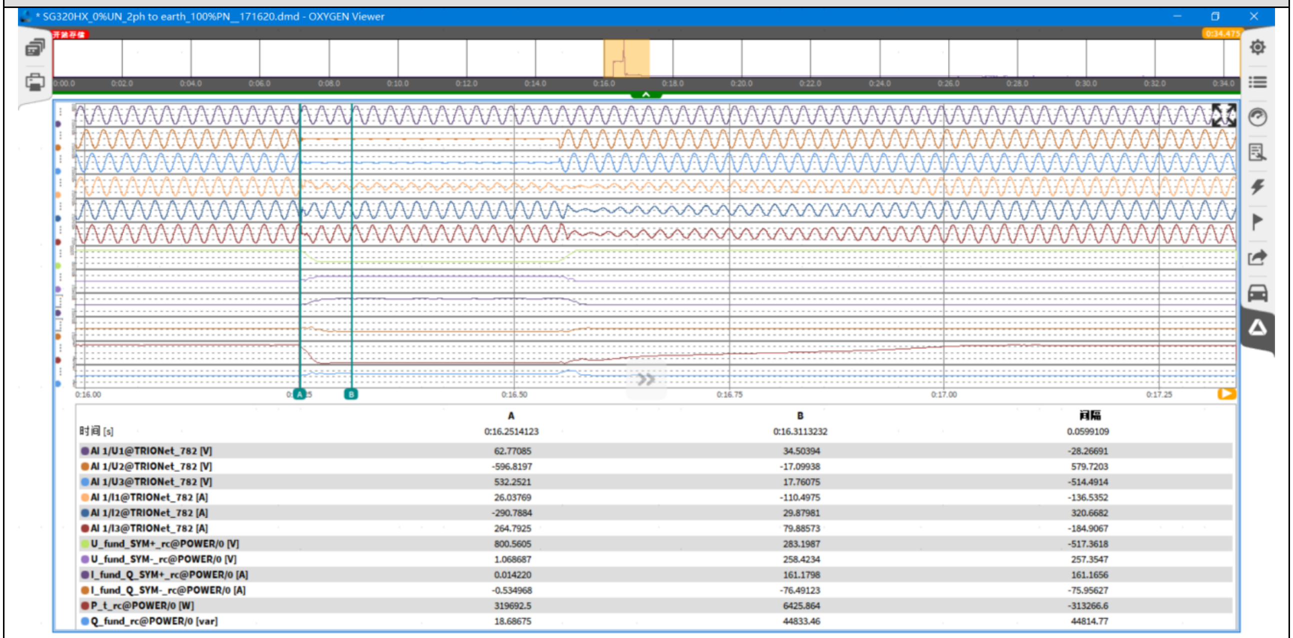
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.4.2 Two phase to earth fault (type E)
U/Un = 0 p.u, P=100%Pn, fault duration



	A	B	间隔
时间 [s]	0:16.2951567	0:16.5471631	0.2520063
AI 1/U1@TRIONet_782 [V]	613.6055	-623.9305	-1237.536
AI 1/U2@TRIONet_782 [V]	-11.31344	1.042128	12.35557
AI 1/U3@TRIONet_782 [V]	-5.336523	9.683371	15.01989
AI 1/I1@TRIONet_782 [A]	-29.30641	-43.63656	-14.33015
AI 1/I2@TRIONet_782 [A]	-274.1444	294.5697	568.7142
AI 1/I3@TRIONet_782 [A]	303.4365	-251.7855	-555.2221
U_fund_SYM+_rc@POWER/0 [V]	283.0486	281.9836	-1.065033
U_fund_SYM-_rc@POWER/0 [V]	258.0685	259.2873	1.218781
I_fund_Q_SYM+_rc@POWER/0 [A]	161.1155	160.8147	-0.300797
I_fund_Q_SYM-_rc@POWER/0 [A]	-75.27372	-77.25038	-1.976662
P_t_rc@POWER/0 [W]	1687.074	5759.510	4072.437
Q_fund_rc@POWER/0 [var]	45352.13	43862.00	-1490.133

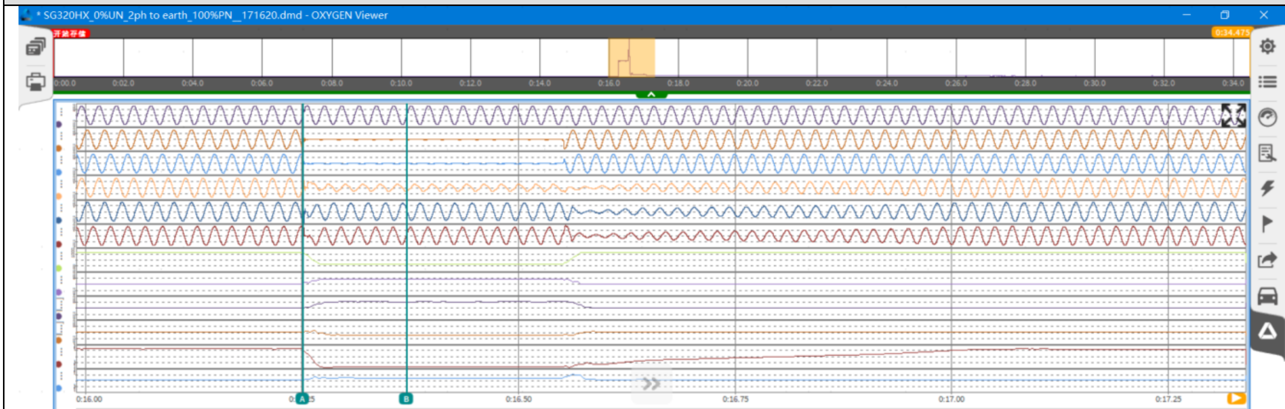
Test no. 1.4.2 Two phase to earth fault (type E)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	间隔
时间 [s]	0:16.2514123	0:16.3113232	0.0599109
AI 1/U1@TRIONet_782 [V]	62.77085	34.50394	-28.26691
AI 1/U2@TRIONet_782 [V]	-596.8197	-17.09938	579.7203
AI 1/U3@TRIONet_782 [V]	532.2521	17.76075	-514.4914
AI 1/I1@TRIONet_782 [A]	26.03769	-110.4975	-136.5352
AI 1/I2@TRIONet_782 [A]	-290.7884	29.87981	320.6682
AI 1/I3@TRIONet_782 [A]	264.7925	79.88573	-184.9067
U_fund_SYM+_rc@POWER/0 [V]	800.5605	283.1987	-517.3618
U_fund_SYM-_rc@POWER/0 [V]	1.068687	258.4234	257.3547
I_fund_Q_SYM+_rc@POWER/0 [A]	0.014220	161.1798	161.1656
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.534968	-76.49123	-75.95627
P_t_rc@POWER/0 [W]	319692.5	6425.864	-313266.6
Q_fund_rc@POWER/0 [var]	18.68675	44833.46	44814.77

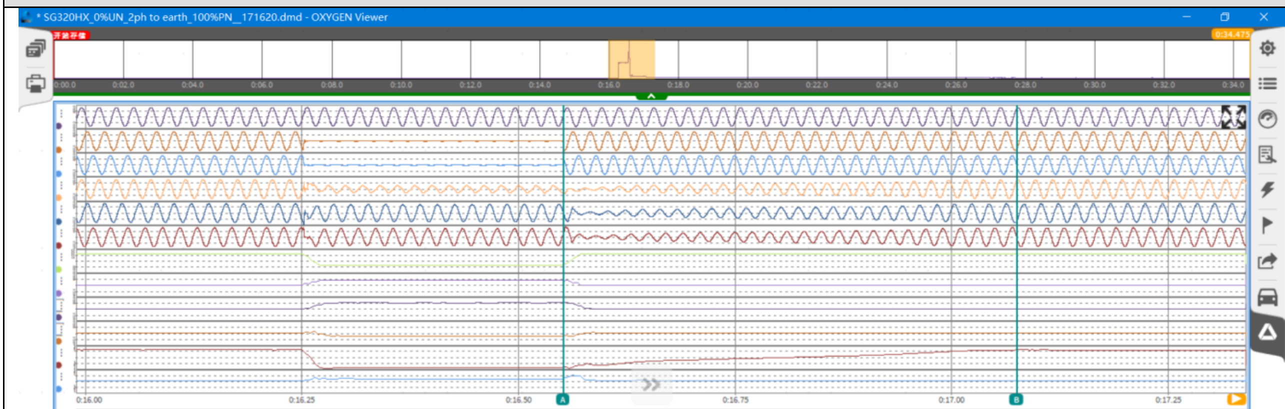
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 1.4.2 Two phase to earth fault (type E)
U/Un = 0 p.u, P=100%Pn, Injected reactive Current after 120ms



时间 [s]	A 0:16.2514123	B 0:16.3712341	间隔 0.1198219
AI 1/U1@TRIONet_782 [V]	62.77085	14.70137	-48.06948
AI 1/U2@TRIONet_782 [V]	-596.8197	-14.48679	582.3329
AI 1/U3@TRIONet_782 [V]	532.2521	14.73522	-517.5169
AI 1/I1@TRIONet_782 [A]	26.03769	-119.5312	-145.5689
AI 1/I2@TRIONet_782 [A]	-290.7884	35.25138	326.0398
AI 1/I3@TRIONet_782 [A]	264.7925	83.58002	-181.2124
U_fund_SYM+_rc@POWER/0 [V]	800.5605	283.2214	-517.3391
U_fund_SYM-_rc@POWER/0 [V]	1.068687	259.1905	258.1218
I_fund_Q_SYM+_rc@POWER/0 [A]	0.014220	160.4427	160.4285
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.534968	-77.36830	-76.83333
P_t_rc@POWER/0 [W]	319692.5	5911.179	-313781.3
Q_fund_rc@POWER/0 [var]	18.68675	43982.32	43963.64

Test no. 1.4.2 Two phase to earth fault (type E)
U/Un = 0 p.u, P=100%Pn, Active power recovery time



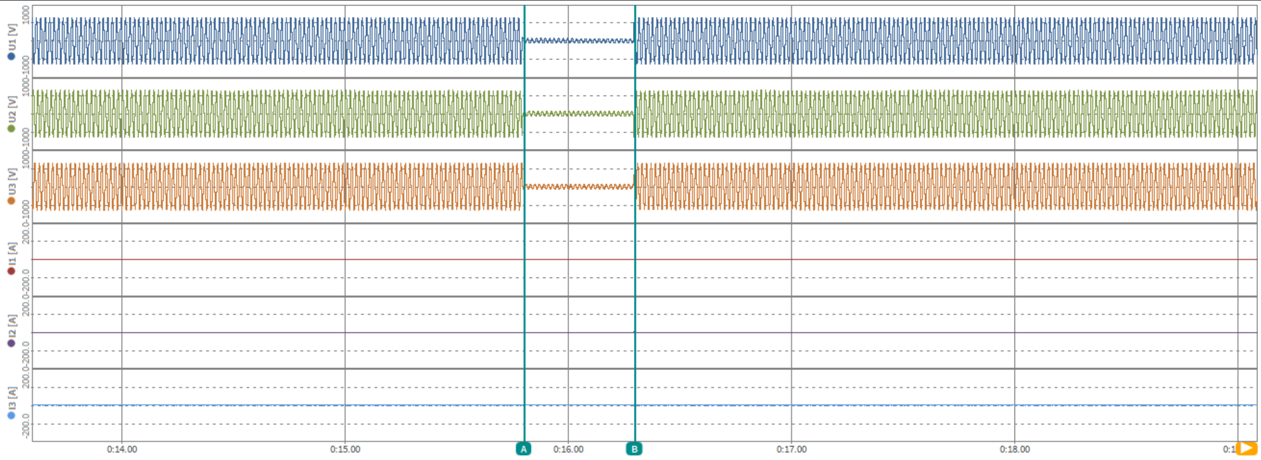
时间 [s]	A 0:16.5519179	B 0:17.0749499	间隔 0.5230320
AI 1/U1@TRIONet_782 [V]	164.5067	609.1273	444.6206
AI 1/U2@TRIONet_782 [V]	-82.54576	-505.2803	-422.7345
AI 1/U3@TRIONet_782 [V]	56.64349	-103.4219	-160.0654
AI 1/I1@TRIONet_782 [A]	-99.40506	312.8529	412.2579
AI 1/I2@TRIONet_782 [A]	10.02193	-259.5532	-269.5751
AI 1/I3@TRIONet_782 [A]	89.06246	-52.91581	-141.9783
U_fund_SYM+_rc@POWER/0 [V]	281.9948	800.1983	518.2035
U_fund_SYM-_rc@POWER/0 [V]	259.3699	0.967634	-258.4023
I_fund_Q_SYM+_rc@POWER/0 [A]	160.7340	2.786933	-157.9470
I_fund_Q_SYM-_rc@POWER/0 [A]	-77.30289	0.192347	77.49523
P_t_rc@POWER/0 [W]	5759.239	319745.2	313985.9
Q_fund_rc@POWER/0 [var]	43789.71	3862.887	-39926.82

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

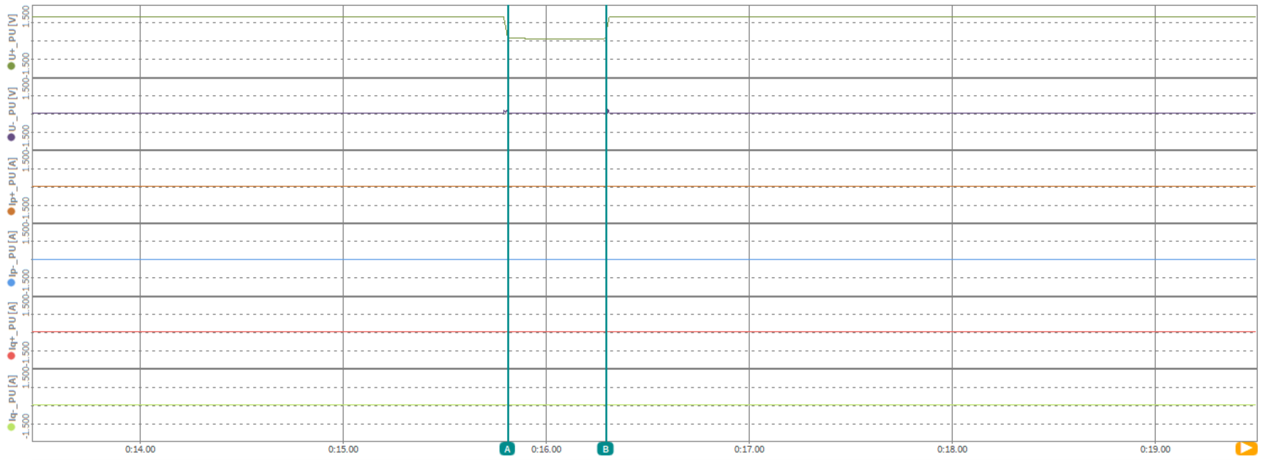
Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	2.1.1	2.1.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	461	462
	2		Phase 2			462	460
	3		Phase 3			460	463
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.2	233
	5		Phase 2			47.2	231
	6		Phase 3			47.0	233
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.2	1.00
	8		total		W	65181	322088
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.002	0.01
	10		total		var	2942	7214
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	50.4	50.4
	12		Phase 2			51.2	51.2
	13		Phase 3			50.6	50.6
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	241.8	242
	15		Phase 2			240.3	240
	16		Phase 3			240.2	241
	17	Total fault duration	All phase	t_1 to t_2	ms	512	519
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.11	0.11
	19		total		var	36584	36741
	20	Reactive current	Positive sequence		p.u.	1.04	1.04
	21	Active power	Positive sequence		p.u.	0.01	0.01
	22		total		W	1664	1647
	23	Active current	Positive sequence		p.u.	0.05	0.05
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	1.04	1.01
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	1.04	1.04
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	461	462
	27		Phase 2			461	460
	28		Phase 3			461	462
	29	Current	Phase 1	t_2+1s	Arms	47.1	233
	30		Phase 2			47.1	231
	31		Phase 3			47.0	232
	32	Active power	Positive sequence	t_2+1s	p.u.	0.2	1.00
	33		total		W	65181	322088
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.002	0.01
	35		total		Var	2942	7214
	36	Active power recovery time	Positive sequence	--	ms	595	645

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.1.0 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=0, Fault Duration



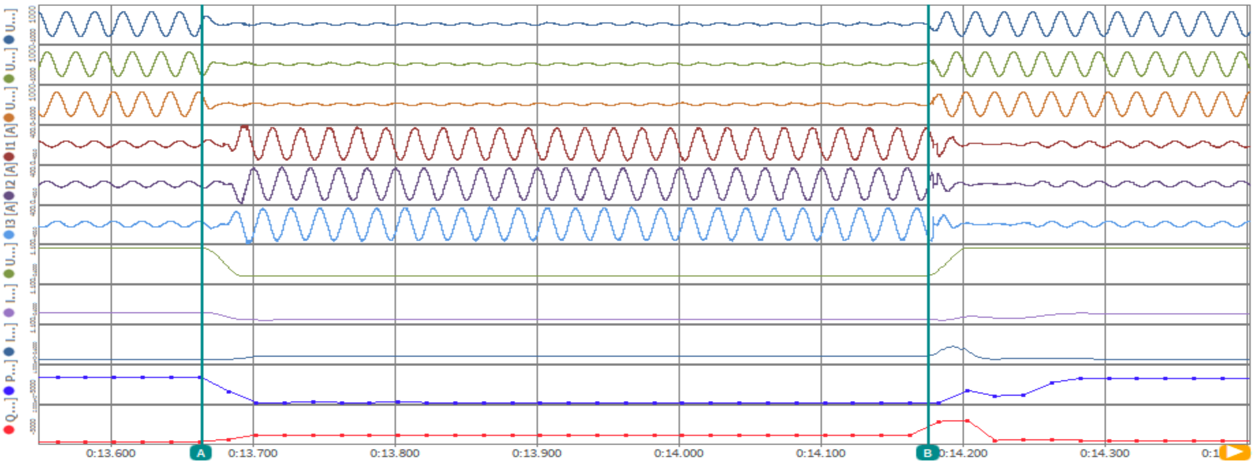
	A	B	间隔	有效值
时间 [s]	0:15.803138	0:16.298686	0.495548	
U1 [V]	38.12790	597.0099	558.8820	56.42662
U2 [V]	31.24440	-521.6396	-552.8840	63.71006
U3 [V]	-67.51371	-75.83976	-8.326054	48.91948
I1 [A]	-0.481129	0.588656	1.069784	0.473092
I2 [A]	-0.297666	0.243783	0.541449	0.307848
I3 [A]	-0.504613	0.798821	1.303434	0.419198



	A	B	间隔
时间 [s]	0:15.812657	0:16.296140	0.483483
U+_PU [V]	0.248182	0.099692	-0.148491
U-_PU [V]	0.121423	2.681e-4	-0.121155
Ip+_PU [A]	6.996e-5	-3.558e-5	-1.055e-4
Ip-_PU [A]	1.239e-4	-2.062e-5	-1.445e-4
Iq+_PU [A]	1.245e-4	3.057e-5	-9.395e-5
Iq-_PU [A]	2.420e-5	3.053e-5	6.330e-6

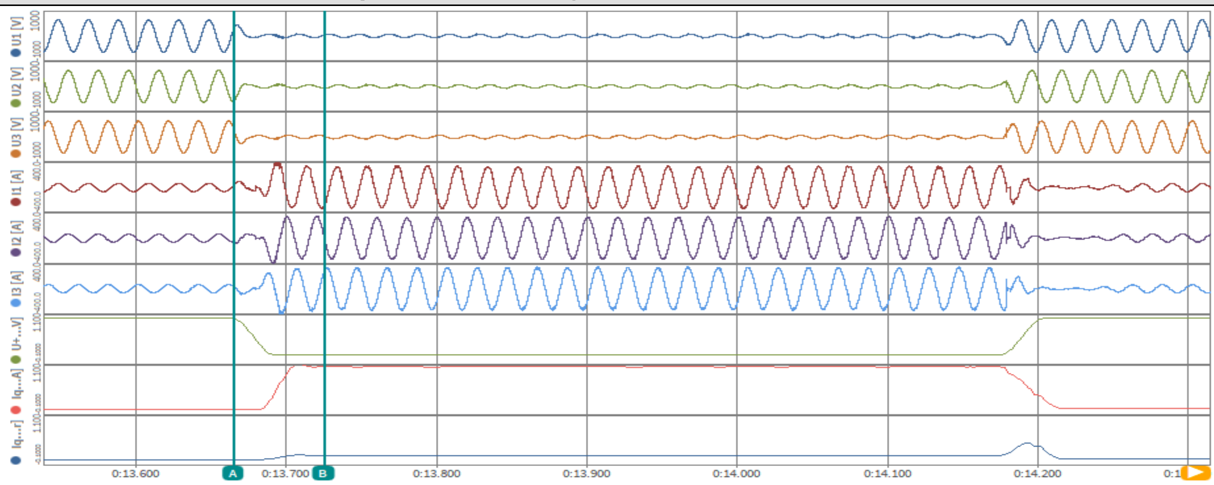
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.1.1 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:13.664148	0:14.175714	0.511566		
U1 [V]	-22.17043	-40.12978	-17.95936	5.866598	64.31939
U2 [V]	-553.7565	98.78290	652.5394	-4.156073	71.63463
U3 [V]	573.2607	-54.87335	-628.1340	-1.347850	62.06638
I1 [A]	-1.721859	301.6701	303.3920	6.359233	237.2070
I2 [A]	-55.62795	-24.37437	31.25358	-5.917080	236.0633
I3 [A]	57.63388	-272.4365	-330.0704	-4.023e-4	235.3310
U+_PU [V]	0.999216	0.109444	-0.889772	0.137946	0.195428
Ip+_PU [W]	0.203737	-5.666e-3	-0.209403	2.271e-3	0.035815
Iq+_PU [var]	2.866e-4	0.113668	0.113382	0.106698	0.109757
P_t@SG320HX [W]	65190.21	-1724.112	-66914.32	1929.955	13925.66
Q_t@SG320HX [var]	2528.700	36654.05	34125.35	34559.96	35348.10

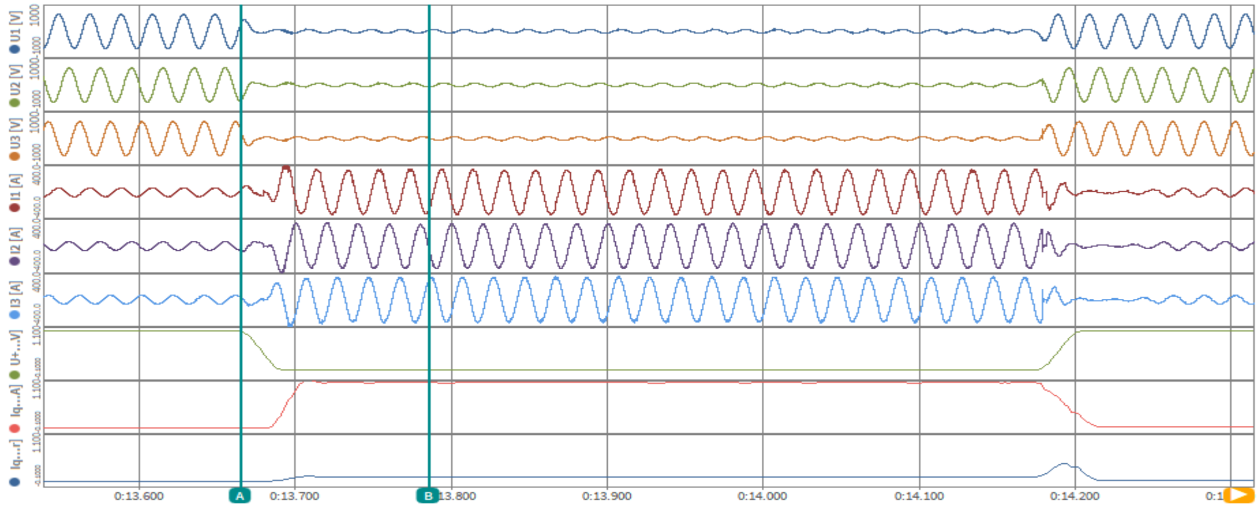
Test no. 2.1.1 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.665701	0:13.725810	0.060109		
U1 [V]	278.7080	30.19774	-248.5103	32.67804	124.3758
U2 [V]	-597.2507	-70.73749	526.5133	-20.67910	120.3933
U3 [V]	325.7755	35.22456	-290.5510	-11.14876	87.13073
I1 [A]	37.82928	-305.1034	-342.9327	20.84677	209.0510
I2 [A]	-74.63110	15.81311	90.44421	-2.229507	204.4225
I3 [A]	40.30442	290.6010	250.2966	-18.39413	196.5753
U+_PU [V]	0.997448	0.109149	-0.888299	0.321730	0.447747
Iq+_PU [A]	3.342e-4	1.045859	1.045525	0.534290	0.713305
Iq+_PU [var]	3.334e-4	0.114160	0.113826	0.059061	0.077853

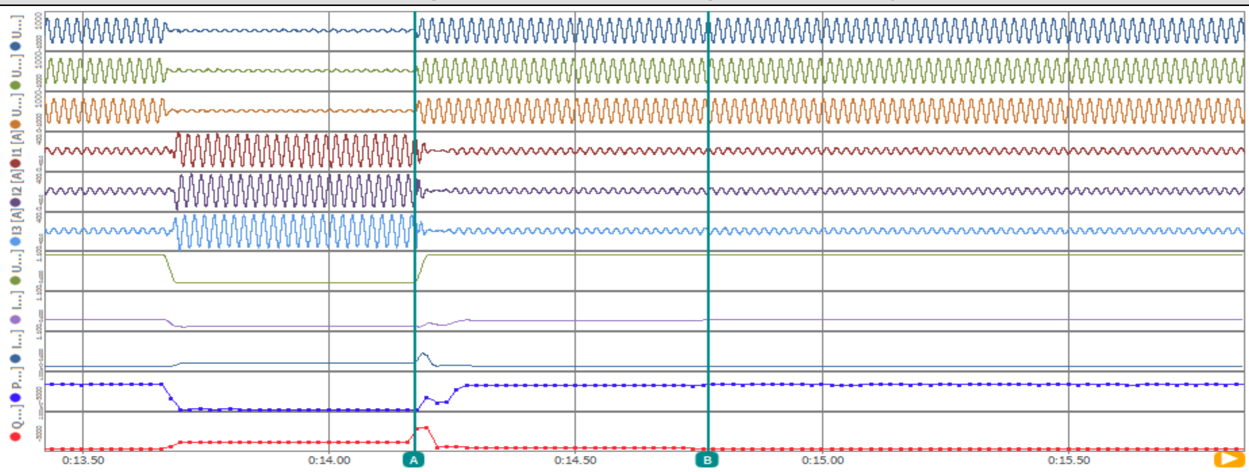
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.1.1 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.665701	0:13.786086	0.120385		
U1 [V]	278.7080	36.37684	-242.3312	17.00688	94.83604
U2 [V]	-597.2507	-68.62128	528.6295	-10.45003	92.50119
U3 [V]	325.7755	30.78079	-294.9947	-5.918911	71.25336
I1 [A]	37.82928	-285.0881	-322.9174	12.58321	225.5862
I2 [A]	-74.63110	-3.192544	71.43856	-3.117805	222.7364
I3 [A]	40.30442	287.5211	247.2167	-9.158072	219.6367
U+_PU [V]	0.997448	0.108951	-0.888497	0.216275	0.327055
Iq+_PU [A]	3.342e-4	1.041343	1.041009	0.786342	0.891925
Iq+_PU [var]	3.334e-4	0.113460	0.113127	0.086161	0.097302

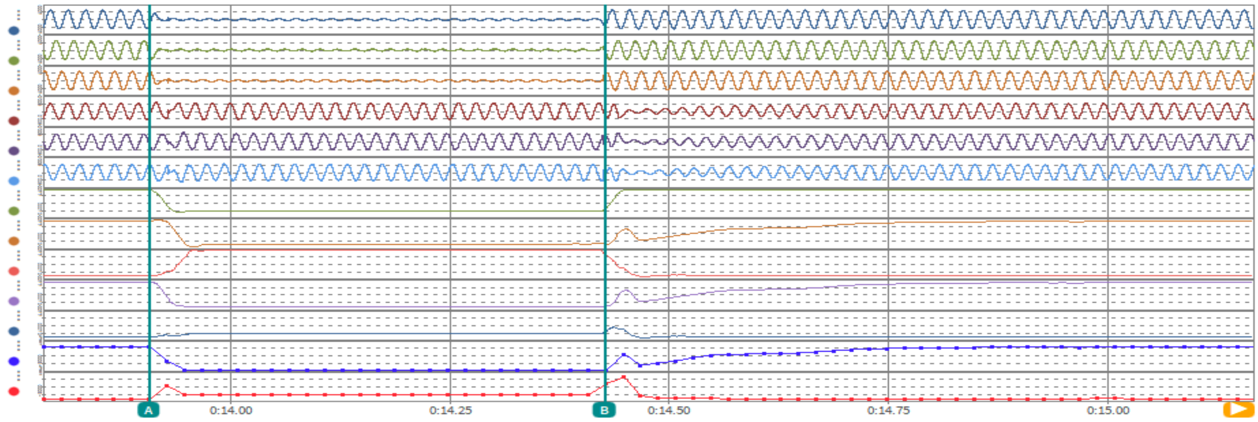
Test no. 2.1.1 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:14.174006	0:14.768905	0.594899		
U1 [V]	8.225203	650.8769	642.6517	-1.646370	458.5898
U2 [V]	62.32643	-368.7961	-431.1226	-3.609908	459.1227
U3 [V]	-63.10511	-286.1407	-223.0356	3.720111	458.0715
I1 [A]	345.6768	64.98814	-280.6887	-0.043060	54.18707
I2 [A]	-204.1468	-35.54905	168.5977	1.304938	48.44925
I3 [A]	-137.2016	-29.59490	107.6067	-0.960784	52.78250
U+_PU [V]	0.109056	0.999254	0.890198	0.973635	0.982397
Ip+_PU [W]	-5.454e-3	0.202027	0.207481	0.173733	0.181871
Iq+_PU [var]	0.113143	2.006e-3	-0.111136	0.034978	0.074324
P_t@SG320HX [W]	-1724.112	64171.14	65895.25	54036.19	57394.03
Q_t@SG320HX [var]	36654.05	5852.605	-30801.45	16614.39	30845.37

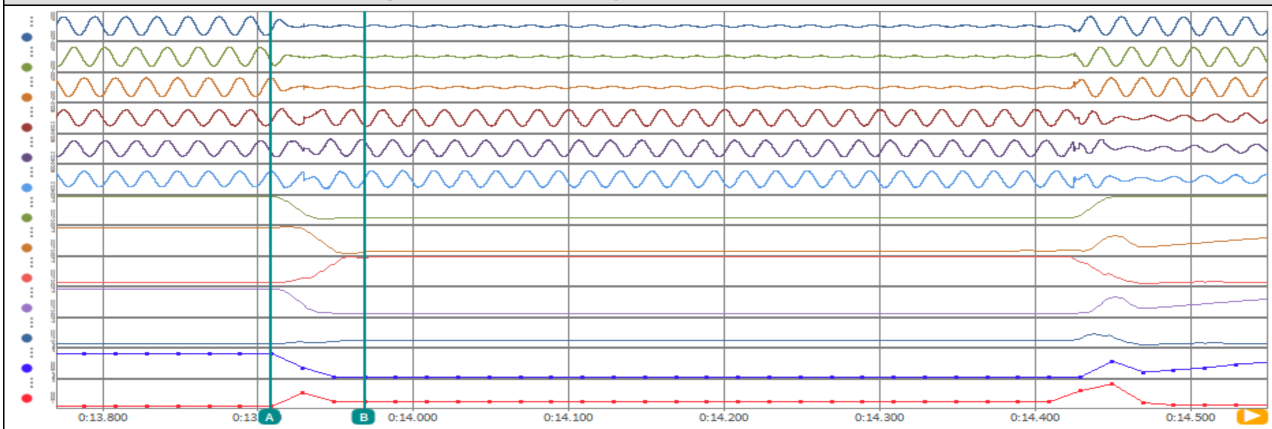
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.1.2 Three phase symmetrical fault type A）
U/Un = 0.1 p.u, P=100%Pn, fault duration



	A	B	Delta	RMS
Time [s]	0:13.908327	0:14.427356	0.519029	
U1 [V]	-420.6782	-338.6677	82.01051	70.82283
U2 [V]	-226.6595	-8.022905	218.6366	77.33341
U3 [V]	636.4733	349.8379	-286.6354	76.01809
I1 [A]	-213.3771	0.896454	214.2736	239.5847
I2 [A]	-112.2607	-0.616074	111.6446	238.5229
I3 [A]	327.4336	1.790881	-325.6427	239.5152
U+_PU [V]	0.999955	0.161310	-0.838645	0.206524
Ip+_PU [A]	1.007291	0.062173	-0.945118	0.246965
Iq+_PU [A]	-1.629e-3	0.970898	0.972527	1.001138
Ip+_PU [W]	1.007288	0.010030	-0.997259	0.179998
Iq+_PU [var]	-1.629e-3	0.156622	0.158251	0.110316
P_t@SG320HX [W]	322203.3	1969.106	-320234.1	90757.01
Q_t@SG320HX [var]	5409.580	36968.62	31559.04	39086.35

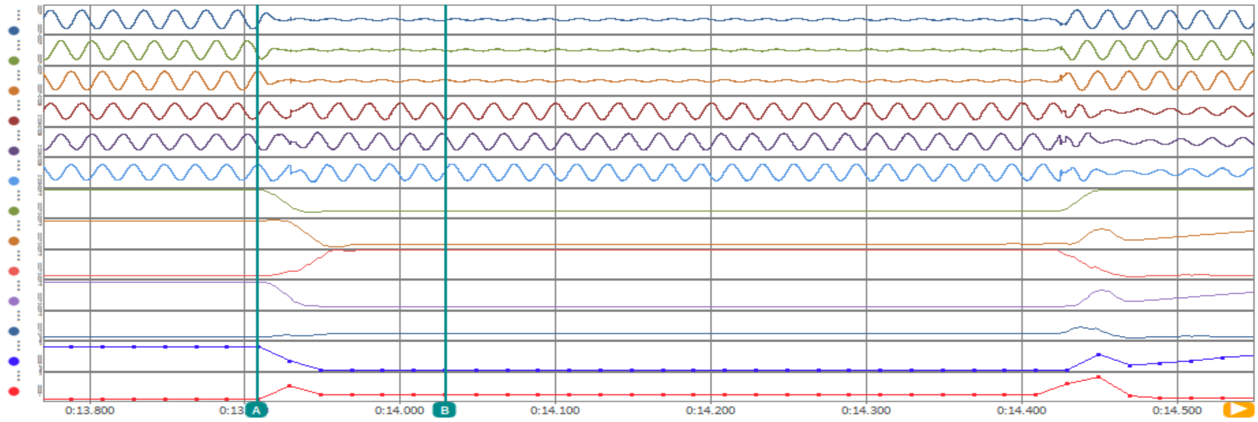
Test no. 2.1.2 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.908327	0:13.968743	0.060416		
U1 [V]	-420.6782	-44.31141	376.3668	27.14297	136.7438
U2 [V]	-226.6595	-16.77990	209.8796	-46.33263	172.5843
U3 [V]	636.4733	58.24280	-578.2305	20.10618	166.8238
I1 [A]	-213.3771	-295.5543	-82.17717	39.62515	223.1786
I2 [A]	-112.2607	313.5174	425.7781	12.17814	229.9879
I3 [A]	327.4336	-18.11874	-345.5523	-51.20747	228.2007
U+_PU [V]	0.999955	0.111640	-0.888315	0.383645	0.518374
Ip+_PU [A]	1.007291	1.497e-4	-1.007141	0.534842	0.703512
Iq+_PU [A]	-1.629e-3	1.013189	1.014818	0.452588	0.610222
Ip+_PU [W]	1.007288	1.671e-5	-1.007272	0.335444	0.521091
Iq+_PU [var]	-1.629e-3	0.113117	0.114746	0.060297	0.072710
P_t@SG320HX [W]	322203.3	742.2317	-321461.0	191664.9	235761.1
Q_t@SG320HX [var]	5409.580	32644.52	27234.94	34543.63	50456.23

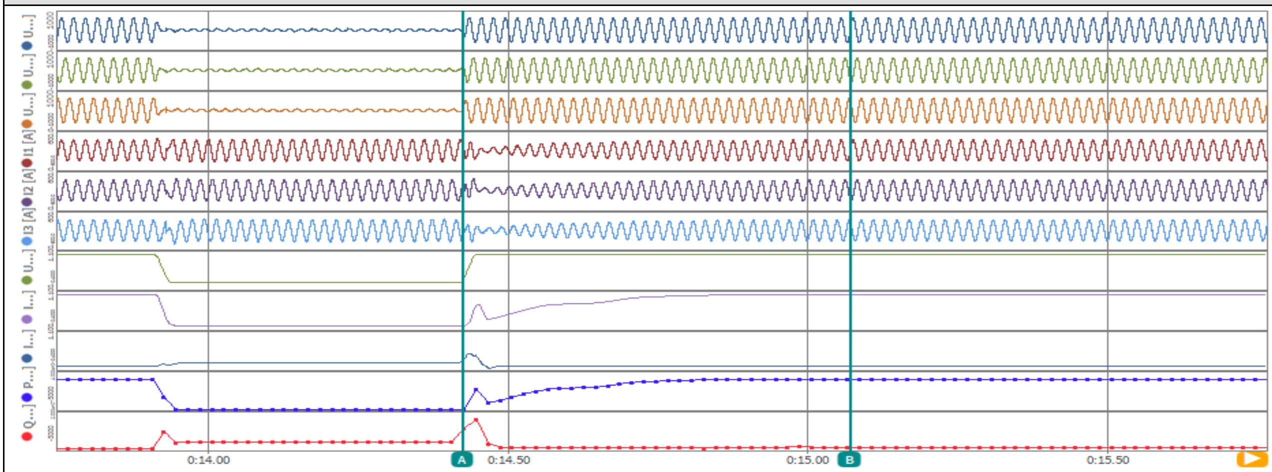
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.1.2 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.908327	0:14.029276	0.120949		
U1 [V]	-420.6782	-33.13899	387.5392	13.80599	103.1341
U2 [V]	-226.6595	-34.31273	192.3468	-22.64373	127.4113
U3 [V]	636.4733	71.64205	-564.8313	9.779881	123.5288
I1 [A]	-213.3771	-303.8242	-90.44707	14.53767	233.2131
I2 [A]	-112.2607	266.0055	378.2662	9.325448	235.7531
I3 [A]	327.4336	42.00435	-285.4293	-23.16271	234.2220
U+_PU [V]	0.999955	0.110454	-0.889501	0.249600	0.377660
Ip+_PU [A]	1.007291	0.035774	-0.971517	0.287764	0.502046
Iq+_PU [A]	-1.629e-3	1.042808	1.044437	0.743736	0.852005
Ip+_PU [W]	1.007288	3.952e-3	-1.003337	0.172244	0.371484
Iq+_PU [var]	-1.629e-3	0.115187	0.116816	0.087714	0.096489
P_t@SG320HX [W]	322203.3	1155.230	-321048.0	109955.5	178220.0
Q_t@SG320HX [var]	5409.580	37246.34	31836.76	35626.14	45207.32

Test no. 2.1.2 Three phase symmetrical fault（type A）
U/Un = 0.1 p.u, P=100%Pn, Active power recovery time



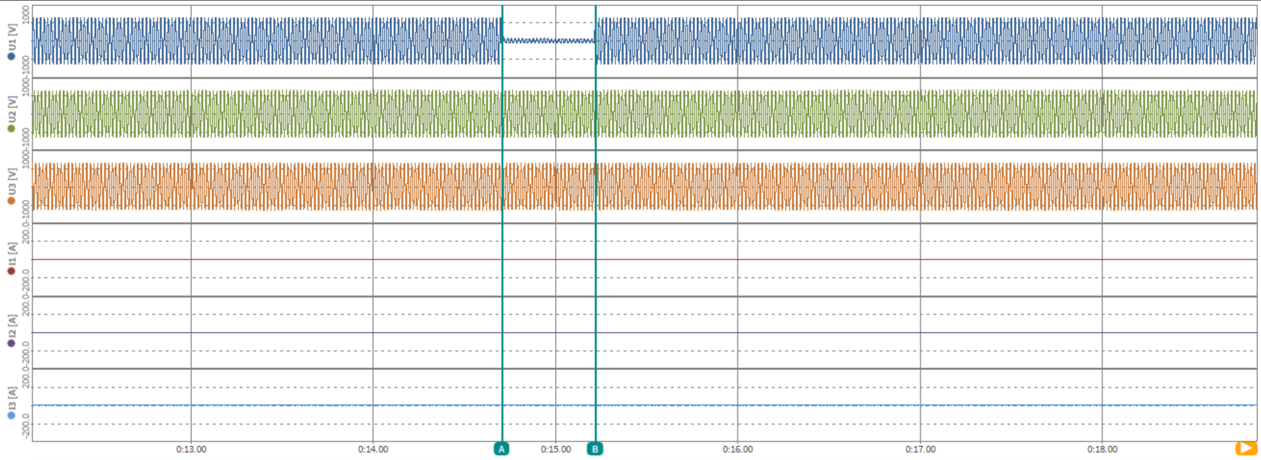
	A	B	Delta	RMS
Time [s]	0:14.425424	0:15.070755	0.645331	
U1 [V]	-284.0195	36.85832	320.8778	460.9226
U2 [V]	279.7896	-584.6291	-864.4187	460.0075
U3 [V]	10.11753	546.7842	536.6667	461.0520
I1 [A]	-60.36198	22.90607	83.26805	197.8486
I2 [A]	-49.36791	-289.8930	-240.5251	196.8714
I3 [A]	115.0748	264.4299	149.3552	196.8701
U+_PU [V]	0.127448	1.000006	0.872558	0.987495
Ip+_PU [W]	9.329e-3	1.008054	0.998725	0.835336
Iq+_PU [var]	0.131997	8.308e-3	-0.123689	0.067913
P_t@SG320HX [W]	1969.106	322580.4	320611.3	264046.7
Q_t@SG320HX [var]	36968.62	8624.493	-28344.12	35398.35

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	2.2.1	2.2.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	463	461.9
	2		Phase 2			460	461.2
	3		Phase 3			461	462.1
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.2	234.9
	5		Phase 2			46.9	234.7
	6		Phase 3			46.9	234.5
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.2	1.01
	8		total		W	65087	324702
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.003	0.01
	10		total		var	2442	5892
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	50.7	50.7
	12		Phase 2			461	464.5
	13		Phase 3			463	461.5
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	242.7	242.2
	15		Phase 2			115.5	118.2
	16		Phase 3			128.0	124.7
	17	Total fault duration	All phase	t_1 to t_2	ms	502	500
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.38	0.03
	19		total		var	124403	124679
	20	Reactive current	Positive sequence		p.u.	0.54	0.04
	21	Active power	Positive sequence		p.u.	0.04	0.37
	22		total		W	11201	7566
	23	Active current	Positive sequence		p.u.	0.06	0.53
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.55	0.51
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.54	0.53
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	462	462.3
	27		Phase 2			460	460.1
	28		Phase 3			461	462.8
	29	Current	Phase 1	t_2+1s	Arms	47.2	235.3
	30		Phase 2			47.0	233.7
	31		Phase 3			47.0	235.1
	32	Active power	Positive sequence	t_2+1s	p.u.	0.2	1.01
	33		total		W	65074	325134
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.003	0.01
	35		total		Var	2839	7110
	36	Active power recovery time	Positive sequence	--	ms	582	560

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.2.0 single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=0, Fault Duration

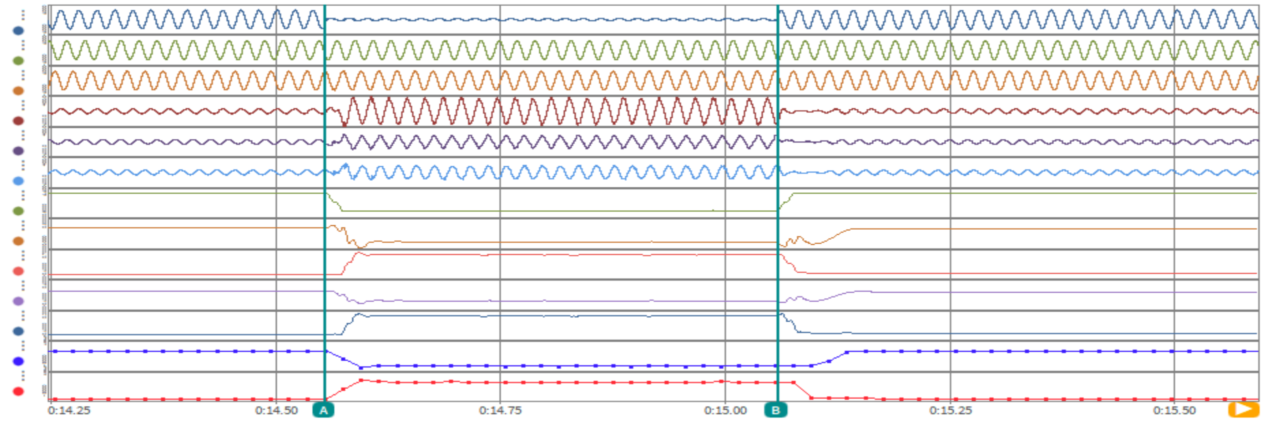


	A	B	间隔	有效值
时间 [s]	0:14.710117	0:15.222259	0.512142	
U1 [V]	-534.0054	649.8691	1183.875	88.61383
U2 [V]	592.7168	-294.2393	-886.9561	461.5572
U3 [V]	-54.98433	-361.9168	-306.9325	460.6859
I1 [A]	0.489473	0.564694	0.075221	0.464514
I2 [A]	0.370145	-0.246286	-0.616431	0.303304
I3 [A]	-0.040412	0.671387	0.711799	0.467989

	A	B	间隔
时间 [s]	0:14.735433	0:15.205482	0.470048
U+_PU [V]	0.704463	0.699128	-5.336e-3
U-_PU [V]	0.290708	0.298610	7.902e-3
Ip+_PU [A]	4.219e-5	2.653e-5	-1.565e-5
Ip-_PU [A]	1.322e-4	1.490e-4	1.676e-5
Iq+_PU [A]	5.125e-4	4.859e-4	-2.655e-5
Iq-_PU [A]	3.808e-4	3.988e-4	1.799e-5

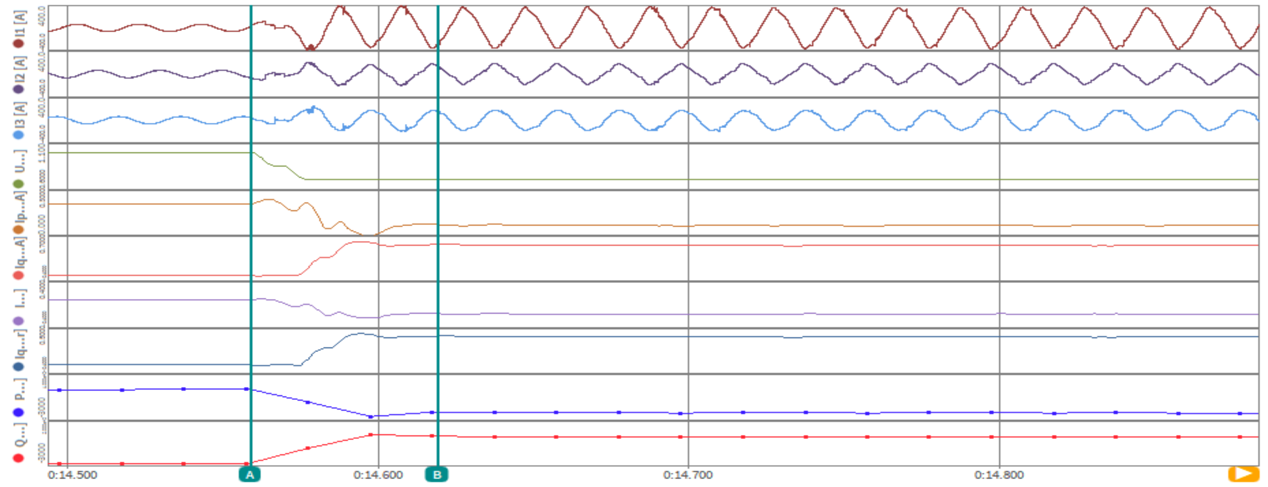
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.5550057	0:15.0576567	0.5026510		
U1 [V]	-570.8286	-11.87408	558.9545	-0.735412	58.93800
U2 [V]	13.41975	-469.4082	-482.8279	-1.465534	461.8216
U3 [V]	557.4633	623.9878	66.52451	3.445041	463.7425
I1 [A]	-59.39377	-368.8382	-309.4444	-0.412160	239.3975
I2 [A]	0.576258	188.1851	187.6088	-0.891805	114.1275
I3 [A]	57.90162	177.2260	119.3243	0.770165	126.7526
U+_PU [V]	0.999054	0.704629	-0.294425	0.712609	0.713979
Ip+_PU [A]	0.204148	0.056306	-0.147842	0.064875	0.073361
Iq+_PU [A]	1.509e-4	0.539731	0.539580	0.508093	0.522006
Ip+_PU [W]	0.203963	0.039677	-0.164287	0.047457	0.057267
Iq+_PU [var]	1.508e-4	0.380326	0.380176	0.357718	0.367545
P_t@SG320HX [W]	65267.22	11172.97	-54094.25	16047.07	21995.50
Q_t@SG320HX [var]	2445.090	124077.1	121632.0	113586.6	118461.0

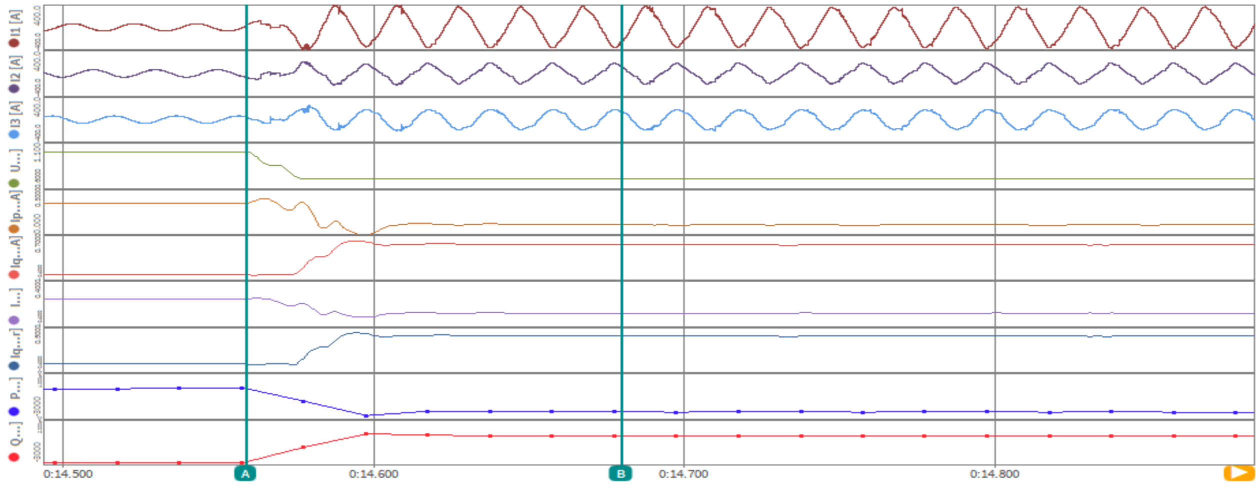
Test no. 2.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.559164	0:14.619317	0.060153		
I1 [A]	30.28178	-291.1138	-321.3955	-15.11707	227.2731
I2 [A]	-75.62030	137.3222	212.9425	-1.941968	109.9069
I3 [A]	47.99187	150.0542	102.0624	16.34173	122.2955
U+_PU [V]	0.999249	0.702768	-0.296481	0.749517	0.754532
Ip+_PU [A]	0.204220	0.066126	-0.138094	0.101405	0.129205
Iq+_PU [A]	-1.128e-4	0.551106	0.551219	0.335005	0.415875
Ip+_PU [W]	0.204076	0.046474	-0.157602	0.081103	0.107740
Iq+_PU [var]	-1.127e-4	0.387316	0.387429	0.235128	0.292175
P_t@SG320HX [W]	65252.14	12894.56	-52357.58	29223.87	37698.87
Q_t@SG320HX [var]	2499.744	126863.3	124363.6	84684.35	99918.25

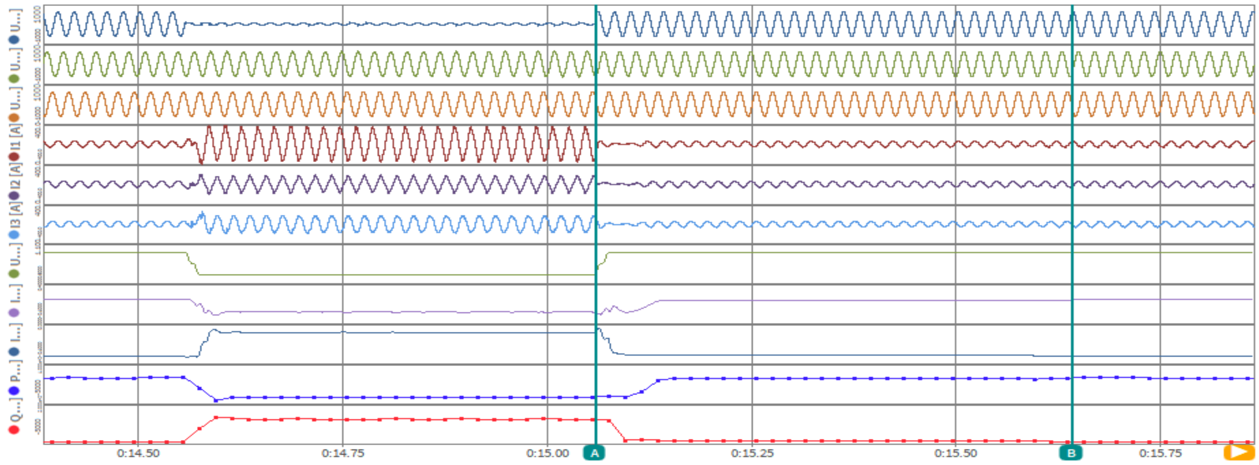
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.559164	0:14.679909	0.120745		
I1 [A]	30.28178	-260.9812	-291.2630	-8.716688	235.1087
I2 [A]	-75.62030	119.1266	194.7469	-0.230249	112.6325
I3 [A]	47.99187	137.8789	89.88703	8.196427	125.2931
U+_PU [V]	0.999249	0.703584	-0.295665	0.726535	0.729515
Ip+_PU [A]	0.204220	0.058486	-0.145734	0.080880	0.101016
Iq+_PU [A]	-1.128e-4	0.538401	0.538513	0.436312	0.481075
Ip+_PU [W]	0.204076	0.041151	-0.162924	0.061813	0.082074
Iq+_PU [var]	-1.127e-4	0.378826	0.378939	0.306589	0.338175
P_t@SG320HX [W]	65252.14	11319.31	-53932.83	21656.79	29488.11
Q_t@SG320HX [var]	2499.744	124241.4	121741.7	101420.7	110755.0

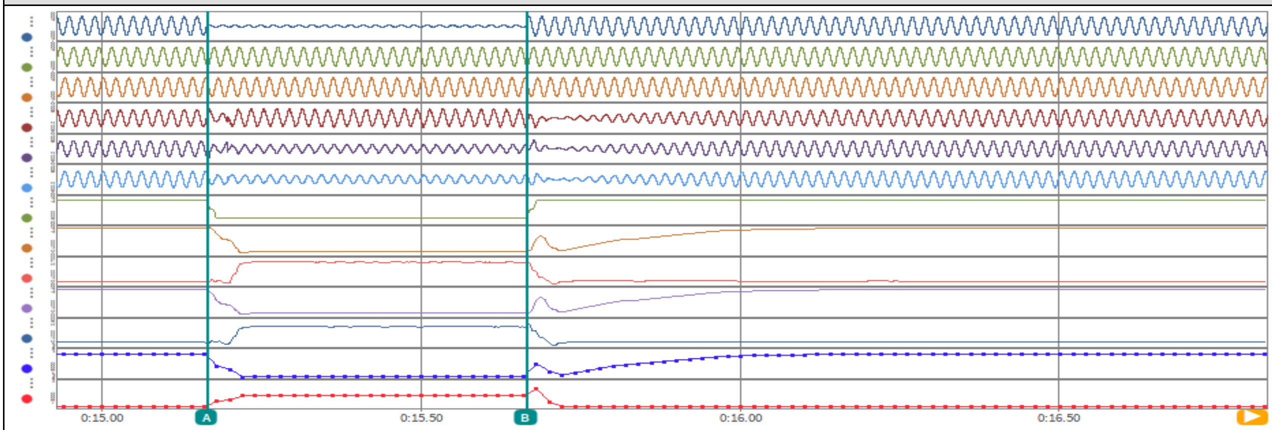
Test no. 2.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:15.058812	0:15.641367	0.582555		
U1 [V]	3.278017	521.8849	518.6069	0.137329	461.2531
U2 [V]	-601.3295	-598.1936	3.135920	-2.764299	462.6953
U3 [V]	515.7705	76.23780	-439.5327	1.264565	461.2311
I1 [A]	-326.8329	53.35546	380.1884	-0.601031	48.09881
I2 [A]	159.8502	-63.36046	-223.2107	0.183505	44.58334
I3 [A]	167.2617	11.11376	-156.1480	-0.019114	45.45627
U+_PU [V]	0.704658	0.999254	0.294596	0.994122	0.994701
Ip+_PU [W]	0.039665	0.201242	0.161576	0.179266	0.184772
Iq+_PU [var]	0.379926	2.236e-3	-0.377690	0.031133	0.069827
P_t@SG320HX [W]	10879.01	64404.86	53525.85	56439.29	58640.43
Q_t@SG320HX [var]	124762.9	5562.116	-119200.8	16198.67	32609.36

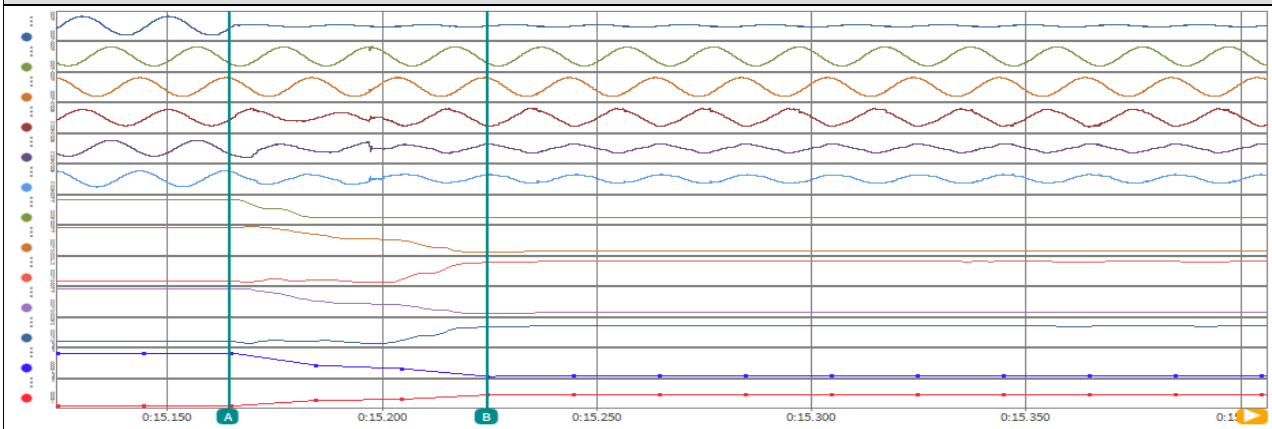
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=100%Pn, fault duration



Time [s]	A 0:15.165666	B 0:15.666020	Delta 0.500355	RMS
U1 [V]	53.97725	29.98936	-23.98789	50.63296
U2 [V]	-592.1589	-620.3498	-28.19085	462.6503
U3 [V]	541.0319	487.6573	-53.37453	462.8466
I1 [A]	20.36166	-318.8650	-339.2266	237.6430
I2 [A]	-292.8404	157.1879	450.0283	122.9112
I3 [A]	269.3887	157.4489	-111.9398	126.1310
U+_PU [V]	0.999455	0.703477	-0.295978	0.711015
Ip+_PU [A]	1.016254	0.044995	-0.971259	0.228983
Iq+_PU [A]	-1.445e-3	0.526486	0.527931	0.503903
Ip+_PU [W]	1.015743	0.031654	-0.984089	0.189508
Iq+_PU [var]	-1.445e-3	0.370386	0.371831	0.354900
P_t@SG320HX [W]	325108.5	7841.801	-317266.7	73983.00
Q_t@SG320HX [var]	5708.897	123337.2	117628.3	118691.0

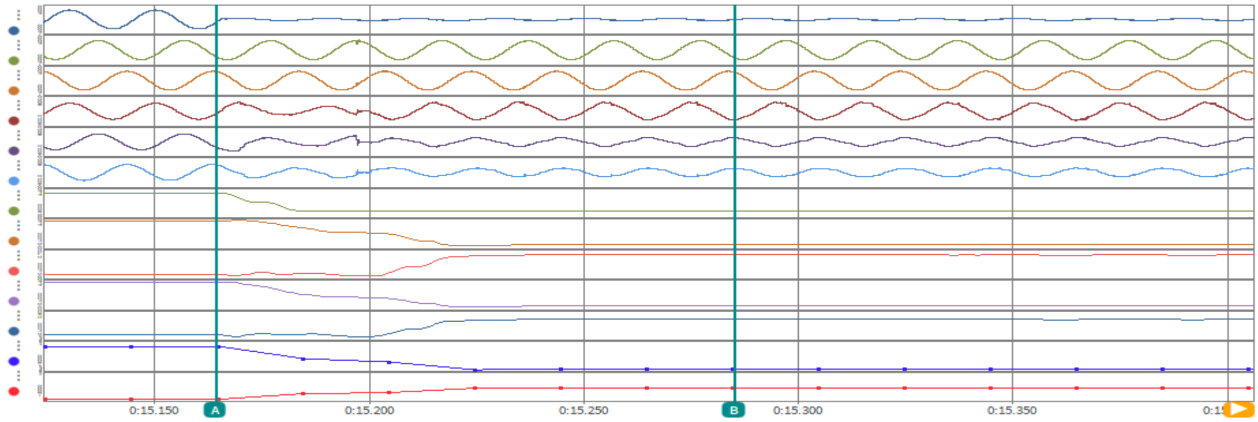
Test no. 2.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 60ms



Time [s]	A 0:15.164379	B 0:15.224590	Delta 0.060211	Avg	RMS
U1 [V]	-214.7660	-18.50546	196.2606	0.885612	52.90802
U2 [V]	-430.2001	-452.0034	-21.80326	-2.412217	460.1711
U3 [V]	637.3911	632.6940	-4.697085	3.187491	462.6543
I1 [A]	-109.2207	-350.8113	-241.5905	22.79238	191.5844
I2 [A]	-218.4842	182.7140	401.1982	-26.86898	153.9251
I3 [A]	323.8150	169.6583	-154.1567	3.952649	140.4960
U+_PU [V]	0.999458	0.701548	-0.297911	0.756735	0.763016
Ip+_PU [A]	1.016594	-0.015286	-1.031880	0.566180	0.659523
Iq+_PU [A]	-1.332e-3	0.506494	0.507826	0.100508	0.201904
Ip+_PU [W]	1.016087	-0.010724	-1.026812	0.453006	0.552837
Iq+_PU [var]	-1.332e-3	0.355345	0.356677	0.070359	0.141752
P_t@SG320HX [W]	325093.6	104817.9	-220275.6	227778.6	248361.4
Q_t@SG320HX [var]	5615.635	73548.18	67932.54	36939.94	48549.57

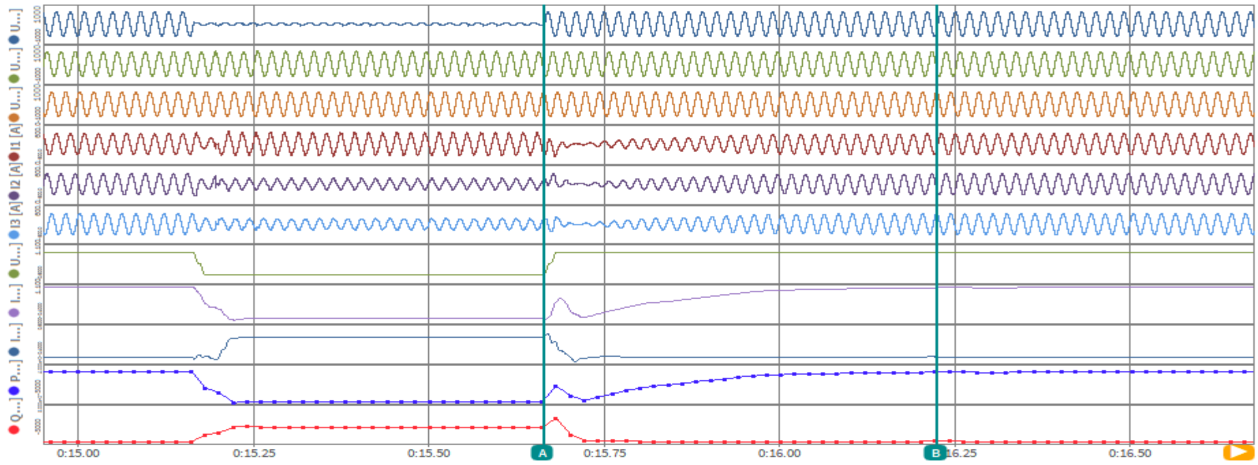
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.164379	0:15.285167	0.120788		
U1 [V]	-214.7660	-2.869845	211.8962	1.394406	51.80186
U2 [V]	-430.2001	-534.1312	-103.9311	-3.874816	461.0164
U3 [V]	637.3911	588.1116	-49.27957	4.717848	463.3980
I1 [A]	-109.2207	-360.0933	-250.8725	11.33979	220.2961
I2 [A]	-218.4842	185.2466	403.7308	-14.36678	138.3116
I3 [A]	323.8150	176.6071	-147.2079	2.814312	133.2771
U+_PU [V]	0.999458	0.703151	-0.296307	0.729779	0.733538
Ip+_PU [A]	1.016594	0.042928	-0.973666	0.299280	0.467114
Iq+_PU [A]	-1.332e-3	0.534250	0.535582	0.316424	0.402643
Ip+_PU [W]	1.016087	0.030186	-0.985901	0.237885	0.391363
Iq+_PU [var]	-1.332e-3	0.375675	0.377006	0.222259	0.282962
P_t@SG320HX [W]	325093.6	8153.836	-316939.7	131971.9	187785.4
Q_t@SG320HX [var]	5615.635	124593.1	118977.5	74574.10	89543.06

Test no. 2.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.1 p.u, P=100%Pn, Active power recovery time



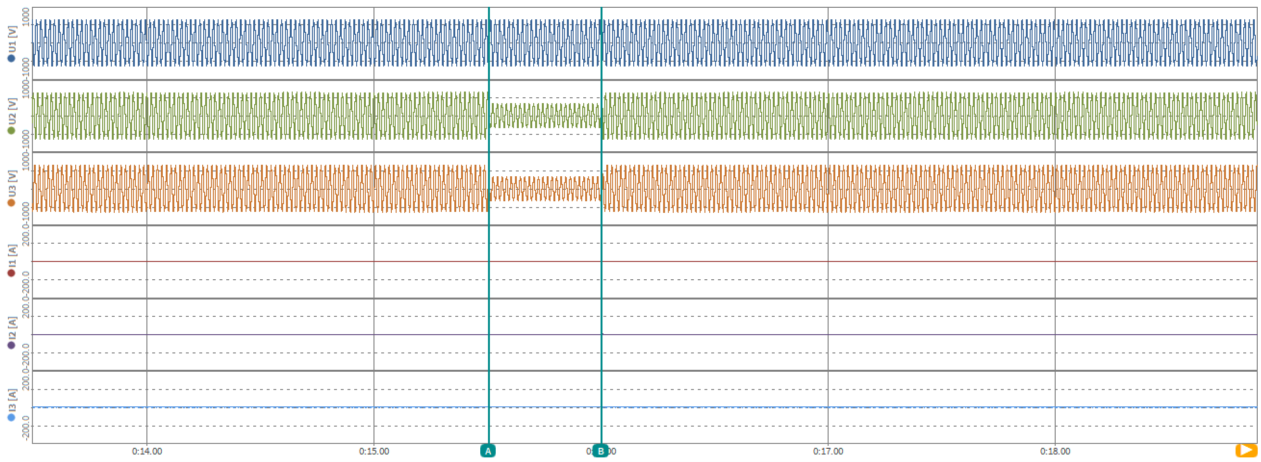
	A	B	Delta	Avg	RMS
Time [s]	0:15.663315	0:16.223528	0.560213		
U1 [V]	-41.85987	-354.5177	-312.6579	-1.580601	461.6856
U2 [V]	-254.2933	-306.0509	-51.75758	0.202934	461.5147
U3 [V]	646.5569	651.9475	5.390644	0.516522	461.7343
I1 [A]	-304.8691	-189.0308	115.8383	-9.242322	185.8736
I2 [A]	150.2441	-161.2727	-311.5168	5.325323	181.9813
I3 [A]	150.6279	351.3965	200.7686	2.815602	182.3070
U+_PU [V]	0.704162	0.999305	0.295143	0.992807	0.993557
Ip+_PU [W]	0.030692	1.006823	0.976130	0.708846	0.769135
Iq+_PU [var]	0.370165	0.012140	-0.358025	0.023082	0.073947
P_t@SG320HX [W]	7284.765	317693.8	310409.0	215007.3	238902.3
Q_t@SG320HX [var]	125165.0	6932.822	-118232.1	24065.71	50718.64

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	2.3.1	2.3.2
	1	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	461.7	461.6
	2		Phase 2			461.3	462.9
	3		Phase 3			461.5	460.8
	4	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	47.1	232.8
	5		Phase 2			47.1	232.9
	6		Phase 3			47.0	231.9
	7	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.2	1.01
	8		total		W	65078	322046
	9	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.01	0.01
	10		total		var	2247	5355
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	460.9	460.8
	12		Phase 2			234.9	235.0
	13		Phase 3			234.8	234.8
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	14.7	12.2
	15		Phase 2			211.8	210.0
	16		Phase 3			202.8	204.4
	17	Total fault duration	All phase	t_1 to t_2	ms	501	501
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.29	0.02
	19		total		var	104114	103225
	20	Reactive current	Positive sequence		p.u.	0.53	0.03
	21	Active power	Positive sequence		p.u.	0.02	0.29
	22		total		W	7579	4835
	23	Active current	Positive sequence		p.u.	0.05	0.53
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.52	0.53
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.53	0.53
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	461.4	462.2
	27		Phase 2			461.3	461.2
	28		Phase 3			461.9	462.1
	29	Current	Phase 1	t_2+1s	Arms	47.1	233.0
	30		Phase 2			47.0	232.1
	31		Phase 3			57.0	232.5
	32	Active power	Positive sequence	t_2+1s	p.u.	0.2	1.01
	33		total		W	65078	322057
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	35		total		Var	2578	7192
	36	Active power recovery time	Positive sequence	--	ms	572	589

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.3.0 two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=0, Fault Duration

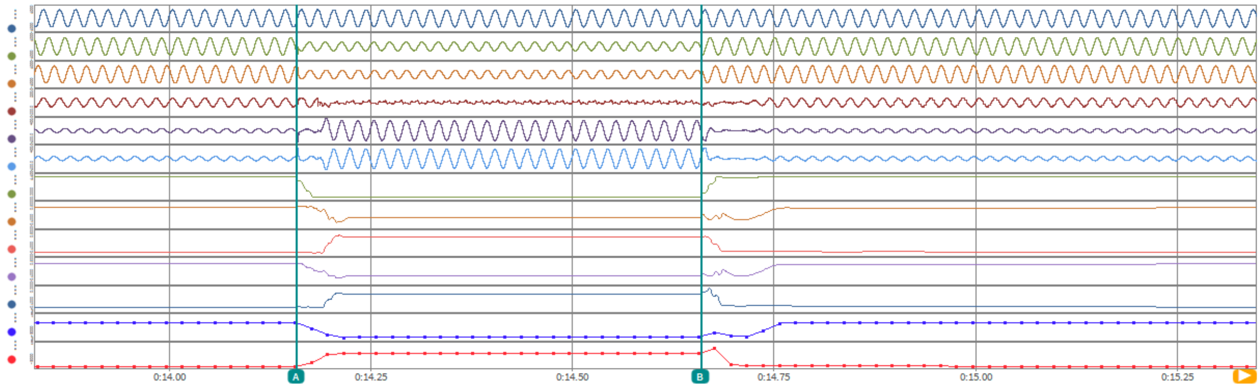


时间 [s]	A	B	间隔	有效值
	0:15.506043	0:16.001568	0.495525	
U1 [V]	-595.3572	156.5528	751.9100	462.3299
U2 [V]	521.0836	-23.95845	-545.0421	237.1156
U3 [V]	81.83551	-133.5759	-215.4114	241.5068
I1 [A]	-0.430584	-0.391245	0.039339	0.485673
I2 [A]	-0.356674	-0.377655	-0.020981	0.285881
I3 [A]	-0.787973	-0.634670	0.153303	0.423628

时间 [s]	A	B	间隔
	0:15.525360	0:16.004516	0.479156
U+_PU [V]	0.694021	0.549230	-0.144791
U-_PU [V]	0.311792	0.449810	0.138018
Ip+_PU [A]	9.982e-5	8.559e-5	-1.423e-5
Ip-_PU [A]	-1.560e-4	-3.239e-5	1.236e-4
Iq+_PU [A]	4.697e-4	2.717e-4	-1.980e-4
Iq-_PU [A]	-1.920e-5	1.175e-4	1.367e-4

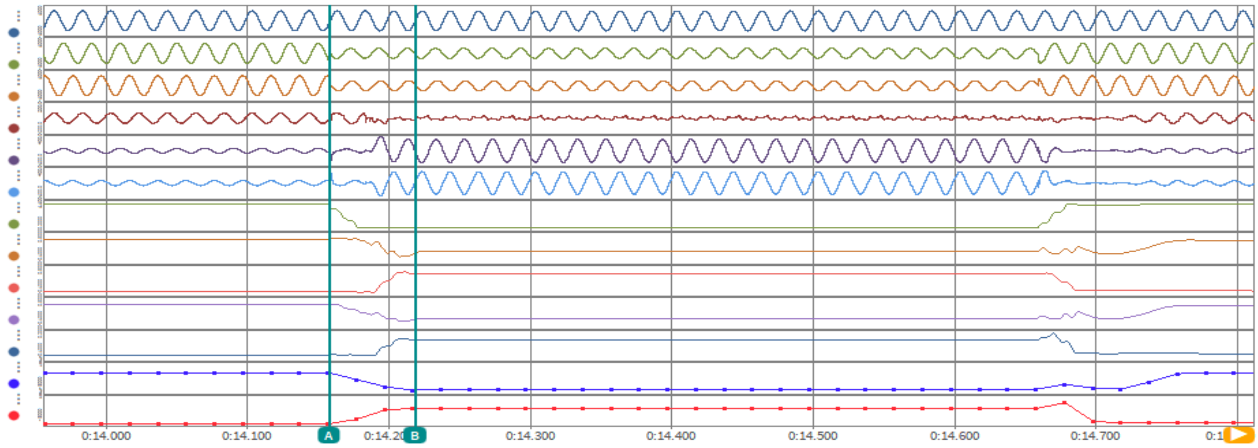
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.1584983	0:14.6596740	0.5011757		
U1 [V]	-123.9922	135.9682	259.9604	-0.180233	460.8071
U2 [V]	-495.7314	-191.4184	304.3130	-0.475483	236.5004
U3 [V]	614.2646	63.28118	-550.9835	0.675825	236.4911
I1 [A]	-14.45103	2.992392	17.44342	-0.770889	19.24219
I2 [A]	-49.52252	-8.198143	41.32438	2.870947	206.4547
I3 [A]	61.98836	1.756191	-60.23217	-2.018640	197.3331
U+_PU [V]	0.999299	0.554022	-0.445278	0.565519	0.568556
Ip+_PU [A]	0.203464	0.049975	-0.153489	0.059612	0.072558
Iq+_PU [A]	3.222e-4	0.530106	0.529784	0.486862	0.507001
Ip+_PU [W]	0.203330	0.027688	-0.175642	0.035466	0.048721
Iq+_PU [var]	3.219e-4	0.293703	0.293381	0.270018	0.281145
P_t@SG320HX [W]	65029.38	7507.528	-57521.85	13294.88	20807.23
Q_t@SG320HX [var]	2313.464	103858.9	101545.4	93775.94	98137.24

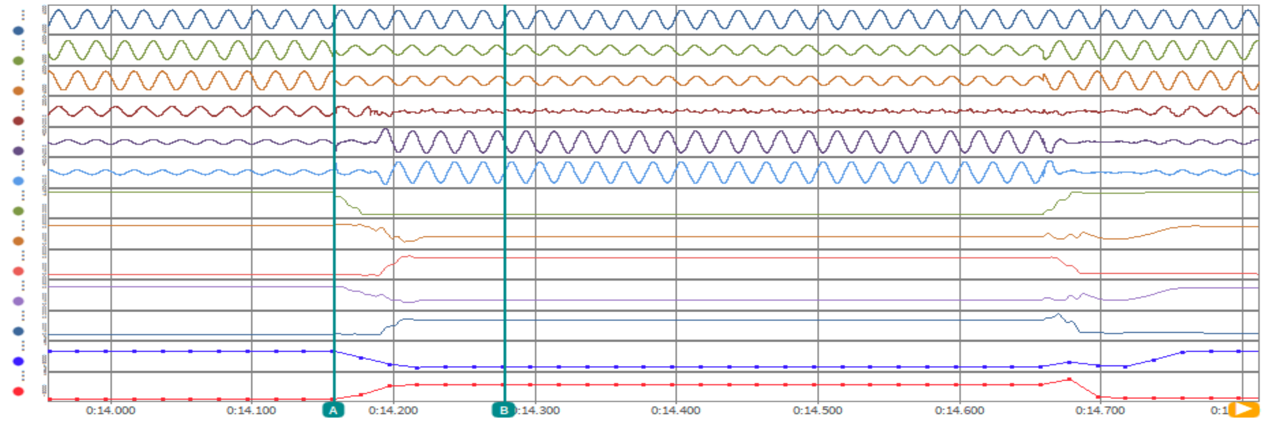
Test no. 2.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.158646	0:14.219408	0.060762		
U1 [V]	-83.31681	89.53441	172.8512	-0.389771	457.7738
U2 [V]	-521.0560	-107.1794	413.8766	-6.991146	244.2643
U3 [V]	598.4880	10.71227	-587.7757	7.151658	244.0981
I1 [A]	-7.771492	-4.615426	3.156066	-8.067978	38.60750
I2 [A]	-53.77102	-54.60072	-0.829697	35.83770	161.0114
I3 [A]	60.64582	58.37179	-2.274037	-27.70377	150.2215
U+_PU [V]	0.999299	0.555469	-0.443830	0.643953	0.659957
Ip+_PU [A]	0.203464	0.012736	-0.190728	0.128903	0.158023
Iq+_PU [A]	3.222e-4	0.517875	0.517553	0.180758	0.296318
Ip+_PU [W]	0.203330	7.074e-3	-0.196255	0.091003	0.117436
Iq+_PU [var]	3.219e-4	0.287676	0.287354	0.100690	0.164550
P_t@SG320HX [W]	65029.38	3725.200	-61304.18	38493.26	45671.23
Q_t@SG320HX [var]	2313.464	103336.1	101022.6	48141.99	65431.58

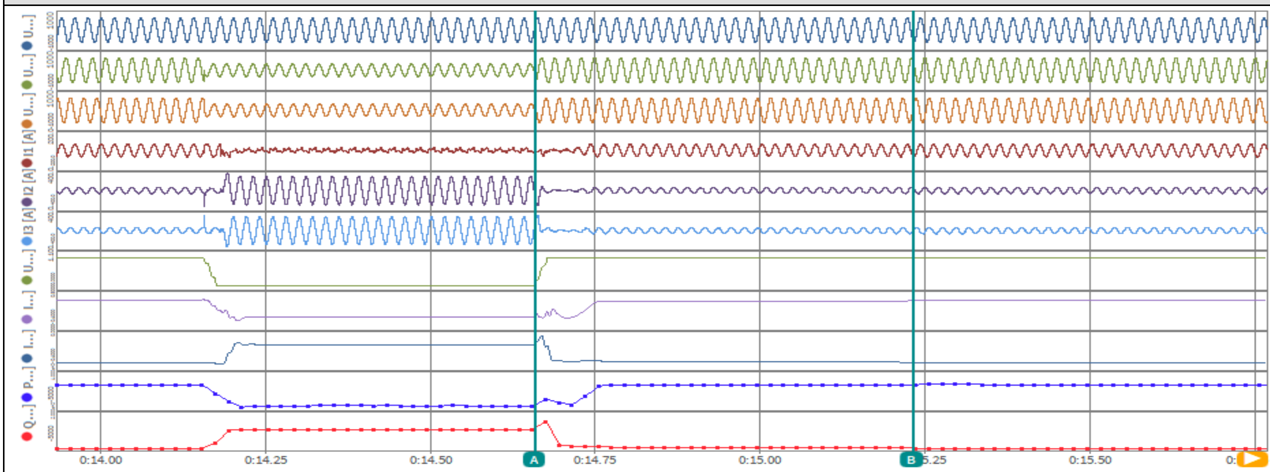
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.158646	0:14.278757	0.120111		
U1 [V]	-83.31681	-64.80742	18.50939	-0.597100	460.6377
U2 [V]	-521.0560	-25.31719	495.7388	-2.632340	241.2143
U3 [V]	598.4880	91.26485	-507.2232	2.997498	240.9211
I1 [A]	-7.771492	-16.54542	-8.773923	-4.202310	29.26420
I2 [A]	-53.77102	3.888607	57.65963	17.32726	188.7620
I3 [A]	60.64582	10.57828	-50.06755	-12.96530	179.1982
U+_PU [V]	0.999299	0.555165	-0.444135	0.600762	0.611202
Ip+_PU [A]	0.203464	0.049673	-0.153791	0.090120	0.118296
Iq+_PU [A]	3.222e-4	0.529368	0.529046	0.350825	0.426299
Ip+_PU [W]	0.203330	0.027578	-0.175752	0.059999	0.086235
Iq+_PU [var]	3.219e-4	0.293899	0.293577	0.195000	0.236757
P_t@SG320HX [W]	65029.38	7585.807	-57443.57	29636.00	38806.50
Q_t@SG320HX [var]	2313.464	104602.8	102289.3	64343.21	78732.86

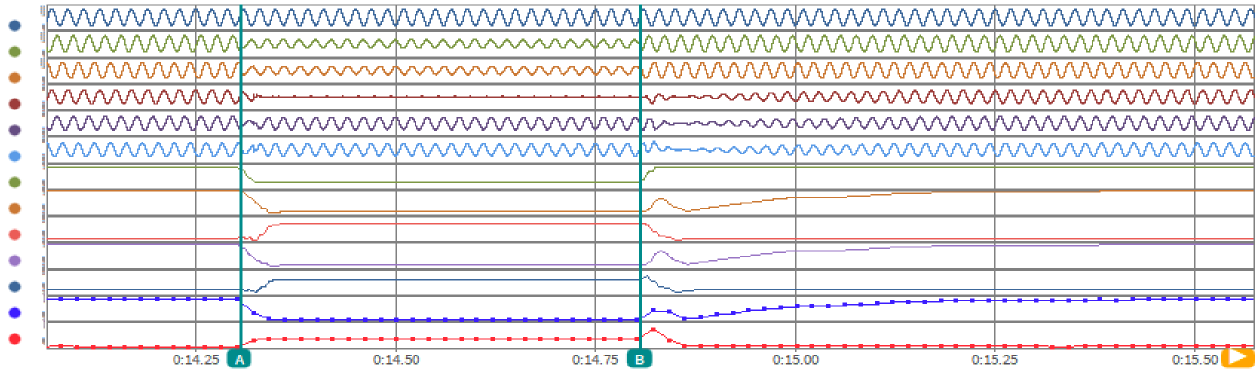
Test no. 2.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:14.659341	0:15.230872	0.571531		
U1 [V]	70.38618	-360.8853	-431.2715	6.605786	461.4324
U2 [V]	-84.31662	650.0557	734.3723	-1.713606	461.1260
U3 [V]	14.58407	-294.8989	-309.4830	-5.022260	460.8979
I1 [A]	-3.204704	-38.80763	-35.60293	-0.054273	43.01407
I2 [A]	-49.79742	70.15825	119.9557	-3.067292	51.33604
I3 [A]	52.37246	-33.23078	-85.60324	2.645163	52.13108
U+_PU [V]	0.554022	0.999232	0.445211	0.989389	0.990855
Ip+_PU [W]	0.027688	0.201209	0.173521	0.173588	0.181387
Iq+_PU [var]	0.293703	2.523e-3	-0.291180	0.035264	0.072585
P_t@SG320HX [W]	7507.528	63591.34	56083.81	54910.93	57606.62
Q_t@SG320HX [var]	103858.9	6212.475	-97646.42	17600.43	34872.09

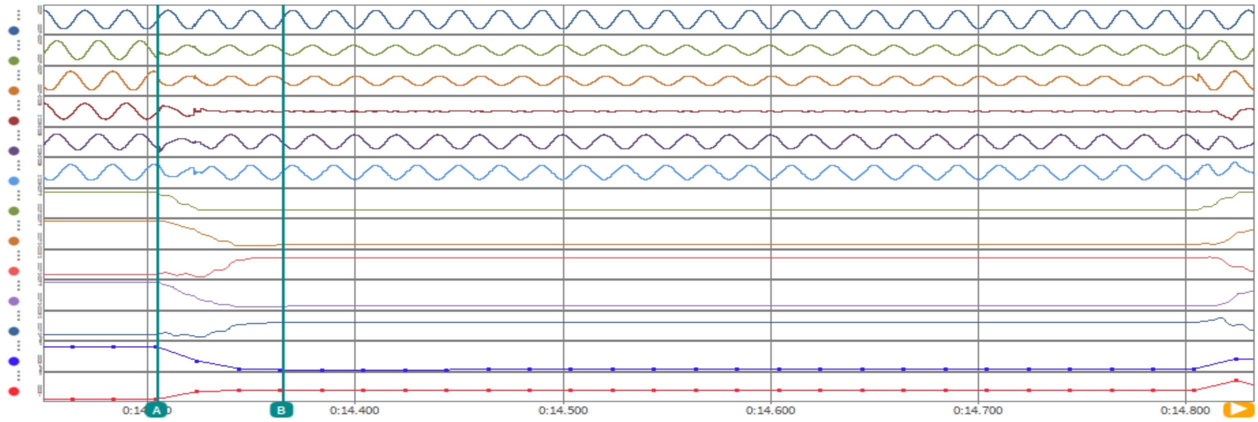
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.3057869	0:14.8067876	0.5010006		
U1 [V]	50.73178	304.0648	253.3330	0.241919	460.9639
U2 [V]	67.11758	-646.7575	-713.8751	-0.908607	236.6731
U3 [V]	-146.9349	351.5650	498.4999	0.496344	235.8926
I1 [A]	-6.399632	-6.486059	-0.086427	0.346839	32.50250
I2 [A]	-490.4441	-145.3587	345.0854	-2.312084	207.2357
I3 [A]	501.5432	148.6707	-352.8725	1.172212	201.6170
U+_PU [V]	0.999769	0.557857	-0.441911	0.564477	0.567174
Ip+_PU [A]	1.006535	0.030590	-0.975945	0.073596	0.185613
Iq+_PU [A]	-9.100e-4	0.524771	0.525681	0.489699	0.506034
Ip+_PU [W]	1.006345	0.017066	-0.989279	0.050055	0.151573
Iq+_PU [var]	-9.099e-4	0.292760	0.293670	0.271693	0.280593
P_t@SG320HX [W]	322055.6	4928.843	-317126.8	21375.71	67167.79

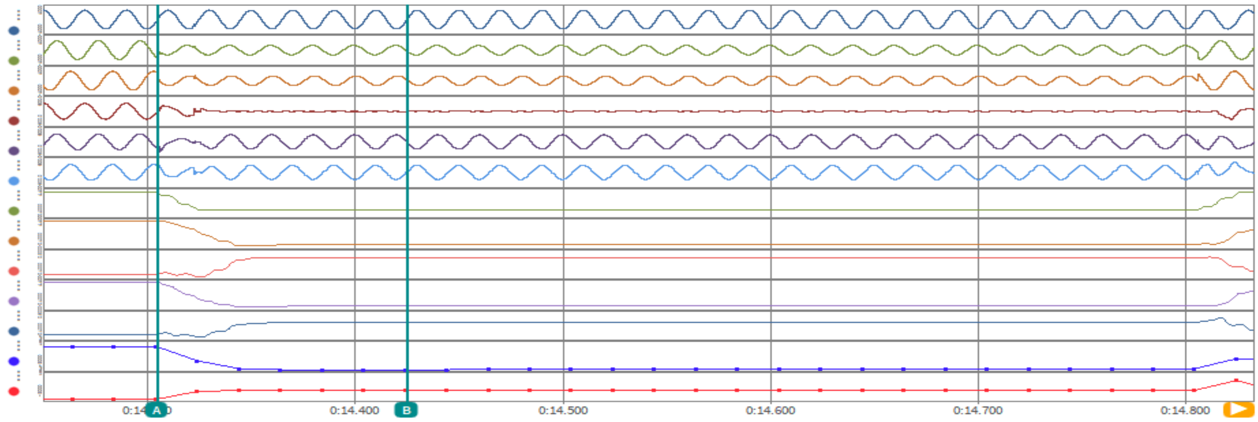
Test no. 2.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.3049081	0:14.3652693	0.0603612		
U1 [V]	-49.01696	5.136252	54.15321	-0.414136	458.8970
U2 [V]	-547.8708	-61.75602	486.1148	-5.736590	243.6282
U3 [V]	594.5058	58.83324	-535.6726	5.984461	243.9604
I1 [A]	-20.55681	-10.40685	10.14996	7.212836	87.63686
I2 [A]	-271.7410	-7.918358	263.8227	-7.042206	187.8113
I3 [A]	289.3937	14.45079	-274.9429	-0.783302	181.6806
U+_PU [V]	0.999733	0.554509	-0.445225	0.642927	0.658978
Ip+_PU [A]	1.006350	0.021717	-0.984634	0.371178	0.535834
Iq+_PU [A]	-1.132e-3	0.526655	0.527787	0.220132	0.318969
Ip+_PU [W]	1.006125	0.012043	-0.994083	0.287919	0.447029
Iq+_PU [var]	-1.132e-3	0.292047	0.293179	0.123460	0.177082
P_t@SG320HX [W]	321922.3	3513.798	-318408.5	154331.8	209962.7
Q_t@SG320HX [var]	5048.048	105028.0	99979.93	61133.92	76679.43

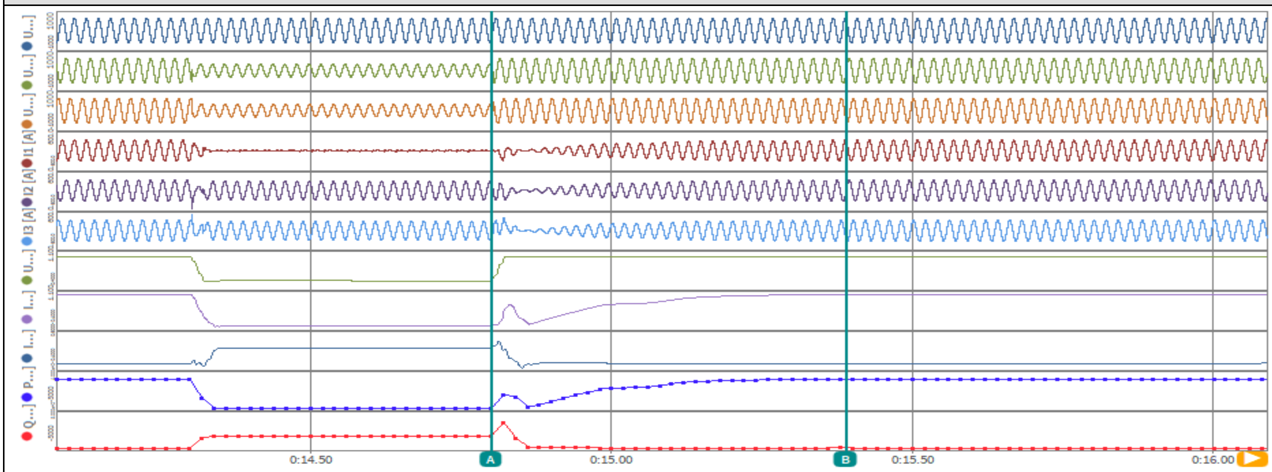
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.3049081	0:14.4251192	0.1202110		
U1 [V]	-49.01696	-13.85892	35.15804	-0.544322	460.0006
U2 [V]	-547.8708	-50.42851	497.4423	-2.716554	240.2221
U3 [V]	594.5058	64.98599	-529.5198	2.847784	240.3118
I1 [A]	-20.55681	-10.18405	10.37276	2.169136	62.69787
I2 [A]	-271.7410	-2.343536	269.3975	-4.021028	199.3500
I3 [A]	289.3937	10.34093	-279.0528	1.166962	193.7919
U+_PU [V]	0.999733	0.554906	-0.444827	0.599577	0.609963
Ip+_PU [A]	1.006350	0.033080	-0.973271	0.204704	0.382674
Iq+_PU [A]	-1.132e-3	0.526515	0.527647	0.371339	0.434280
Ip+_PU [W]	1.006125	0.018357	-0.987768	0.155237	0.318932
Iq+_PU [var]	-1.132e-3	0.292179	0.293311	0.206696	0.240984
P_t@SG320HX [W]	321922.3	4550.929	-317371.4	98142.53	166012.9
Q_t@SG320HX [var]	5048.048	103569.5	98521.44	77117.65	87817.60

Test no. 2.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.1 p.u, P=100%Pn, Active power recovery time



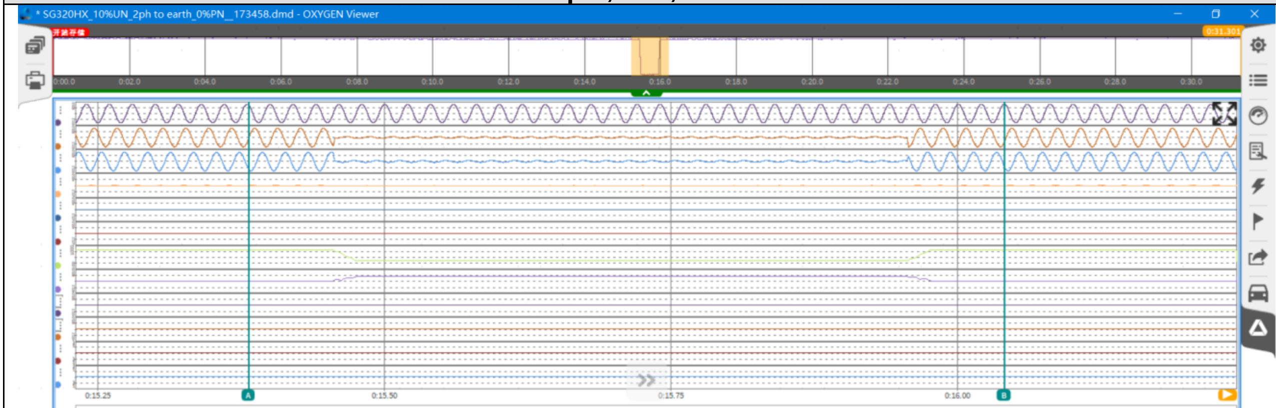
	A	B	Delta	Avg	RMS
Time [s]	0:14.802101	0:15.390700	0.588599		
U1 [V]	-533.5763	640.3813	1173.958	2.412117	461.8964
U2 [V]	231.9762	-218.0617	-450.0379	-4.679788	460.0659
U3 [V]	300.7733	-428.2459	-729.0192	2.640119	458.5997
I1 [A]	-7.679344	328.9952	336.6746	-4.516900	182.6939
I2 [A]	235.3577	-118.5526	-353.9102	-4.099237	184.6788
I3 [A]	-226.0625	-208.3798	17.68279	6.512004	185.0539
U+_PU [V]	0.553948	0.999474	0.445527	0.987453	0.989356
Ip+_PU [W]	0.018948	1.003535	0.984587	0.713282	0.772033
Iq+_PU [var]	0.291565	9.785e-3	-0.281781	0.024804	0.072228
P_t@SG320HX [W]	4890.363	321870.4	316980.0	219770.5	242281.7
Q_t@SG320HX [var]	103056.4	11720.44	-91335.97	23427.54	49569.39

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

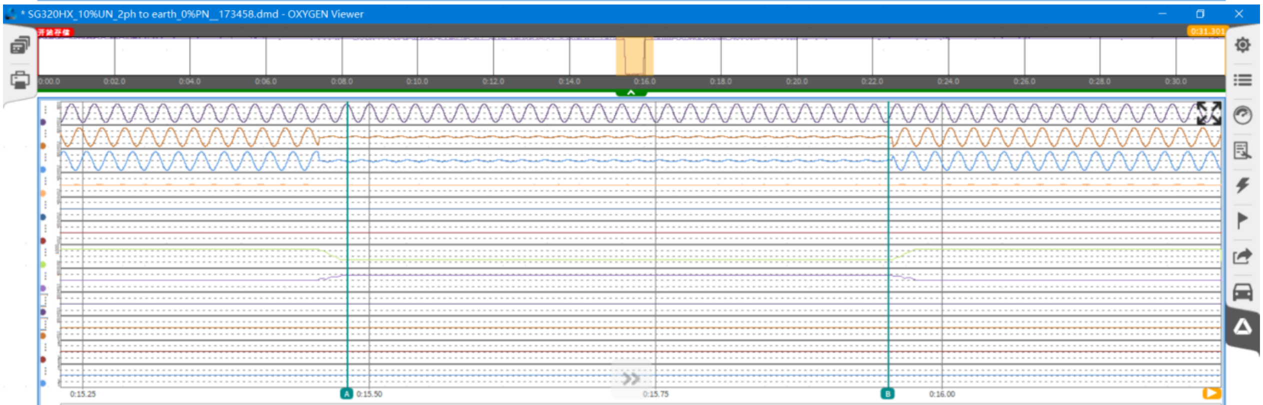
Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
	74	Test number	--	--	--	2.4.1	2.4.2
Before dip < t_1	75	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	462.6	463.7
	76		Phase 2			459.9	461.1
	77		Phase 3			461.2	460.6
	78	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	49.6	234.2
	79		Phase 2			49.4	232.6
	80		Phase 3			49.5	232.3
	81	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.21	1.00
	82		total		W	65622	319568
	83	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.00	0.00
	84		total		var	-169	3.82
During dip t_1 to t_2	85	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	462.8	463.4
	86		Phase 2			50.5	50.4
	87		Phase 3			50.4	50.3
	88	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	85.1	84.9
	89		Phase 2			214.5	214.7
	90		Phase 3			207.5	207.0
	91	Total fault duration	All phase	t_1 to t_2	ms	451	471
	92	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.19	0.03
	93		total		var	59546	10265
	94	Reactive current	Positive sequence		p.u.	0.63	0.63
	95	Active power	Positive sequence		p.u.	0.02	0.01
	96		total		W	6147	3942
	97	Active current	Positive sequence		p.u.	0.02	0.01
	98	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.63	0.63
	99	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.63	0.63
After dip > t_2	100	Voltage	Phase 1	t_2+1s	Vrms	461.1	463.5
	101		Phase 2			460.8	460.9
	102		Phase 3			462.4	460.9
	103	Current	Phase 1	t_2+1s	Arms	47.1	233.9
	104		Phase 2			47.1	232.0
	105		Phase 3			47.1	232.1
	106	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.02
	107		total		W	63087	325272
	108	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	109		total		Var	4185	2789
	110	Active power recovery time	Positive sequence	--	ms	73	564

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.4.0 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=0, Fault Duration



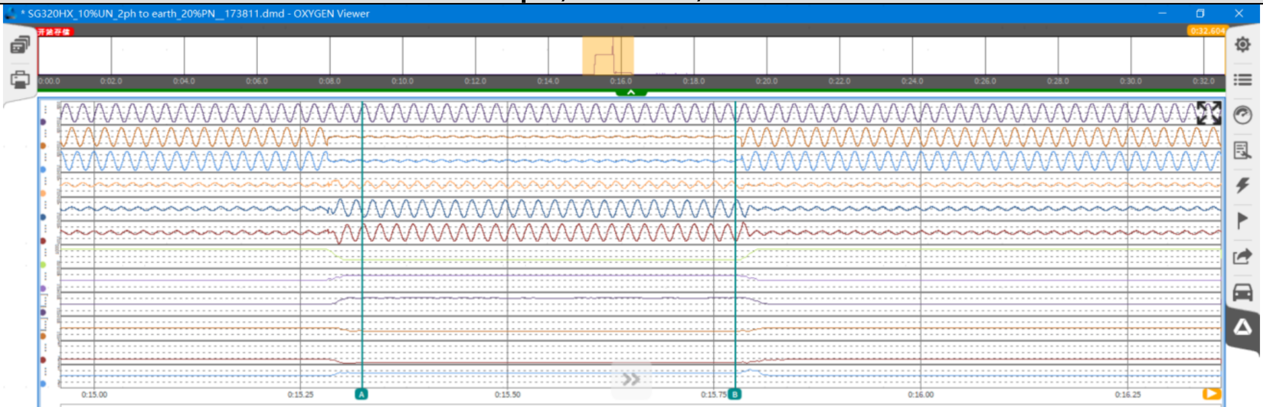
	A	B	间隔
时间 [s]	0:15.3820158	0:16.0406511	0.6586353
AI 1/U1@TRIONet_782 [V]	597.8511	653.5373	55.68624
AI 1/U2@TRIONet_782 [V]	-78.11141	-339.3984	-261.2870
AI 1/U3@TRIONet_782 [V]	-523.4294	-315.3370	208.0925
AI 1/I1@TRIONet_782 [A]	-0.178814	-0.233650	-0.054836
AI 1/I2@TRIONet_782 [A]	-0.338554	-0.302792	0.035763
AI 1/I3@TRIONet_782 [A]	-0.016689	0.102520	0.119209
U_fund_SYM+_rc@POWER/0 [V]	799.9227	798.4465	-1.476135
U_fund_SYM-_rc@POWER/0 [V]	0.862245	3.034776	2.172531
I_fund_Q_SYM+_rc@POWER/0 [A]	0.139971	0.139185	-7.867e-4
I_fund_Q_SYM-_rc@POWER/0 [A]	1.635e-3	-2.013e-3	-3.648e-3
P_t_rc@POWER/0 [W]	7.004020	5.782908	-1.221112
Q_fund_rc@POWER/0 [var]	193.9402	192.4811	-1.459122



	A	B	间隔
时间 [s]	0:15.4812036	0:15.9528807	0.4716771
AI 1/U1@TRIONet_782 [V]	645.8612	-513.0067	-1158.868
AI 1/U2@TRIONet_782 [V]	-23.64922	-9.803057	13.84616
AI 1/U3@TRIONet_782 [V]	-43.12992	59.74532	102.8752
AI 1/I1@TRIONet_782 [A]	-0.149012	-0.251532	-0.102520
AI 1/I2@TRIONet_782 [A]	-0.138283	-0.061989	0.076294
AI 1/I3@TRIONet_782 [A]	0.047684	0.041723	-5.960e-3
U_fund_SYM+_rc@POWER/0 [V]	321.1608	319.6573	-1.503448
U_fund_SYM-_rc@POWER/0 [V]	239.2639	240.1195	0.855560
I_fund_Q_SYM+_rc@POWER/0 [A]	0.054048	0.053719	-3.290e-4
I_fund_Q_SYM-_rc@POWER/0 [A]	0.037240	0.036438	-8.017e-4
P_t_rc@POWER/0 [W]	5.544029	7.018120	1.474091
Q_fund_rc@POWER/0 [var]	35.22092	34.72691	-0.494007

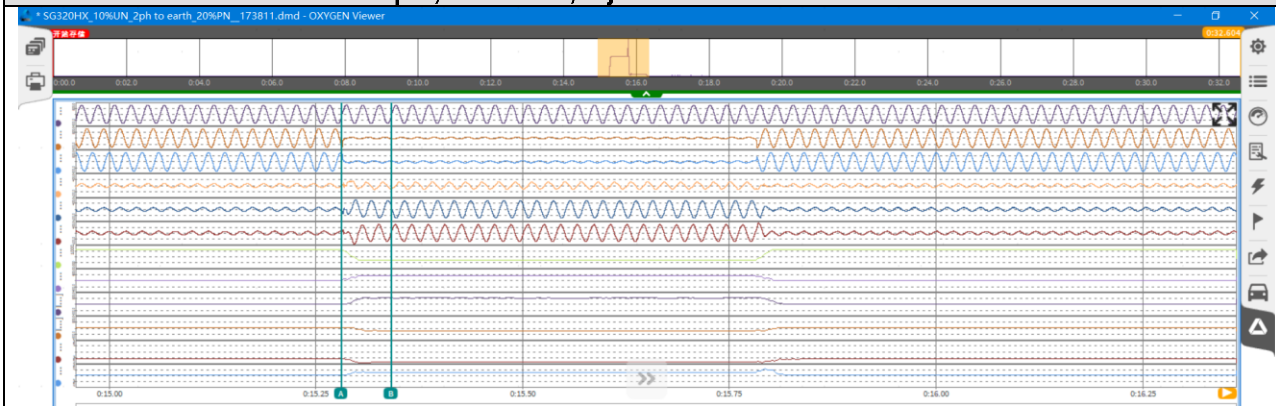
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.4.1 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=20%Pn, fault duration



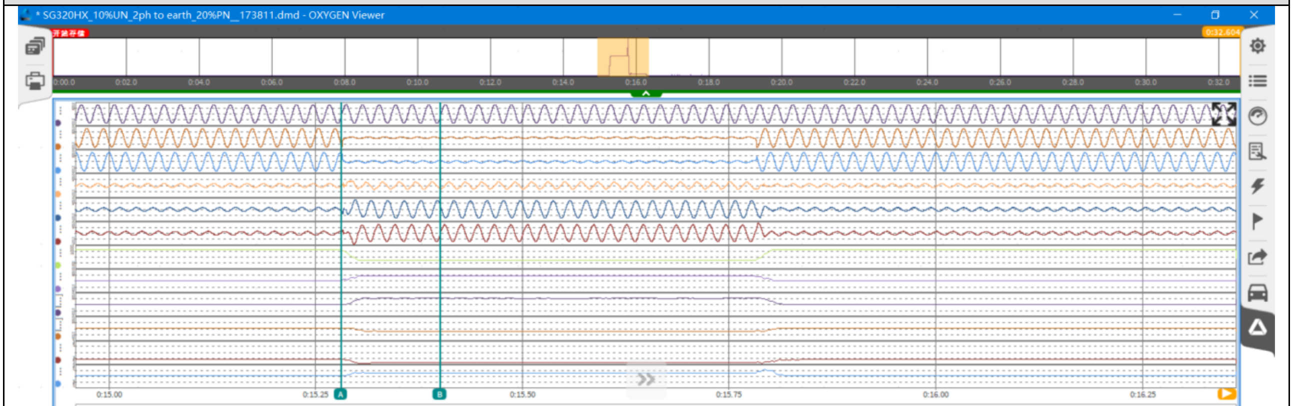
时间 [s]	A 0:15.3245544	B 0:15.7756799	间隔 0.4511255
AI 1/U1@TRIONet_782 [V]	469.8715	-593.0612	-1062.933
AI 1/U2@TRIONet_782 [V]	-68.29691	53.68495	121.9819
AI 1/U3@TRIONet_782 [V]	16.52265	3.106833	-13.41581
AI 1/I1@TRIONet_782 [A]	-74.45455	30.73335	105.1879
AI 1/I2@TRIONet_782 [A]	-181.7930	255.3463	437.1393
AI 1/I3@TRIONet_782 [A]	255.7624	-286.8676	-542.6300
U_fund_SYM+_rc@POWER/0 [V]	325.2469	324.3293	-0.917633
U_fund_SYM-_rc@POWER/0 [V]	237.1271	238.1498	1.022720
I_fund_Q_SYM+_rc@POWER/0 [A]	158.5117	160.8034	2.291672
I_fund_Q_SYM-_rc@POWER/0 [A]	-74.66910	-77.32719	-2.658096
P_t_rc@POWER/0 [W]	2749.713	6019.521	3269.808
Q_fund_rc@POWER/0 [var]	58640.99	58445.59	-195.3984

Test no. 2.4.1 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 60ms



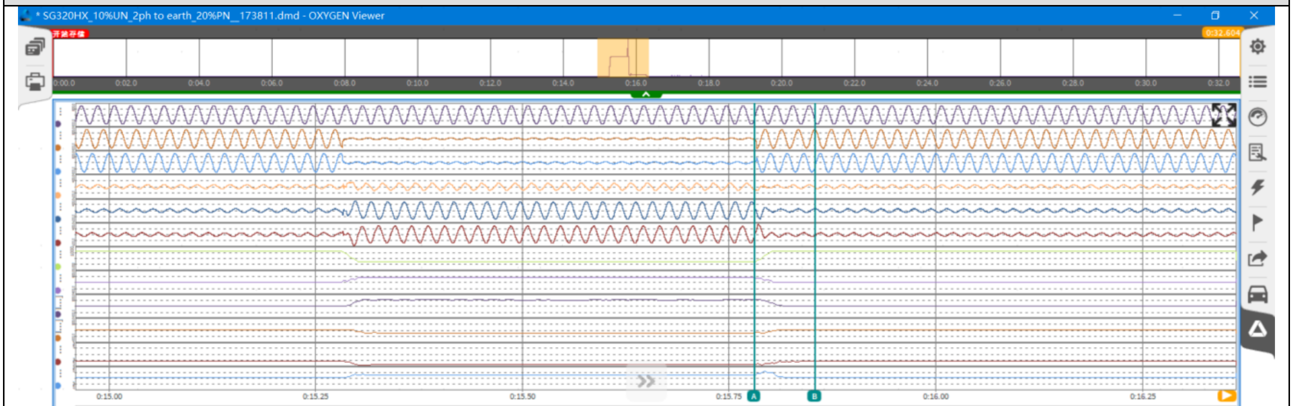
时间 [s]	A 0:15.2810248	B 0:15.3413727	间隔 0.0603479
AI 1/U1@TRIONet_782 [V]	-194.9263	-135.3195	59.60679
AI 1/U2@TRIONet_782 [V]	-445.7605	-53.15733	392.6032
AI 1/U3@TRIONet_782 [V]	632.9706	64.54420	-568.4264
AI 1/I1@TRIONet_782 [A]	-17.19713	-125.6037	-108.4066
AI 1/I2@TRIONet_782 [A]	-48.37036	95.57248	143.9428
AI 1/I3@TRIONet_782 [A]	65.17053	29.18959	-35.98094
U_fund_SYM+_rc@POWER/0 [V]	800.1316	325.2723	-474.8593
U_fund_SYM-_rc@POWER/0 [V]	0.952839	237.3800	236.4272
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.049228	161.5306	161.5799
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.356834	-76.53929	-76.18246
P_t_rc@POWER/0 [W]	65572.81	6147.644	-59425.17
Q_fund_rc@POWER/0 [var]	-68.82951	59546.98	59615.81

Test no. 2.4.1 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	间隔
时间 [s]	0:15.2810248	0:15.4007313	0.1197065
AI 1/U1@TRIONet_782 [V]	-194.9263	-254.1056	-59.17931
AI 1/U2@TRIONet_782 [V]	-445.7605	-47.89758	397.8629
AI 1/U3@TRIONet_782 [V]	632.9706	72.28184	-560.6888
AI 1/I1@TRIONet_782 [A]	-17.19713	-127.1117	-109.9145
AI 1/I2@TRIONet_782 [A]	-48.37036	155.4012	203.7716
AI 1/I3@TRIONet_782 [A]	65.17053	-29.24204	-94.41257
U_fund_SYM+_rc@POWER/0 [V]	800.1316	325.2733	-474.8583
U_fund_SYM-_rc@POWER/0 [V]	0.952839	237.7762	236.8233
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.049228	160.7511	160.8003
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.356834	-77.34576	-76.98892
P_t_rc@POWER/0 [W]	65572.81	5922.322	-59650.49
Q_fund_rc@POWER/0 [var]	-68.82951	58722.08	58790.91

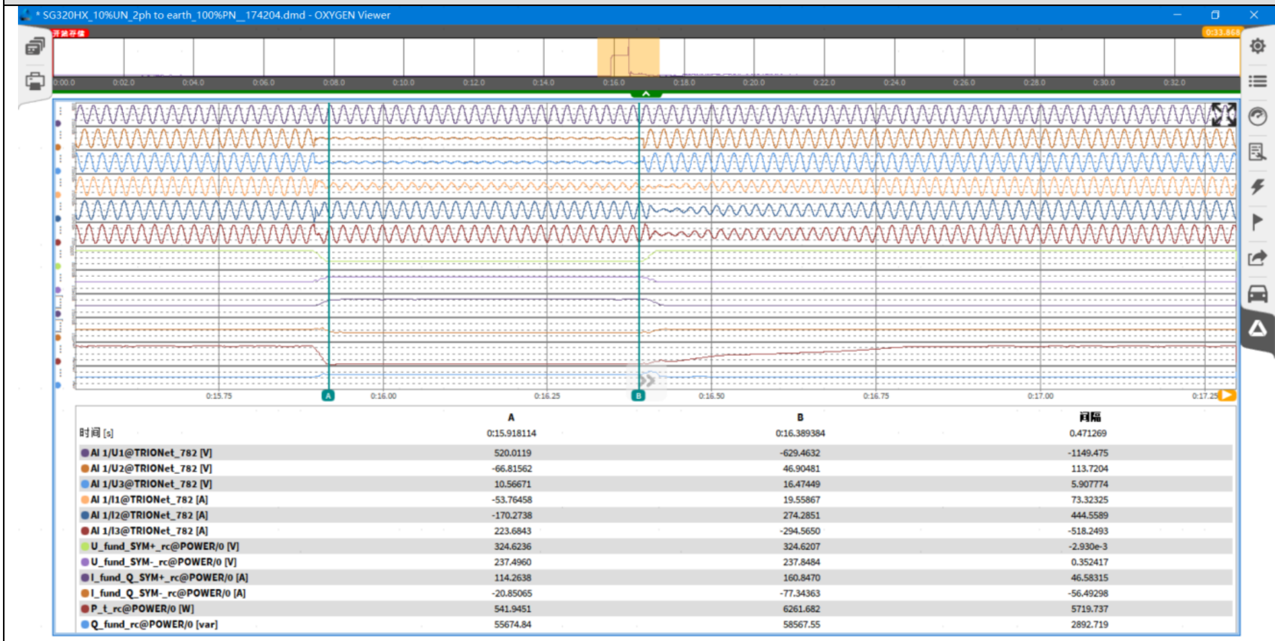
Test no. 2.4.1 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=20%Pn, Active power recovery time



	A	B	间隔
时间 [s]	0:15.7806265	0:15.8538355	0.0732090
AI 1/U1@TRIONet_782 [V]	-268.3849	-367.0376	-98.65261
AI 1/U2@TRIONet_782 [V]	-44.24572	647.5294	691.7751
AI 1/U3@TRIONet_782 [V]	69.28063	-276.6781	-345.9587
AI 1/I1@TRIONet_782 [A]	-133.0316	-27.44794	105.5837
AI 1/I2@TRIONet_782 [A]	172.8344	65.53054	-107.3039
AI 1/I3@TRIONet_782 [A]	-40.51686	-38.48434	2.032519
U_fund_SYM+_rc@POWER/0 [V]	324.3489	799.7669	475.4180
U_fund_SYM-_rc@POWER/0 [V]	238.1629	3.978916	-234.1840
I_fund_Q_SYM+_rc@POWER/0 [A]	160.8410	0.651898	-160.1891
I_fund_Q_SYM-_rc@POWER/0 [A]	-77.34657	0.326827	77.67340
P_t_rc@POWER/0 [W]	6001.364	64001.72	58000.36
Q_fund_rc@POWER/0 [var]	58462.33	905.2068	-57557.12

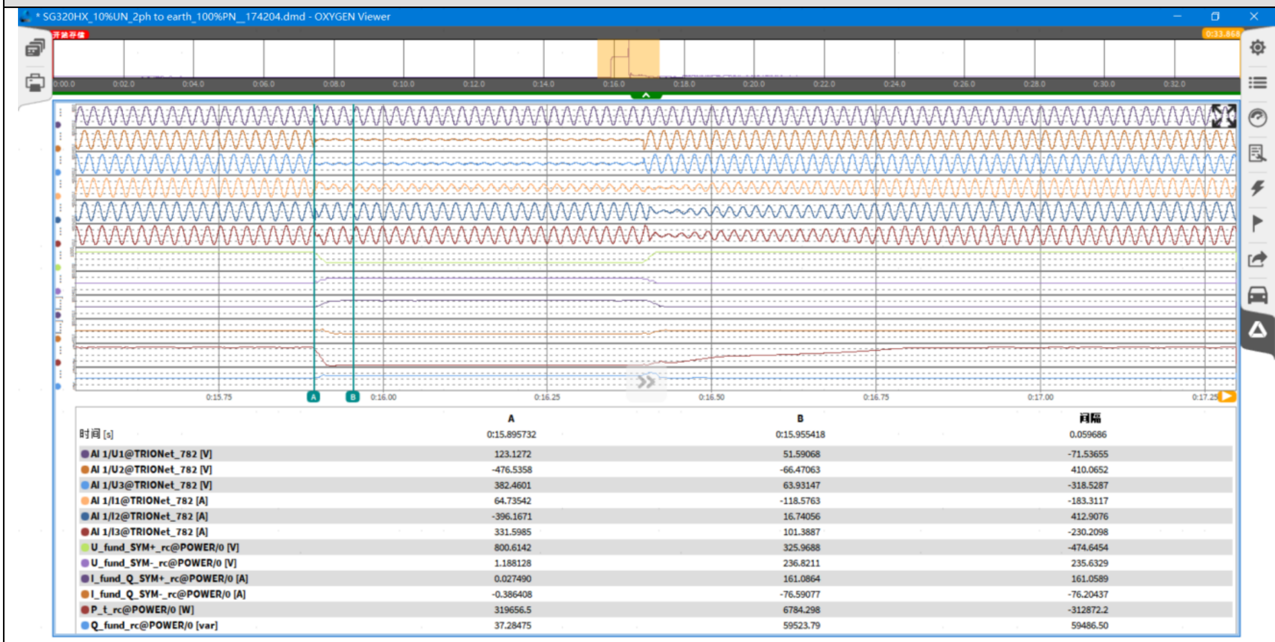
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.4.2 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=100%Pn, fault duration



	A	B	间隔
时间 [s]	0:15.918114	0:16.389384	0.471269
AI 1/U1@TRIONet_782 [V]	520.0119	-629.4632	-1149.475
AI 1/U2@TRIONet_782 [V]	-66.81562	46.90481	113.7204
AI 1/U3@TRIONet_782 [V]	10.56671	16.47449	5.907774
AI 1/I1@TRIONet_782 [A]	-53.76458	19.55867	73.32325
AI 1/I2@TRIONet_782 [A]	-170.2738	274.2851	444.5589
AI 1/I3@TRIONet_782 [A]	223.6843	-294.5650	-518.2493
U_fund_SYM+_rc@POWER/0 [V]	324.6236	324.6207	-2.930e-3
U_fund_SYM-_rc@POWER/0 [V]	237.4960	237.8484	0.352417
I_fund_Q_SYM+_rc@POWER/0 [A]	114.2638	160.8470	46.58315
I_fund_Q_SYM-_rc@POWER/0 [A]	-20.85065	-77.34363	-56.49298
P_t_rc@POWER/0 [W]	541.9451	6261.682	5719.737
Q_fund_rc@POWER/0 [var]	55674.84	58567.55	2892.719

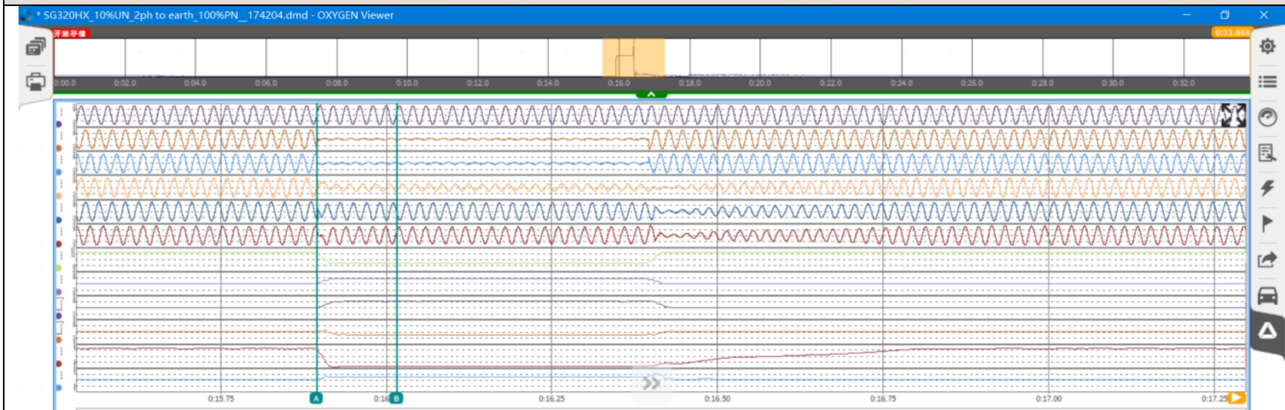
Test no. 2.4.2 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	间隔
时间 [s]	0:15.895732	0:15.955418	0.059686
AI 1/U1@TRIONet_782 [V]	123.1272	51.59068	-71.53655
AI 1/U2@TRIONet_782 [V]	-476.5358	-66.47063	410.0652
AI 1/U3@TRIONet_782 [V]	382.4601	63.93147	-318.5287
AI 1/I1@TRIONet_782 [A]	64.73542	-118.5763	-183.3117
AI 1/I2@TRIONet_782 [A]	-396.1671	16.74056	412.9076
AI 1/I3@TRIONet_782 [A]	331.5985	101.3887	-230.2098
U_fund_SYM+_rc@POWER/0 [V]	800.6142	325.9688	-474.6454
U_fund_SYM-_rc@POWER/0 [V]	1.188128	236.8211	235.6329
I_fund_Q_SYM+_rc@POWER/0 [A]	0.027490	161.0864	161.0589
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.386408	-76.59077	-76.20437
P_t_rc@POWER/0 [W]	319656.5	6784.298	-312872.2
Q_fund_rc@POWER/0 [var]	37.28475	59523.79	59486.50

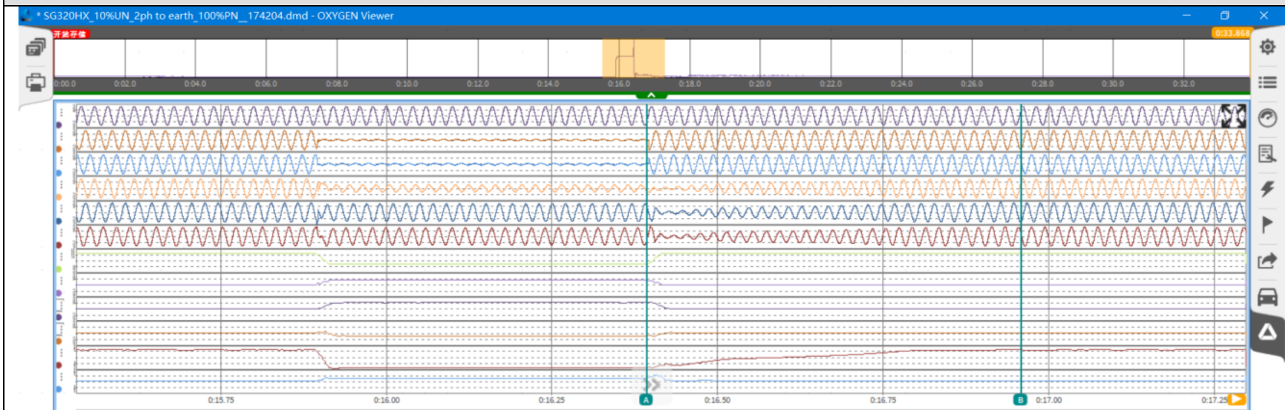
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 2.4.2 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=100%Pn, Injected reactive Current after 120ms



时间 [s]	A 0:15.895732	B 0:16.016347	间隔 0.120615
AI 1/U1@TRIONet_782 [V]	123.1272	239.7521	116.6248
AI 1/U2@TRIONet_782 [V]	-476.5358	-72.23416	404.3017
AI 1/U3@TRIONet_782 [V]	382.4601	40.27653	-342.1836
AI 1/I1@TRIONet_782 [A]	64.73542	-89.20789	-153.9433
AI 1/I2@TRIONet_782 [A]	-396.1671	-57.80697	338.3601
AI 1/I3@TRIONet_782 [A]	331.5985	146.7168	-184.8817
U_fund_SYM+_rc@POWER/0 [V]	800.6142	325.5586	-475.0556
U_fund_SYM-_rc@POWER/0 [V]	1.188128	237.6474	236.4593
I_fund_Q_SYM+_rc@POWER/0 [A]	0.027490	160.9381	160.9106
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.386408	-77.39055	-77.00414
P_t_rc@POWER/0 [W]	319656.5	5870.610	-313785.9
Q_fund_rc@POWER/0 [var]	37.28475	58889.34	58852.06

Test no. 2.4.2 Two phase to earth fault (type E)
U/Un = 0.1 p.u, P=100%Pn, Active power recovery time



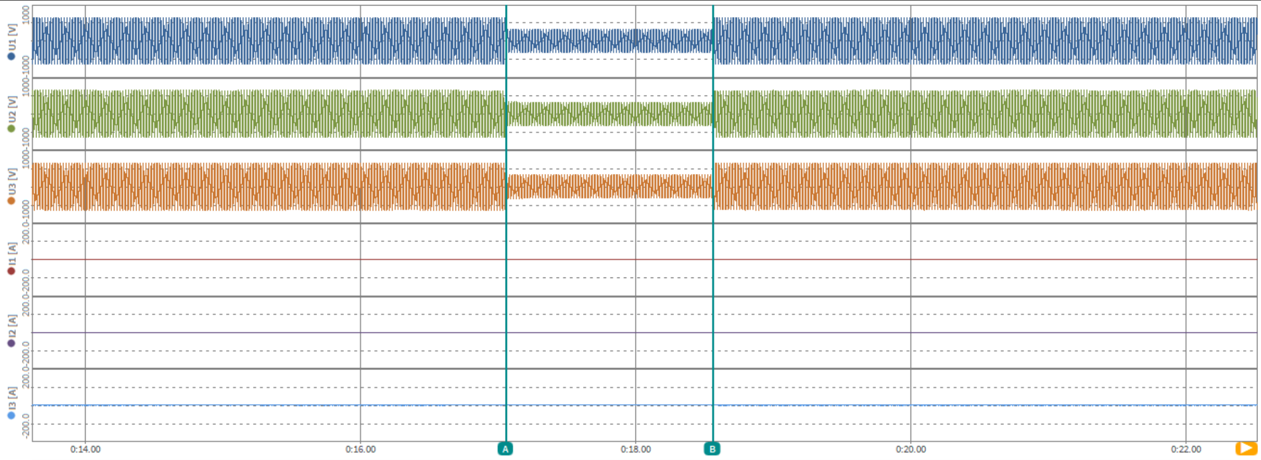
时间 [s]	A 0:16.393114	B 0:16.957642	间隔 0.564529
AI 1/U1@TRIONet_782 [V]	-394.7945	469.3771	864.1716
AI 1/U2@TRIONet_782 [V]	-31.62170	-626.7071	-595.0854
AI 1/U3@TRIONet_782 [V]	67.88397	163.0688	95.18481
AI 1/I1@TRIONet_782 [A]	-114.7199	225.3509	340.0707
AI 1/I2@TRIONet_782 [A]	221.8855	-303.4353	-525.3208
AI 1/I3@TRIONet_782 [A]	-107.5649	78.41230	185.9772
U_fund_SYM+_rc@POWER/0 [V]	324.6499	800.4799	475.8300
U_fund_SYM-_rc@POWER/0 [V]	237.8707	0.937115	-236.9336
I_fund_Q_SYM+_rc@POWER/0 [A]	160.8458	1.778304	-159.0675
I_fund_Q_SYM-_rc@POWER/0 [A]	-77.33560	-1.228323	76.10728
P_t_rc@POWER/0 [W]	6270.792	320893.2	314622.4
Q_fund_rc@POWER/0 [var]	58575.32	2463.489	-56111.83

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	1.3.1	1.3.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	461.9	463.4
	2		Phase 2			460.4	459.6
	3		Phase 3			462.2	462.2
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.2	233.8
	5		Phase 2			47.0	231.5
	6		Phase 3			47.1	232.8
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.01
	8		total		W	65209	322329
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.01	0.01
	10		total		var	2278	5381
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	235.2	235.2
	12		Phase 2			235.6	235.5
	13		Phase 3			234.9	235.2
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	243.6	244.0
	15		Phase 2			243.4	243.7
	16		Phase 3			243.5	243.6
	17	Total fault duration	All phase	t_1 to t_2	ms	1501	1502
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.52	0.52
	19		total		var	166376	167672
	20	Reactive current	Positive sequence		p.u.	1.02	1.03
	21	Active power	Positive sequence		p.u.	0.13	0.12
	22		total		W	43083	38911
	23	Active current	Positive sequence		p.u.	0.26	0.24
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	1.08	1.07
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	1.02	1.02
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	463.0	462.2
	27		Phase 2			460.6	461.5
	28		Phase 3			460.9	461.6
	29	Current	Phase 1	t_2+1s	Arms	47.3	233.6
	30		Phase 2			47.9	232.8
	31		Phase 3			47.0	232.8
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.01
	33		total		W	65208	322790
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	35		total		Var	2876	6956
	36	Active power recovery time	Positive sequence	--	ms	603	593

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.1.0 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=0, Fault Duration

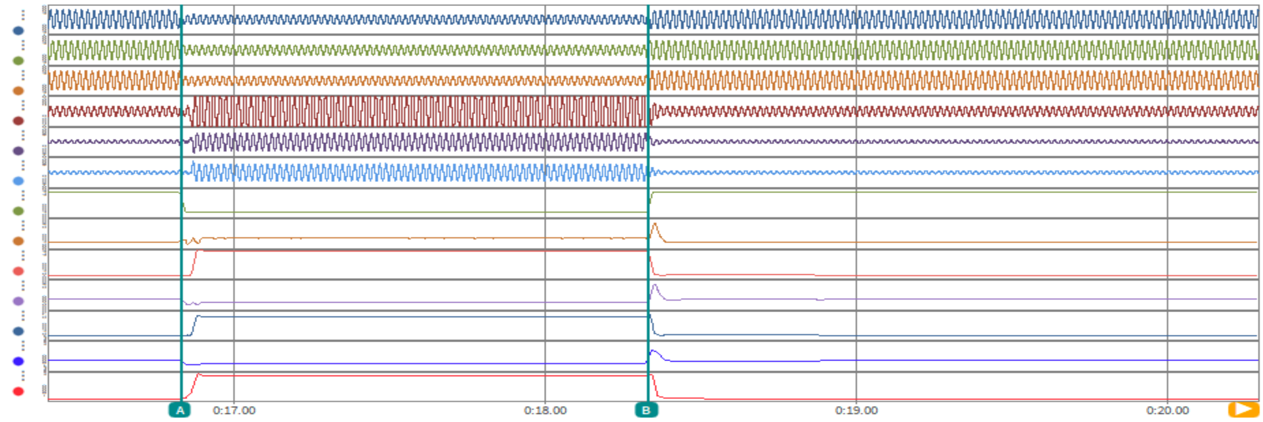


	A	B	间隔	有效值
时间 [s]	0:17.057324	0:18.559651	1.502327	
U1 [V]	-282.5326	-301.9352	-19.40262	233.2756
U2 [V]	649.5048	256.8133	-392.6915	233.1175
U3 [V]	-370.5799	44.80505	415.3849	232.9580
I1 [A]	-0.267148	-0.555515	-0.288367	0.475478
I2 [A]	-0.419259	-0.268698	0.150561	0.303821
I3 [A]	-0.655890	-0.715852	-0.059962	0.420635

	A	B	间隔
时间 [s]	0:17.08347	0:18.56894	1.48547
U+_PU [V]	0.598615	0.546501	-0.052114
U-_PU [V]	0.073654	0.044579	-0.029075
Ip+_PU [A]	-5.276e-6	-2.079e-4	-2.026e-4
Ip-_PU [A]	2.294e-5	-5.451e-5	-7.745e-5
Iq+_PU [A]	3.576e-4	3.623e-4	4.696e-6
Iq-_PU [A]	1.068e-4	-5.654e-5	-1.633e-4

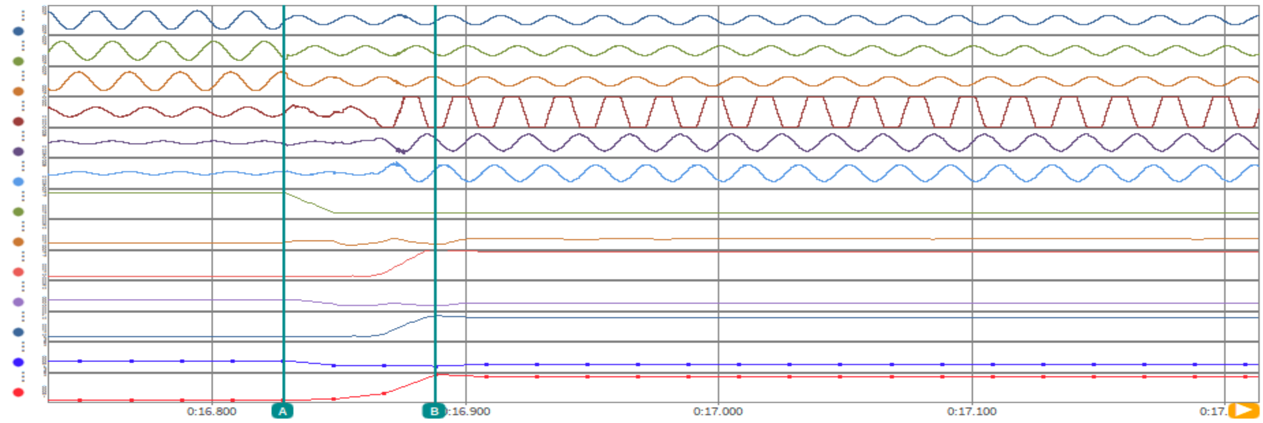
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.1.1 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:16.828799	0:18.329948	1.501150		
U1 [V]	-77.25442	158.2673	235.5217	0.730005	235.0717
U2 [V]	-525.6934	-563.9093	-38.21588	-0.565921	235.9257
U3 [V]	596.0549	409.5291	-186.5258	0.207721	235.4080
I1 [A]	-5.617261	-294.5622	-288.9450	-1.464790	241.0173
I2 [A]	-53.34890	43.74028	97.08918	-9.200e-3	240.6925
I3 [A]	61.92243	250.6451	188.7226	0.809123	240.5531
U+_PU [V]	0.999051	0.508706	-0.490345	0.513085	0.514395
Ip+_PU [A]	0.203695	0.264375	0.060680	0.261612	0.261948
Iq+_PU [A]	-2.075e-4	1.019935	1.020142	0.988529	1.003249
Ip+_PU [W]	0.203511	0.134495	-0.069016	0.134087	0.134376
Iq+_PU [var]	-2.073e-4	0.518869	0.519076	0.503490	0.510991
P_t@SG320HX [W]	65290.28	43006.61	-22283.68	43305.15	43492.99
Q_t@SG320HX [var]	2454.678	166168.4	163713.7	158855.4	162333.2

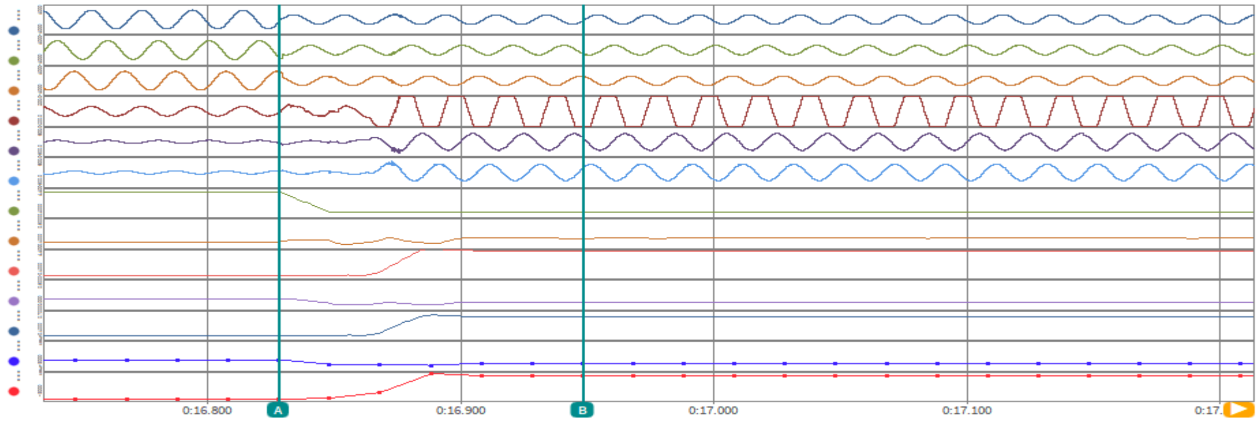
Test no. 3.1.1 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:16.828239	0:16.888034	0.059795		
U1 [V]	-179.1207	-110.0823	69.03840	0.594972	235.0014
U2 [V]	-457.7264	-219.5636	238.1628	-5.383234	245.5147
U3 [V]	630.4604	329.2821	-301.1784	5.636243	246.5605
I1 [A]	-19.02461	-351.1493	-332.1247	-10.68750	157.0732
I2 [A]	-47.55795	206.0733	253.6312	7.144775	162.3716
I3 [A]	62.57379	146.8868	84.31304	3.263741	158.6998
U+_PU [V]	0.999051	0.512088	-0.486963	0.603989	0.624406
Ip+_PU [A]	0.203695	0.183353	-0.020342	0.210684	0.212383
Iq+_PU [A]	-2.075e-4	1.079635	1.079843	0.221102	0.410678
Ip+_PU [W]	0.203511	0.093897	-0.109613	0.128416	0.134724
Iq+_PU [var]	-2.073e-4	0.552892	0.553100	0.112779	0.209669
P_t@SG320HX [W]	65290.28	36541.58	-28748.70	50914.61	52875.85
Q_t@SG320HX [var]	2454.678	52844.77	50390.09	17723.18	27284.11

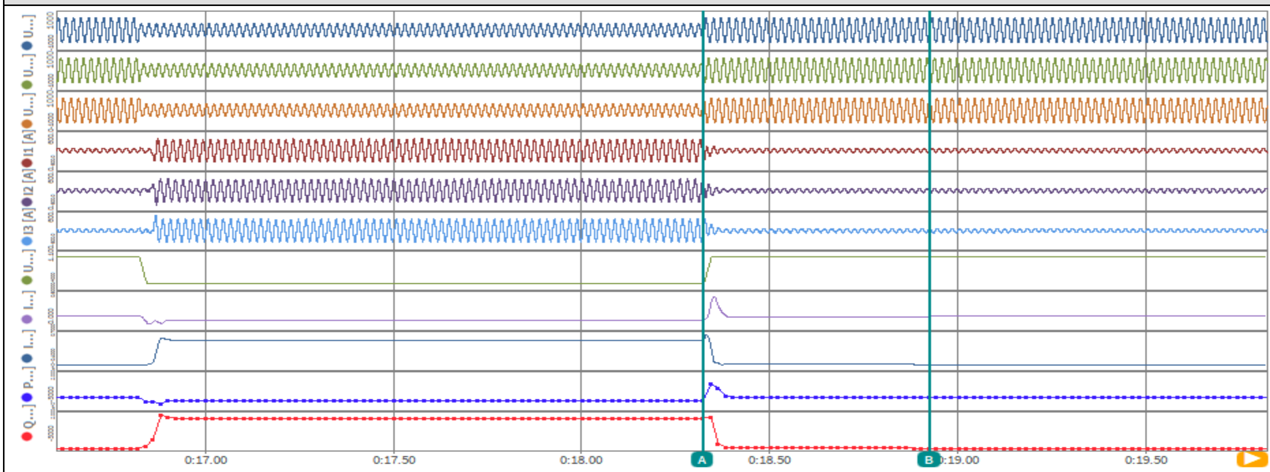
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.1.1 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:16.828239	0:16.948368	0.120129		
U1 [V]	-179.1207	-79.21446	99.90621	0.547671	235.1707
U2 [V]	-457.7264	-241.5925	216.1338	-3.392834	241.0130
U3 [V]	630.4604	318.1493	-312.3111	3.493990	241.4057
I1 [A]	-19.02461	-358.7218	-339.6971	-6.158397	205.7279
I2 [A]	-47.55795	175.5122	223.0702	3.785526	207.2084
I3 [A]	62.57379	183.7287	121.1549	1.833354	205.6133
U+_PU [V]	0.999051	0.510363	-0.488688	0.557225	0.570164
Ip+_PU [A]	0.203695	0.263003	0.059308	0.232173	0.234812
Iq+_PU [A]	-2.075e-4	1.019825	1.020032	0.630040	0.788110
Ip+_PU [W]	0.203511	0.134233	-0.069278	0.128957	0.132522
Iq+_PU [var]	-2.073e-4	0.520503	0.520710	0.321985	0.402863
P_t@SG320HX [W]	65290.28	43377.29	-21912.99	45810.26	47653.99
Q_t@SG320HX [var]	2454.678	166180.2	163725.5	83942.28	114718.6

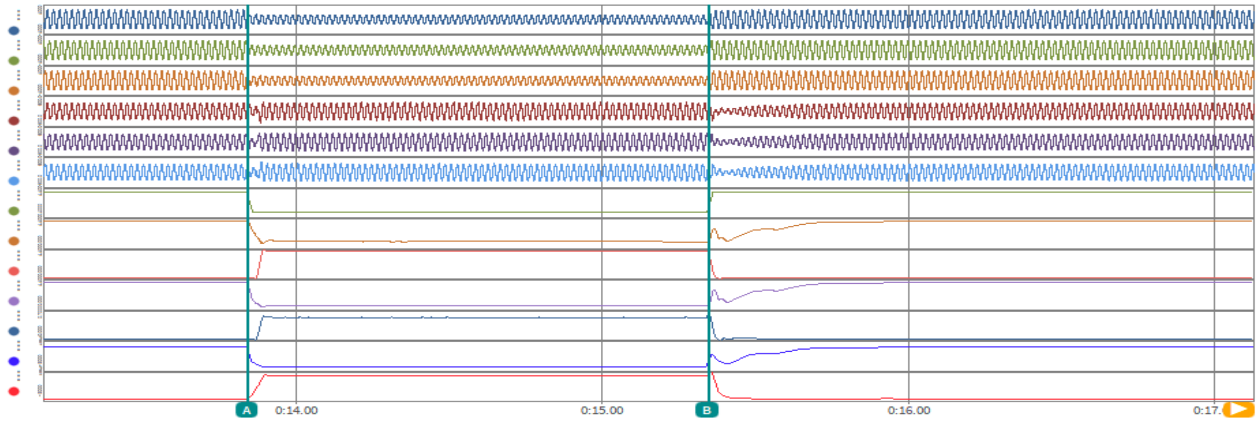
Test no. 3.1.1 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:18.323496	0:18.926142	0.602647		
U1 [V]	-325.4852	-511.1323	-185.6470	-2.839325	460.3168
U2 [V]	217.5465	-99.38646	-316.9329	1.605619	458.9542
U3 [V]	116.3210	601.8626	485.5416	-0.014933	458.6621
I1 [A]	-28.52345	-47.42599	-18.90254	-3.536933	59.78873
I2 [A]	302.0752	-14.55879	-316.6340	1.837321	60.68514
I3 [A]	-274.9406	60.95493	335.8956	0.704124	59.97395
U+_PU [V]	0.508757	0.999305	0.490548	0.984374	0.987068
Ip+_PU [W]	0.134320	0.202627	0.068307	0.207511	0.213767
Iq+_PU [var]	0.519135	1.915e-3	-0.517220	0.041481	0.115650
P_t@SG320HX [W]	42928.29	64045.88	21117.58	65641.65	67659.07
Q_t@SG320HX [var]	166295.1	5604.298	-160690.8	24526.06	53260.77

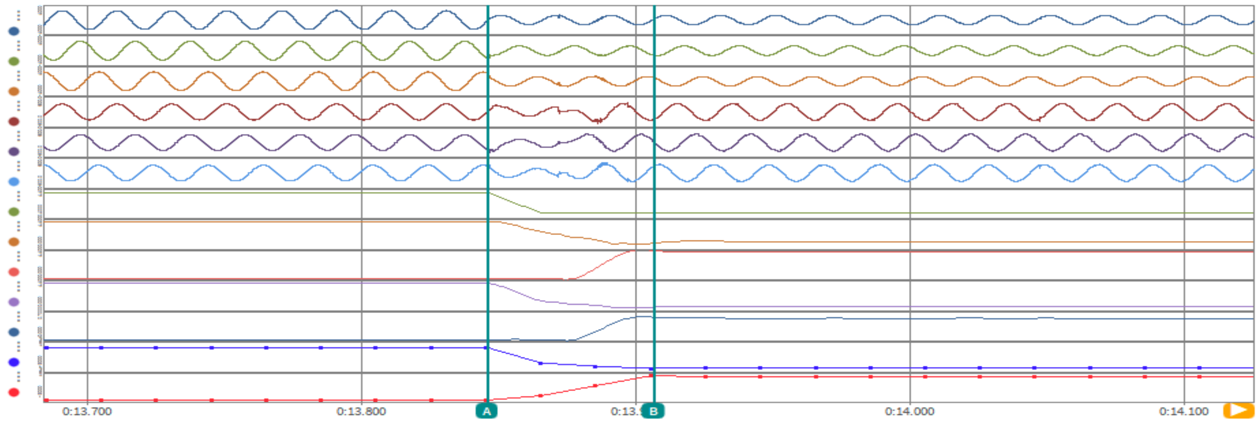
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.1.2 Three phase symmetrical fault type A）
U/Un = 0.5 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:13.845597	0:15.347256	1.501659		
U1 [V]	-141.0654	199.7631	340.8284	0.855045	235.1632
U2 [V]	-487.8346	-590.6638	-102.8292	-0.732636	236.1730
U3 [V]	617.7869	395.1757	-222.6112	0.348422	235.7721
I1 [A]	-67.44564	-314.9325	-247.4868	-0.528651	242.4862
I2 [A]	-241.9077	47.25015	289.1579	-1.343757	242.1685
I3 [A]	312.1627	266.0115	-46.15116	1.061962	241.6913
U+_PU [V]	0.999698	0.508486	-0.491212	0.513579	0.515013
Ip+_PU [A]	1.007615	0.224877	-0.782738	0.250665	0.264214
Iq+_PU [A]	-1.854e-3	1.029587	1.031440	0.997700	1.011580
Ip+_PU [W]	1.007354	0.114352	-0.893002	0.131585	0.152671
Iq+_PU [var]	-1.853e-3	0.523553	0.525406	0.508395	0.515453
P_t@SG320HX [W]	322325.7	36571.26	-285754.4	47244.15	65690.60
Q_t@SG320HX [var]	5666.141	167756.6	162090.5	161045.9	163895.1

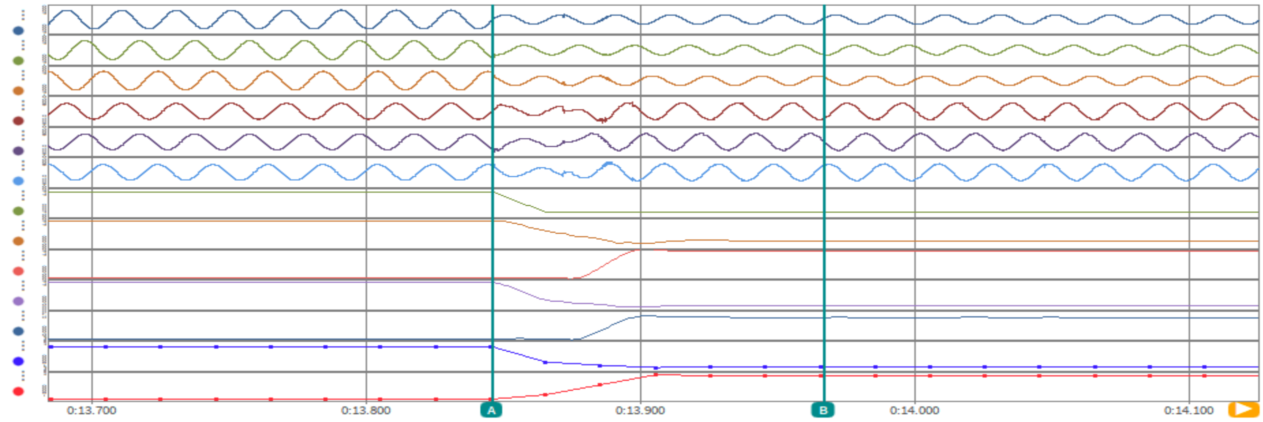
Test no. 3.1.2 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.845942	0:13.906574	0.060632		
U1 [V]	-53.34866	30.76112	84.10979	1.408370	233.6750
U2 [V]	-543.2326	-305.6569	237.5757	-7.448573	243.9340
U3 [V]	589.8933	275.7960	-314.0973	6.972577	243.2870
I1 [A]	-16.46686	-329.2530	-312.7861	-7.618685	202.4347
I2 [A]	-276.0899	48.97225	325.0622	5.342526	201.8261
I3 [A]	290.8660	282.0270	-8.839012	1.802269	188.1799
U+_PU [V]	0.999709	0.514049	-0.485660	0.602006	0.621815
Ip+_PU [A]	1.007542	0.185179	-0.822364	0.520556	0.596136
Iq+_PU [A]	-1.920e-3	1.074344	1.076264	0.311014	0.524286
Ip+_PU [W]	1.007292	0.095195	-0.912097	0.352216	0.455648
Iq+_PU [var]	-1.920e-3	0.552289	0.554209	0.159663	0.268729
P_t@SG320HX [W]	322325.7	31399.94	-290925.7	167198.3	211222.9
Q_t@SG320HX [var]	5666.141	178177.6	172511.4	65328.60	93412.95

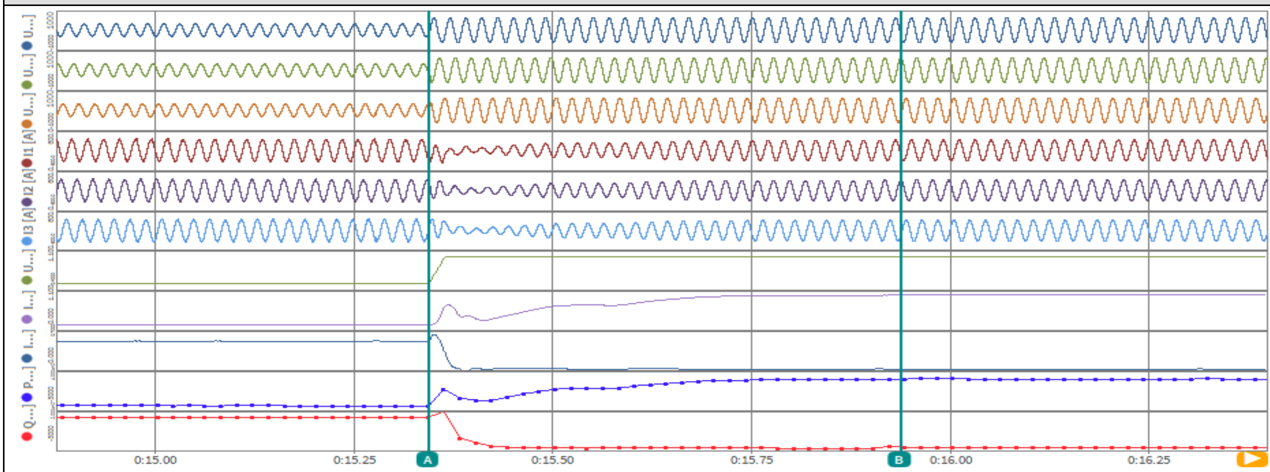
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.1.2 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:13.845942	0:13.966708	0.120767		
U1 [V]	-53.34866	54.43728	107.7859	1.362894	234.9309
U2 [V]	-543.2326	-311.5599	231.6727	-4.139599	240.7872
U3 [V]	589.8933	259.0379	-330.8554	3.632116	240.2144
I1 [A]	-16.46686	-316.6824	-300.2155	-4.073767	224.5911
I2 [A]	-276.0899	30.14302	306.2329	1.455509	224.1645
I3 [A]	290.8660	283.6476	-7.218481	1.990894	218.1121
U+_PU [V]	0.999709	0.512349	-0.487360	0.557601	0.570098
Ip+_PU [A]	1.007542	0.266726	-0.740817	0.393706	0.462007
Iq+_PU [A]	-1.920e-3	1.020577	1.022497	0.667987	0.814097
Ip+_PU [W]	1.007292	0.136662	-0.870630	0.244584	0.336491
Iq+_PU [var]	-1.920e-3	0.522913	0.524833	0.342847	0.417703
P_t@SG320HX [W]	322325.7	43726.31	-278599.3	121244.7	169212.2
Q_t@SG320HX [var]	5666.141	167435.2	161769.0	103887.0	126716.0

Test no. 3.1.2 Three phase symmetrical fault（type A）
U/Un = 0.5 p.u, P=100%Pn, Active power recovery time



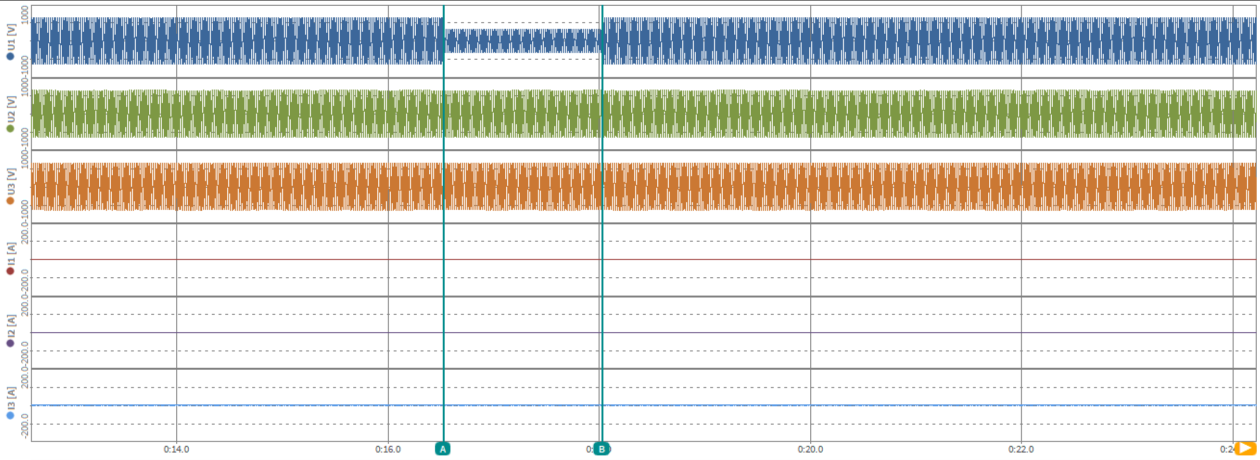
	A	B	Delta	Avg	RMS
Time [s]	0:15.343975	0:15.937361	0.593387		
U1 [V]	-216.6662	-250.5376	-33.87141	3.735672	460.3781
U2 [V]	-118.6102	645.5421	764.1522	-2.510615	460.0799
U3 [V]	326.2578	-400.6168	-726.8746	-2.482289	460.3241
I1 [A]	-294.4308	-132.9225	161.5082	-4.800671	191.6283
I2 [A]	277.6290	340.3288	62.69980	0.178685	189.7270
I3 [A]	15.15246	-206.4105	-221.5630	3.028343	191.2627
U+_PU [V]	0.508611	0.999323	0.490713	0.986811	0.988931
Ip+_PU [W]	0.114612	1.005808	0.891196	0.763291	0.801014
Iq+_PU [var]	0.524011	7.611e-3	-0.516400	0.031960	0.109938
P_t@SG320HX [W]	37035.83	318314.3	281278.5	235447.5	250950.6
Q_t@SG320HX [var]	167633.9	12217.98	-155415.9	26430.51	57553.22

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

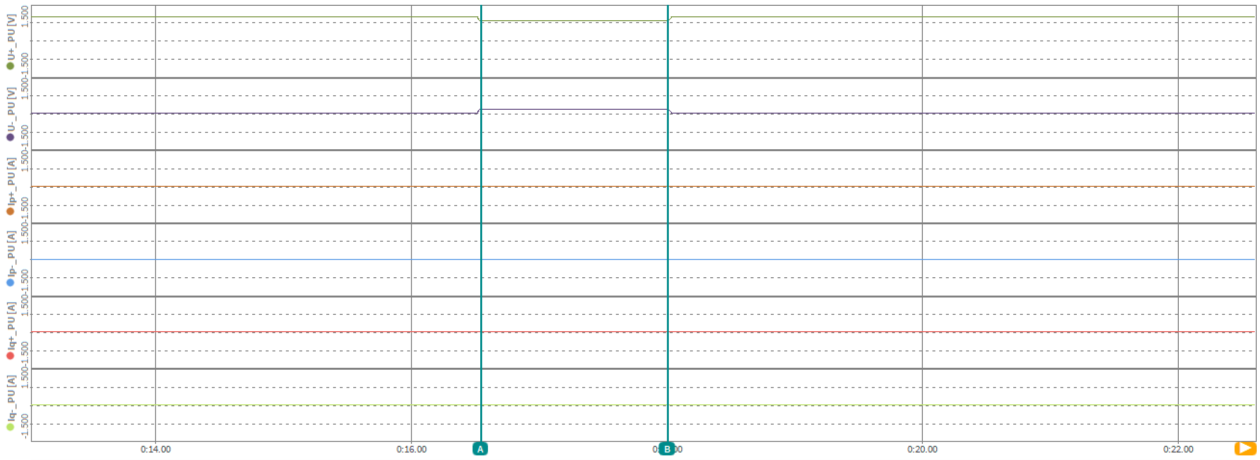
Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	3.3.1	3.3.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	461.4	460.6
	2		Phase 2			460.2	462.7
	3		Phase 3			462.9	462.0
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.1	232.4
	5		Phase 2			47.0	233.9
	6		Phase 3			47.2	232.7
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.01
	8		total		W	65170	32351
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.01	0.01
	10		total		var	2468	5469
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	234.0	233.9
	12		Phase 2			462.1	462.8
	13		Phase 3			462.2	462.4
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	167.4	210.9
	15		Phase 2			48.7	88.2
	16		Phase 3			125.2	207.5
	17	Total fault duration	All phase	t_1 to t_2	ms	1501	1500
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.30	0.29
	19		total		var	102099	90723
	20	Reactive current	Positive sequence		p.u.	0.35	0.34
	21	Active power	Positive sequence		p.u.	0.20	0.51
	22		total		W	62429	162539
	23	Active current	Positive sequence		p.u.	0.23	0.61
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.38	0.37
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.35	0.34
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	460.3	462.5
	27		Phase 2			461.6	462.4
	28		Phase 3			462.7	460.5
	29	Current	Phase 1	t_2+1s	Arms	47.9	233.1
	30		Phase 2			47.1	233.1
	31		Phase 3			47.2	231.2
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.01
	33		total		W	65185	322692
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	35		total		Var	2805	7102
	36	Active power recovery time	Positive sequence	--	ms	680	582

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.2.0 single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=0, Fault Duration



	A	B	间隔	有效值
时间 [s]	0:16.52691	0:18.02887	1.50197	
U1 [V]	217.3809	630.1054	412.7245	231.9289
U2 [V]	-638.1160	-447.3384	190.7777	461.5823
U3 [V]	210.2590	-189.6702	-399.9292	461.2031
I1 [A]	0.254273	-0.391960	-0.646234	0.471135
I2 [A]	-0.211477	-0.367641	-0.156164	0.309919
I3 [A]	0.404239	-0.108600	-0.512838	0.471050



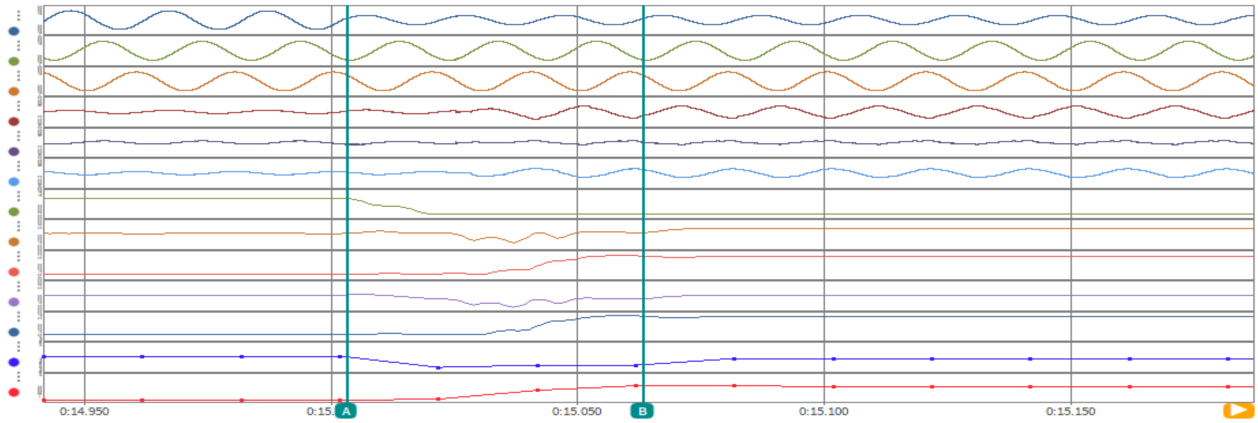
	A	B	间隔
时间 [s]	0:16.547533	0:18.006995	1.459462
U+_PU [V]	0.833979	0.832560	-1.419e-3
U-_PU [V]	0.164966	0.165954	9.879e-4
Ip+_PU [A]	2.589e-5	2.301e-5	-2.880e-6
Ip-_PU [A]	1.633e-4	1.696e-4	6.315e-6
Iq+_PU [A]	5.206e-4	5.083e-4	-1.225e-5
Iq-_PU [A]	3.272e-4	3.241e-4	-3.078e-6

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=20%Pn, fault duration

	A	B	Delta	Avg	RMS
Time [s]	0:15.003567	0:16.504521	1.500954		
U1 [V]	115.1298	404.0343	288.9044	1.058286	233.9860
U2 [V]	-641.6054	-647.1298	-5.524397	-0.526190	462.5348
U3 [V]	427.7399	242.7144	-185.0255	0.207082	462.2822
I1 [A]	36.81159	-125.0237	-161.8353	-0.309537	166.1462
I2 [A]	-70.18936	2.372384	72.56175	-5.272e-3	48.66266
I3 [A]	36.58140	125.0627	88.48131	0.190501	124.4094
U+_PU [V]	0.998758	0.839904	-0.158854	0.837174	0.837242
Ip+_PU [A]	0.204019	0.231330	0.027311	0.233497	0.233659
Iq+_PU [A]	-1.198e-3	0.358376	0.359574	0.344386	0.348587
Ip+_PU [W]	0.203775	0.194304	-9.471e-3	0.195465	0.195595
Iq+_PU [var]	-1.196e-3	0.301015	0.302211	0.287979	0.291493
P_t@SG320HX [W]	65074.61	62391.14	-2683.469	62185.53	62202.52
Q_t@SG320HX [var]	2584.175	101753.1	99168.93	99392.70	100562.3

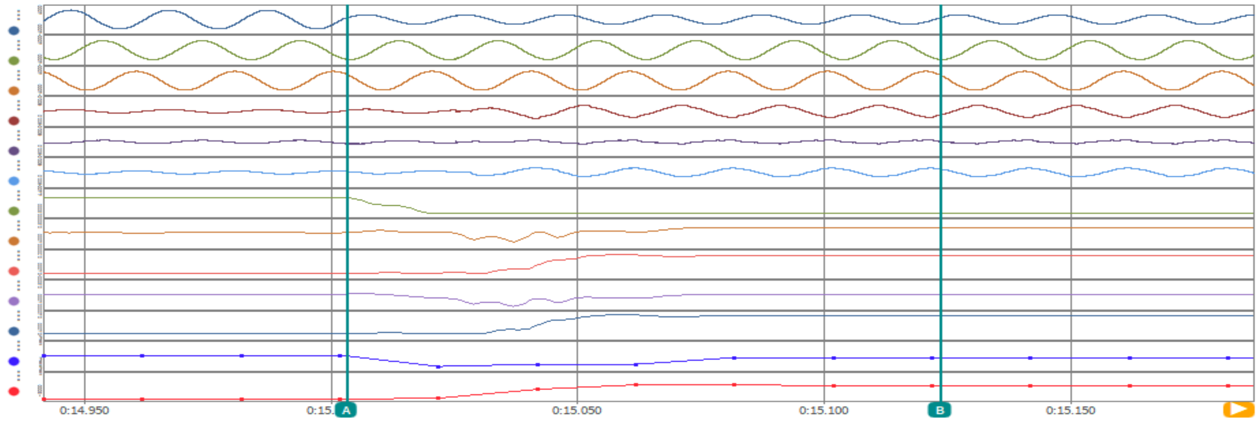
Test no. 3.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.003295	0:15.063357	0.060062		
U1 [V]	89.12874	94.37991	5.251170	1.399076	234.0135
U2 [V]	-626.0116	-631.6623	-5.650640	-2.143776	461.7953
U3 [V]	468.0877	451.7957	-16.29198	1.969528	461.8482
I1 [A]	34.49273	-165.6839	-200.1766	-10.39316	129.5187
I2 [A]	-76.13051	15.52308	91.65359	-1.308871	46.47765
I3 [A]	43.38634	147.2219	103.8356	11.51737	98.56568
U+_PU [V]	0.999041	0.836408	-0.162633	0.863324	0.864785
Ip+_PU [A]	0.203539	0.208304	4.766e-3	0.197038	0.198190
Iq+_PU [A]	1.042e-4	0.377930	0.377825	0.123709	0.195600
Ip+_PU [W]	0.203352	0.174235	-0.029117	0.170516	0.172181
Iq+_PU [var]	1.041e-4	0.316117	0.316013	0.103401	0.163536
P_t@SG320HX [W]	65074.61	56240.12	-8834.492	57702.46	57864.76
Q_t@SG320HX [var]	2584.175	109275.4	106691.3	50512.74	66875.91

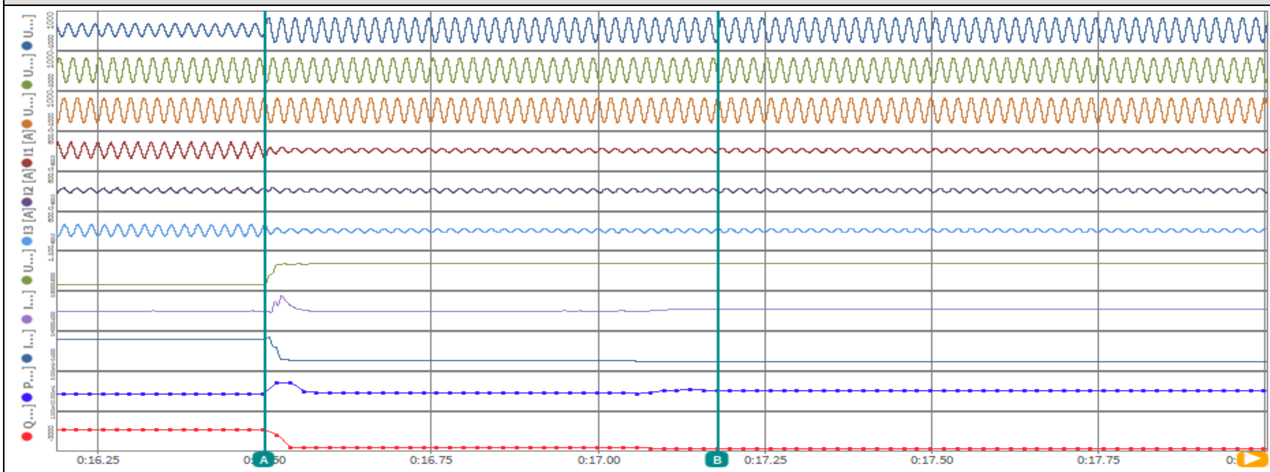
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.003295	0:15.123620	0.120325		
U1 [V]	89.12874	123.8401	34.71136	1.475592	234.4133
U2 [V]	-626.0116	-648.9939	-22.98224	-2.717218	462.3174
U3 [V]	468.0877	411.8525	-56.23520	2.250553	461.8884
I1 [A]	34.49273	-152.3010	-186.7937	-5.011472	149.6724
I2 [A]	-76.13051	15.65695	91.78746	-0.686350	47.85325
I3 [A]	43.38634	136.4609	93.07457	5.432612	112.7141
U+_PU [V]	0.999041	0.836522	-0.162519	0.849904	0.850752
Ip+_PU [A]	0.203539	0.235281	0.031742	0.215414	0.216765
Iq+_PU [A]	1.042e-4	0.353654	0.353550	0.238928	0.286087
Ip+_PU [W]	0.203352	0.196826	-6.526e-3	0.183043	0.184282
Iq+_PU [var]	1.041e-4	0.295852	0.295748	0.199826	0.239288
P_t@SG320HX [W]	65074.61	62557.20	-2517.414	59834.00	59974.06
Q_t@SG320HX [var]	2584.175	102069.0	99484.84	72718.38	83923.43

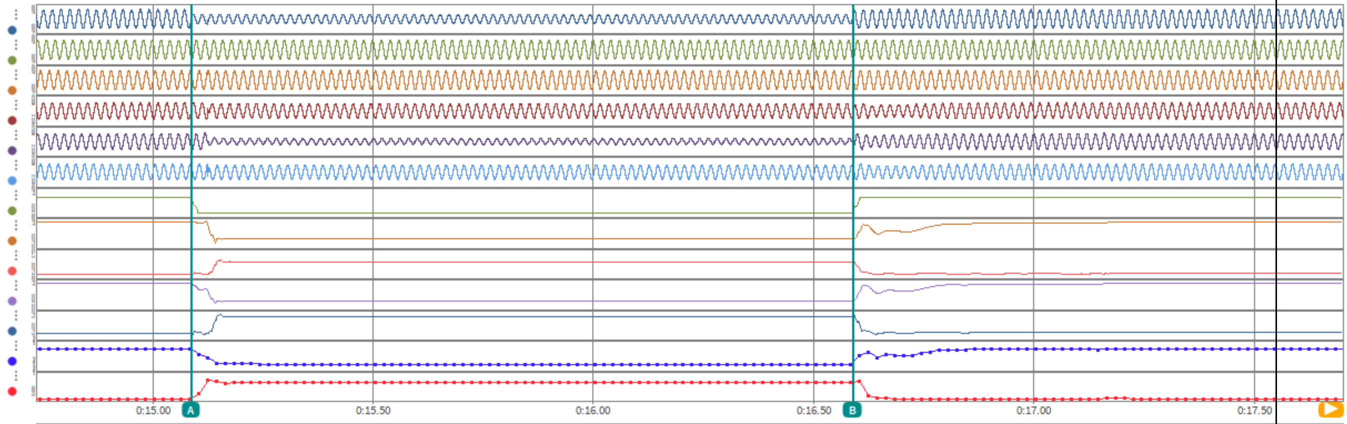
Test no. 3.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:16.500467	0:17.180018	0.679552		
U1 [V]	-194.6722	-437.4573	-242.7851	-1.421124	461.1235
U2 [V]	-274.0060	-206.0406	67.96539	0.240933	461.5993
U3 [V]	650.5143	636.6389	-13.87537	-0.400912	461.5993
I1 [A]	-235.0358	-40.27415	194.7616	-0.797838	49.97737
I2 [A]	69.45980	-24.10042	-93.56022	0.741699	46.56258
I3 [A]	165.8710	63.69698	-102.1740	0.027127	48.70482
U+_PU [V]	0.836091	0.999197	0.163106	0.996065	0.996251
Ip+_PU [W]	0.195980	0.204172	8.192e-3	0.199832	0.200109
Iq+_PU [var]	0.294753	2.523e-3	-0.292230	0.023146	0.050410
P_t@SG320HX [W]	62492.39	65358.50	2866.113	63689.26	63721.22
Q_t@SG320HX [var]	102215.3	4893.504	-97321.79	15206.22	28693.81

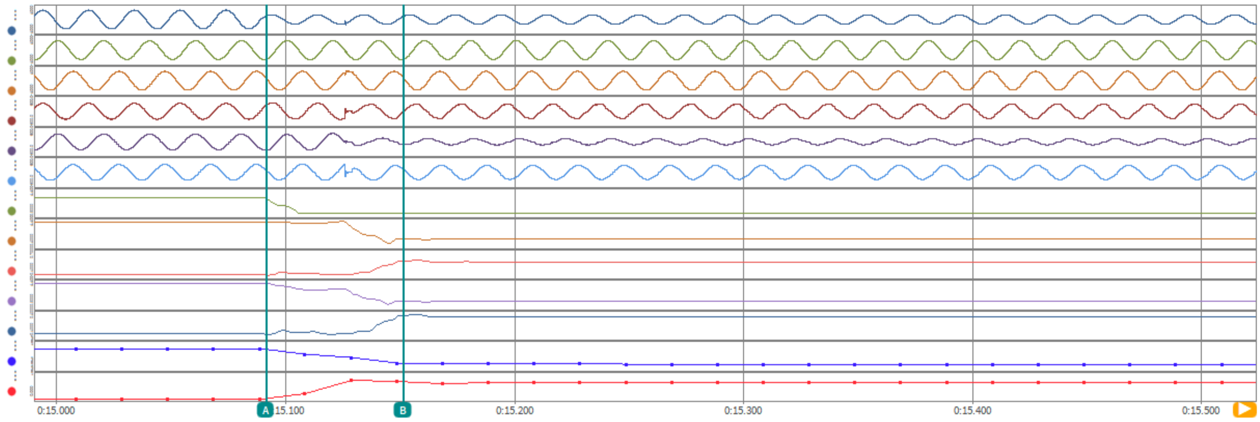
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:15.089693	0:16.589890	1.500197		
U1 [V]	37.05967	47.61899	10.55932	1.115003	234.1510
U2 [V]	-581.5367	-608.3984	-26.86167	-0.107957	462.4750
U3 [V]	546.3426	515.7510	-30.59161	0.044046	462.3723
I1 [A]	13.08310	-163.4629	-176.5460	0.487114	211.6087
I2 [A]	-284.8405	-81.05183	203.7887	-0.117768	94.91916
I3 [A]	272.9467	245.4964	-27.45032	-0.307130	207.8103
U+_PU [V]	0.999704	0.835920	-0.163784	0.837546	0.837628
Ip+_PU [A]	1.007593	0.610116	-0.397477	0.621093	0.624575
Iq+_PU [A]	-4.142e-4	0.342064	0.342478	0.332472	0.337914
Ip+_PU [W]	1.007338	0.510030	-0.497308	0.520660	0.524420
Iq+_PU [var]	-4.141e-4	0.285951	0.286365	0.278110	0.282660
P_t@SG320HX [W]	322358.5	162587.8	-159770.7	166960.6	168498.2
Q_t@SG320HX [var]	5288.900	90352.57	85063.67	89080.16	89852.75

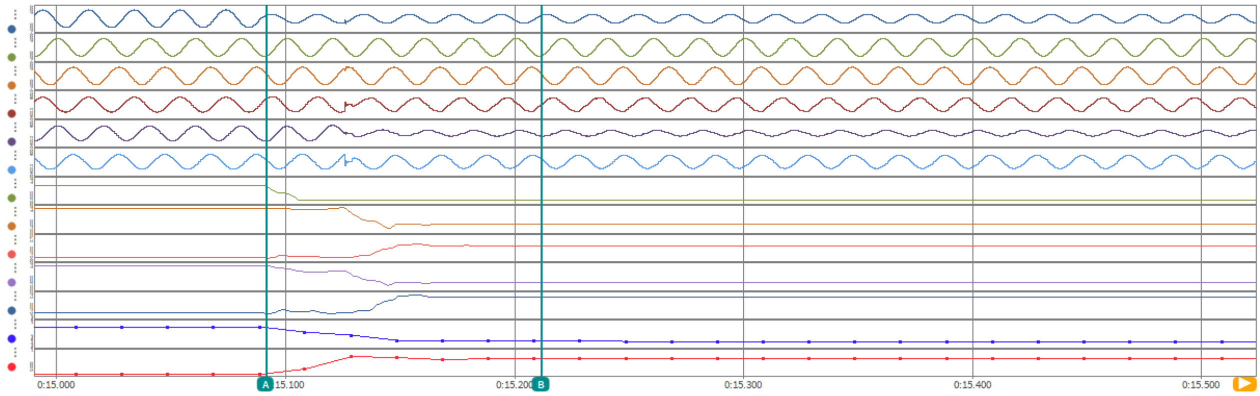
Test no. 3.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.091647	0:15.151555	0.059908		
U1 [V]	212.5505	201.3353	-11.21521	1.423321	234.0138
U2 [V]	-644.8834	-646.5191	-1.635671	0.392971	461.5832
U3 [V]	237.3886	253.5825	16.19387	-0.448699	461.3831
I1 [A]	228.3200	-42.99569	-271.3157	10.70406	226.0405
I2 [A]	-337.5787	-114.4639	223.1147	10.69071	188.0872
I3 [A]	111.3181	154.0468	42.72867	-21.30259	214.4362
U+_PU [V]	0.997563	0.837066	-0.160496	0.858199	0.859402
Ip+_PU [A]	1.008320	0.621911	-0.386409	0.878904	0.897020
Iq+_PU [A]	-8.567e-3	0.366485	0.375053	0.065030	0.123893
Ip+_PU [W]	1.005905	0.520603	-0.485302	0.757539	0.777112
Iq+_PU [var]	-8.547e-3	0.306786	0.315333	0.054491	0.103727
P_t@SG320HX [W]	322358.5	166922.1	-155436.5	246213.9	252562.2
Q_t@SG320HX [var]	5288.900	97832.11	92543.21	60073.85	73117.91

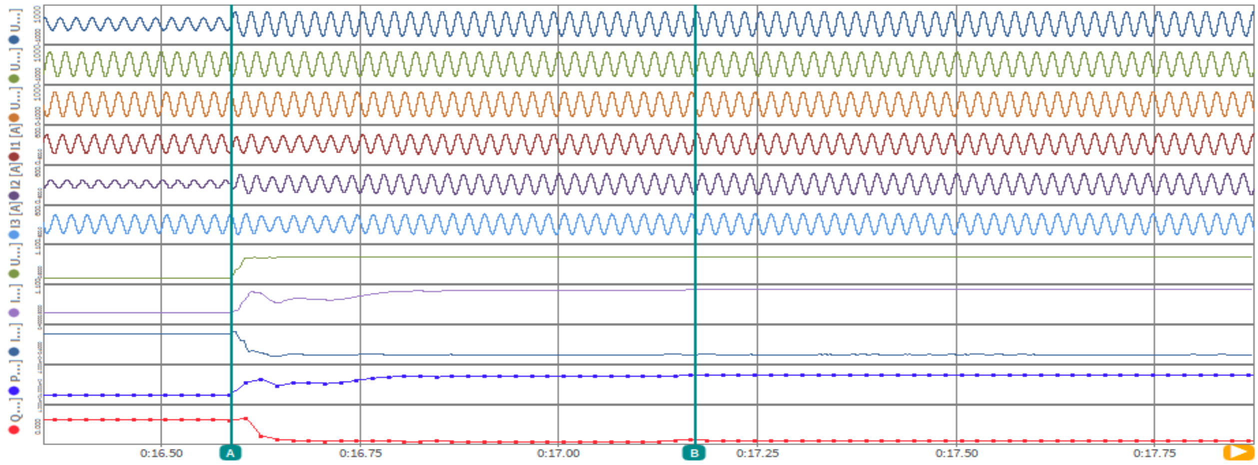
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.091647	0:15.211796	0.120149		
U1 [V]	212.5505	214.6058	2.055287	1.927535	234.6721
U2 [V]	-644.8834	-639.3115	5.571962	-0.725619	462.3049
U3 [V]	237.3886	218.7809	-18.60774	-0.061868	461.5378
I1 [A]	228.3200	-27.80056	-256.1206	5.151933	218.4513
I2 [A]	-337.5787	-122.1945	215.3841	5.703261	146.9417
I3 [A]	111.3181	149.3571	38.03897	-10.56726	211.4571
U+_PU [V]	0.997563	0.837134	-0.160428	0.847741	0.848420
Ip+_PU [A]	1.008320	0.613631	-0.394689	0.746315	0.768828
Iq+_PU [A]	-8.567e-3	0.342900	0.351467	0.205325	0.260507
Ip+_PU [W]	1.005905	0.513713	-0.492192	0.635748	0.659099
Iq+_PU [var]	-8.547e-3	0.287066	0.295612	0.171913	0.218085
P_t@SG320HX [W]	322358.5	163777.5	-158581.1	210819.5	218916.8
Q_t@SG320HX [var]	5288.900	90538.12	85249.22	72911.52	80801.46

Test no. 3.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.5 p.u, P=100%Pn, Active power recovery time



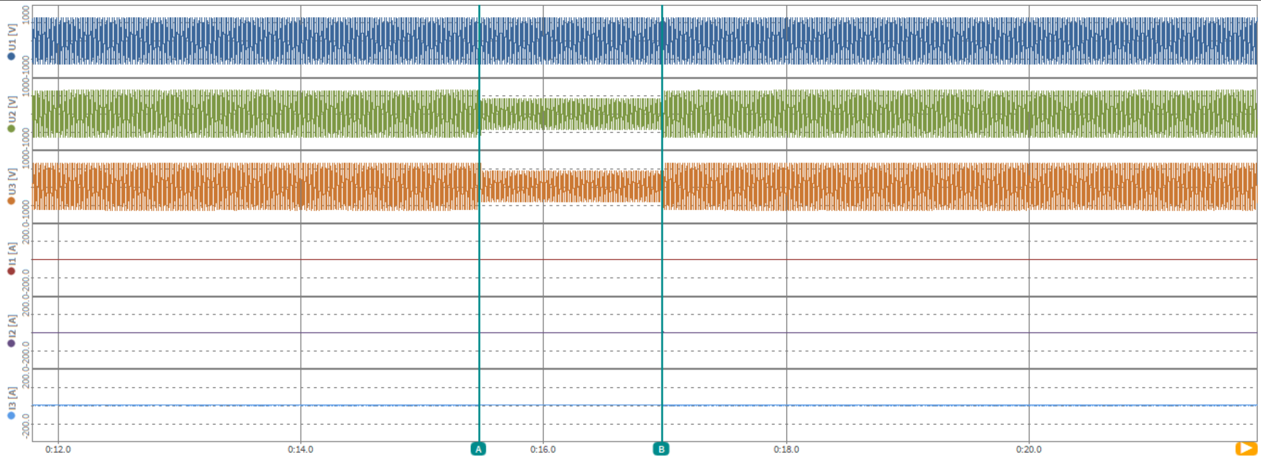
	A	B	Delta	Avg	RMS
Time [s]	0:16.589289	0:17.171568	0.582279		
U1 [V]	-16.55603	411.2420	427.7981	-2.099530	461.1533
U2 [V]	-547.2522	-642.3619	-95.10971	-2.460065	462.2252
U3 [V]	581.7608	238.3911	-343.3697	1.742249	461.5057
I1 [A]	-240.1756	200.6081	440.7838	-1.549268	216.0716
I2 [A]	-39.96182	-327.3212	-287.3594	-0.175218	215.7843
I3 [A]	279.3799	125.5448	-153.8351	1.456390	216.8182
U+_PU [V]	0.835920	0.999770	0.163850	0.996238	0.996424
Ip+_PU [W]	0.510030	1.007225	0.497195	0.921352	0.926651
Iq+_PU [var]	0.285951	7.130e-3	-0.278820	0.017346	0.048892
P_t@SG320HX [W]	162587.8	321169.3	158581.4	292993.4	295120.4
Q_t@SG320HX [var]	90352.57	13750.55	-76602.02	13325.67	25658.13

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	3.3.1	3.3.2
	1	Voltage	Phase 1	t_1-500ms to t_1-100ms	Vrms	461.0	461.8
	2		Phase 2			460.3	460.9
	3		Phase 3			463.3	462.4
	4	Current	Phase 1	t_1-500ms to t_1-100ms	Arms	47.1	233.0
	5		Phase 2			47.0	232.1
	6		Phase 3			47.2	232.9
	7	Active power	Positive sequence	t_1-500ms to t_1-100ms	p.u.	0.20	1.01
	8		total		W	65208	322315
	9	Reactive power	Positive sequence	t_1-500ms to t_1-100ms	p.u.	0.01	0.01
	10		total		var	2435	6047
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2-20ms	Vrms	461.5	461.6
	12		Phase 2			307.6	307.4
	13		Phase 3			307.5	307.8
	14	Current	Phase 1	t_1+100ms to t_2-20ms	Arms	27.7	26.0
	15		Phase 2			216.7	219.0
	16		Phase 3			190.8	194.2
	17	Total fault duration	All phase	t_1 to t_2	ms	1499	1499
	18	Reactive power	Positive sequence	t_1+100ms to t_2-20ms	p.u.	0.39	0.39
	19		total		var	135110	13635
	20	Reactive current	Positive sequence		p.u.	0.52	0.52
	21	Active power	Positive sequence		p.u.	0.09	0.09
	22		total		W	28978	27689
	23	Active current	Positive sequence		p.u.	0.12	0.11
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.51	0.51
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.52	0.52
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	461.4	461.9
	27		Phase 2			461.5	461.0
	28		Phase 3			461.6	462.4
	29	Current	Phase 1	t_2+1s	Arms	47.2	233.3
	30		Phase 2			47.2	232.4
	31		Phase 3			47.9	233.1
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.01
	33		total		W	65199	322667
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	35		total		Var	2837	7362
	36	Active power recovery time	Positive sequence	--	ms	585	570

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.3.0 two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=0, Fault Duration

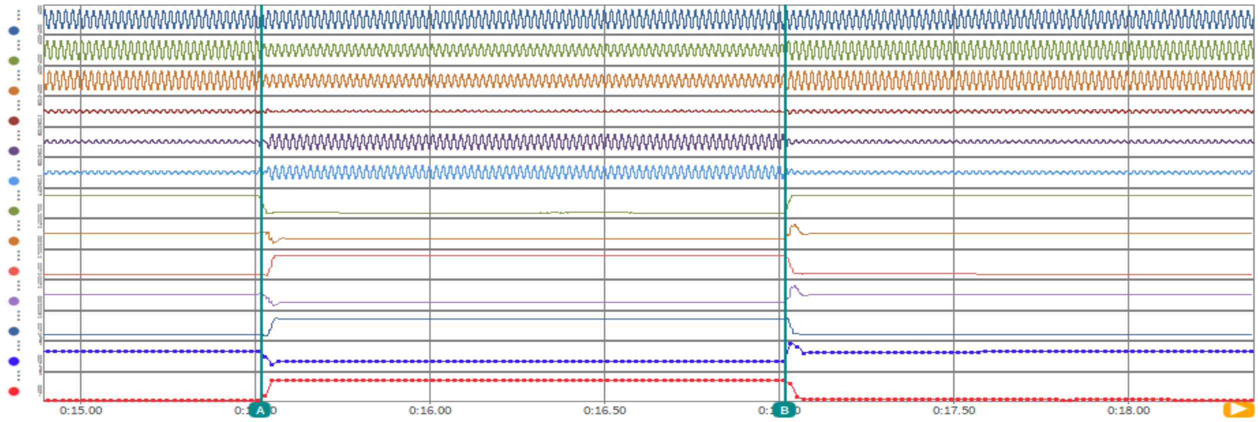


	A	B	间隔	有效值
时间 [s]	0:15.470819	0:16.974820	1.504001	
U1 [V]	319.8010	639.7548	319.9538	461.7562
U2 [V]	-649.2905	-257.3831	391.9074	307.6839
U3 [V]	332.7749	-379.7740	-712.5489	307.6721
I1 [A]	-0.336170	0.513315	0.849485	0.476549
I2 [A]	-0.196338	0.190496	0.386834	0.281131
I3 [A]	-0.028372	0.467777	0.496149	0.413723

	A	B	间隔
时间 [s]	0:15.53701	0:16.98043	1.44342
U+_PU [V]	0.751008	0.749112	-1.896e-3
U-_PU [V]	0.249628	0.250102	4.742e-4
Ip+_PU [A]	1.714e-5	2.715e-5	1.000e-5
Ip-_PU [A]	-1.213e-4	-1.258e-4	-4.524e-6
Iq+_PU [A]	3.616e-4	3.604e-4	-1.170e-6
Iq-_PU [A]	1.575e-5	4.961e-6	-1.079e-5

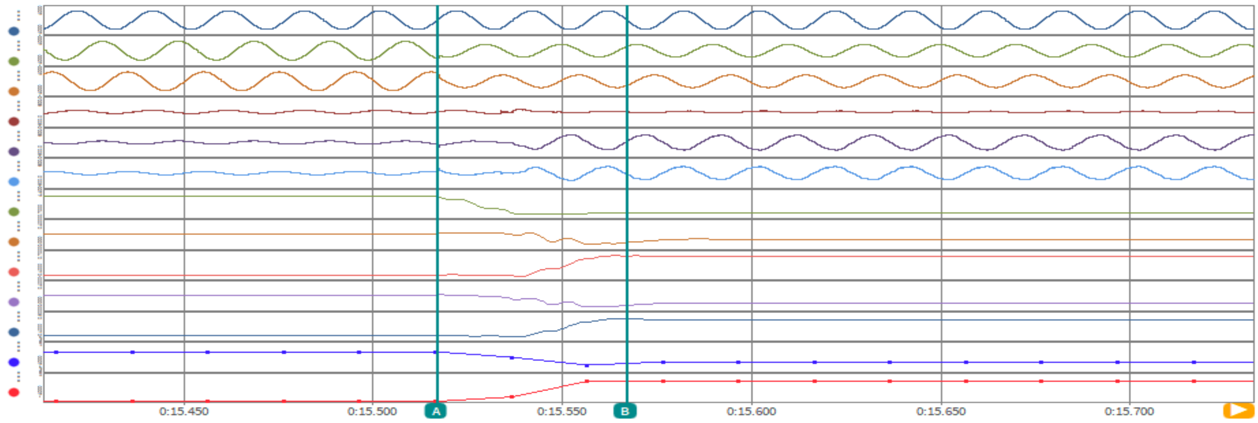
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:15.517639	0:17.017007	1.499369		
U1 [V]	76.64776	-32.76730	-109.4151	-9.598e-3	461.7017
U2 [V]	-508.2221	-271.7785	236.4437	0.158976	307.5662
U3 [V]	422.1818	304.7378	-117.4439	-0.222008	307.6206
I1 [A]	13.19575	-23.18275	-36.37851	0.535417	28.35789
I2 [A]	-147.4962	-10.16820	137.3280	-0.694251	215.2438
I3 [A]	138.4400	35.44581	-102.9942	-0.101330	189.5074
U+_PU [V]	0.999538	0.753598	-0.245940	0.755577	0.755775
Ip+_PU [A]	0.203602	0.121516	-0.082086	0.123400	0.124092
Iq+_PU [A]	-1.041e-4	0.517206	0.517310	0.505855	0.511141
Ip+_PU [W]	0.203517	0.091578	-0.111939	0.093404	0.094274
Iq+_PU [var]	-1.041e-4	0.389782	0.389886	0.381327	0.385313
P_t@SG320HX [W]	65116.66	28529.56	-36587.10	29562.24	29931.04
Q_t@SG320HX [var]	2506.243	134864.2	132357.9	131930.3	133357.2

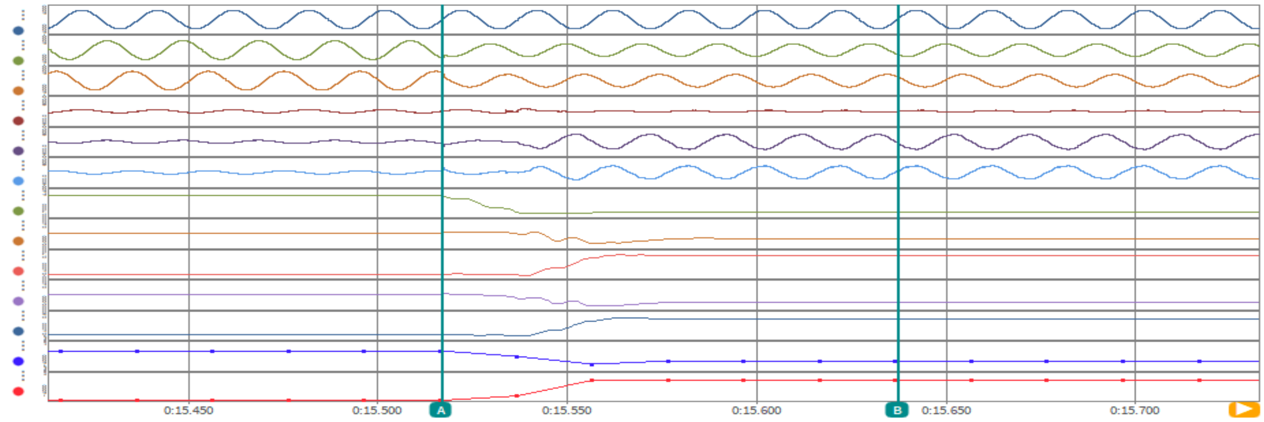
Test no. 3.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.516892	0:15.566923	0.050032		
U1 [V]	-86.42281	63.86507	150.2879	82.52330	460.5208
U2 [V]	-517.9690	256.8553	774.8243	-49.67987	313.9308
U3 [V]	601.0286	-319.6566	-920.6852	-32.61942	314.0166
I1 [A]	-10.00071	20.49840	30.49910	11.84832	41.07315
I2 [A]	-52.60122	0.575662	53.17688	-29.87432	163.0836
I3 [A]	61.83827	-20.82360	-82.66187	17.88434	144.3505
U+_PU [V]	0.999193	0.754617	-0.244576	0.810999	0.815187
Ip+_PU [A]	0.203728	0.075426	-0.128301	0.155875	0.167759
Iq+_PU [A]	-1.102e-4	0.530151	0.530261	0.166229	0.267508
Ip+_PU [W]	0.203572	0.056920	-0.146652	0.129708	0.142736
Iq+_PU [var]	-1.101e-4	0.400078	0.400188	0.125295	0.201705
P_t@SG320HX [W]	65205.90	19924.82	-45281.07	48928.15	52335.63
Q_t@SG320HX [var]	2466.681	136215.9	133749.2	42194.26	69513.04

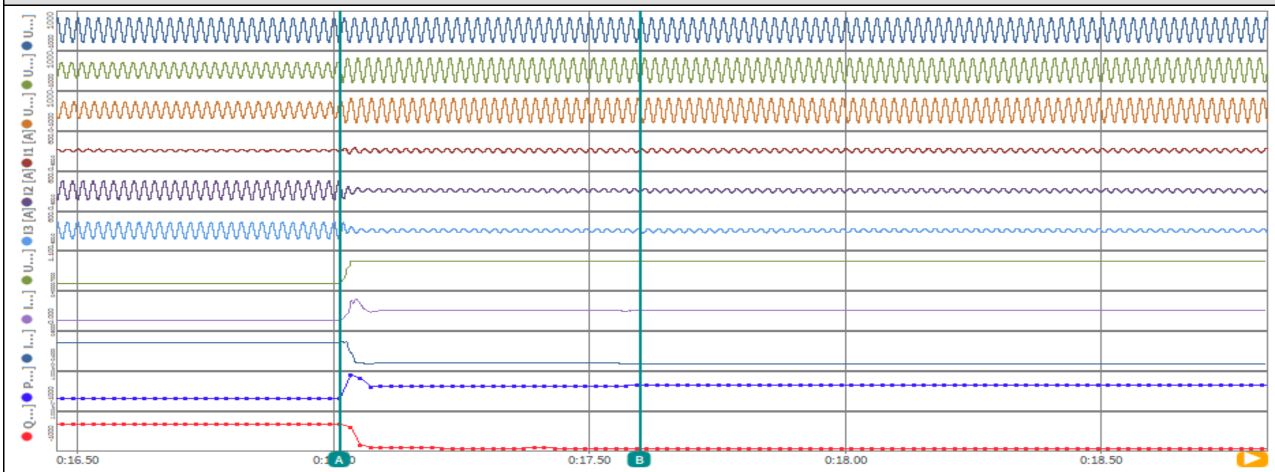
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.516892	0:15.637266	0.120374		
U1 [V]	-86.42281	-0.344276	86.07853	-0.108648	460.4520
U2 [V]	-517.9690	-290.8718	227.0973	-2.725631	310.6406
U3 [V]	601.0286	287.4896	-313.5390	2.906092	310.6070
I1 [A]	-10.00071	-13.94177	-3.941059	2.445283	34.60765
I2 [A]	-52.60122	-28.69189	23.90933	2.909414	196.5717
I3 [A]	61.83827	40.59911	-21.23916	-5.487795	172.5480
U+_PU [V]	0.999193	0.754413	-0.244781	0.778394	0.780732
Ip+_PU [A]	0.203728	0.127671	-0.076056	0.137555	0.144426
Iq+_PU [A]	-1.102e-4	0.516675	0.516785	0.370156	0.431089
Ip+_PU [W]	0.203572	0.096321	-0.107251	0.108898	0.117094
Iq+_PU [var]	-1.101e-4	0.389803	0.389913	0.279282	0.325286
P_t@SG320HX [W]	65205.90	30243.31	-34962.59	39384.50	42603.65
Q_t@SG320HX [var]	2466.681	135591.8	133125.1	88881.23	107728.5

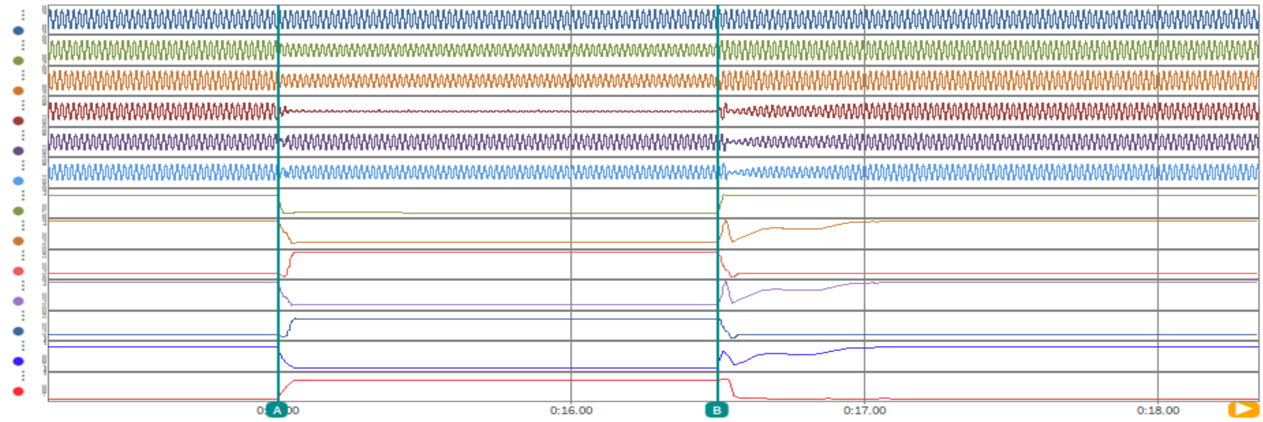
Test no. 3.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:17.013570	0:17.599022	0.585452		
U1 [V]	-593.6972	361.6518	955.3490	-1.700894	460.7462
U2 [V]	183.5762	-650.8276	-834.4038	-2.617698	460.1565
U3 [V]	414.3394	292.0134	-122.3260	4.019688	460.6729
I1 [A]	-38.13982	36.54587	74.68570	-1.082196	46.26120
I2 [A]	275.9698	-68.50708	-344.4768	-0.615088	53.88521
I3 [A]	-240.2368	30.88141	271.1182	1.274055	51.89490
U+_PU [V]	0.753587	0.999252	0.245664	0.992504	0.993106
Ip+_PU [W]	0.091505	0.200195	0.108689	0.196859	0.198316
Iq+_PU [var]	0.389728	1.992e-3	-0.387736	0.031610	0.077743
P_t@SG320HX [W]	28529.56	64025.40	35495.84	61912.01	62840.65
Q_t@SG320HX [var]	134864.2	5664.876	-129199.3	19782.93	40782.85

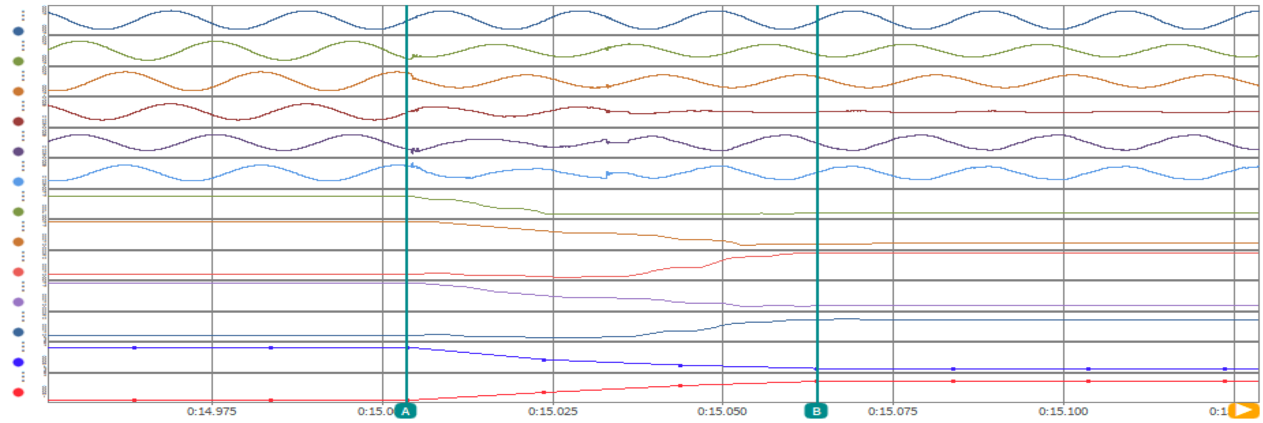
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:15.003272	0:16.502015	1.498743		
U1 [V]	-177.2243	-384.8671	-207.6428	0.203720	461.6554
U2 [V]	-457.8746	-43.14995	414.7246	-0.133931	307.9103
U3 [V]	625.2312	423.2205	-202.0106	-0.291927	307.9457
I1 [A]	-86.66122	-21.71588	64.94534	1.377810	33.13818
I2 [A]	-234.1143	137.8909	372.0052	-1.433319	217.7388
I3 [A]	318.0335	-118.8594	-436.8929	-0.252853	193.1820
U+_PU [V]	0.999641	0.753680	-0.245960	0.755763	0.756003
Ip+_PU [A]	1.007213	0.114977	-0.892236	0.133078	0.166697
Iq+_PU [A]	-7.150e-4	0.519203	0.519918	0.503476	0.511237
Ip+_PU [W]	1.006894	0.086659	-0.920235	0.102194	0.137097
Iq+_PU [var]	-7.147e-4	0.391330	0.392045	0.379522	0.385366
P_t@SG320HX [W]	322196.3	27661.70	-294534.6	37689.42	61969.23
Q_t@SG320HX [var]	5863.304	136436.0	130572.7	131622.8	133559.0

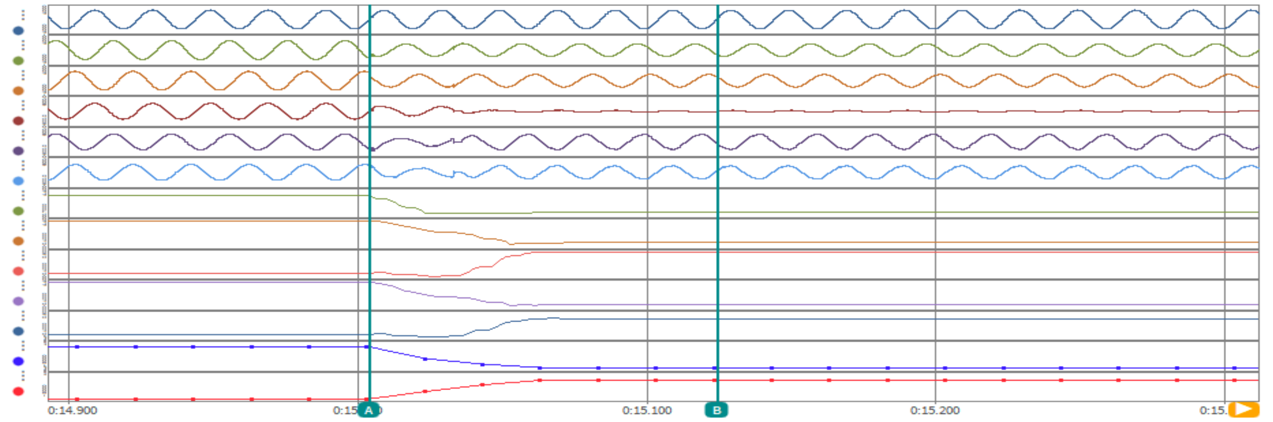
Test no. 3.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.003640	0:15.063825	0.060185		
U1 [V]	-94.47742	-59.22330	35.25412	-0.160307	459.8324
U2 [V]	-513.2879	-260.2989	252.9891	-5.172954	312.6113
U3 [V]	602.5379	316.5845	-285.9534	5.197340	313.5892
I1 [A]	-44.70325	-17.47286	27.23038	20.17766	105.0259
I2 [A]	-258.2497	-9.333134	248.9165	-7.242287	178.4474
I3 [A]	302.5028	25.71976	-276.7830	-13.20092	161.7761
U+_PU [V]	0.999641	0.754312	-0.245329	0.802208	0.806264
Ip+_PU [A]	1.007213	0.082952	-0.924261	0.504223	0.594995
Iq+_PU [A]	-7.150e-4	0.512694	0.513409	0.123807	0.235542
Ip+_PU [W]	1.006894	0.062575	-0.944320	0.425548	0.523338
Iq+_PU [var]	-7.147e-4	0.386748	0.387463	0.093477	0.177521
P_t@SG320HX [W]	322196.3	75754.88	-246441.4	218225.0	243253.5
Q_t@SG320HX [var]	5863.304	107387.0	101523.7	44845.65	61736.14

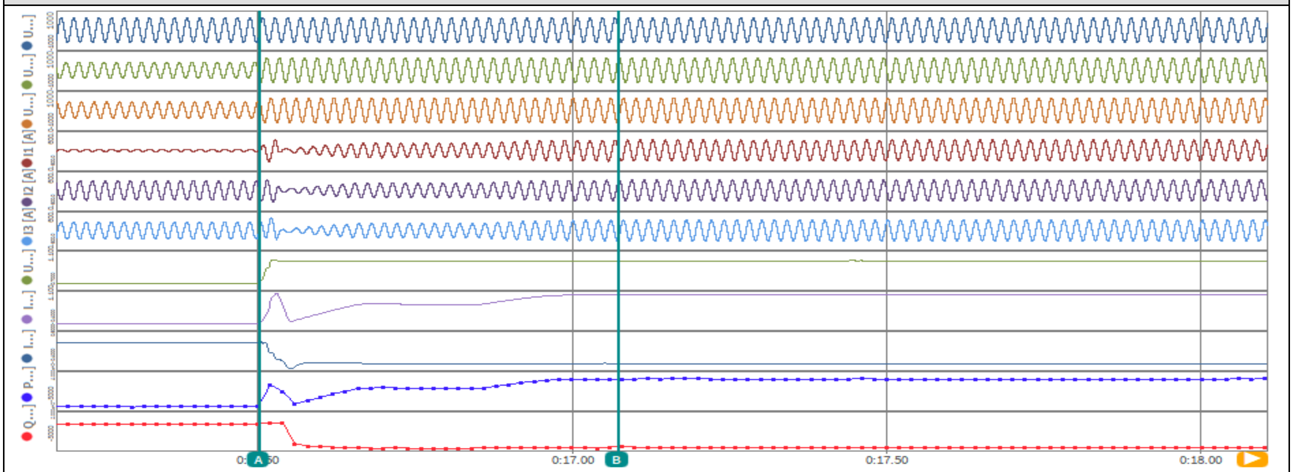
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:15.0042002	0:15.1245023	0.1203022		
U1 [V]	32.02605	92.19194	60.16589	0.386320	460.2384
U2 [V]	-586.8751	-333.7342	253.1409	-1.545446	308.7744
U3 [V]	553.2185	242.7513	-310.4673	1.087666	308.9022
I1 [A]	8.483053	3.480554	-5.002499	10.73297	76.94771
I2 [A]	-282.6170	-72.80541	209.8116	-3.946595	199.6191
I3 [A]	270.9712	66.76937	-204.2018	-7.073354	177.1425
U+_PU [V]	0.999646	0.754577	-0.245069	0.776897	0.779154
Ip+_PU [A]	1.007167	0.122533	-0.884634	0.311394	0.425044
Iq+_PU [A]	-7.576e-4	0.517690	0.518448	0.321303	0.403143
Ip+_PU [W]	1.006853	0.092464	-0.914389	0.256021	0.369204
Iq+_PU [var]	-7.574e-4	0.390654	0.391411	0.242454	0.304108
P_t@SG320HX [W]	322184.5	28924.21	-293260.3	94941.81	139469.1
Q_t@SG320HX [var]	5750.257	136796.6	131046.4	103791.7	114441.8

Test no. 3.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.5 p.u, P=100%Pn, Active power recovery time



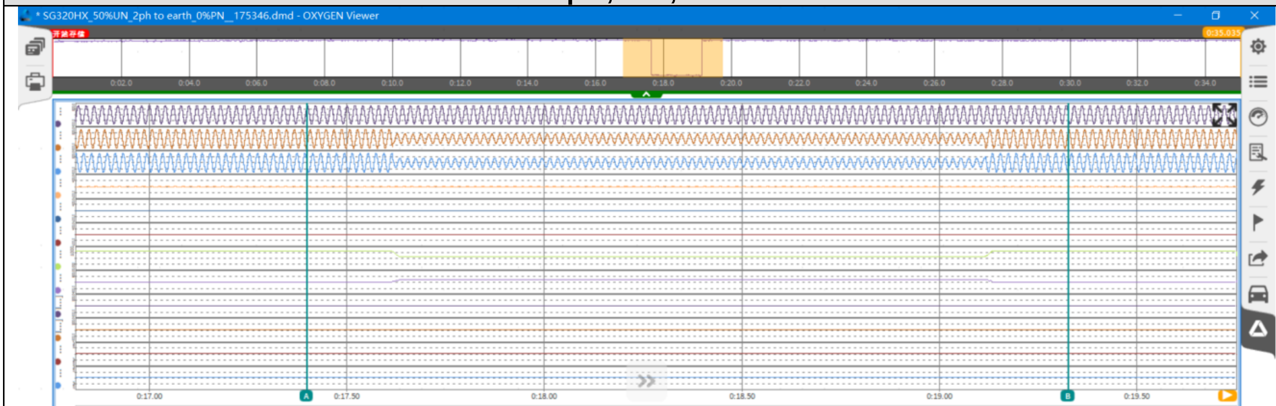
	A	B	Delta	Avg	RMS
Time [s]	0:16.502619	0:17.072792	0.570173		
U1 [V]	-282.5253	250.9304	533.4558	6.586305	462.0661
U2 [V]	-122.5511	399.9768	522.5278	-5.290881	460.0549
U3 [V]	397.9938	-644.9162	-1042.910	-1.132543	460.3914
I1 [A]	-17.26556	141.7880	159.0536	0.649166	176.1312
I2 [A]	83.95350	194.3169	110.3634	-3.432487	177.2019
I3 [A]	-67.81507	-337.5528	-269.7377	2.588712	176.5015
U+_PU [V]	0.753680	0.999551	0.245870	0.992961	0.993505
Ip+_PU [W]	0.086659	1.001160	0.914500	0.705494	0.741674
Iq+_PU [var]	0.391330	7.281e-3	-0.384049	0.023513	0.076043
P_t@SG320HX [W]	27661.70	316739.3	289077.6	217524.9	231956.6
Q_t@SG320HX [var]	136436.0	10836.63	-125599.4	25902.51	51665.70

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

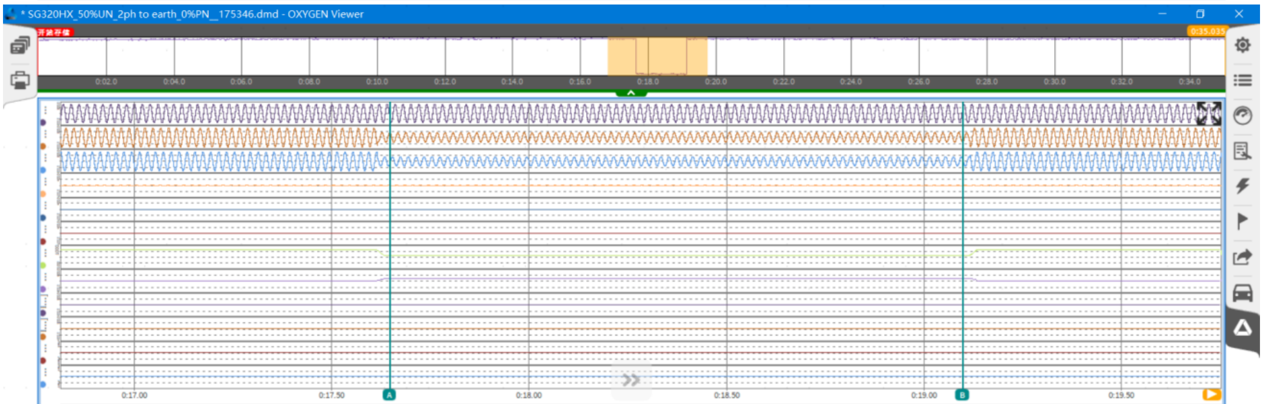
Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
	111	Test number	--	--	--	3.4.1	3.4.2
Before dip < t_1	112	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	462.0	462.6
	113		Phase 2			461.7	462.1
	114		Phase 3			462.1	462.1
	115	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	46.3	231.0
	116		Phase 2			47.9	230.5
	117		Phase 3			47.2	230.2
	118	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.00
	119		total		W	65584	319554
	120	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.00	0.00
	121		total		var	-322	-198
During dip t_1 to t_2	122	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	463.1	463.4
	123		Phase 2			235.9	237.7
	124		Phase 3			235.5	237.6
	125	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	83.3	82.8
	126		Phase 2			213.1	212.7
	127		Phase 3			210.2	209.4
	128	Total fault duration	All phase	t_1 to t_2	ms	1445	1460
	129	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.42	0.42
	130		total		var	133052	133481
	131	Reactive current	Positive sequence		p.u.	0.63	0.63
	132	Active power	Positive sequence		p.u.	0.02	0.02
	133		total		W	6896	6959
	134	Active current	Positive sequence		p.u.	0.02	0.02
	135	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.64	0.64
	136	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.63	0.63
After dip > t_2	137	Voltage	Phase 1	t_2+1s	Vrms	462.0	462.7
	138		Phase 2			461.8	462.1
	139		Phase 3			462.0	462.2
	140	Current	Phase 1	t_2+1s	Arms	48.0	230.6
	141		Phase 2			48.7	229.8
	142		Phase 3			46.8	229.9
	143	Active power	Positive sequence	t_2+1s	p.u.	0.26	1.01
	144		total		W	83398	322411
	145	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.01
	146		total		Var	4352	4479
	147	Active power recovery time	Positive sequence	--	ms	84	523

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.4.0 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=0, Fault Duration



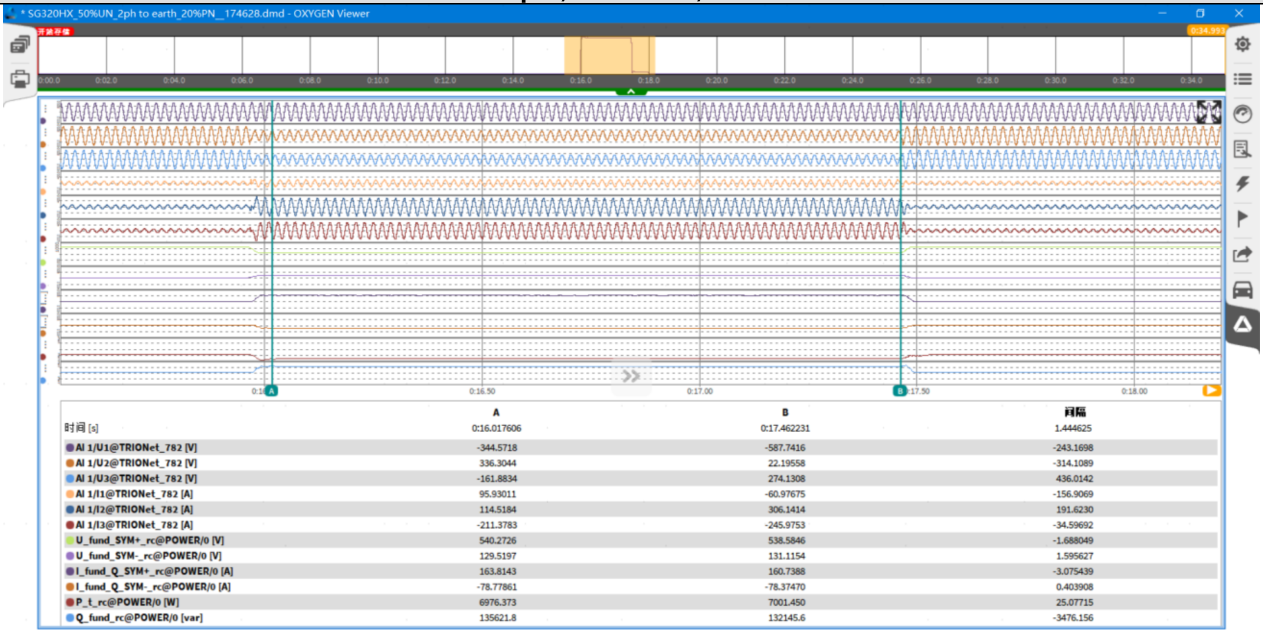
时间 [s]	A 0:17.399486	B 0:19.326081	间隔 1.926595
AI 1/U1@TRIONet_782 [V]	577.1995	-29.12045	-606.3199
AI 1/U2@TRIONet_782 [V]	-551.1184	578.4092	1129.528
AI 1/U3@TRIONet_782 [V]	-21.75021	-549.7480	-527.9978
AI 1/I1@TRIONet_782 [A]	-0.309944	4.768e-3	0.314713
AI 1/I2@TRIONet_782 [A]	-0.228882	-0.218153	0.010729
AI 1/I3@TRIONet_782 [A]	0.132322	-0.108480	-0.240803
U_fund_SYM+_rc@POWER/0 [V]	799.8942	799.3576	-0.536621
U_fund_SYM-_rc@POWER/0 [V]	0.800270	1.837377	1.037108
I_fund_Q_SYM+_rc@POWER/0 [A]	0.143169	0.141953	-1.216e-3
I_fund_Q_SYM-_rc@POWER/0 [A]	2.398e-3	2.076e-3	-3.218e-4
P_t_rc@POWER/0 [W]	5.147664	3.099917	-2.047747
Q_fund_rc@POWER/0 [var]	198.3296	196.4986	-1.831055



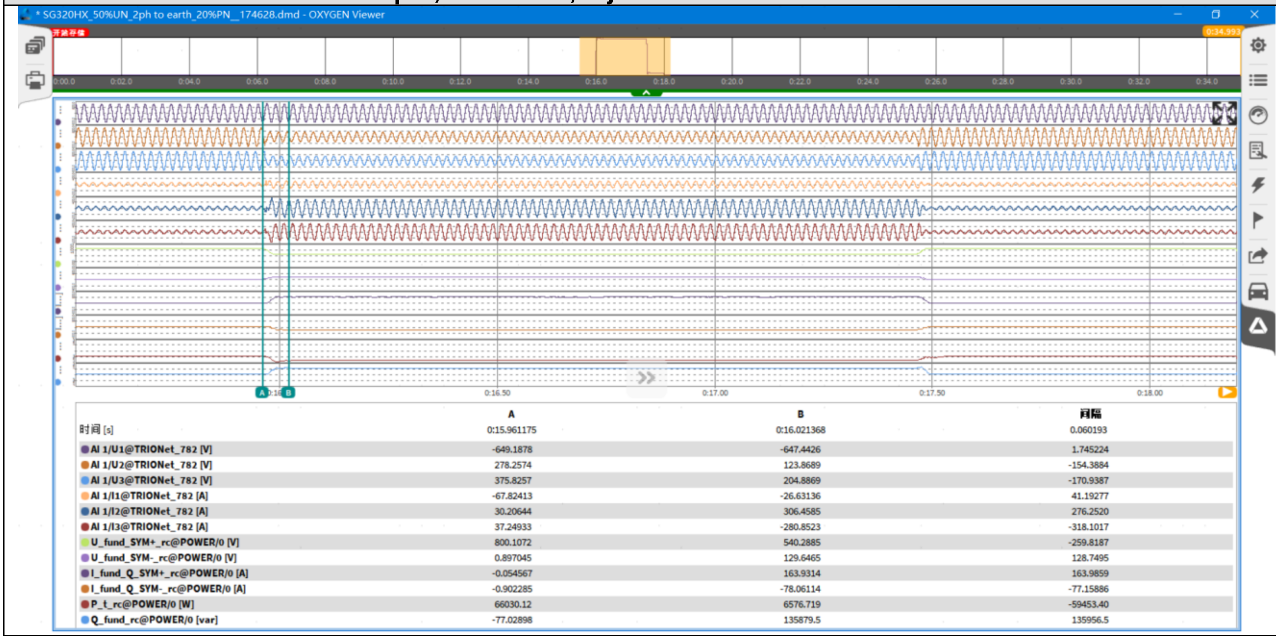
时间 [s]	A 0:17.648079	B 0:19.098204	间隔 1.450125
AI 1/U1@TRIONet_782 [V]	-396.9050	436.6849	833.5898
AI 1/U2@TRIONet_782 [V]	326.8774	-318.6565	-645.5338
AI 1/U3@TRIONet_782 [V]	-129.3774	102.7274	232.1048
AI 1/I1@TRIONet_782 [A]	-0.056028	-0.329018	-0.272989
AI 1/I2@TRIONet_782 [A]	-0.128746	-0.131130	-2.384e-3
AI 1/I3@TRIONet_782 [A]	-0.129938	0.054836	0.184774
U_fund_SYM+_rc@POWER/0 [V]	536.2414	533.6495	-2.591858
U_fund_SYM-_rc@POWER/0 [V]	132.1626	133.3982	1.235565
I_fund_Q_SYM+_rc@POWER/0 [A]	0.095279	0.095480	2.016e-4
I_fund_Q_SYM-_rc@POWER/0 [A]	0.026840	0.027108	2.682e-4
P_t_rc@POWER/0 [W]	6.350822	6.189557	-0.161266
Q_fund_rc@POWER/0 [var]	99.75983	99.66919	-0.090637

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.4.1 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=20%Pn, fault duration

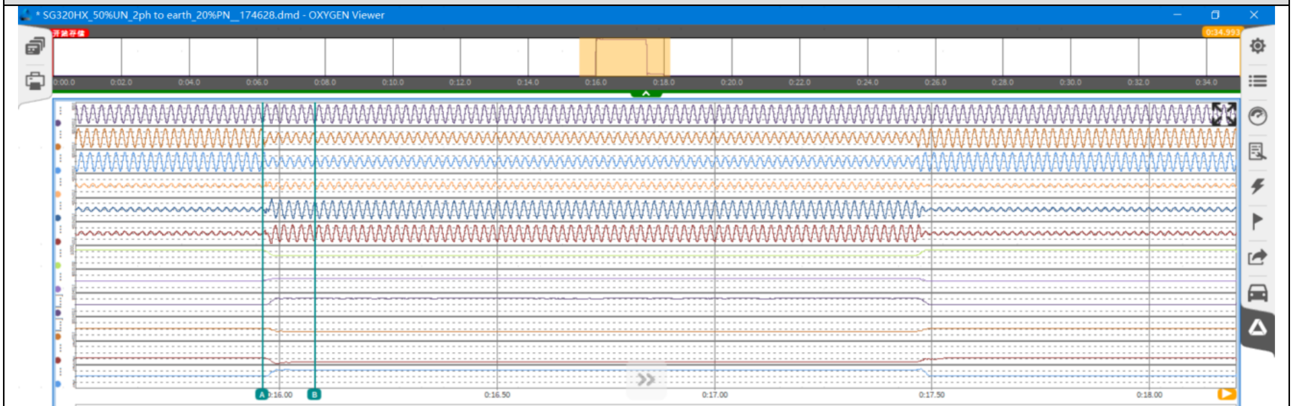


Test no. 3.4.1 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 60ms



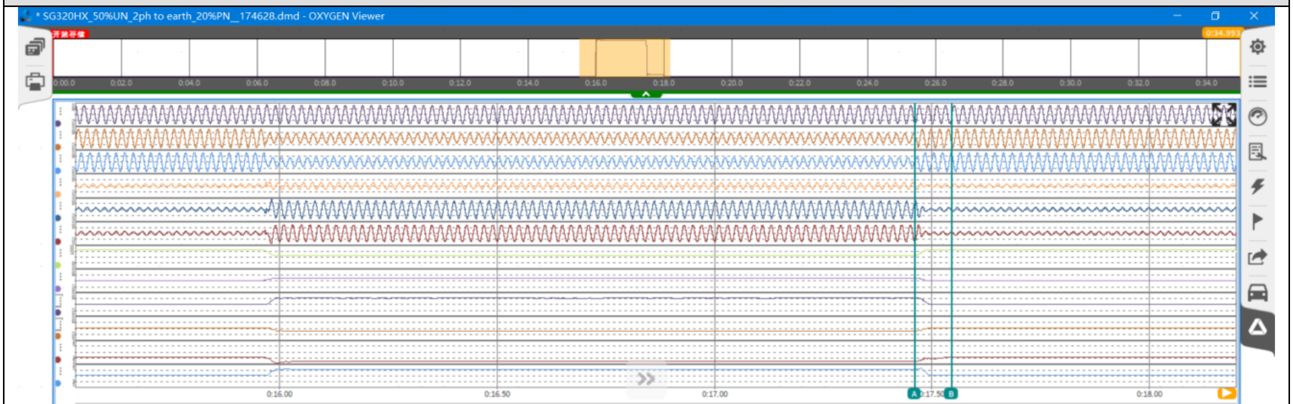
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.4.1 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=20%Pn, Injected reactive Current after 120ms



时间 [s]	A 0:15.961175	B 0:16.081561	间隔 0.120385
AI 1/U1@TRIONet_782 [V]	-649.1878	-638.9816	10.20622
AI 1/U2@TRIONet_782 [V]	278.2574	100.0190	-178.2384
AI 1/U3@TRIONet_782 [V]	375.8257	223.6338	-152.1919
AI 1/I1@TRIONet_782 [A]	-67.82413	-31.71444	36.10969
AI 1/I2@TRIONet_782 [A]	30.20644	310.7107	280.5042
AI 1/I3@TRIONet_782 [A]	37.24933	-280.1001	-317.3495
U_fund_SYM+_rc@POWER/0 [V]	800.1072	539.8517	-260.2555
U_fund_SYM-_rc@POWER/0 [V]	0.897045	130.2246	129.3276
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.054567	161.1015	161.1560
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.902285	-77.96160	-77.05932
P_t_rc@POWER/0 [W]	66030.12	6896.090	-59134.03
Q_fund_rc@POWER/0 [var]	-77.02898	133052.3	133129.3

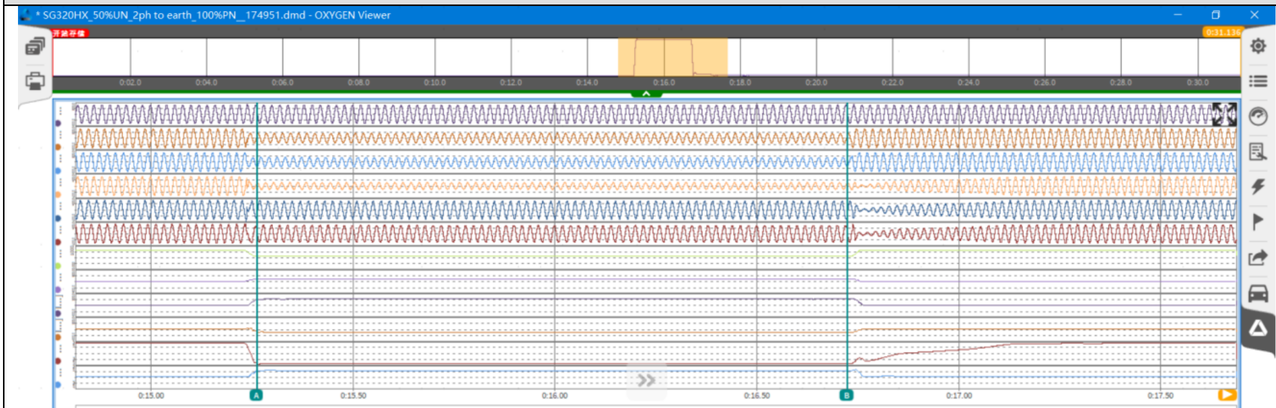
Test no. 3.4.1 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=20%Pn, Active power recovery time



时间 [s]	A 0:17.460350	B 0:17.544996	间隔 0.084646
AI 1/U1@TRIONet_782 [V]	-649.6175	-178.8743	470.7432
AI 1/U2@TRIONet_782 [V]	206.3823	-458.7803	-665.1626
AI 1/U3@TRIONet_782 [V]	125.0107	629.0720	504.0613
AI 1/I1@TRIONet_782 [A]	4.513264	-30.20048	-34.71375
AI 1/I2@TRIONet_782 [A]	283.5429	-32.16982	-315.7127
AI 1/I3@TRIONet_782 [A]	-289.0480	61.94592	350.9939
U_fund_SYM+_rc@POWER/0 [V]	538.5735	798.6942	260.1206
U_fund_SYM-_rc@POWER/0 [V]	131.1064	4.900264	-126.2061
I_fund_Q_SYM+_rc@POWER/0 [A]	160.7102	5.138750	-155.5714
I_fund_Q_SYM-_rc@POWER/0 [A]	-78.34600	-0.144574	78.20143
P_t_rc@POWER/0 [W]	6998.813	63526.39	56527.57
Q_fund_rc@POWER/0 [var]	132123.7	7107.615	-125016.0

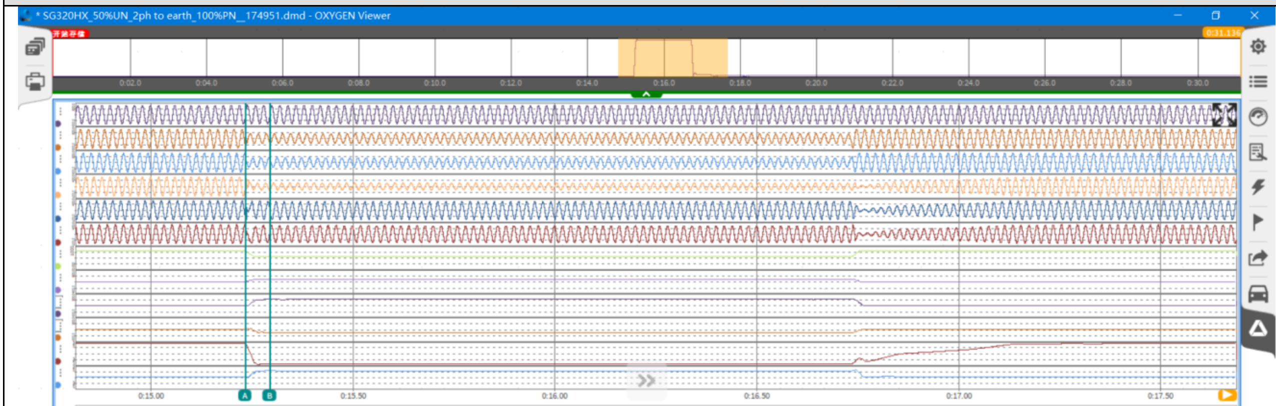
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.4.2 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=100%Pn, fault duration



时间 [s]	A 0:15.263509	B 0:16.723658	间隔 1.460149
AI 1/U1@TRIONet_782 [V]	560.5703	542.3816	-18.18872
AI 1/U2@TRIONet_782 [V]	10.20789	26.99709	16.78920
AI 1/U3@TRIONet_782 [V]	-292.4285	-296.3565	-3.927946
AI 1/I1@TRIONet_782 [A]	50.25864	78.42422	28.16558
AI 1/I2@TRIONet_782 [A]	-276.1293	-293.0939	-16.96468
AI 1/I3@TRIONet_782 [A]	225.5476	214.6113	-10.93626
U_fund_SYM+_rc@POWER/0 [V]	539.8261	538.3617	-1.464417
U_fund_SYM-_rc@POWER/0 [V]	130.3264	131.2690	0.942642
I_fund_Q_SYM+_rc@POWER/0 [A]	140.7945	161.0324	20.23792
I_fund_Q_SYM-_rc@POWER/0 [A]	-53.39296	-78.03510	-24.64214
P_t_rc@POWER/0 [W]	12585.87	7062.356	-5523.515
Q_fund_rc@POWER/0 [var]	119590.1	132415.5	12825.32

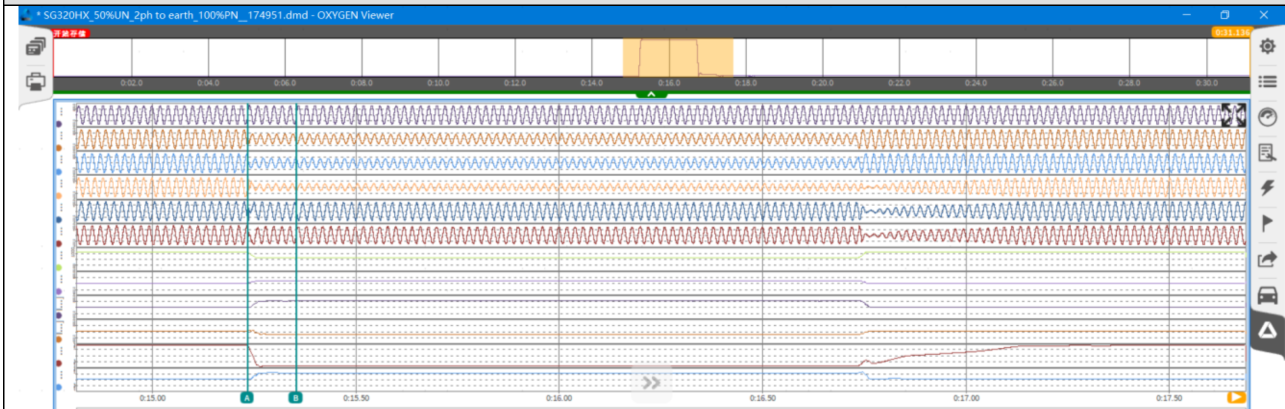
Test no. 3.4.2 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 60ms



时间 [s]	A 0:15.235157	B 0:15.295912	间隔 0.060755
AI 1/U1@TRIONet_782 [V]	-325.7127	-183.4328	142.2799
AI 1/U2@TRIONet_782 [V]	-336.7722	-237.2680	99.50424
AI 1/U3@TRIONet_782 [V]	649.1061	325.0904	-324.0156
AI 1/I1@TRIONet_782 [A]	-159.2326	-119.3428	39.88981
AI 1/I2@TRIONet_782 [A]	-164.9070	116.7905	281.6975
AI 1/I3@TRIONet_782 [A]	324.1956	1.845360	-322.3503
U_fund_SYM+_rc@POWER/0 [V]	800.6473	541.4795	-259.1678
U_fund_SYM-_rc@POWER/0 [V]	1.074614	129.1470	128.0724
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.116953	163.4284	163.5453
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.507173	-77.26014	-76.75297
P_t_rc@POWER/0 [W]	319851.6	6000.237	-313851.4
Q_fund_rc@POWER/0 [var]	-163.1588	135990.2	136153.3

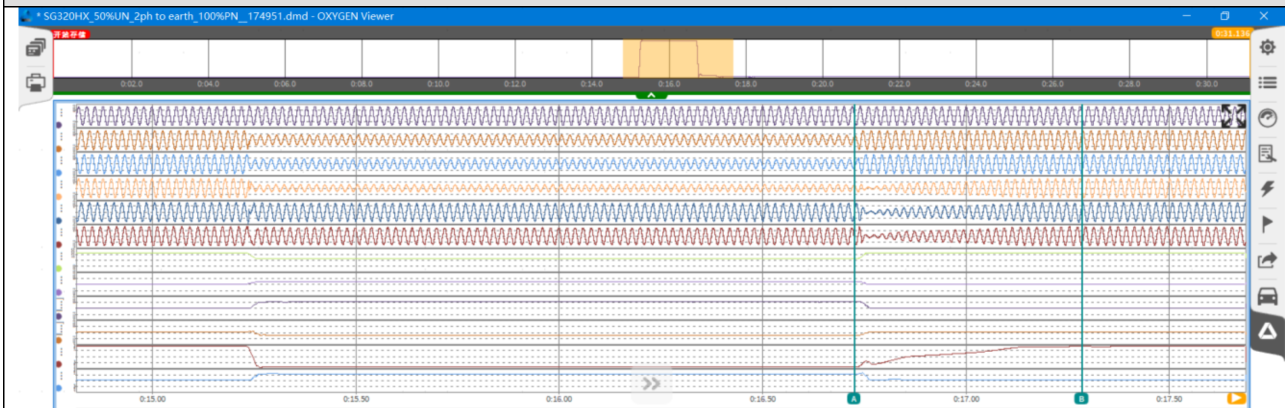
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 3.4.2 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=100%Pn, Injected reactive Current after 120ms



时间 [s]	A	B	间隔
	0:15.235157	0:15.354642	0.119485
AI 1/U1@TRIONet_782 [V]	-325.7127	-414.5468	-88.83405
AI 1/U2@TRIONet_782 [V]	-336.7722	-124.4514	212.3208
AI 1/U3@TRIONet_782 [V]	649.1061	329.1686	-319.9375
AI 1/I1@TRIONet_782 [A]	-159.2326	-87.92878	71.30385
AI 1/I2@TRIONet_782 [A]	-164.9070	200.9225	365.8295
AI 1/I3@TRIONet_782 [A]	324.1956	-113.5266	-437.7222
U_fund_SYM+_rc@POWER/0 [V]	800.6473	541.5975	-259.0499
U_fund_SYM-_rc@POWER/0 [V]	1.074614	129.8776	128.8030
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.116953	161.0348	161.1517
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.507173	-78.14636	-77.63919
P_t_rc@POWER/0 [W]	319851.6	6959.030	-312892.6
Q_fund_rc@POWER/0 [var]	-163.1588	133481.2	133644.3

Test no. 3.4.2 Two phase to earth fault (type E)
U/Un = 0.5 p.u, P=100%Pn, Active power recovery time



时间 [s]	A	B	间隔
	0:16.725684	0:17.284631	0.558947
AI 1/U1@TRIONet_782 [V]	227.4816	392.8135	165.3319
AI 1/U2@TRIONet_782 [V]	216.3425	261.7116	45.36915
AI 1/U3@TRIONet_782 [V]	-321.2290	-649.1692	-327.9402
AI 1/I1@TRIONet_782 [A]	114.7080	195.0967	80.38879
AI 1/I2@TRIONet_782 [A]	-137.5115	123.9002	261.4117
AI 1/I3@TRIONet_782 [A]	22.66765	-319.3522	-342.0198
U_fund_SYM+_rc@POWER/0 [V]	538.3637	800.4526	262.0889
U_fund_SYM-_rc@POWER/0 [V]	131.2345	1.013092	-130.2215
I_fund_Q_SYM+_rc@POWER/0 [A]	161.0601	0.609707	-160.4504
I_fund_Q_SYM-_rc@POWER/0 [A]	-78.02997	-0.336530	77.69344
P_t_rc@POWER/0 [W]	7072.523	321097.9	314025.4
Q_fund_rc@POWER/0 [var]	132447.7	844.6580	-131603.0

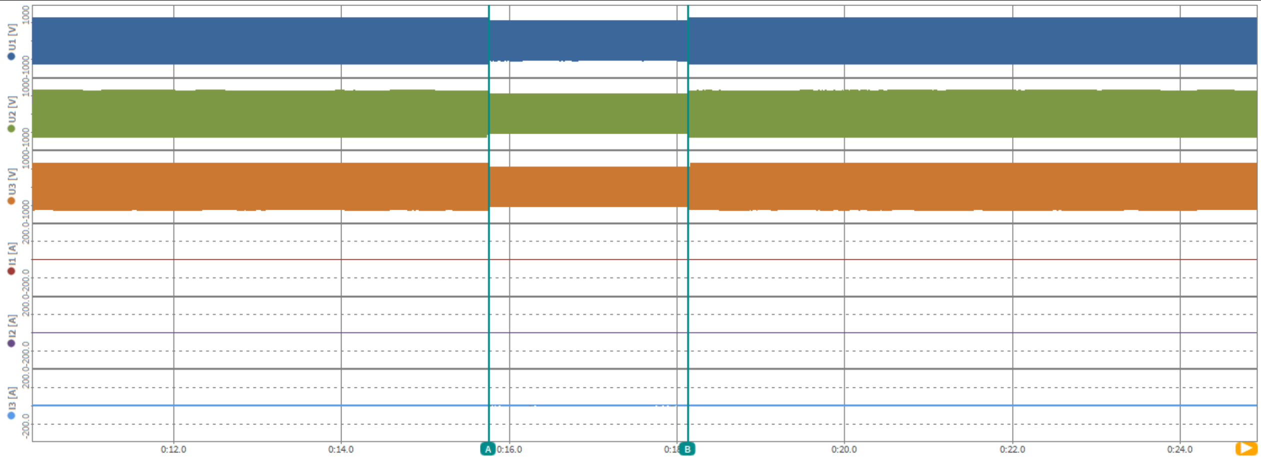
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	4.1.1	4.1.2
	1	Voltage	Phase 1	t_1-500ms to t_1 -100ms	Vrms	460.8	462.4
	2		Phase 2			460.8	462.5
	3		Phase 3			462.2	460.4
	4	Current	Phase 1	t_1-500ms to t_1 -100ms	Arms	49.4	232.7
	5		Phase 2			49.6	232.5
	6		Phase 3			40.5	231.3
	7	Active power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.20	1.01
	8		total		W	62869	321722
	9	Reactive power	Positive sequence	t_1-500ms to t_1 -100ms	p.u.	0.06	0.01
	10		total		var	21840	6576
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	393.3	394.3
	12		Phase 2			393.7	393.6
	13		Phase 3			393.2	393.7
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	78.8	232.4
	15		Phase 2			78.4	231.7
	16		Phase 3			78.9	232.1
	17	Total fault duration	All phase	t_1 to t_2	ms	2401	2401
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.22	0.27
	19		total		var	69719	85849
	20	Reactive current	Positive sequence		p.u.	0.25	0.31
	21	Active power	Positive sequence		p.u.	0.19	0.83
	22		total		W	61470	260462
	23	Active current	Positive sequence		p.u.	0.22	0.95
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.23	0.26
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.25	0.31
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	462.6	463.7
	27		Phase 2			459.9	461.1
	28		Phase 3			461.2	460.6
	29	Current	Phase 1	t_2+1s	Arms	49.6	234.2
	30		Phase 2			49.4	232.6
	31		Phase 3			49.5	232.3
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.01
	33		total		W	65099	322814
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.06	0.01
	35		total		Var	21221	6991
	36	Active power recovery time	Positive sequence	--	ms	592	580

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.1.0 Three phase symmetrical fault（type A）

U/Un = 0.85 p.u, P=0, Fault Duration

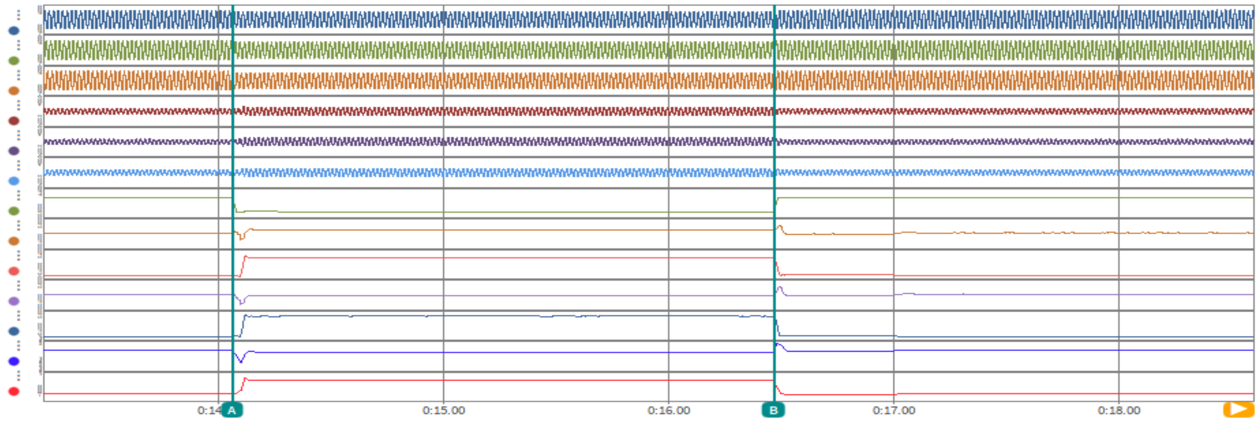


时间 [s]	A	B	间隔	有效值
	0:15.75819	0:18.13131	2.37312	
U1 [V]	-394.5326	535.7671	930.2997	392.5226
U2 [V]	533.5538	-147.9358	-681.4895	392.1724
U3 [V]	-141.3194	-394.5070	-253.1876	392.1489
I1 [A]	-0.455380	-0.459552	-4.172e-3	0.472314
I2 [A]	-0.107765	-0.442863	-0.335097	0.293998
I3 [A]	-0.777960	-0.257730	0.520229	0.447541

时间 [s]	A	B	间隔
	0:15.76401	0:18.16426	2.40025
U+_PU [V]	0.871693	0.983615	0.111922
U-_PU [V]	0.019461	0.016539	-2.921e-3
Ip+_PU [A]	3.693e-5	-4.424e-5	-8.116e-5
Ip-_PU [A]	-2.153e-5	-5.172e-5	-3.019e-5
Iq+_PU [A]	5.048e-4	5.905e-4	8.576e-5
Iq-_PU [A]	2.557e-4	-2.483e-4	-5.040e-4

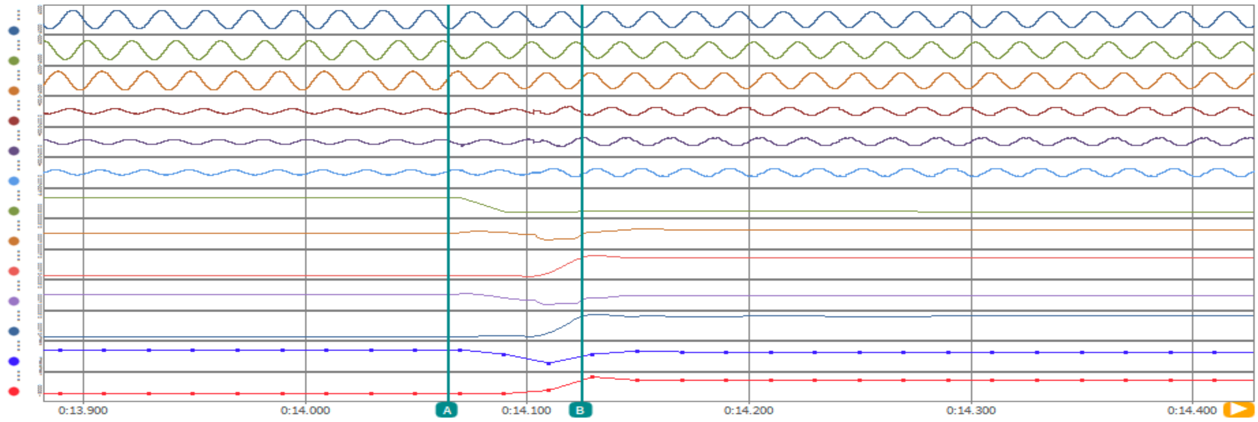
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.1.1 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=20%Pn, fault duration



Time [s]	A 0:14.069350	B 0:16.470258	Delta 2.400908	Avg	RMS
U1 [V]	-285.4374	-74.65744	210.7799	0.096682	393.4293
U2 [V]	-370.7925	-442.1604	-71.36786	-0.219129	393.4609
U3 [V]	647.5991	513.9175	-133.6817	0.206219	393.5182
I1 [A]	-7.572175	-110.2313	-102.6591	-0.231287	78.48059
I2 [A]	-56.56588	3.259182	59.82507	-0.338484	78.10364
I3 [A]	66.23960	106.3942	40.15458	0.244236	78.46501
U+_PU [V]	0.998567	0.851760	-0.146807	0.852555	0.852607
Ip+_PU [A]	0.203660	0.225418	0.021757	0.224456	0.224553
Iq+_PU [A]	-0.067898	0.252292	0.320190	0.247207	0.251055
Ip+_PU [W]	0.203377	0.192010	-0.011367	0.191357	0.191438
Iq+_PU [var]	-0.067803	0.214901	0.282705	0.210518	0.213864
P_t@SG320HX [W]	65019.20	61520.36	-3498.840	61292.51	61321.74
Q_t@SG320HX [var]	21963.56	69361.90	47398.34	68280.96	68778.36

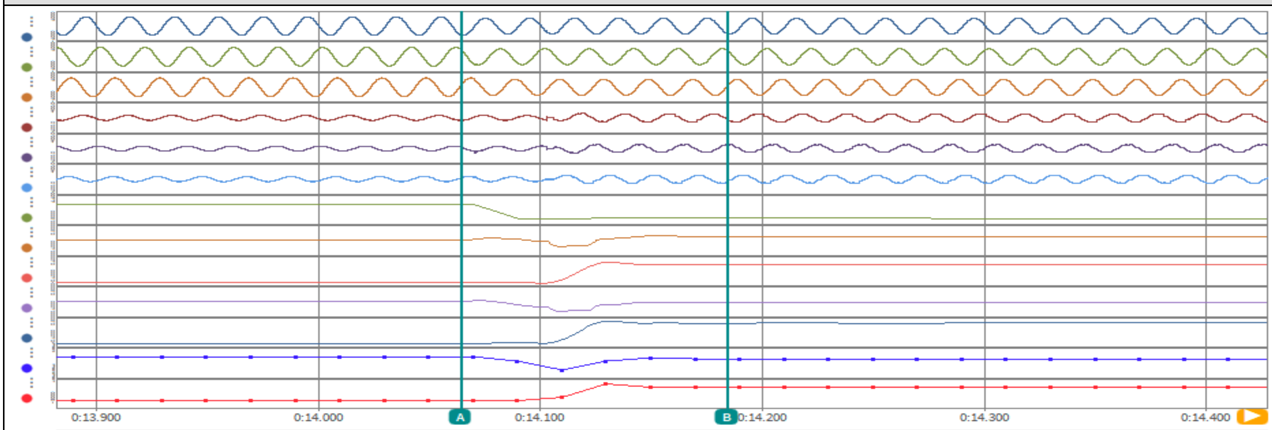
Test no. 4.1.1 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 60ms



Time [s]	A 0:14.064236	B 0:14.124635	Delta 0.060400	Avg	RMS
U1 [V]	-575.4556	-520.5342	54.92139	-10.75937	403.8652
U2 [V]	552.9430	427.8277	-125.1153	3.090975	398.7674
U3 [V]	27.50600	97.67962	70.17363	8.108839	402.0395
I1 [A]	-66.14590	-30.16687	35.97903	9.413167	58.06783
I2 [A]	42.64772	94.72693	52.07920	-10.56506	57.54827
I3 [A]	23.96405	-61.12600	-85.09005	1.087213	59.99036
U+_PU [V]	0.998563	0.852417	-0.146146	0.894298	0.896172
Ip+_PU [A]	0.203543	0.175695	-0.027848	0.190201	0.191317
Iq+_PU [A]	-0.067753	0.235630	0.303384	-0.023807	0.087438
Ip+_PU [W]	0.203259	0.149772	-0.053487	0.170842	0.172913
Iq+_PU [var]	-0.067659	0.200864	0.268523	-0.023141	0.076801
P_t@SG320HX [W]	65019.20	42410.36	-22608.84	57199.06	57943.29
Q_t@SG320HX [var]	21963.56	32780.66	10817.10	24120.55	24648.32

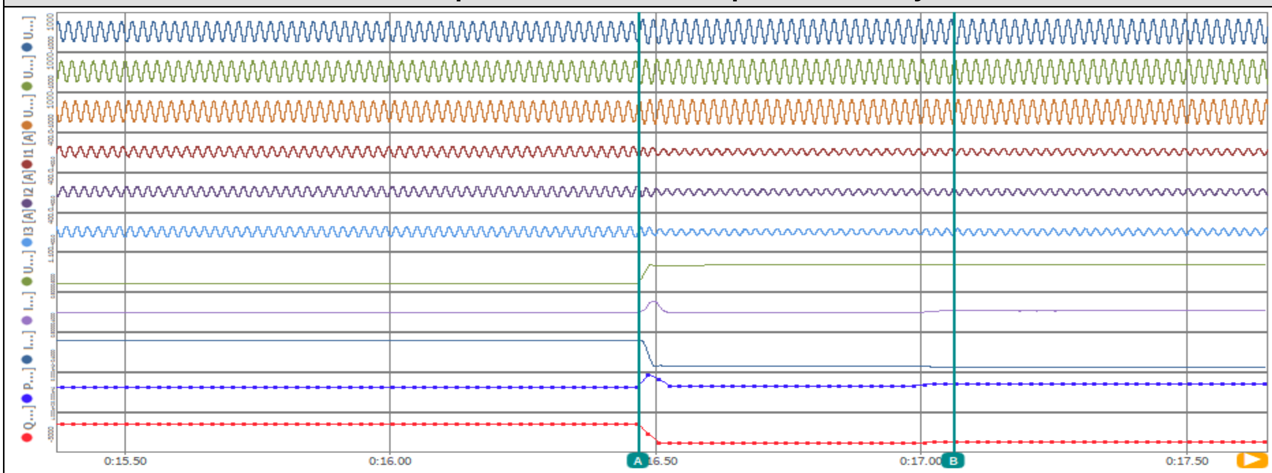
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.1.1 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.064236	0:14.184247	0.120012		
U1 [V]	-575.4556	-494.9624	80.49322	-3.315645	398.4959
U2 [V]	552.9430	465.1053	-87.83770	0.086303	396.1056
U3 [V]	27.50600	29.47021	1.964212	3.691258	398.5969
I1 [A]	-66.14590	-27.92847	38.21743	4.760761	69.01029
I2 [A]	42.64772	100.8354	58.18773	-5.852230	68.65573
I3 [A]	23.96405	-72.33739	-96.30144	1.000368	69.92128
U+_PU [V]	0.998563	0.852456	-0.146107	0.873996	0.875226
Ip+_PU [A]	0.203543	0.225795	0.022252	0.205307	0.206520
Iq+_PU [A]	-0.067753	0.251770	0.319523	0.113694	0.190999
Ip+_PU [W]	0.203259	0.192489	-0.010771	0.179500	0.180816
Iq+_PU [var]	-0.067659	0.214632	0.282291	0.095492	0.163399
P_t@SG320HX [W]	65019.20	61653.83	-3365.363	58555.41	59014.34
Q_t@SG320HX [var]	21963.56	69154.73	47191.17	44788.81	50973.19

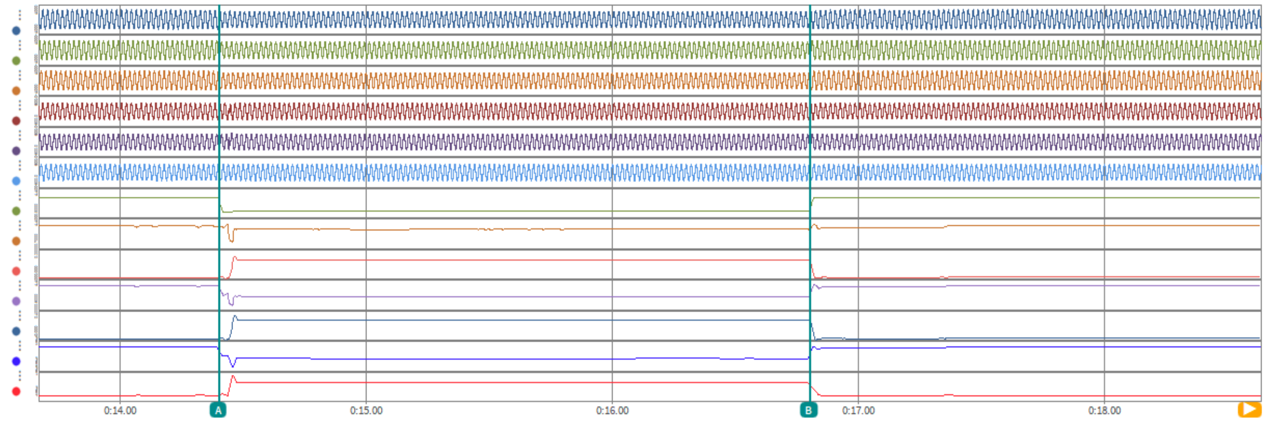
Test no. 4.1.1 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:16.469045	0:17.061504	0.592458		
U1 [V]	-275.5209	-190.4345	85.08647	5.658472	460.5311
U2 [V]	-286.1165	632.1751	918.2916	-3.493076	461.1441
U3 [V]	554.1478	-447.8532	-1002.001	-2.786068	461.5026
I1 [A]	-108.2655	-43.08033	65.18519	0.739194	48.06600
I2 [A]	29.61874	70.42039	40.80165	-0.367337	48.10535
I3 [A]	75.67907	-29.00100	-104.6801	-0.439500	48.31212
U+_PU [V]	0.851756	0.998663	0.146907	0.995410	0.995586
Ip+_PU [W]	0.192008	0.204135	0.012128	0.198421	0.198667
Iq+_PU [var]	0.214944	-0.065582	-0.280526	-0.041223	0.060889
P_t@SG320HX [W]	61520.36	65272.34	3751.980	63415.95	63485.53
Q_t@SG320HX [var]	69361.90	21816.71	-47545.18	21656.99	25439.96

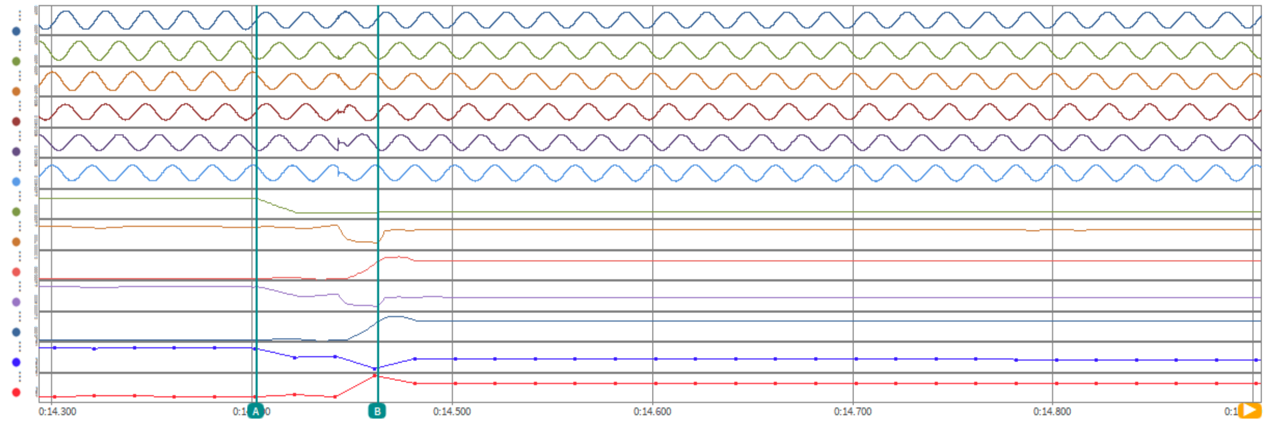
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.1.2 Three phase symmetrical fault type A)
U/Un = 0.85 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.402344	0:16.803052	2.400708		
U1 [V]	-33.71453	134.0679	167.7824	0.221617	394.2129
U2 [V]	-549.6400	-620.5715	-70.93156	-0.142176	393.7283
U3 [V]	575.9919	490.7732	-85.21867	-0.036556	393.8225
I1 [A]	-8.044482	-25.07413	-17.02964	-0.154458	232.2508
I2 [A]	-272.0312	-213.7730	58.25818	0.051949	231.4982
I3 [A]	276.7450	238.7617	-37.98330	-0.027958	231.9195
U+_PU [V]	0.999677	0.852641	-0.147036	0.853482	0.853524
Ip+_PU [A]	0.993875	0.954164	-0.039710	0.953745	0.953867
Iq+_PU [A]	-2.914e-3	0.312761	0.315675	0.305546	0.308924
Ip+_PU [W]	0.993596	0.813595	-0.180001	0.814071	0.814251
Iq+_PU [var]	-2.913e-3	0.266685	0.269598	0.260594	0.263473
P_t@SG320HX [W]	320510.0	260370.3	-60139.69	261225.2	261375.4
Q_t@SG320HX [var]	6242.174	85921.95	79679.77	83750.25	84963.66

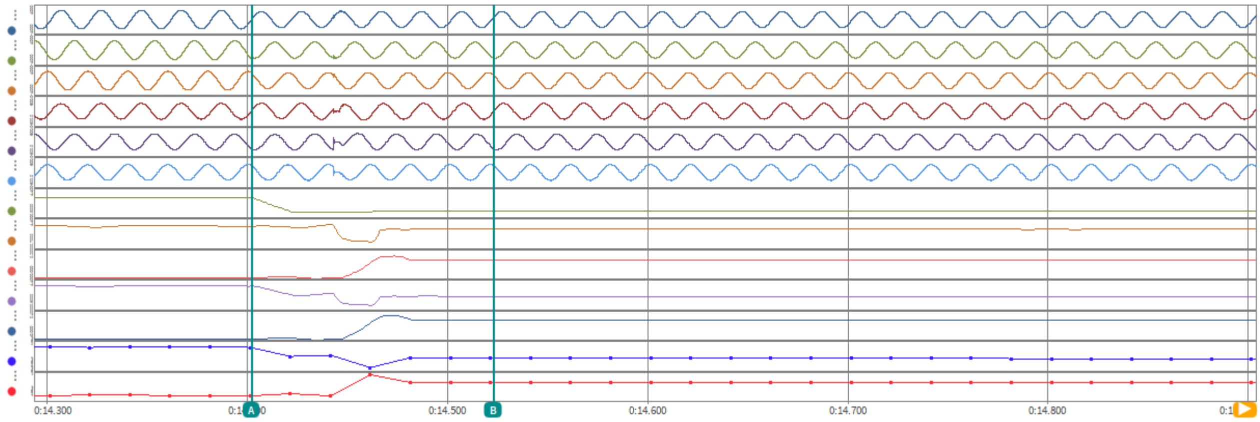
Test no. 4.1.2 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.402384	0:14.463016	0.060632		
U1 [V]	-33.71453	98.99414	132.7087	1.083406	391.2942
U2 [V]	-549.6400	-522.1972	27.44281	-6.884775	395.6090
U3 [V]	575.9919	425.7918	-150.2001	6.410613	395.3654
I1 [A]	-8.044482	-60.44019	-52.39570	-14.23665	228.2255
I2 [A]	-272.0312	-243.9673	28.06389	18.77425	222.0246
I3 [A]	276.7450	301.2657	24.52076	-4.621436	225.0239
U+_PU [V]	0.999677	0.851862	-0.147815	0.878299	0.879524
Ip+_PU [A]	0.993875	0.776725	-0.217150	0.940310	0.944379
Iq+_PU [A]	-2.914e-3	0.262718	0.265632	0.031633	0.070546
Ip+_PU [W]	0.993596	0.661691	-0.331905	0.827503	0.833764
Iq+_PU [var]	-2.913e-3	0.223809	0.226722	0.027069	0.060104
P_t@SG320HX [W]	320510.0	211747.5	-108762.6	279300.5	282102.9
Q_t@SG320HX [var]	6242.174	132897.1	126655.0	34315.51	60194.56

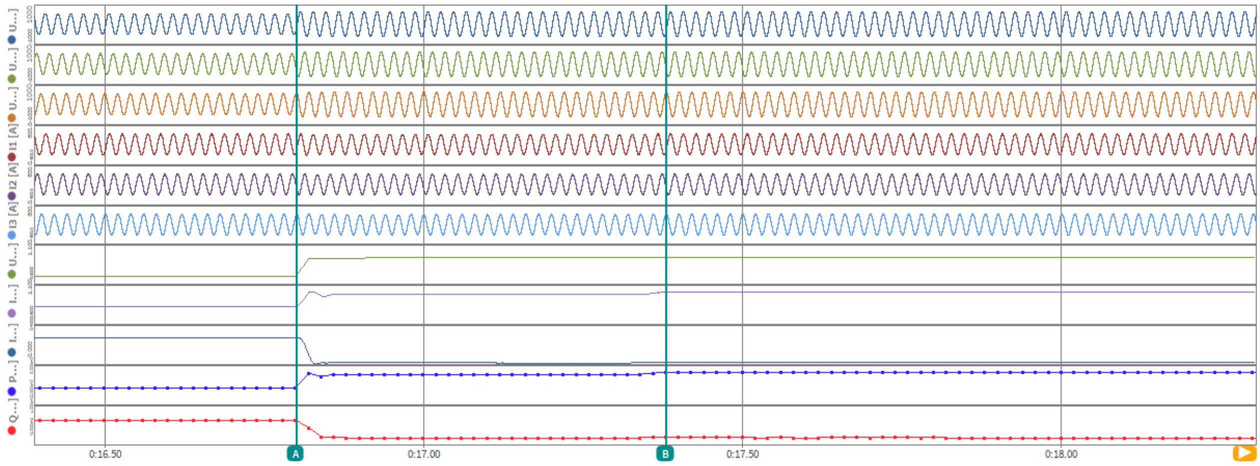
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.1.2 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.402384	0:14.523130	0.120746		
U1 [V]	-33.71453	118.8920	152.6065	0.921057	392.7981
U2 [V]	-549.6400	-526.5519	23.08810	-3.681991	394.9911
U3 [V]	575.9919	415.7728	-160.2191	3.286059	394.7827
I1 [A]	-8.044482	-17.64333	-9.598852	-8.865732	230.0214
I2 [A]	-272.0312	-273.5790	-1.547814	8.823359	227.3079
I3 [A]	276.7450	289.4195	12.67457	-0.124821	228.8870
U+_PU [V]	0.999677	0.853540	-0.146137	0.866047	0.866755
Ip+_PU [A]	0.993875	0.955315	-0.038559	0.943899	0.946265
Iq+_PU [A]	-2.914e-3	0.311220	0.314133	0.177136	0.234204
Ip+_PU [W]	0.993596	0.815435	-0.178161	0.818249	0.821749
Iq+_PU [var]	-2.913e-3	0.265650	0.268563	0.151277	0.199961
P_t@SG320HX [W]	320510.0	260946.7	-59563.30	272403.1	274346.6
Q_t@SG320HX [var]	6242.174	85534.11	79291.94	53829.97	71142.21

Test no. 4.1.2 Three phase symmetrical fault（type A）
U/Un = 0.85 p.u, P=100%Pn, Active power recovery time



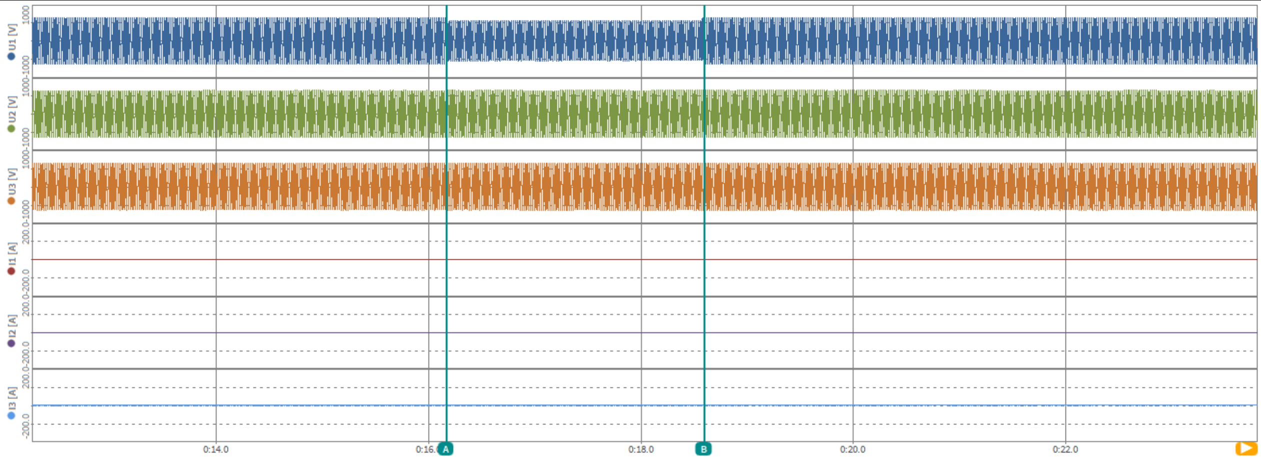
	A	B	Delta	Avg	RMS
Time [s]	0:16.800512	0:17.380152	0.579639		
U1 [V]	-307.0375	-416.7732	-109.7357	-0.707108	462.0362
U2 [V]	-256.4852	-234.4663	22.01891	0.297178	460.9459
U3 [V]	555.0688	640.4525	85.38378	-0.188139	460.8750
I1 [A]	-258.2258	-217.9959	40.22992	-0.338424	227.6313
I2 [A]	-49.94345	-116.2223	-66.27882	0.058552	226.5193
I3 [A]	305.5777	329.9210	24.34337	0.208243	226.8917
U+_PU [V]	0.852649	0.999985	0.147336	0.995875	0.996056
Ip+_PU [W]	0.813620	1.007177	0.193557	0.977141	0.977411
Iq+_PU [var]	0.266597	0.013582	-0.253015	0.015461	0.045522
P_t@SG320HX [W]	260439.1	317771.6	57332.50	310173.4	310465.1
Q_t@SG320HX [var]	85883.34	12484.88	-73398.46	13118.69	24780.71

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	4.2.1	4.2.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	460.5	460.9
	2		Phase 2			461.5	462.2
	3		Phase 3			462.5	462.4
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.1	2324
	5		Phase 2			47.2	232.6
	6		Phase 3			47.1	232.7
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.01
	8		total		W	65219	322173
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.001	0.002
	10		total		var	2476	6241
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	392.6	393.2
	12		Phase 2			461.5	461.6
	13		Phase 3			461.3	461.4
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	50.3	246.7
	15		Phase 2			50.1	246.4
	16		Phase 3			49.5	244.9
	17	Total fault duration	All phase	t_1 to t_2	ms	2400	2401
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.21	0.003
	19		total		var	3295	7069
	20	Reactive current	Positive sequence		p.u.	0.0001	0.003
	21	Active power	Positive sequence		p.u.	0.21	1.01
	22		total		W	65647	323210
	23	Active current	Positive sequence		p.u.	0.22	1.06
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	-	-
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	-	-
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	461.1	463.5
	27		Phase 2			460.8	460.9
	28		Phase 3			462.4	460.9
	29	Current	Phase 1	t_2+1s	Arms	47.1	233.9
	30		Phase 2			47.1	232.0
	31		Phase 3			47.1	232.1
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.01
	33		total		W	65220	322311
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.001	0.002
	35		total		Var	2272	5501
	36	Active power recovery time	Positive sequence	--	ms	301	714

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.2.0 single-pole short circuit with earth (type B)
U/Un = 0.85 p.u, P=0, Fault Duration



时间 [s]	A 0:16.171926	B 0:18.596385	间隔 2.424459	有效值
U1 [V]	-430.0368	-551.8779	-121.8411	393.4327
U2 [V]	638.7610	-31.66044	-670.4214	461.3433
U3 [V]	-210.6213	576.8019	787.4232	461.2481
I1 [A]	0.791669	-0.721812	-1.513481	0.492951
I2 [A]	0.221849	-0.499368	-0.721216	0.334171
I3 [A]	0.272393	-0.896096	-1.168490	0.466862

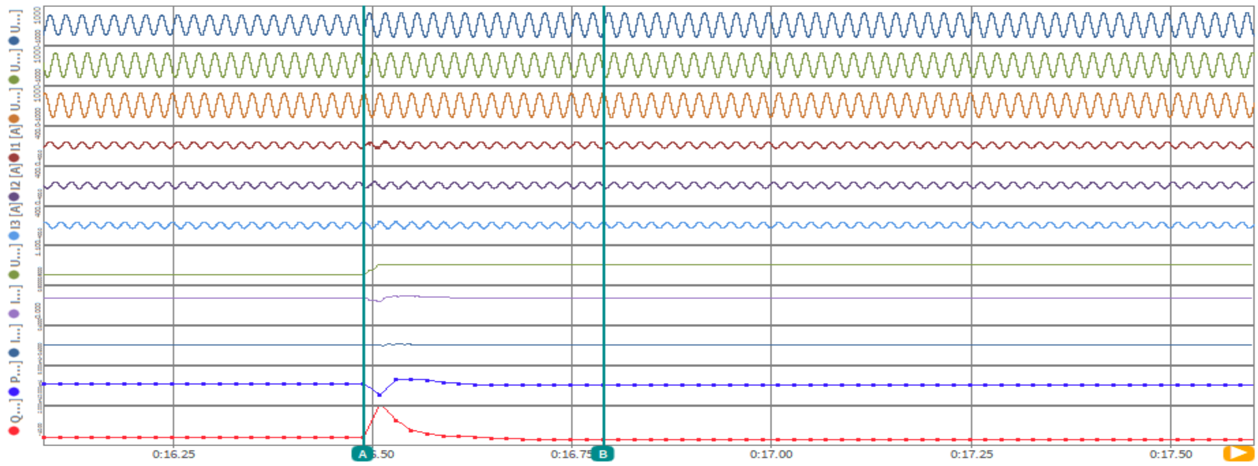
时间 [s]	A 0:16.20043	B 0:18.59379	间隔 2.39335
U+_PU [V]	0.949486	0.978134	0.028649
U-_PU [V]	0.050386	0.022950	-0.027435
Ip+_PU [A]	-3.581e-5	-6.229e-5	-2.648e-5
Ip-_PU [A]	7.946e-5	1.576e-4	7.811e-5
Iq+_PU [A]	6.271e-4	6.436e-4	1.657e-5
Iq-_PU [A]	2.379e-4	1.528e-4	-8.504e-5

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.85 p.u, P=20%Pn, fault duration

	A	B	Delta	Avg	RMS
Time [s]	0:14.092610	0:16.491875	2.399265		
U1 [V]	187.4169	65.76670	-121.6502	0.172723	392.5918
U2 [V]	-639.7217	-600.7665	38.95521	0.169164	461.2801
U3 [V]	426.3901	524.9391	98.54901	-0.192555	461.4995
I1 [A]	26.21293	11.08468	-15.12826	0.046105	50.28513
I2 [A]	-69.41092	-66.76209	2.648831	-0.101983	50.05129
I3 [A]	42.10580	53.10428	10.99849	-0.035870	49.50690
U+_PU [V]	0.999177	0.949255	-0.049922	0.949486	0.949490
Ip+_PU [A]	0.204037	0.216523	0.012485	0.215949	0.215954
Iq+_PU [A]	2.901e-4	1.529e-4	-1.373e-4	8.780e-5	2.677e-4
Ip+_PU [W]	0.203878	0.205544	1.666e-3	0.205047	0.205051
Iq+_PU [var]	2.899e-4	1.451e-4	-1.448e-4	8.333e-5	2.563e-4
P_t@SG320HX [W]	65239.44	65746.86	507.4219	65588.43	65589.62
Q_t@SG320HX [var]	2428.216	3350.489	922.2727	3305.345	3310.835

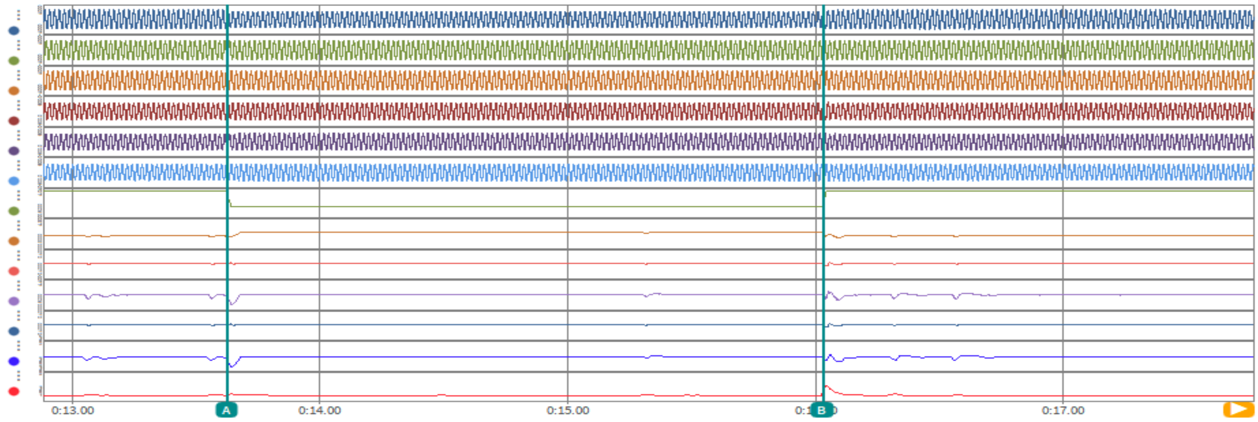
Test no. 4.2.1 Single-pole short circuit with earth (type B)
U/Un = 0.85 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:16.488813	0:16.789627	0.300814		
U1 [V]	-410.0464	-356.3460	53.70033	-2.563838	460.8990
U2 [V]	-147.9615	-300.8552	-152.8937	-0.705549	460.7121
U3 [V]	621.5427	649.4382	27.89545	1.837786	462.1678
I1 [A]	-53.85733	-37.86409	15.99324	-0.112780	47.92764
I2 [A]	-16.07466	-29.03056	-12.95590	-0.141731	47.67359
I3 [A]	67.03544	66.58829	-0.447154	0.155846	47.65421
U+_PU [V]	0.949201	0.999103	0.049902	0.996481	0.996524
Ip+_PU [W]	0.205419	0.203871	-1.548e-3	0.205067	0.205209
Iq+_PU [var]	8.286e-5	6.050e-4	5.221e-4	5.281e-4	1.432e-3
P_t@SG320HX [W]	65639.50	65288.90	-350.5977	65637.53	65690.49
Q_t@SG320HX [var]	3432.263	2480.097	-952.1660	5179.658	7026.465

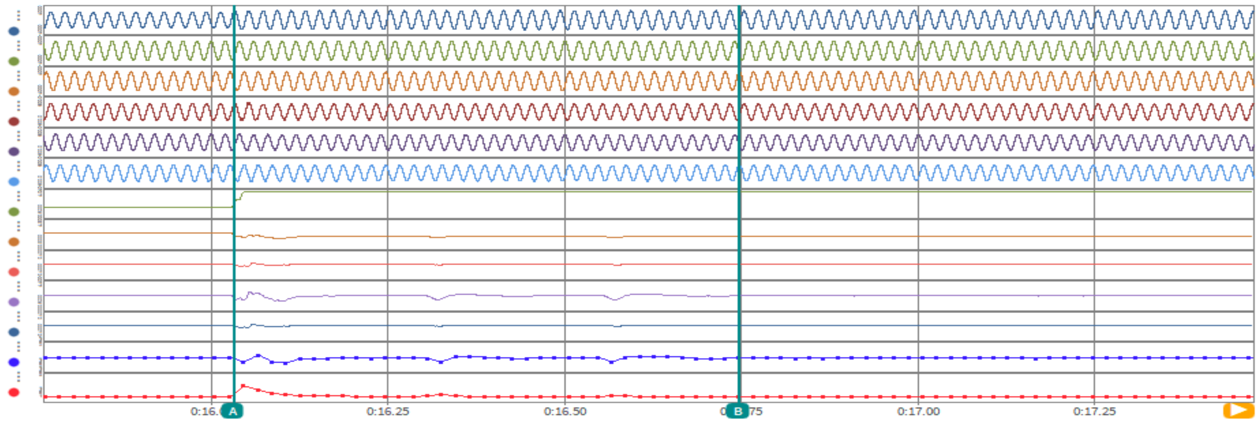
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.85 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:13.630107	0:16.031517	2.401410		
U1 [V]	98.76156	391.6356	292.8740	0.386228	393.1238
U2 [V]	-613.0838	-644.9317	-31.84796	-0.410365	461.7137
U3 [V]	501.6827	259.1114	-242.5712	0.185289	461.5048
I1 [A]	61.92816	187.4483	125.5201	0.080033	246.3927
I2 [A]	-308.1178	-308.5537	-0.435948	-0.277872	245.1549
I3 [A]	242.1111	120.1722	-121.9390	0.111241	244.7705
U+_PU [V]	0.999783	0.950703	-0.049080	0.950163	0.950168
Ip+_PU [A]	1.000990	1.061012	0.060022	1.062217	1.062251
Iq+_PU [A]	-3.499e-3	7.459e-4	4.245e-3	-2.612e-3	2.768e-3
Ip+_PU [W]	1.000815	1.008750	7.935e-3	1.009309	1.009331
Iq+_PU [var]	-3.499e-3	7.092e-4	4.208e-3	-2.482e-3	2.634e-3
P_t@SG320HX [W]	320120.4	323479.2	3358.813	322902.5	322910.1
Q_t@SG320HX [var]	5982.434	6741.599	759.1650	7118.850	7142.586

Test no. 4.2.2 Single-pole short circuit with earth (type B)
U/Un = 0.85 p.u, P=100%Pn, Active power recovery time



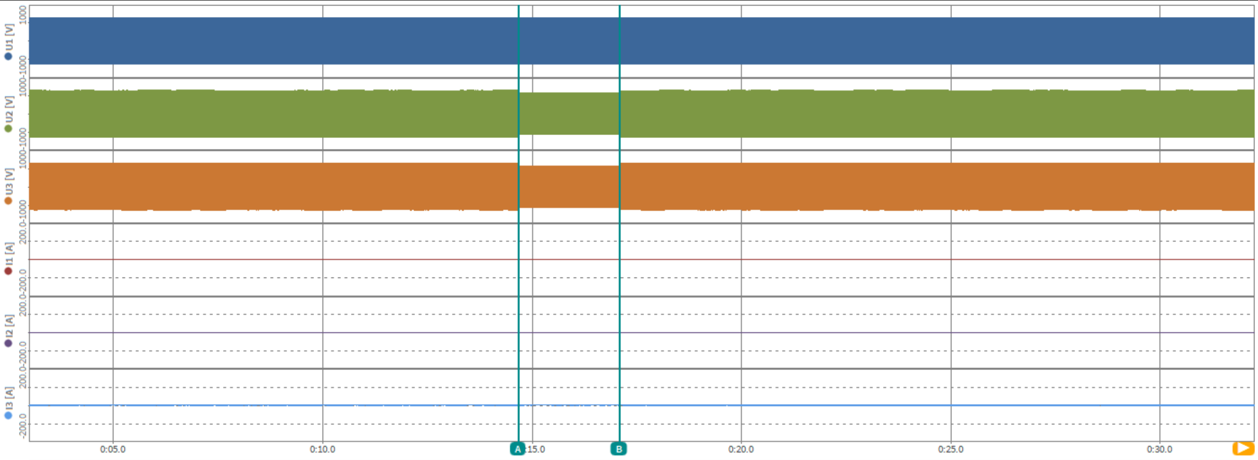
	A	B	Delta	Avg	RMS
Time [s]	0:16.031710	0:16.746050	0.714340		
U1 [V]	424.9807	-580.7059	-1005.687	3.459e-3	463.1118
U2 [V]	-638.2088	24.33217	662.5410	3.393918	461.3938
U3 [V]	221.4093	552.7640	331.3546	-4.294092	460.8196
I1 [A]	203.6650	-290.6368	-494.3018	0.470904	233.4295
I2 [A]	-303.3450	2.886057	306.2310	1.784420	231.9167
I3 [A]	100.4853	287.1692	186.6839	-2.296841	231.6556
U+_PU [V]	0.950703	0.999891	0.049188	0.999117	0.999127
Ip+_PU [A]	1.061012	1.006886	-0.054126	1.006001	1.006045
Iq+_PU [A]	7.459e-4	-2.100e-3	-2.846e-3	-2.479e-3	3.585e-3
Ip+_PU [W]	1.008750	1.006820	-1.930e-3	1.005143	1.005184
Iq+_PU [var]	7.092e-4	-2.100e-3	-2.809e-3	-2.476e-3	3.573e-3
P_t@SG320HX [W]	323479.2	321855.8	-1623.375	321662.5	321676.5
Q_t@SG320HX [var]	6741.599	5873.565	-868.0337	9284.746	11852.25

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
Before dip < t_1	0	Test number	--	--	--	4.3.1	4.3.2
	1	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	460.8	458.3
	2		Phase 2			461.1	463.9
	3		Phase 3			462.5	462.9
	4	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.1	231.4
	5		Phase 2			47.2	233.8
	6		Phase 3			47.1	233.5
	7	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.00
	8		total		W	65220	322605
	9	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.003	0.01
	10		total		var	2288	5872
During dip t_1 to t_2	11	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	461.6	462.0
	12		Phase 2			411.8	411.2
	13		Phase 3			411.4	412.1
	14	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	48.9	193.7
	15		Phase 2			97.9	228.57
	16		Phase 3			59.3	168.6
	17	Total fault duration	All phase	t_1 to t_2	ms	2402	2402
	18	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.15	0.15
	19		total		var	62317	58226
	20	Reactive current	Positive sequence		p.u.	0.17	0.15
	21	Active power	Positive sequence		p.u.	0.19	0.77
	22		total		W	61108	246324
	23	Active current	Positive sequence		p.u.	0.20	0.83
	24	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.18	0.10
	25	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.17	0.15
After dip > t_2	26	Voltage	Phase 1	t_2+1s	Vrms	460.8	462.1
	27		Phase 2			461.0	461.8
	28		Phase 3			462.7	461.5
	29	Current	Phase 1	t_2+1s	Arms	47,1	233.4
	30		Phase 2			47.1	232.7
	31		Phase 3			47.2	232.6
	32	Active power	Positive sequence	t_2+1s	p.u.	0.20	1.00
	33		total		W	65207	322678
	34	Reactive power	Positive sequence	t_2+1s	p.u.	0.003	0.01
	35		total		Var	2778	7079
	36	Active power recovery time	Positive sequence	--	ms	7054	578

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.3.0 two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=0, Fault Duration

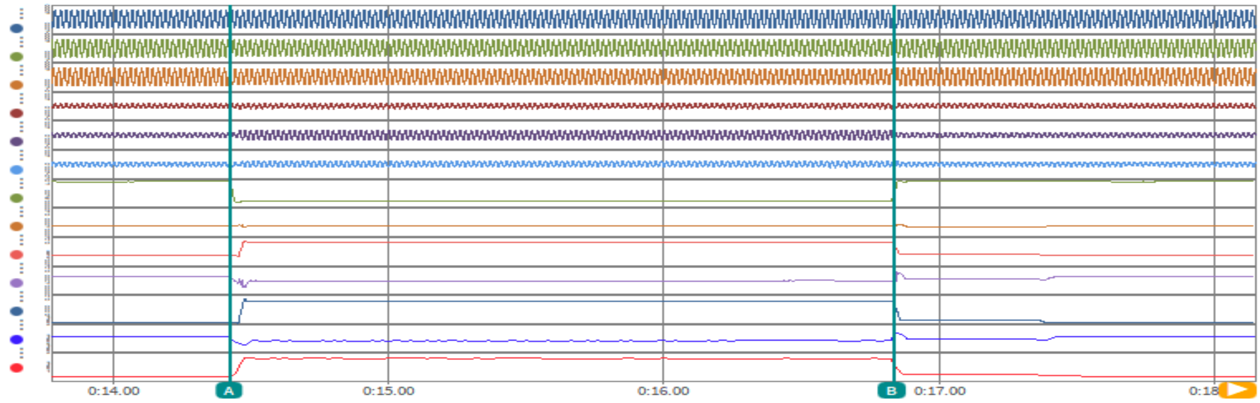


	A	B	间隔	有效值
时间 [s]	0:14.67953	0:17.09091	2.41137	
U1 [V]	-247.2500	496.1973	743.4472	461.4054
U2 [V]	646.5609	-616.7953	-1263.356	410.9669
U3 [V]	-402.0030	124.5294	526.5323	410.8965
I1 [A]	-0.497580	-0.014782	0.482798	0.478274
I2 [A]	-0.319123	-0.187755	0.131369	0.290752
I3 [A]	-0.820160	0.302792	1.122952	0.434182

	A	B	间隔
时间 [s]	0:14.72776	0:17.14534	2.41758
U+_PU [V]	0.924739	0.998460	0.073721
U-_PU [V]	0.074961	6.609e-4	-0.074300
Ip+_PU [A]	-3.453e-5	-3.277e-5	1.759e-6
Ip-_PU [A]	-1.422e-4	-2.121e-4	-6.988e-5
Iq+_PU [A]	5.063e-4	5.621e-4	5.583e-5
Iq-_PU [A]	-1.099e-4	1.255e-4	2.354e-4

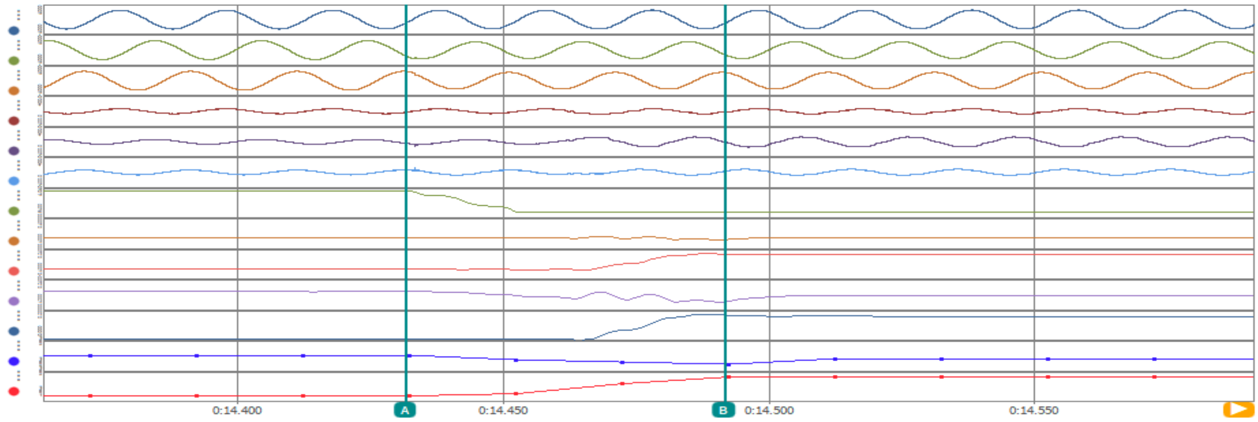
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=20%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.43062	0:16.83309	2.40247		
U1 [V]	-433.4913	37.98819	471.4794	-0.256970	461.5444
U2 [V]	-211.5449	-496.5211	-284.9763	-0.449292	411.5260
U3 [V]	636.2559	459.8571	-176.3988	0.637863	411.9256
I1 [A]	-46.46337	-0.469804	45.99357	0.033573	48.94861
I2 [A]	-20.90669	-56.24569	-35.33900	-0.507812	97.35734
I3 [A]	63.40778	57.97267	-5.435109	0.190749	59.02973
U+_PU [V]	0.999195	0.925782	-0.073413	0.926154	0.926167
Ip+_PU [A]	0.203928	0.205893	1.965e-3	0.205840	0.205847
Iq+_PU [A]	1.332e-4	0.168829	0.168696	0.166060	0.167559
Ip+_PU [W]	0.203773	0.190620	-0.013153	0.190648	0.190657
Iq+_PU [var]	1.331e-4	0.156306	0.156173	0.153734	0.155121
P_t@SG320HX [W]	65191.69	61116.31	-4075.379	61112.69	61117.29
Q_t@SG320HX	2355.719	62220.57	59864.85	60739.43	61421.56

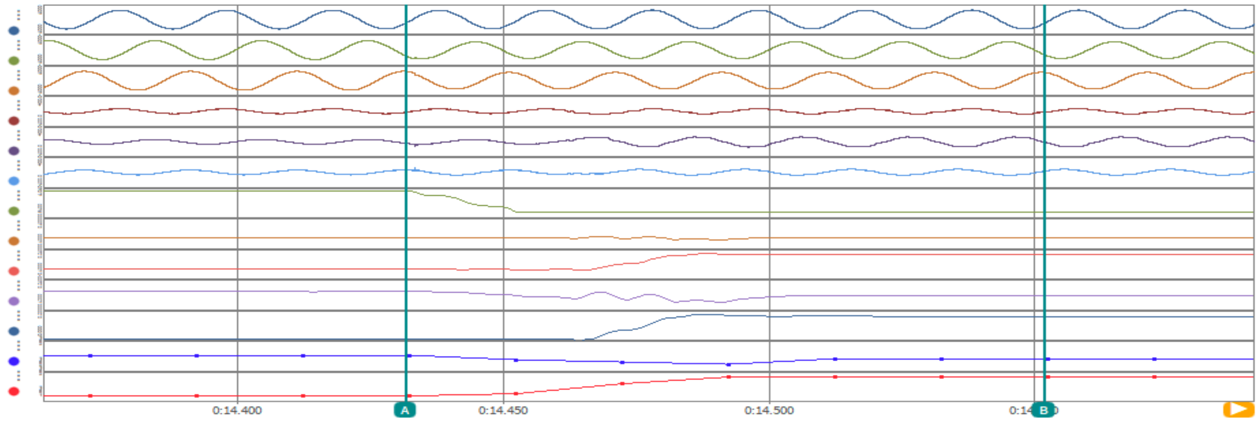
Test no. 4.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.431809	0:14.491693	0.059884		
U1 [V]	-226.5566	-265.9822	-39.42561	0.239273	461.9921
U2 [V]	-420.1066	-309.8725	110.2340	-1.063983	413.9274
U3 [V]	641.4893	568.3922	-73.09711	0.689102	413.9052
I1 [A]	-21.84487	-29.38044	-7.535577	-3.117162	49.09545
I2 [A]	-41.97288	-2.871990	39.10089	8.103494	74.56081
I3 [A]	65.54842	29.04082	-36.50761	-5.030498	50.30655
U+_PU [V]	0.999192	0.925844	-0.073348	0.941103	0.941423
Ip+_PU [A]	0.203911	0.184678	-0.019233	0.201896	0.202061
Iq+_PU [A]	1.247e-4	0.179879	0.179754	0.047662	0.084280
Ip+_PU [W]	0.203755	0.170991	-0.032765	0.190081	0.190366
Iq+_PU [var]	1.246e-4	0.166547	0.166422	0.044128	0.078021
P_t@SG320HX [W]	65191.69	58433.51	-6758.180	62430.08	62497.18
Q_t@SG320HX [var]	2355.719	40250.49	37894.77	13622.26	20749.28

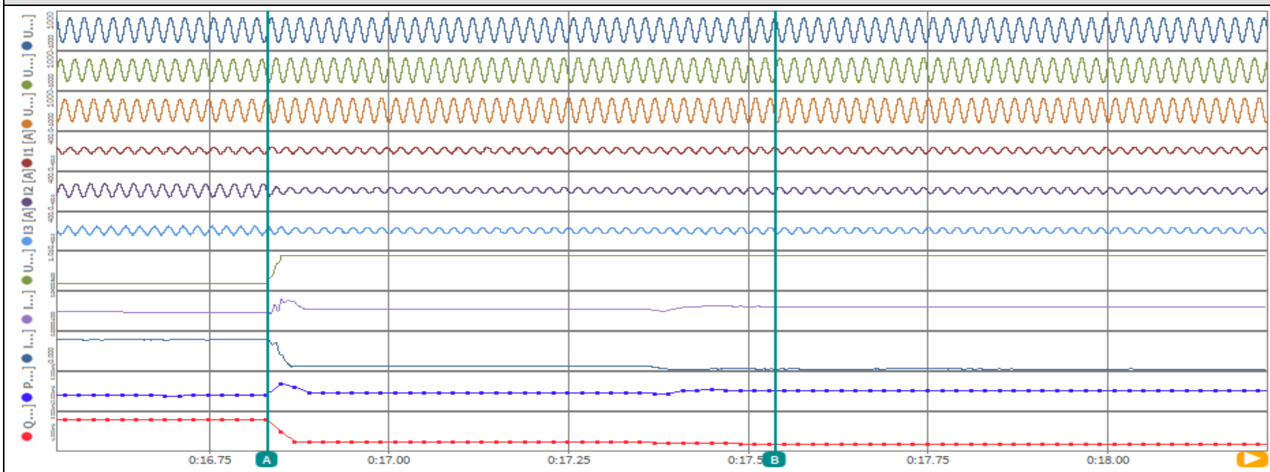
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.431809	0:14.551740	0.119931		
U1 [V]	-226.5566	-247.5237	-20.96713	-0.175780	461.7198
U2 [V]	-420.1066	-325.2211	94.88547	-0.613470	412.7227
U3 [V]	641.4893	565.7361	-75.75322	0.723421	412.8924
I1 [A]	-21.84487	-27.20499	-5.360127	-1.434239	49.02373
I2 [A]	-41.97288	-4.442215	37.53066	2.883856	87.18708
I3 [A]	65.54842	33.57077	-31.97766	-1.504704	55.10829
U+_PU [V]	0.999192	0.925743	-0.073449	0.933529	0.933722
Ip+_PU [A]	0.203911	0.205923	2.011e-3	0.203169	0.203278
Iq+_PU [A]	1.247e-4	0.169357	0.169232	0.108481	0.134036
Ip+_PU [W]	0.203755	0.190640	-0.013116	0.189696	0.189862
Iq+_PU [var]	1.246e-4	0.156787	0.156663	0.100438	0.124096
P_t@SG320HX [W]	65191.69	61192.77	-3998.922	61187.20	61266.15
Q_t@SG320HX [var]	2355.719	62379.16	60023.44	34829.00	44190.98

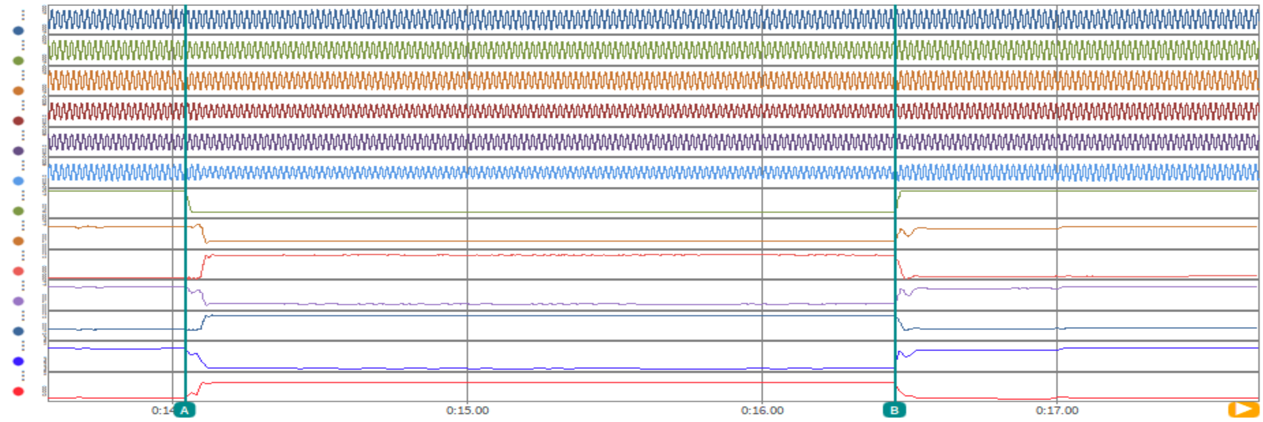
Test no. 4.3.1 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=20%Pn, Active power recovery time



	A	B	Delta	Avg	RMS
Time [s]	0:16.831966	0:17.537437	0.705470		
U1 [V]	-190.1391	647.6272	837.7662	2.480974	461.3036
U2 [V]	-369.5463	-392.2625	-22.71617	-4.360840	462.0953
U3 [V]	555.9280	-259.8142	-815.7422	1.732789	460.7731
I1 [A]	-26.97623	64.94785	91.92408	0.317487	46.23846
I2 [A]	-10.05232	-36.33797	-26.28565	-0.207168	47.00095
I3 [A]	38.25891	-30.84707	-69.10599	-0.072631	46.45017
U+_PU [V]	0.925788	0.999271	0.073482	0.997837	0.997873
Ip+_PU [W]	0.190647	0.203817	0.013170	0.198792	0.198844
Iq+_PU [var]	0.156335	2.935e-3	-0.153400	0.017791	0.028413
P_t@SG320HX [W]	61144.93	65260.67	4115.734	63647.34	63670.46
Q_t@SG320HX [var]	62377.03	3607.161	-58769.87	10855.74	16969.45

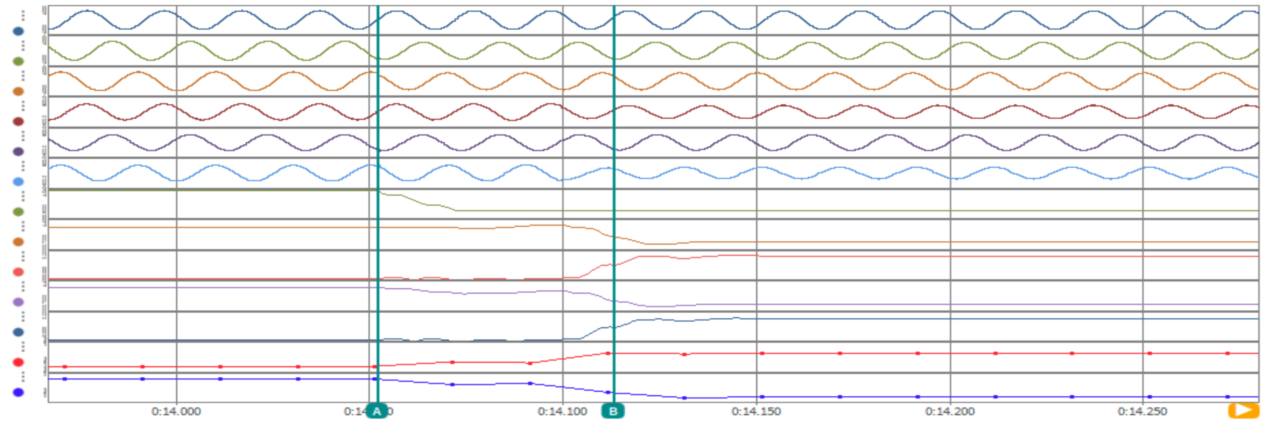
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=100%Pn, fault duration



	A	B	Delta	Avg	RMS
Time [s]	0:14.04911	0:16.45118	2.40207		
U1 [V]	-535.8705	-198.3217	337.5488	-0.384685	462.1013
U2 [V]	-60.02689	-366.4553	-306.4285	-0.629193	411.4140
U3 [V]	591.6987	557.2725	-34.42621	0.867509	412.1942
I1 [A]	-273.1340	-86.83098	186.3030	-0.192536	194.7630
I2 [A]	-26.53861	-152.3538	-125.8152	-2.424760	228.7432
I3 [A]	298.2449	234.7248	-63.52008	1.636145	170.3064
U+_PU [V]	0.999700	0.926290	-0.073411	0.926631	0.926645
Ip+_PU [A]	1.008177	0.831372	-0.176805	0.835166	0.835653
Iq+_PU [A]	1.226e-4	0.157305	0.157182	0.153428	0.155376
Ip+_PU [W]	1.007918	0.770124	-0.237793	0.774001	0.774560
Iq+_PU [var]	1.226e-4	0.145716	0.145593	0.142111	0.143914
P_t@SG320HX [W]	322651.3	246613.3	-76038.03	248643.3	248931.7
Q_t@SG320HX [var]	5728.665	57926.50	52197.83	56719.95	57290.42

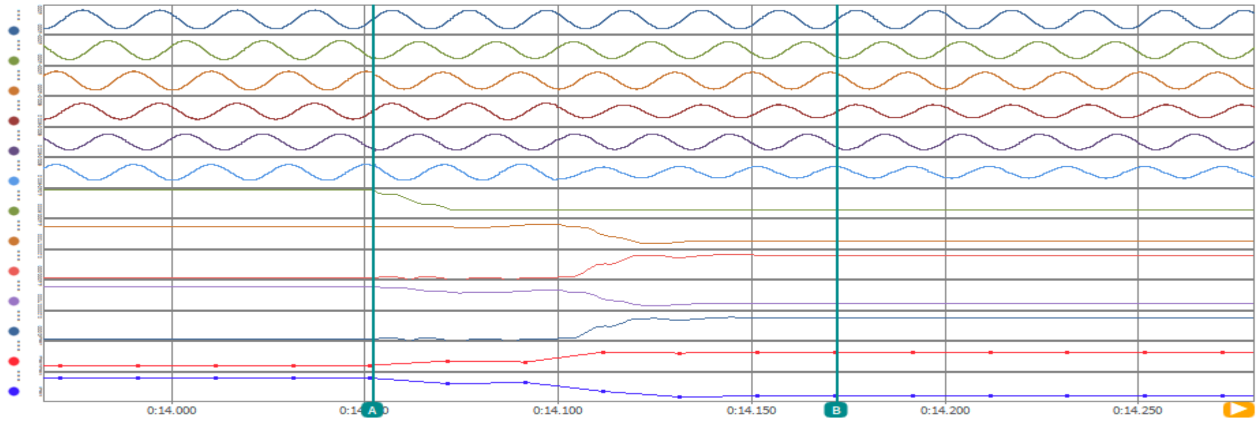
Test no. 4.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.052323	0:14.113266	0.060943		
U1 [V]	31.08788	216.4079	185.3200	1.981938	458.7401
U2 [V]	-583.0665	-560.9072	22.15934	-8.854520	413.7721
U3 [V]	549.1584	350.5293	-198.6290	6.611877	412.1724
I1 [A]	10.34319	89.72407	79.38087	5.288683	227.4506
I2 [A]	-282.8055	-280.4108	2.394676	-0.744911	232.2527
I3 [A]	272.6367	188.0121	-84.62453	-4.630282	220.7582
U+_PU [V]	0.999702	0.926105	-0.073597	0.939701	0.939985
Ip+_PU [A]	1.008509	0.894601	-0.113908	1.003640	1.003955
Iq+_PU [A]	-1.963e-4	0.096390	0.096586	9.600e-3	0.026513
Ip+_PU [W]	1.008252	0.828530	-0.179722	0.943234	0.943882
Iq+_PU [var]	-1.963e-4	0.089271	0.089467	8.936e-3	0.024568
Q_t@SG320HX [var]	5951.724	57941.48	51989.75	26972.27	33048.76
P_t@SG320HX [W]	322643.4	267923.1	-54720.34	297876.9	298525.6

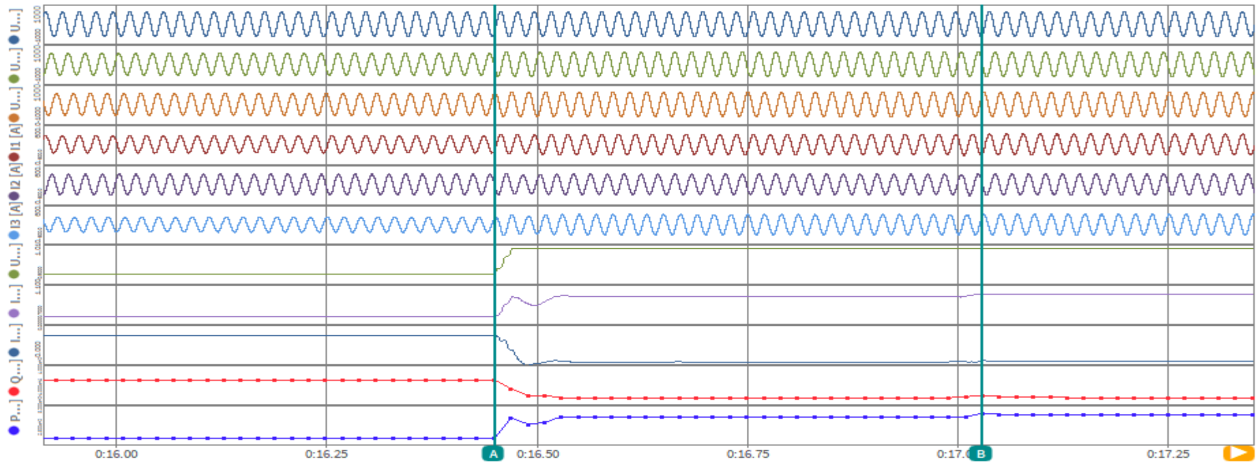
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 120ms



	A	B	Delta	Avg	RMS
Time [s]	0:14.052323	0:14.172021	0.119698		
U1 [V]	31.08788	-31.86989	-62.95777	-0.100729	462.5432
U2 [V]	-583.0665	-468.0385	115.0280	0.821114	411.5212
U3 [V]	549.1584	493.6688	-55.48954	-1.030816	412.2575
I1 [A]	10.34319	-23.65017	-33.99337	0.924887	212.5406
I2 [A]	-282.8055	-222.8855	59.91996	0.925797	229.6625
I3 [A]	272.6367	247.6887	-24.94800	-1.936497	196.1632
U+_PU [V]	0.999702	0.926954	-0.072749	0.933435	0.933604
Ip+_PU [A]	1.008509	0.832344	-0.176166	0.919576	0.923846
Iq+_PU [A]	-1.963e-4	0.155732	0.155928	0.078044	0.106895
Ip+_PU [W]	1.008252	0.771577	-0.236675	0.858990	0.863744
Iq+_PU [var]	-1.963e-4	0.144362	0.144559	0.072358	0.099082
Q_t@SG320HX [var]	5951.724	58478.06	52526.33	36684.54	42183.26
P_t@SG320HX [W]	322643.4	246972.6	-75670.84	280423.3	281966.5

Test no. 4.3.2 Two-pole short circuit without earth (type C)
U/Un = 0.85 p.u, P=100%Pn, Active power recovery time



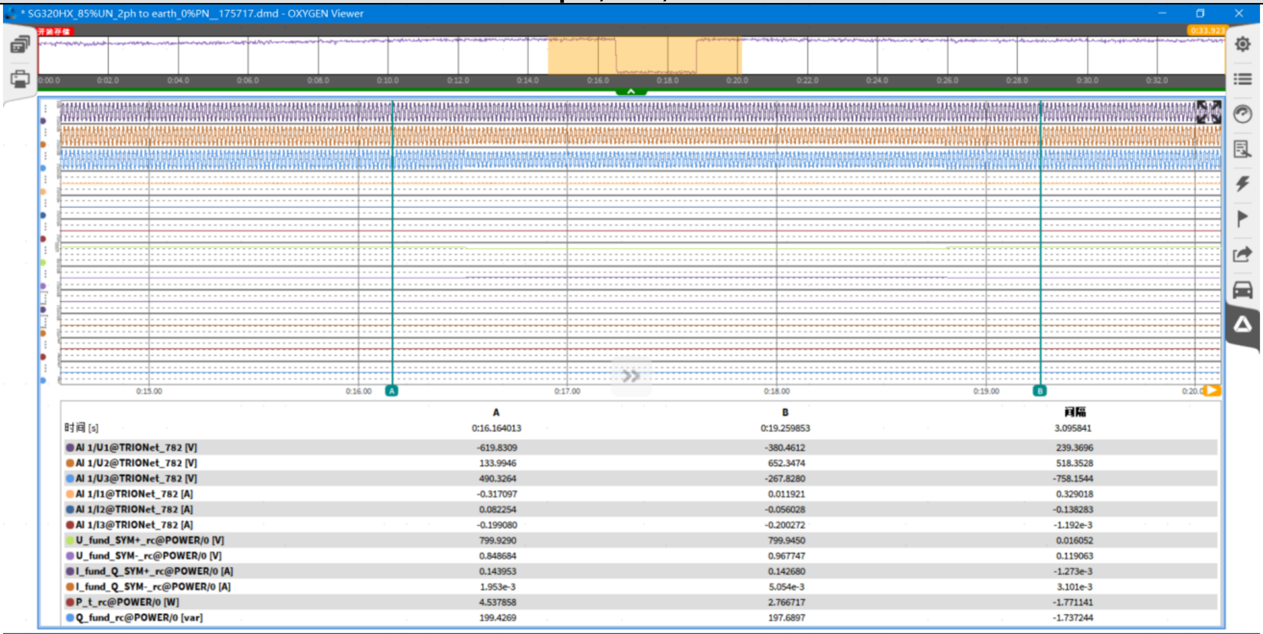
	A	B	Delta	Avg	RMS
Time [s]	0:16.449235	0:17.027790	0.578556		
U1 [V]	-509.1648	-636.4236	-127.2588	1.382641	461.8866
U2 [V]	-46.47851	202.9474	249.4259	0.610762	461.6706
U3 [V]	556.1006	438.0756	-118.0251	-2.004054	460.7069
I1 [A]	-198.8422	-323.2194	-124.3773	0.573620	226.6069
I2 [A]	11.56974	109.4333	97.86356	2.519051	226.5325
I3 [A]	188.4900	214.3216	25.83158	-3.400858	225.7081
U+_PU [V]	0.926300	0.999956	0.073656	0.997716	0.997767
Ip+_PU [W]	0.770281	1.005144	0.234863	0.973856	0.974510
Iq+_PU [var]	0.145548	9.814e-3	-0.135734	0.011744	0.026207
Q_t@SG320HX [var]	57926.50	10143.14	-47783.36	10710.96	17295.30
P_t@SG320HX [W]	246613.3	315242.9	68629.56	308832.0	309331.1

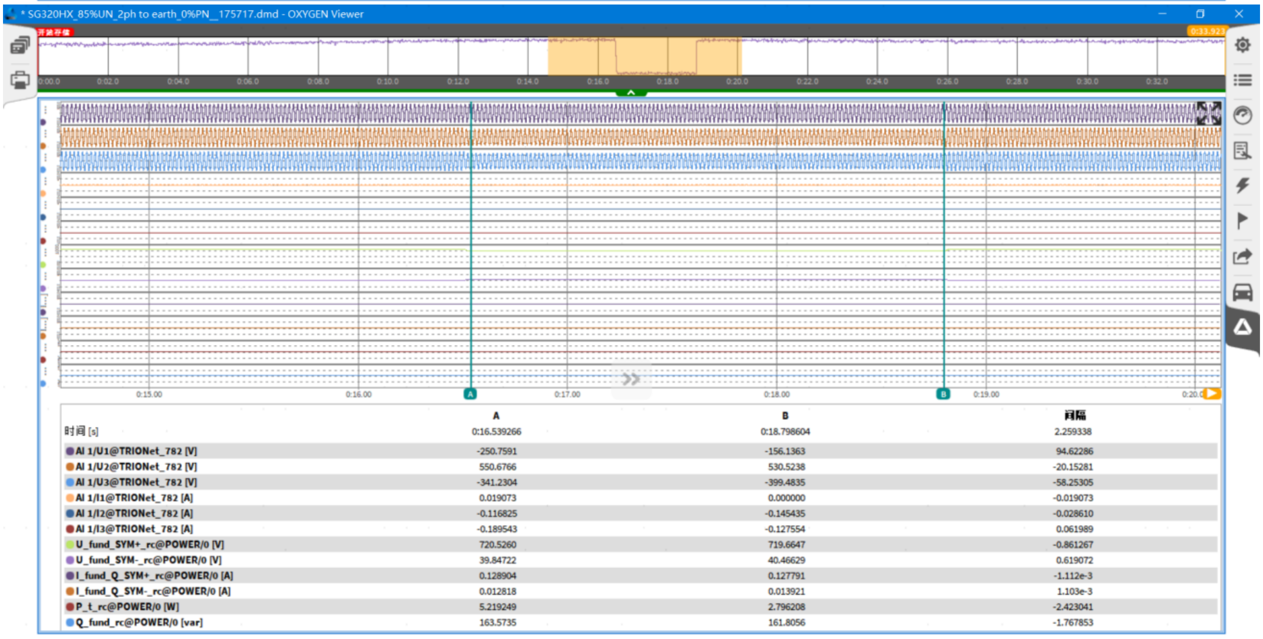
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Item	No.	Parameter	Phase reference	Time reference	Unit	Measured value	
	148	Test number	--	--	--	4.4.1	4.4.2
Before dip < t_1	149	Voltage	Phase 1	t_1-500ms to t_1 - 100ms	Vrms	462.0	462.6
	150		Phase 2			461.8	461.9
	151		Phase 3			462.0	462.2
	152	Current	Phase 1	t_1-500ms to t_1 - 100ms	Arms	47.7	231.0
	153		Phase 2			48.1	230.3
	154		Phase 3			46.5	230.5
	155	Active power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.20	1.00
	156		total		W	65497	319577
	157	Reactive power	Positive sequence	t_1-500ms to t_1 - 100ms	p.u.	0.00	0.00
	158		total		var	-391	240
During dip t_1 to t_2	159	Voltage	Phase 1	t_1+100ms to t_2 -20ms	Vrms	462.8	463.8
	160		Phase 2			393.7	394.3
	161		Phase 3			393.9	394.6
	162	Current	Phase 1	t_1+100ms to t_2 -20ms	Arms	78.7	228.8
	163		Phase 2			78.2	228.7
	164		Phase 3			78.7	229.5
	165	Total fault duration	All phase	t_1 to t_2	ms	2233	2247
	166	Reactive power	Positive sequence	t_1+100ms to t_2 -20ms	p.u.	0.24	0.24
	167		total		var	76247	76735
	168	Reactive current	Positive sequence		p.u.	0.24	0.24
	169	Active power	Positive sequence		p.u.	0.19	0.86
	170		total		W	60787	276191
	171	Active current	Positive sequence		p.u.	0.19	0.86
	172	Reactive Current	Positive sequence	t_1+60ms	p.u.	0.24	0.24
	173	Reactive Current	Positive sequence	t_1+120ms	p.u.	0.24	0.24
After dip > t_2	174	Voltage	Phase 1	t_2+1s	Vrms	462.0	462.7
	175		Phase 2			461.8	462.0
	176		Phase 3			462.2	462.2
	177	Current	Phase 1	t_2+1s	Arms	46.9	231.2
	178		Phase 2			47.7	230.4
	179		Phase 3			48.9	230.3
	180	Active power	Positive sequence	t_2+1s	p.u.	0.20	0.98
	181		total		W	63403	312133
	182	Reactive power	Positive sequence	t_2+1s	p.u.	0.01	0.02
	183		total		Var	3981	5010
	184	Active power recovery time	Positive sequence	--	ms	107	531

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

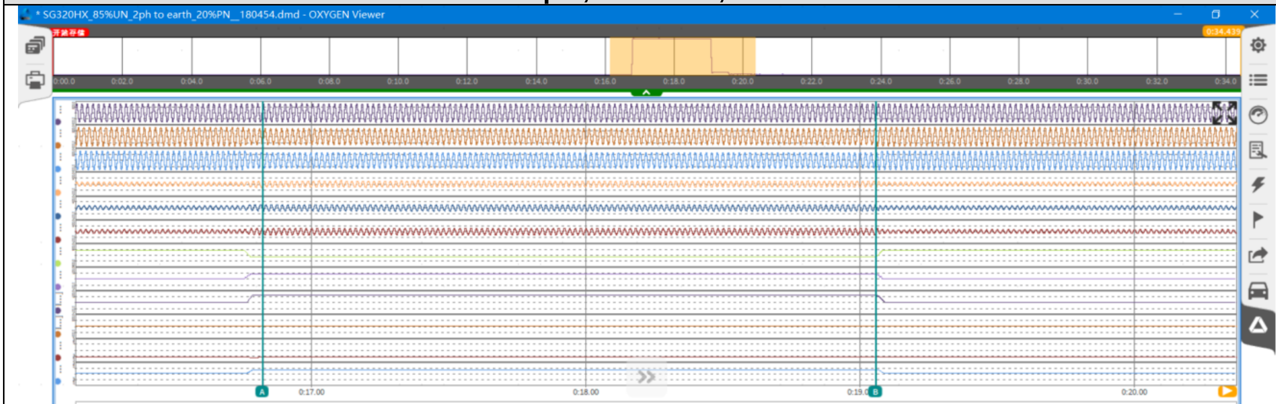
Test no. 4.4.0 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=0, Fault Duration





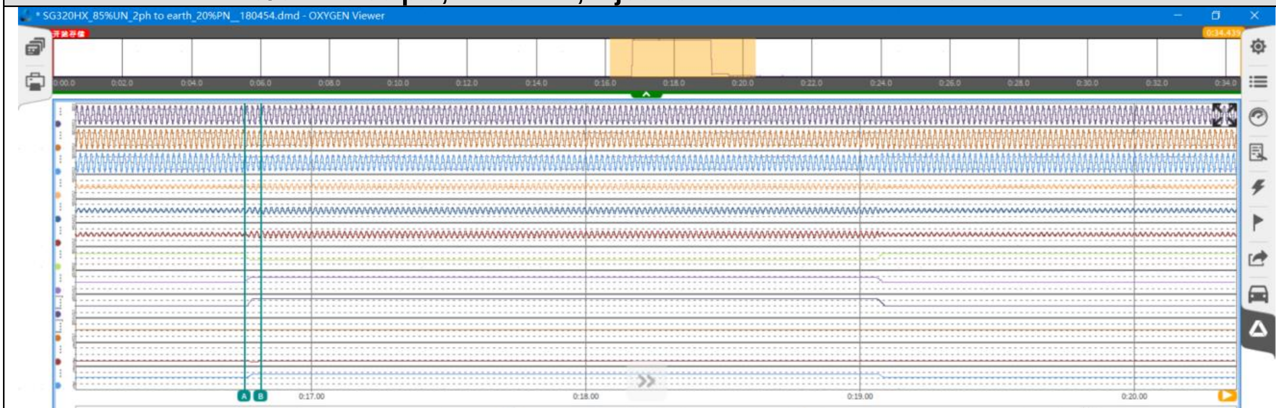
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.4.1 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=20%Pn, fault duration



时间 [s]	A 0:16.824713	B 0:19.057820	间隔 2.233107
AI 1/U1@TRIONet_782 [V]	389.0317	-652.9322	-1041.964
AI 1/U2@TRIONet_782 [V]	-553.6268	243.3603	796.9871
AI 1/U3@TRIONet_782 [V]	224.2062	316.4342	92.22794
AI 1/I1@TRIONet_782 [A]	-30.90263	-76.33925	-45.43662
AI 1/I2@TRIONet_782 [A]	-80.72496	106.8854	187.6104
AI 1/I3@TRIONet_782 [A]	111.3057	-30.85971	-142.1654
U_fund_SYM+_rc@POWER/0 [V]	722.0994	721.6464	-0.453064
U_fund_SYM-_rc@POWER/0 [V]	40.02850	40.81130	0.782803
I_fund_Q_SYM+_rc@POWER/0 [A]	62.22355	61.29737	-0.926178
I_fund_Q_SYM-_rc@POWER/0 [A]	0.536028	0.507419	-0.028609
P_t_rc@POWER/0 [W]	60068.18	60959.31	891.1328
Q_fund_rc@POWER/0 [var]	77859.33	76651.34	-1207.992

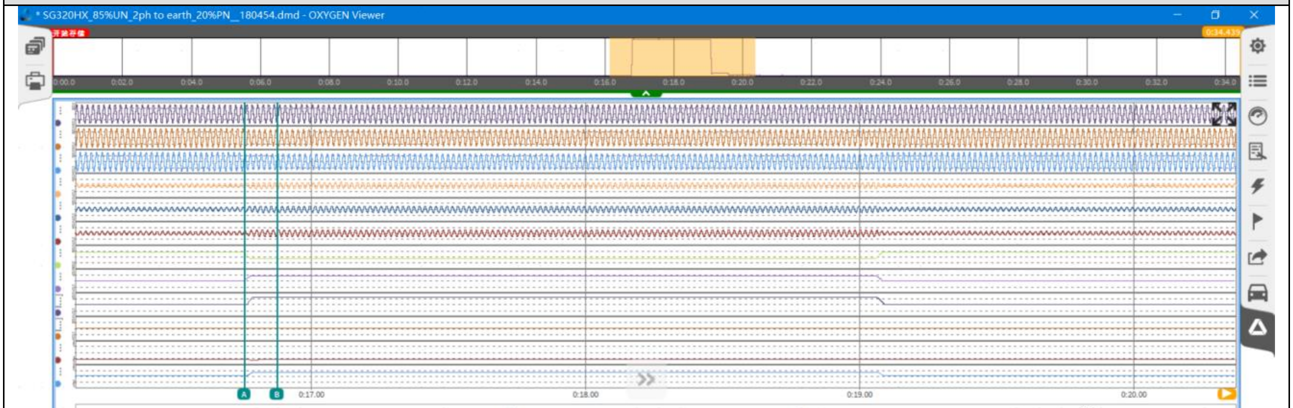
Test no. 4.4.1 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 60ms



时间 [s]	A 0:16.759121	B 0:16.818750	间隔 0.059629
AI 1/U1@TRIONet_782 [V]	-587.9352	-620.0383	-32.10306
AI 1/U2@TRIONet_782 [V]	51.85318	112.4327	60.57954
AI 1/U3@TRIONet_782 [V]	540.2561	415.9689	-124.2871
AI 1/I1@TRIONet_782 [A]	-62.13546	-96.92073	-34.78527
AI 1/I2@TRIONet_782 [A]	4.719496	110.0469	105.3274
AI 1/I3@TRIONet_782 [A]	57.11913	-13.60655	-70.72568
U_fund_SYM+_rc@POWER/0 [V]	800.1340	722.0450	-78.08899
U_fund_SYM-_rc@POWER/0 [V]	1.046353	40.09413	39.04778
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.271357	62.39305	62.66441
I_fund_Q_SYM-_rc@POWER/0 [A]	0.744350	0.158948	-0.585402
P_t_rc@POWER/0 [W]	65209.97	58399.86	-6810.113
Q_fund_rc@POWER/0 [var]	-374.6744	78039.16	78413.83

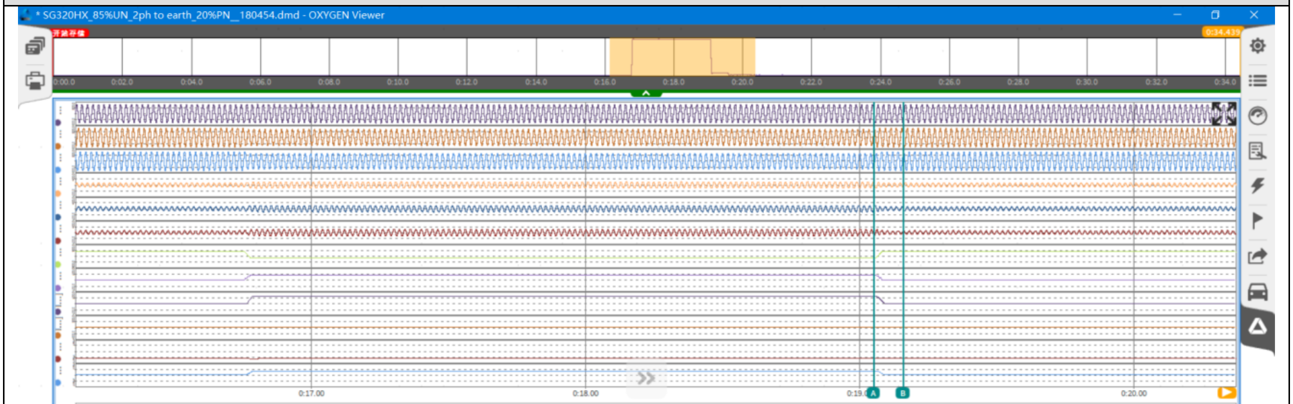
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.4.1 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=20%Pn, Injected reactive Current after 120ms



时间 [s]	A 0:16.759121	B 0:16.878379	间隔 0.119258
AI 1/U1@TRIONet_782 [V]	-587.9352	-642.4919	-54.55661
AI 1/U2@TRIONet_782 [V]	51.85318	177.3856	125.5324
AI 1/U3@TRIONet_782 [V]	540.2561	368.4378	-171.8183
AI 1/I1@TRIONet_782 [A]	-62.13546	-85.54817	-23.41271
AI 1/I2@TRIONet_782 [A]	4.719496	109.0133	104.2938
AI 1/I3@TRIONet_782 [A]	57.11913	-23.66662	-80.78576
U_fund_SYM+_rc@POWER/0 [V]	800.1340	721.9979	-78.13611
U_fund_SYM-_rc@POWER/0 [V]	1.046353	40.27214	39.22579
I_fund_Q_SYM+_rc@POWER/0 [A]	-0.271357	60.94733	61.21869
I_fund_Q_SYM-_rc@POWER/0 [A]	0.744350	0.465038	-0.279312
P_t_rc@POWER/0 [W]	65209.97	60787.18	-4422.785
Q_fund_rc@POWER/0 [var]	-374.6744	76247.66	76622.34

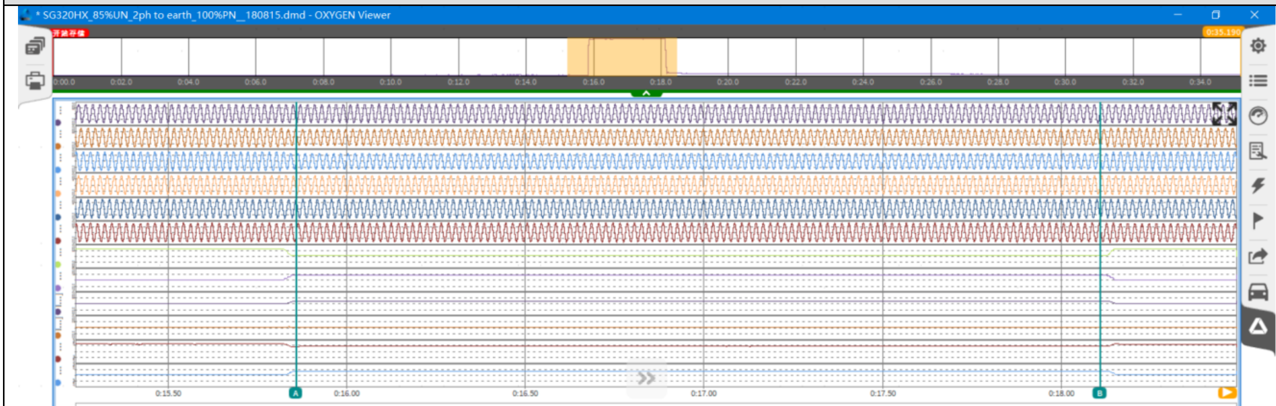
Test no. 4.4.1 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=20%Pn, Active power recovery time



时间 [s]	A 0:19.051857	B 0:19.159189	间隔 0.107332
AI 1/U1@TRIONet_782 [V]	158.0734	-574.3616	-732.4350
AI 1/U2@TRIONet_782 [V]	402.9052	22.79568	-380.1096
AI 1/U3@TRIONet_782 [V]	-532.9883	553.6785	1086.667
AI 1/I1@TRIONet_782 [A]	113.2786	-58.09069	-171.3693
AI 1/I2@TRIONet_782 [A]	-16.56771	14.88328	31.45099
AI 1/I3@TRIONet_782 [A]	-97.18896	43.04290	140.2319
U_fund_SYM+_rc@POWER/0 [V]	721.6620	799.9421	78.28009
U_fund_SYM-_rc@POWER/0 [V]	40.73645	2.152204	-38.58425
I_fund_Q_SYM+_rc@POWER/0 [A]	61.39109	3.106467	-58.28462
I_fund_Q_SYM-_rc@POWER/0 [A]	0.573952	-0.281562	-0.855514
P_t_rc@POWER/0 [W]	61044.39	63503.33	2458.941
Q_fund_rc@POWER/0 [var]	76774.73	4303.160	-72471.57

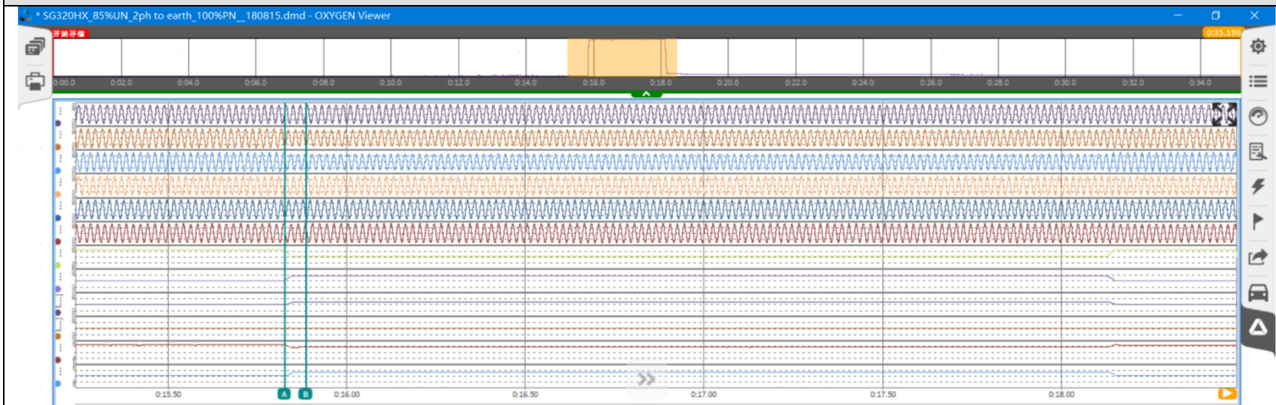
G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.4.2 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=100%Pn, fault duration



	A	B	间隔
时间 [s]	0:15.86016	0:18.10784	2.24768
AI 1/U1@TRIONet_782 [V]	-350.6897	-88.51481	262.1749
AI 1/U2@TRIONet_782 [V]	554.5514	-444.9992	-999.5506
AI 1/U3@TRIONet_782 [V]	-261.9863	510.8238	772.8100
AI 1/I1@TRIONet_782 [A]	-90.51800	-135.9677	-45.44974
AI 1/I2@TRIONet_782 [A]	319.7622	-189.7228	-509.4850
AI 1/I3@TRIONet_782 [A]	-230.1657	325.6142	555.7800
U_fund_SYM+_rc@POWER/0 [V]	723.1706	722.3123	-0.858276
U_fund_SYM-_rc@POWER/0 [V]	39.85422	40.72384	0.869617
I_fund_Q_SYM+_rc@POWER/0 [A]	63.36386	61.74794	-1.615925
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.380455	0.257306	0.637761
P_t_rc@POWER/0 [W]	267978.2	275879.7	7901.563
Q_fund_rc@POWER/0 [var]	79335.63	77263.48	-2072.156

Test no. 4.4.2 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 60ms



	A	B	间隔
时间 [s]	0:15.82812	0:15.88763	0.05951
AI 1/U1@TRIONet_782 [V]	-45.64023	-152.7472	-107.1069
AI 1/U2@TRIONet_782 [V]	-545.4557	-409.9972	135.4585
AI 1/U3@TRIONet_782 [V]	584.2147	532.4030	-51.81170
AI 1/I1@TRIONet_782 [A]	-12.74109	-164.8462	-152.1051
AI 1/I2@TRIONet_782 [A]	-276.5143	-165.5614	110.9529
AI 1/I3@TRIONet_782 [A]	289.1815	330.3242	41.14270
U_fund_SYM+_rc@POWER/0 [V]	800.5709	723.1473	-77.42358
U_fund_SYM-_rc@POWER/0 [V]	0.918131	39.99837	39.08024
I_fund_Q_SYM+_rc@POWER/0 [A]	0.028245	62.10860	62.08036
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.382064	0.534215	0.916279
P_t_rc@POWER/0 [W]	319743.7	276225.6	-43518.06
Q_fund_rc@POWER/0 [var]	38.48948	77823.90	77785.41

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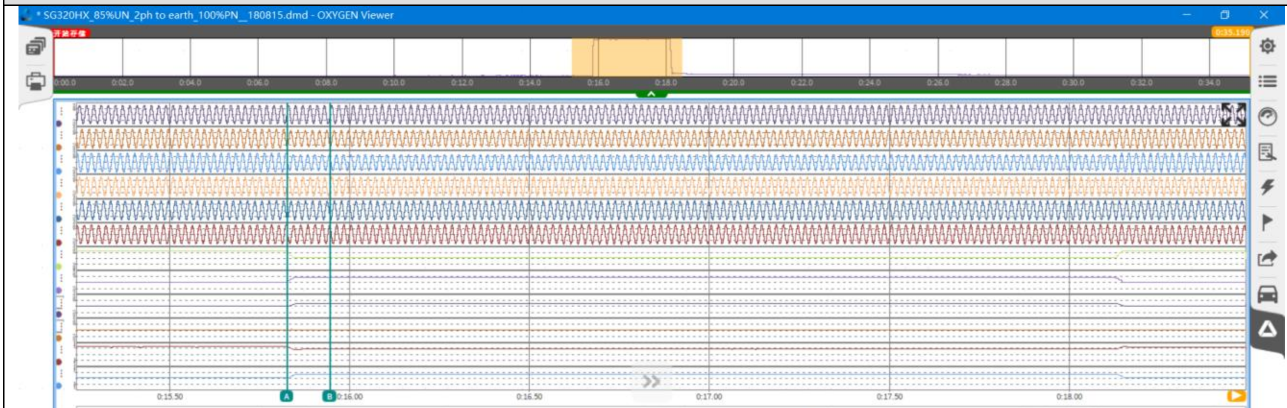
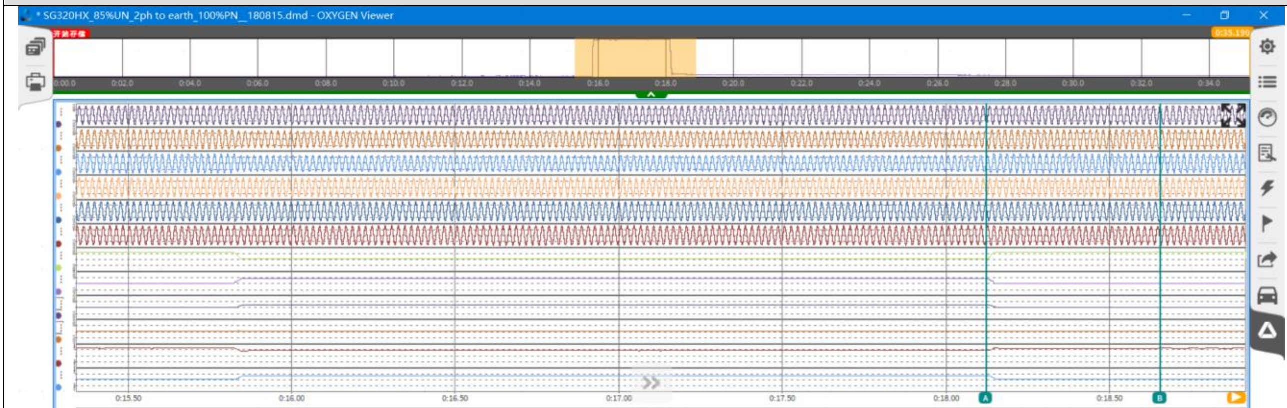
Clause	Requirement - Test	Result - Remark	Verdict

Test no. 4.4.2 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=100%Pn, Injected reactive Current after 120ms



时间 [s]	A 0:15.82812	B 0:15.94714	间隔 0.11902
AI 1/U1@TRIONet_782 [V]	-45.64023	-248.9667	-203.3265
AI 1/U2@TRIONet_782 [V]	-545.4557	-348.4028	197.0530
AI 1/U3@TRIONet_782 [V]	584.2147	551.8933	-32.32146
AI 1/I1@TRIONet_782 [A]	-12.74109	-203.6905	-190.9495
AI 1/I2@TRIONet_782 [A]	-276.5143	-123.9300	152.5843
AI 1/I3@TRIONet_782 [A]	289.1815	327.3368	38.15532
U_fund_SYM+_rc@POWER/0 [V]	800.5709	722.7884	-77.78253
U_fund_SYM-_rc@POWER/0 [V]	0.918131	40.24570	39.32757
I_fund_Q_SYM+_rc@POWER/0 [A]	0.028245	61.27657	61.24833
I_fund_Q_SYM-_rc@POWER/0 [A]	-0.382064	0.262827	0.644891
P_t_rc@POWER/0 [W]	319743.7	276191.9	-43551.81
Q_fund_rc@POWER/0 [var]	38.48948	76725.08	76686.59

Test no. 4.4.2 Two phase to earth fault (type E)
U/Un = 0.85 p.u, P=100%Pn, Active power recovery time



时间 [s]	A 0:18.12158	B 0:18.65334	间隔 0.53176
AI 1/U1@TRIONet_782 [V]	-565.0392	652.8109	1217.850
AI 1/U2@TRIONet_782 [V]	483.3987	-306.9027	-790.3014
AI 1/U3@TRIONet_782 [V]	4.370690	-351.5740	-355.9447
AI 1/I1@TRIONet_782 [A]	-231.3841	324.4341	555.8181
AI 1/I2@TRIONet_782 [A]	305.4261	-149.8795	-455.3056
AI 1/I3@TRIONet_782 [A]	-74.95761	-174.5832	-99.62559
U_fund_SYM+_rc@POWER/0 [V]	722.3187	800.8940	78.57538
U_fund_SYM-_rc@POWER/0 [V]	40.78459	1.295349	-39.48924
I_fund_Q_SYM+_rc@POWER/0 [A]	61.76072	2.348561	-59.41215
I_fund_Q_SYM-_rc@POWER/0 [A]	0.227144	-1.493265	-1.720409
P_t_rc@POWER/0 [W]	275846.4	320519.0	44672.56
Q_fund_rc@POWER/0 [var]	77277.98	3254.497	-74023.49

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.5.4, 13.5.5	TABLE: Reactive Power capability requirements – Versus Voltage (For Type C and Type D)				P
Model: SG350HX					
Inductive supply reactive power					
Rating voltage [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
100%	281.314	212.438	66%	0.80	800.26
99%	277.664	211.753	66%	0.80	792.40
98%	272.793	211.330	66%	0.79	784.13
97%	267.999	210.657	66%	0.79	776.15
96%	263.874	211.324	66%	0.78	768.19
95%	259.792	211.024	66%	0.78	760.19
94%	254.412	210.540	66%	0.77	752.22
93%	249.766	210.940	66%	0.76	744.27
92%	244.551	211.213	66%	0.76	736.29
91%	239.465	211.093	66%	0.75	728.30
90%	235.905	210.598	66%	0.75	718.98
87.5%	204.225	211.195	66%	0.70	700.02
100%	280.692	211.568	66%	0.80	800.20
101%	280.638	212.317	66%	0.80	808.21
102%	281.747	210.021	66%	0.80	816.17
103%	282.076	209.935	66%	0.80	824.15
104%	281.907	211.458	66%	0.80	832.18
105%	281.703	209.986	66%	0.80	840.09
106%	281.998	210.944	66%	0.80	848.19
107%	281.634	210.955	66%	0.80	856.20
108%	282.231	211.190	66%	0.80	864.19
109%	281.753	211.137	66%	0.80	872.19
110%	281.227	210.209	66%	0.80	880.17
Capacitive supply reactive power					
Rating voltage [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
100%	282.358	-211.255	-66%	0.80	800.81
99%	277.771	-211.403	-66%	0.80	792.15
98%	273.051	-210.877	-66%	0.79	784.13
97%	268.055	-211.292	-66%	0.79	776.10
96%	262.811	-211.150	-66%	0.78	768.08
95%	259.325	-211.975	-66%	0.78	760.03
94%	254.963	-210.947	-66%	0.77	752.02
93%	250.544	-211.103	-66%	0.76	744.04
92%	245.816	-211.631	-66%	0.76	735.98
91%	240.851	-211.656	-66%	0.75	727.87
90%	236.093	-210.986	-66%	0.75	719.84
87.5%	205.120	-210.687	-66%	0.70	700.38

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Clause	Requirement - Test	Result - Remark	Verdict

100%	281.832	-211.026	-66%	0.80	800.91
101%	281.632	-211.207	-66%	0.80	808.80
102%	282.084	-211.146	-66%	0.80	816.86
103%	281.790	-211.493	-66%	0.80	824.84
104%	281.628	-211.069	-66%	0.80	832.85
105%	281.346	-210.853	-66%	0.80	840.86
106%	281.521	-211.178	-66%	0.80	848.85
107%	281.625	-211.645	-66%	0.80	856.85
108%	282.008	-211.686	-66%	0.80	864.87
109%	281.702	-211.212	-66%	0.80	872.90
110%	281.577	-211.172	-66%	0.80	880.87

Note:
The PV inverter maximum reactive power set point Q more than 33%Pn.

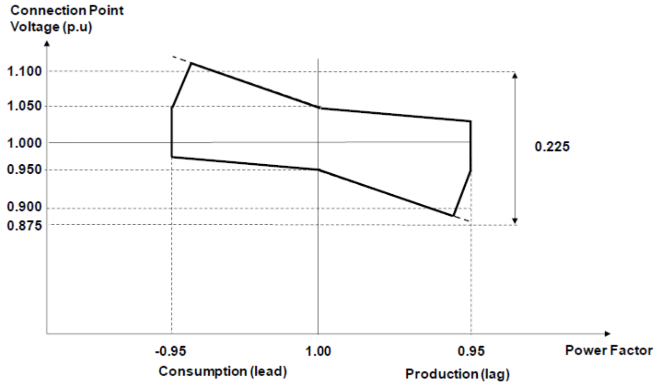

Figure 13.11 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage above 33 kV)

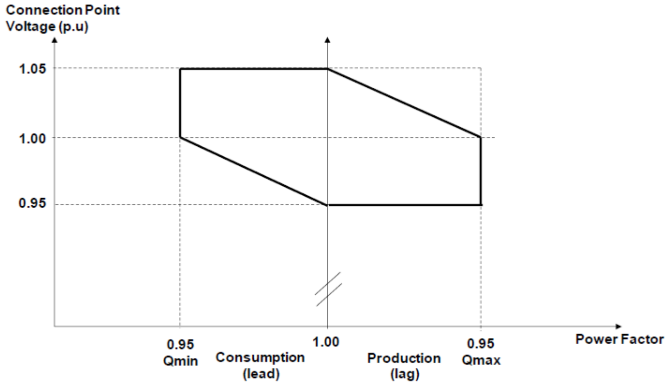

Figure 13.12 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage at or below 33 kV)

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.5.6	TABLE: Reactive Power capability requirements – Q setpoint mode (For Type C and Type D)				P
Model: SG350HX					
Inductive supply reactive power					
Rating power [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
10%	32.023	210.098	65.66	0.15	799.87
20%	64.078	210.279	65.71	0.29	800.03
30%	96.097	210.391	65.75	0.42	800.05
40%	127.986	210.368	65.74	0.52	800.08
50%	160.092	210.112	65.66	0.61	800.11
60%	192.233	209.866	65.58	0.68	800.13
70%	224.037	209.606	65.50	0.73	800.15
80%	256.147	209.348	65.42	0.77	800.18
90%	287.956	198.774	62.12	0.82	800.19
100%	319.794	142.216	44.44	0.91	800.18
Capacitive supply reactive power					
Rating power [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
10%	31.855	-210.734	-65.85	0.15	799.87
20%	63.868	-210.477	-65.77	0.29	799.89
30%	95.881	-210.344	-65.73	0.41	799.92
40%	127.993	-210.296	-65.72	0.52	799.94
50%	160.179	-210.477	-65.77	0.61	799.97
60%	192.205	-210.736	-65.86	0.67	799.99
70%	224.152	-210.926	-65.91	0.73	800.02
80%	257.094	-211.147	-65.98	0.77	800.05
90%	287.737	-195.796	-61.19	0.83	800.10
100%	320.101	-138.076	-43.15	0.92	800.16
Note: The PV inverter maximum reactive power set point Q more than 33%Pn.					

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.5 C.7.4	TABLE: Voltage Control and Reactive power Stability (For Type C and Type D)				P
Model: SG350HX					
Inductive supply reactive power(100%Pn)					
Rating Voltage [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
100%	320.168	0.314	0.10	1.00	801.04
(i) 95%	316.029	105.587	33.00	0.95	761.73
(iii) 93%	308.879	105.499	32.97	0.95	745.81
Capacitive supply reactive power(100%Pn)					
Rating Voltage [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
100%	320.147	0.606	0.19	1.00	800.93
(ii) 105%	319.856	-104.432	-32.64	0.95	840.36
(iv)107%	319.712	-105.196	-32.87	0.95	856.37

Note:
For step injection into the **Power Park Module** voltage Setpoint, steps of ±1% and ±2% (or larger if required by the **DNO**) shall be applied to the voltage control system Setpoint summing junction. The injection shall be maintained for 10 s as per Figure C.9.2.
The PV inverter maximum reactive power set point Q = 33%Pn.

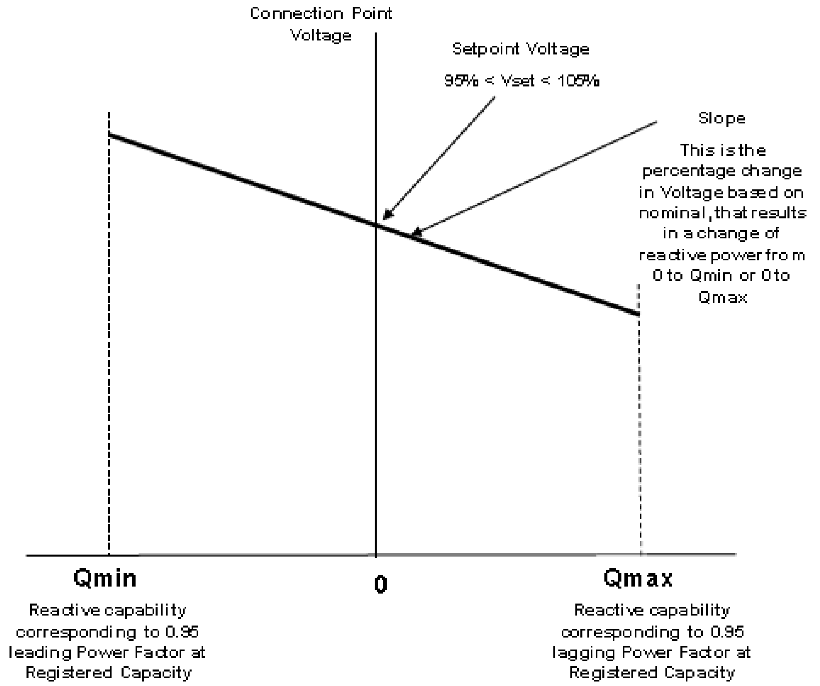

Figure C.5.1 Setpoint Voltage and Slope Characteristic

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

13.5 C.9.3	**TABLE: Reactive power output capability (For Type C and Type D)**				**P**
Model: SG350HX					
Power level [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Duration [mins]
i.60%	193.876	-211.222	-66.01	0.676	30
ii.60%	192.778	213.116	66.60	0.671	30
iii.50%	161.064	213.738	66.79	0.602	30
iv.50%	160.9157	-210.948	-65.90	0.606	30
v.20%	65.309	-211.227	-66.01	0.296	60
vi.20%	65.258	213.943	66.86	0.292	60
vii.<20%	50.488	213.922	66.85	0.230	5
viii.0%	-2.531	214.657	67.08	0.012	5
ix.0%	-2.743	-210.179	-65.68	0.013	5

Note:

(i) Operation in excess of 60% **Registered capacity** and maximum continuous lagging **Reactive Power** for 30 minutes.
(ii) Operation in excess of 60% **Registered capacity** and maximum continuous leading **Reactive Power** for 30 minutes.
(iii) Operation at 50% **Registered capacity** and maximum continuous leading **Reactive Power** for 30 minutes.
(iv)Operation at 50% **Registered capacity** and maximum continuous lagging **Reactive Power** for 30 minutes.
(v) Operation at 20% **Registered capacity** and maximum continuous leading **Reactive Power** for 60 minutes.
(vi) Operation at 20% **Registered capacity** and maximum continuous lagging **Reactive Power** for 60 minutes.
(vii) Operation at less than 20% **Registered capacity** and unity **Power Factor** for 5 minutes. This test only applies to systems which do not offer voltage control below 20% of **Registered capacity**.
(viii) Operation at the lower of the **Minimum Generation** or 0% **Registered capacity** and maximum continuous leading **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.
(ix) Operation at the lower of the **Minimum Generation** or 0% **Registered capacity** and maximum continuous lagging **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

C.7.8.2	**TABLE: Voltage and Frequency Controller Model Verification and Validation (For Type C and Type D)**				**P**
Model: SG350HX					
Test (80%Pn)					
Frequency [Hz]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Time [s]
50.0	256.381	0.290	0.09	1.000	10
50.0->49.5	256.474	0.141	0.04	1.000	10
49.5	256.384	0.207	0.06	1.000	20
49.5->49.8	256.330	0.201	0.06	1.000	30
49.8	256.368	0.388	0.12	1.000	60
49.8->50.0	256.340	0.205	0.06	1.000	10

Note:
Power Park Module operating at 80% of **Registered Capacity**.
(i) a ramped reduction in the measured system frequency of 0.5Hz in 10 s followed by
(ii) 20 s of steady state with the measured system frequency depressed by 0.5Hz followed by
(iii) a ramped increase in measured system frequency of 0.3Hz over 30 s followed by
(iv) 60 s of steady state with the measured system frequency depressed by 0.2Hz as illustrated in Figure C.7.4 below.

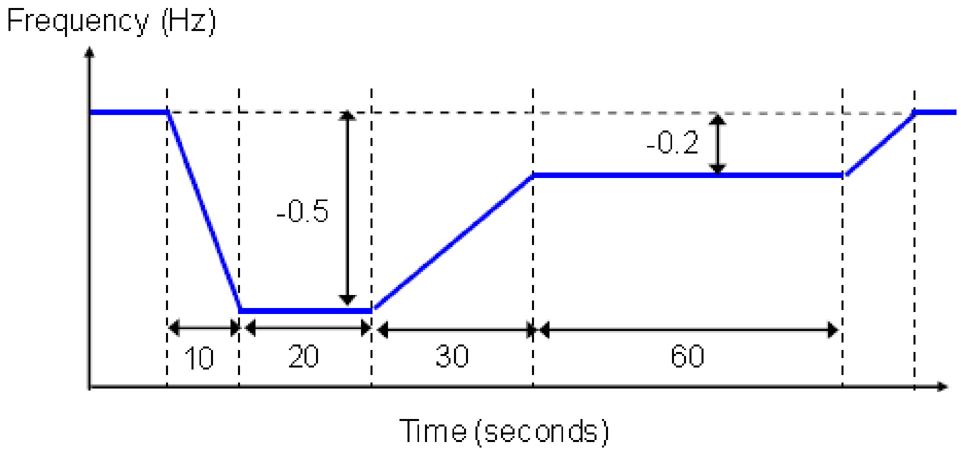

Figure C.7.4 Controller simulation

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

C.7.8.4	**TABLE: Voltage and Frequency Controller Model Verification and Validation (For Type C and Type D)**				**P**
Model: SG350HX					
Test (100%Pn)					
Rated Voltage [%]	Active power [kW]	Reactive Power [kVar]	Q/Pn [%]	Power factor [cos φ]	Voltage [V]
100	321.281	1.324	0.41%	1.000	800.53
102	321.504	0.713	0.22%	1.000	816.51
104	321.875	1.160	0.36%	1.000	832.61
106	322.630	1.271	0.40%	1.000	848.57
108	321.338	1.029	0.32%	1.000	864.58
110	321.416	1.479	0.46%	1.000	880.69

Note:
the **Power Park Module** operating at **Registered Capacity** and unity **Power Factor** at the **Connection Point** to a 2% step increase in the voltage reference. The simulation study shall show the terminal voltage, **Active Power**, **Reactive Power** and **Power System Stabiliser** output signal as appropriate.

10. Protection – Re-connection timer					**P**
Model: SG350HX					
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of “no reconnection” can be made.					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
240 s	241.3 s	At 1.16 pu (928V)	At 0.78 pu (624V)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No Reconnection	No Reconnection	No Reconnection	No Reconnection

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

Fault level contribution:		P
These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
Model: SG350HX		
For Inverter output		
Time after fault	Volts	Amps
20ms	153.8 V	20.8 A
100ms	53.7 V	0.9 A
250ms	32.1 V	0.5 A
500ms	19.5 V	0.1 A
Time to trip	0.05	In seconds

12.7/13.9 Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.7.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	N/A
15.2 Wiring functional tests: If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	N/A
11.1.3.1/12.1.3.1/ 13.1.3.1Logic interface (input port).	
Confirm that an input port is provided and can be used to shut down the module.	P
9.1.7 Cyber security	
Confirm that the Power Generating Module has been designed to comply with cyber security requirements, as detailed in 9.1.7.	P
Additional comments.	
The inverter communication terminal COM2 is located at the bottom of the inverter, as shown in the figure below. To short or open pin3 and pin4 of logic interface port (COM2 port) to control the inverter to normal or shutdown active power of output. A logic interface is provided that can be operated by an external switch or contactor. Users can install by themselves. Users install the switch connected to pin4 and pin6 of COM2 port and just need control the switch signal causing the switch to open or short. When the switch is closed, the inverter will operate normally. When the switch is opened, the inverter will cease to export active power within 5 seconds.	

G99/1-8			
Clause	Requirement - Test	Result - Remark	Verdict

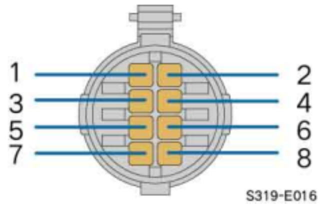

table 5-7 Communication terminal COM2 definition

Port	PIN	Definition	Description
/	1	/	
/	2	/	
DI	3	DI	emergency stop dry contact
	4	PGND	
D0	5	COM	fault output dry contact
	6	NC	
	7	NO	
/	8	/	

Appendix 2: Photo documentation

Enclosure Front View

Enclosure Rear View

Enclosure Left Side View

Enclosure Right Side View


Enclosure Top Side View

Enclosure Bottom Side View


--- End of test report---