

Conformity Declaration

Sungrow Power Supply Co. hereby declares compliance with the operating regulations to allow the connection and operation of solar photovoltaic plants in the SIN national interconnected system of Colombia. Specifically with the verification tests of the LVRT and HVRT performance curves required in CREG 060 of 2019 and CNO1223 agreement. Where it can be verified through the certifying agent performed by DEKRA and TÜVNord accredited under ISO/IEC 17065 for the certification of SG3125HV-30 inverters under IEC62910 and IEC61727 standards.

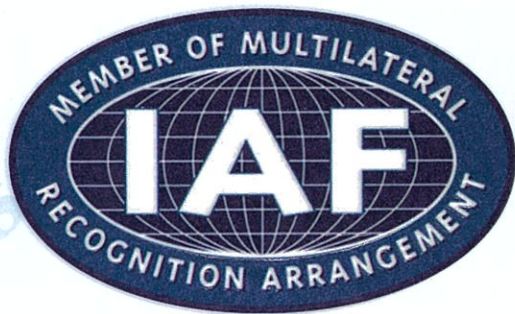
Verificación	Apartado reporte No.6092407.51	Resultado
Priorización de la inyección de corriente reactiva de forma que alcanza un 90% del delta de cambio esperado en menos de 50 ms, con una tolerancia del 20%, ante desviaciones de tensión que excedan los límites operativos de la tensión nominal en la planta de generación. Los 50 ms consideran el tiempo necesario para detectar la falla.	5.1, 5.2	Pasa
Limitación del aporte de potencia reactiva adicional al 100% de la corriente nominal de cada generador.	5.1, 5.2	Pasa
Sostenimiento del aporte de potencia reactiva adicional siempre que la tensión esté por fuera del rango normal de operación.	5.1, 5.2	Pasa
Sostenimiento de la potencia reactiva durante 500 ms después de la tensión entre a la banda muerta de tensión manteniendo un aporte adicional proporcional a la desviación de la tensión con respecto al valor de referencia (1p.u.).	5.1, 5.2	Pasa
Si la ganancia k es configurable en cada inversor y en qué rango. Debe demostrarse que al menos es configurable entre 0 y 10.	5.1, 5.2. Test no muestra el rango de este valor. SG3125HV-30 configurable su factor k entre 0 y 10.	Pasa
El ajuste de la banda muerta.	5.1, 5.2	Pasa



Daniel Du

Standard and Certification Engineer.

January 1, 2023



China National Accreditation Service for Conformity Assessment

**PRODUCT CERTIFICATION BODY
ACCREDITATION CERTIFICATE**

(Registration No. CNAS C183-P)

TUV NORD (Hangzhou) Co., Ltd.

Floor 5, No.50, Jiuhuan Road, Jiang Gan District, Hangzhou, P.R.China, 310019

to ISO/IEC 17065:2012 Conformity Assessment - Requirements for Bodies Certifying Products, Processes and Services (CNAS-CC02) for the competence to undertake the product certification service as described in the schedule attached to this certificate.

The scope of accreditation is detailed in the attached schedule bearing the same registration number as above. The schedule forms an integral part of this certificate.

Date of Issue: 2020-11-10

Date of Expiry: 2025-11-23

Date of Initial Accreditation: 2016-11-24

Signed on behalf of China National Accreditation Service for Conformity Assessment

China National Accreditation Service for Conformity Assessment (CNAS) is authorized by Certification and Accreditation Administration of the People's Republic of China (CNCA) to operate the national accreditation schemes for conformity assessment. CNAS is a signatory of the International Accreditation Forum Multilateral Recognition Arrangement (IAF MLA) and the Asia Pacific Accreditation Cooperation Mutual Recognition Arrangement (APAC MRA). The validity of the certificate can be checked on CNAS website at <http://www.cnas.org.cn/english/findanaccreditedbody/index.shtml>.

Certificate

of Conformity

Registered No.:
COCPPV04005/20B-01

File reference
PVP04005/20B-01

Test report No.
TRPVP04005/20B/01

Date of issue
2020-04-17

On the basis of the tests undertaken, the samples of the below product(s) have been found to comply with the essential requirements of the referenced specifications at the time the tests were carried out:

Applicant: **Sungrow Power Supply Co., Ltd.**
No. 1699 Xiyou Road, New & High Technology Industrial Development Zone
Hefei City, Anhui Province, 230088, P.R China

Manufacturer: **Sungrow Power Supply Co., Ltd.**
No. 1699 Xiyou Road, New & High Technology Industrial Development Zone
Hefei City, Anhui Province, 230088, P.R China

Product: **Grid-connected PV inverter**

Type designation: **SG3125HV-30**

Standard(s): Test according to IEC 61727:2004 for PV Inverter.
See test report for detailed information.

This document is based on the evaluation of the samples of the above mentioned product(s). It does not imply an assessment of the mass-production of the product(s), and it does not permit the use of a TÜV NORD mark. The holder of this document may use it in connection with the related test report(s)



Renewable Energy

TÜV NORD (HANGZHOU) CO., LTD.
Member of TÜV NORD Group
Tel: +86-571-85386989
Fax: +86-571-85386986
www.tuv-nord.com/cn
P.R. China



CERTIFICATE OF ACCREDITATION

This is to attest that

DEKRA TESTING AND CERTIFICATION (SHANGHAI) LTD.

NO.250, JIANGCHANGSAN ROAD, JING'AN DISTRICT
SHANGHAI, 200436
PEOPLE'S REPUBLIC OF CHINA

Product Certification Agency PCA-141

has met the requirements of the applicable provisions of AC370, *IAS Accreditation Criteria for Product Certification Agencies*, has demonstrated compliance with ISO/IEC Standard 17065:2012, *Conformity assessment - Requirements for bodies certifying products, process and services*. This third-party product certification agency is accredited to provide the services specified in the scope of accreditation.

Effective Date February 23, 2022



President

Visit www.iasonline.org for current accreditation information.

SCOPE OF ACCREDITATION

International Accreditation Service, Inc.

3060 Saturn Street, Suite 100, Brea, California 92821, U.S.A. | www.iasonline.org

DEKRA TESTING AND CERTIFICATION (SHANGHAI) LTD.

www.dekra.com.cn

Contact Name Wayne Wang

Contact Phone +86-2160567603

Accredited to ISO/IEC 17065:2012

Effective Date February 23, 2022

Product Category and Sub-Category	Certification Scheme and Scheme Owner / Standard
Low Voltage Electrical Equipment and Appliances	DEKRA
Household and similar electrical appliances	DEKRA Seal Scheme - Scheme Type 5 Certificate of Conformity (CoC) - Scheme Type 1a
Luminaires	Certificate of Conformity (CoC) - Scheme Type 1a
Audio, video and similar electronic apparatus, information and communication technology equipment	Certificate of Conformity (CoC) - Scheme Type 1a
- Switches for appliances and automatic controls for electrical household appliances - Measuring relays and protection equipment	Certificate of Conformity (CoC) - Scheme Type 1a
Electrical Engineering	DEKRA
- Batteries - Primary batteries - Secondary cells and batteries containing alkaline or other non-acid electrolytes, Nickel systems - Secondary cells and batteries containing alkaline or other non-acid electrolytes, Lithium systems - Stationary electrical energy storage systems intended for connection to the low voltage grid - Stationary battery energy storage systems with lithium batteries	Certificate of Conformity (CoC) - Scheme Type 1a
IT and Office Equipment	Certificate of Conformity (CoC) - Scheme Type 1a

SCOPE OF ACCREDITATION

International Accreditation Service, Inc.

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o Uninterruptible power systems (UPS)	
Electrical Engineering	DEKRA
• Electrical equipment for measurement, control, and laboratory use	Certificate of Conformity (CoC) - Scheme Type 1a
• Plug, socket outlets, cord extension set	Certificate of Conformity (CoC) - Scheme Type 1a
• Lamp control gear	Certificate of Conformity (CoC) - Scheme Type 1a
• Lamps	Certificate of Conformity (CoC) - Scheme Type 1a
• Transformers, reactors, power supply units and combinations	Certificate of Conformity (CoC) - Scheme Type 1a
• Installation Accessories and Connection Devices - o Power electronic converter systems and equipment - o Bi-directional grid-connected power converters	Certificate of Conformity (CoC) - Scheme Type 1a
• Low voltage, high power switching equipment - o Low-voltage switchgear and control gear assemblies - o PV Combiner Box	Certificate of Conformity (CoC) - Scheme Type 1a
• Cables and Cords - o Cable management - Cable tray systems and cable ladder systems - o Cable management systems – Cable ties for electrical installations - o Cable cleats for electrical installations - o Coaxial communication cables - o Communication cable - o Multicore and symmetrical pair/quad cables for digital communications - o Optical fibre cables - o Automotive cables	Certificate of Conformity (CoC) - Scheme Type 1a
• Installation Protective Equipment - o Lightning protection system components (LPSC) - o SPD multi-function(s) monitoring devices	Certificate of Conformity (CoC) - Scheme Type 1a

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Energy Efficiency	DEKRA
Luminaires	Certificate of Conformity (CoC) - Scheme Type 1a
Lamp control gear	Certificate of Conformity (CoC) - Scheme Type 1a
Lamps	Certificate of Conformity (CoC) - Scheme Type 1a
Household and similar electrical appliances	Certificate of Conformity (CoC) - Scheme Type 1a
- Photovoltaics - Power converters for use in photovoltaic power systems - PV inverter - Photovoltaic systems - Power conditioners - Grid connected photovoltaic inverters - Grid connected photovoltaic inverters or generator - Battery charge controllers for photovoltaic systems	Certificate of Conformity (CoC) - Scheme Type 1a Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators. Rozporządzenie Komisji (UE) 2016/631 z dnia 14 kwietnia 2016 r. ustanawiające kodeks sieci dotyczący wymagań dotyczących przyłączenia wytwórców do sieci. General Application Requirements resulting from the EU Commission Regulation 2016/631 of April 14, 2016 (PSE 2018-12-18) Wymogi Ogólnego Stosowania wynikające z rozporządzenia komisji UE 2016/631 z dnia 14 kwietnia 2016 r. ustanawiającego kodeks sieci dotyczący wymogów w zakresie przyłączenia jednostek wytwórczych do sieci - zatwierdzone Decyzją Prezesa Urzędu Regulacji Energetyki DRE.WOSE.7128.550.2.2018.ZJ z dnia 2 stycznia 2019 r. Conditions and procedures for the use of certificates in the process of connecting power generating modules to power grids. (PTPiREE 2021-04-28) Warunki i procedury wykorzystania certyfikatów w procesie przyłączenia modułów wytwarzania energii do sieci elektroenergetycznych
Road Vehicle	DEKRA
- Electrical Vehicles - EV Charging System - EV On-Board Charger - Road Vehicles – Environment Condition - Electrically Propelled Road Vehicles —Electric Propulsion Components - EV charging coupler - Vehicle connectors - Vehicle high-voltage connectors	Certificate of Conformity (CoC) - Scheme Type 1a

SCOPE OF ACCREDITATION

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Miscellaneous	DEKRA
Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS)	Certificate of Conformity (CoC) - Scheme Type 1a

Notes:

The product certification used most closely resembles a product certification scheme type as described in ISO/IEC 17067 (2013), Conformity assessment — Fundamentals of product certification and guidelines for product certification schemes.

- a. Type 1a: In this scheme, one or more samples of the product are subjected to the determination activities. A certificate of conformity or other statement of conformity (e.g. a letter) is issued for the product type, the characteristics of which are detailed in the certificate or a document referred to in the certificate. Subsequent production items are not covered by the certification body's attestation of conformity.

The samples are representative of subsequent production items which could be referred to by the manufacturer as being manufactured in accordance with the certified type. The certification body may grant to the manufacturer the right to use the type certificate or other statement of conformity (e.g. letter) as a basis for the manufacturer to declare that subsequent production items conform to the specified requirements.

- b. Type 5: The surveillance part of this scheme allows for the choice between periodically taking samples of the product either from the point of production, or from the market, or from both, and subjecting them to determination activities to check that items produced subsequent to the initial attestation fulfill the specified requirements. The surveillance includes periodic assessment of the production process, or audit of the management system, or both. The extent to which the four surveillance activities are conducted may be varied for a g

ATTESTATION OF CONFORMITY

Issued to: Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd., New & High Technology Industrial Development Zone,
230088, Hefei, P. R. China

For the product: Grid-connected PV inverter

Trade name: 

Type/Model: SG3125HV-30, SG3125HV-31, SG3125HV-32

Ratings: See Annex

Manufactured by: Sungrow Power Supply Co., Ltd.
No.1699 Xiyou Rd., New & High Technology Industrial Development Zone,
230088, Hefei, P. R. China

Requirements: IEC TS 62910:2020

This Attestation is granted on account of an examination by DEKRA, the results of which are laid down in a confidential file no. 6092407.51

The examination has been carried out on one single specimen or several specimens of the product, submitted by the manufacturer. The Attestation does not include an assessment of the manufacturer's production. Conformity of his production with the specimen tested by DEKRA is not the responsibility of DEKRA.

Arnhem, 23 December 2020

Number: 6092407.02AOC

DEKRA Testing and Certification (Shanghai) Ltd.

Kreny Lin
Certification Manager



© Integral publication of this attestation and adjoining reports is allowed

Page 1 of 2

Annex to 6092407.02AOC

Ratings of the test product:

Operating temperature range: - 35°C to + 60°C

Protective class: I

Ingress protection rating: IP65 (Optional IP55)

Power factor range (adjustable): 0.8 leading...0.8 lagging

SG3125HV-30:

PV input: Max. 1500 Vdc, MPPT voltage range: 875-1300 Vdc, max current: 3997 A, Isc PV: 10000 A

Output: 600V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3437 kVA

SG3125HV-31:

PV input: Max. 1500 Vdc, MPPT voltage range: 915-1300 Vdc, max current: 3997 A, Isc PV: 10000 A

Output: 630V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3610 kVA

SG3125HV-32:

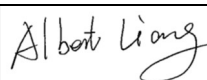
PV input: Max. 1500 Vdc, MPPT voltage range: 960-1300 Vdc, max current: 3997 A, Isc PV: 10000 A

Output: 660V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3781 kVA



TEST REPORT IEC TS 62910 Utility-interconnected photovoltaic inverters - Test procedure for low voltage ride-through measurements	
Report	
Report Number	6092407.51
Date of issue	2020-12-23
Total number of pages	81
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	IEC TS 62910:2020
Test procedure	Type test
Non-standard test method	N/A
Test Report Form No	IEC TS 62910_V2.0
Test Report Form(s) Originator	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Master TRF	Dated 2020-08
Test item description	Grid-connected PV inverter
Trade Mark	阳光电源
Manufacturer	Sungrow Power Supply Co., Ltd. No.1699 Xiyou Rd., New & High Technology Industrial Development Zone, 230088, Hefei, P. R. China
Model/Type reference	SG3125HV-30, SG3125HV-31, SG3125HV-32

Ratings.....:	Operating temperature range: - 35°C to + 60°C Protective class: I Ingress protection rating: IP65 (Optional IP55) Power factor range (adjustable): 0.8 leading...0.8 lagging SG3125HV-30: PV input: Max. 1500 Vdc, MPPT voltage range: 875-1300 Vdc, max current: 3997 A, Isc PV: 10000 A Output: 600V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3437 kVA SG3125HV-31: PV input: Max. 1500 Vdc, MPPT voltage range: 915-1300 Vdc, max current: 3997 A, Isc PV: 10000 A Output: 630V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3610 kVA SG3125HV-32: PV input: Max. 1500 Vdc, MPPT voltage range: 960-1300 Vdc, max current: 3997 A, Isc PV: 10000 A Output: 660V, 3~, 50/60 Hz, max 3308 A, rated 3125 kW, max 3781 kVA
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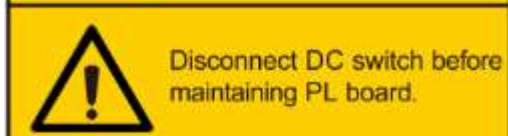
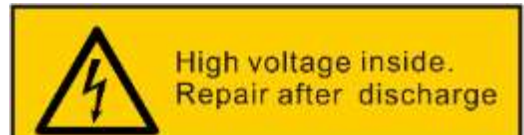
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
☒	Testing Laboratory:	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Testing location/ address.....:		No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
☒	Associated Testing Laboratory:	Shanghai Testing & Inspection Institute for Electrical Equipment Co.,Ltd
Testing location/ address.....:		No.505, Wuning Road, Putuo District, Shanghai, China
Tested by (name, function, signature).....:		Albert Liang 
Approved by (name, function, signature)		Jason Guo 
☐	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).....:		

Rating label:

SUNGROW 光伏并网逆变器	
GRID-CONNECTED PV INVERTER	
型号 Model	SG3125HV-30
序列号 S/N	
直流输入 DC-Input	
最大输入电压 Max. Input Voltage	DC1500V
最小MPP电压 Min. MPP Voltage	DC675V
最大MPP电压 Max. MPP Voltage	DC1300V
最大输入电流 Max. Input Current	DC3997A
最大短路电流 Isc PV	DC10000A
交流输出 AC-Output	
额定输出电压 Rated Output Voltage	600V, 3~
额定输出频率 Rated Output Frequency	50Hz/60Hz
最大输出电流 Max. Output Current	AC3308A
额定输出功率 Rated Output Power	3125kW
最大视在功率 Max. Apparent Power	3437kVA
功率因数范围 Power Factor Range	[-0.8, 0.8]
安全等级 Safety Class	I
过压等级 Overvoltage Category	III(AC), II(DC)
防护等级 Enclosure	IP65
工作温度范围 Ambient Temperature	-35℃~+60℃
重量 Weight	3200kg
尺寸(宽×高×深) Dimensions(W×H×D)	2280×2280×1600mm
  	
阳光电源股份有限公司 SUNGROW POWER SUPPLY CO.,LTD. www.sungrowpower.com 中国制造Made in China	

SUNGROW 光伏并网逆变器	
GRID-CONNECTED PV INVERTER	
型号 Model	SG3125HV-31
序列号 S/N	
直流输入 DC-Input	
最大输入电压 Max. Input Voltage	DC1500V
最小MPP电压 Min. MPP Voltage	DC915V
最大MPP电压 Max. MPP Voltage	DC1300V
最大输入电流 Max. Input Current	DC3997A
最大短路电流 Isc PV	DC10000A
交流输出 AC-Output	
额定输出电压 Rated Output Voltage	630V, 3~
额定输出频率 Rated Output Frequency	50Hz/60Hz
最大输出电流 Max. Output Current	AC3308A
额定输出功率 Rated Output Power	3125kW
最大视在功率 Max. Apparent Power	3610kVA
功率因数范围 Power Factor Range	[-0.8, 0.8]
安全等级 Safety Class	I
过压等级 Overvoltage Category	III(AC), II(DC)
防护等级 Enclosure	IP65
工作温度范围 Ambient Temperature	-35℃~+60℃
重量 Weight	3200kg
尺寸(宽×高×深) Dimensions(W×H×D)	2280×2280×1600mm
  	
阳光电源股份有限公司 SUNGROW POWER SUPPLY CO.,LTD. www.sungrowpower.com 中国制造Made in China	

SUNGROW 光伏并网逆变器	
GRID-CONNECTED PV INVERTER	
型号 Model	SG3125HV-32
序列号 S/N	
直流输入 DC-Input	
最大输入电压 Max. Input Voltage	DC1500V
最小MPP电压 Min. MPP Voltage	DC960V
最大MPP电压 Max. MPP Voltage	DC1300V
最大输入电流 Max. Input Current	DC3997A
最大短路电流 Isc PV	DC10000A
交流输出 AC-Output	
额定输出电压 Rated Output Voltage	660V, 3~
额定输出频率 Rated Output Frequency	50Hz/60Hz
最大输出电流 Max. Output Current	AC3308A
额定输出功率 Rated Output Power	3125kW
最大视在功率 Max. Apparent Power	3781kVA
功率因数范围 Power Factor Range	[-0.8, 0.8]
安全等级 Safety Class	I
过压等级 Overvoltage Category	III(AC), II(DC)
防护等级 Enclosure	IP65
工作温度范围 Ambient Temperature	-35℃~+60℃
重量 Weight	3200kg
尺寸(宽×高×深) Dimensions(W×H×D)	2280×2280×1600mm
  	
阳光电源股份有限公司 SUNGROW POWER SUPPLY CO.,LTD. www.sungrowpower.com 中国制造Made in China	

Warning Label:

Test item particulars:

Equipment mobility	movable <u>fixed</u>	hand-held transportable	stationary for building-in
Connection to the mains	pluggable equipment <u>permanent connection</u>		direct plug-in for building-in
Environmental category	<u>outdoor</u>	indoor unconditional	indoor conditional
Over voltage category Mains	OVC I	OVC II	<u>OVC III</u> OVC IV
Over voltage category PV	OVC I	<u>OVC II</u>	OVC III OVC IV
Mains supply tolerance (%).....	±10%		
Tested for power systems.....	TN		
IT testing, phase-phase voltage (V).....	N/A		
Class of equipment.....	<u>Class I</u> Not classified	Class II	Class III
Mass of equipment (kg).....	3200		
Pollution degree.....	Outside PD3; Inside PD2		
IP protection class	IP65 (Optional IP55)		

Possible test case verdicts:

- test case does not apply to the test object.....: N/A
- test object does meet the requirement.....: P (Pass)
- test object does not meet the requirement.....: F (Fail)
- this clause is information reference for installation: Info.

Testing:

Date of receipt of test item: 2020-10-25 (samples provided by applicant)

Date (s) of performance of tests: 2020-10-25 to 2020-11-30

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.
This report is only for reference and is not used for legal proof function in China market.
The information provided by the customer in this report may affect the validity of the results, the test lab is not responsible for it.

"(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 Xiyu 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

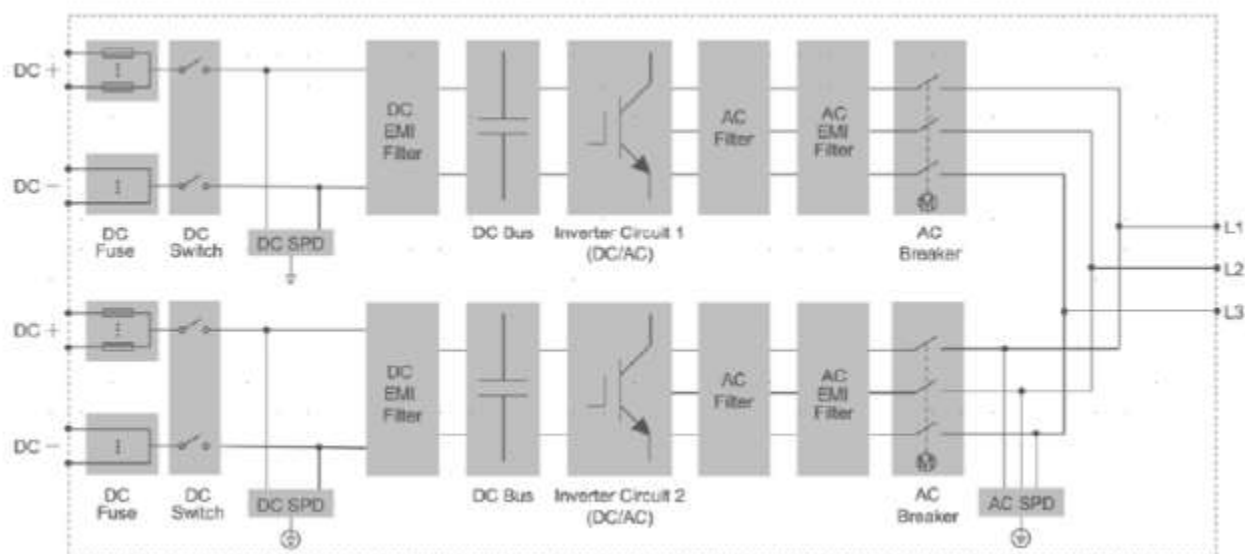
3. Sungrow Developers (India) Private Limited

No. 85, Kaniminike village, Kengeri hobli Bangalore South Taluk,
560074 Bangalore, India

General product information:**Brief description:**

The PCE under test (EUT) is Grid-Connected PV Inverter which utilizes the advanced power electronics conversion components such as MosFET, IGBT, IPM to convert the variable DC power generated from the photovoltaic (PV) arrays to the stable utility AC power which can be fed into the commercial electrical grid.

The PCE under test is three-phase Grid-Connected PV Inverter for solar power generation with the rated output power of 3125 kW. The external circuit breakers or fuses for PV array and Grid connection are required which the statements are provided in the installation manual.

Block Diagram:

The models SG3125HV-31, SG3125HV-30 are identical to SG3125HV-32 except for the model name and electrical ratings.

Unless otherwise specified, all the tests were conducted on the basic model of SG3125HV-32 to represent the others.

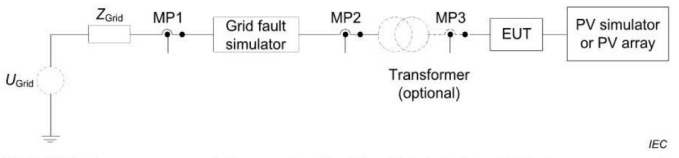
The product was tested on:

Firmware version:

DSP_SG3125HV-30_V1_A

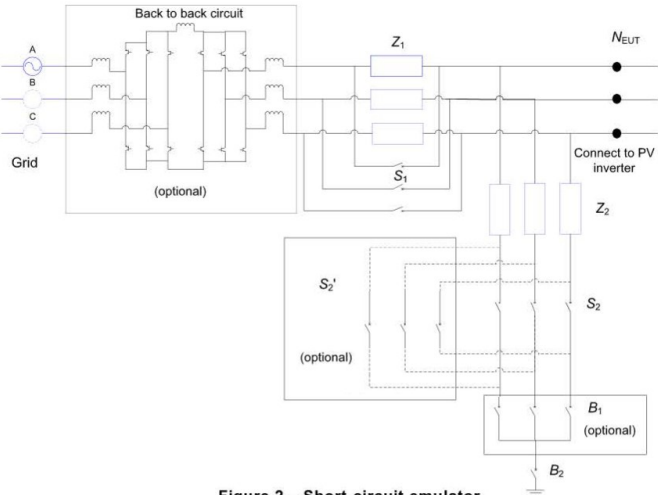
LCD_SG3125HV-30_V1_A

Unless otherwise specified, all tests were conducted on basic model of SG3125HV-32 to represent the other models.

IEC TS 62910			
Clause	Requirement - Test	Result - Remark	Verdict
4	Test circuit and equipment		P
4.1	General		P
	The circuits and equipment described in this clause are developed to allow tests that simulate the full range of anticipated grid faults, including:		P
	• Single phase to ground fault (any phase)		P
	• Two phase isolated fault, between any two phases		P
	• Two phase grounded fault, involving any two phases		P
	• Three phase short-circuit fault.		P
	A full discussion of these faults and the resulting impact on voltage magnitude and phase angles is included in Annex A.		P
	The short circuit emulator and grid simulator described in 4.3.3 and 4.3.4 are informative examples and are not intended to restrict design flexibility. Other designs may be used to achieve equivalent test functionality.	The grid simulator used to achieve test of 4.3.4.	P
4.2	Test circuit		P
	The LVRT test circuit includes a DC source, the EUT, a grid fault simulator and the grid. A PV simulator (or PV array) provides input energy for the EUT. The output of the EUT is connected to the grid via a grid fault simulator, as shown in Figure 1.  NOTE MP1 is the measurement point between the grid and the grid fault simulator; MP2 is the measurement point at the high voltage side of the transformer; MP3 is the measurement point at the low voltage side of the transformer. IEC Figure 1 – Testing circuit diagram	PV array simulator and the grid simulator used in the LVRT test circuit.	P
4.3	Test equipment		P
4.3.1	Measuring instruments		P
	Waveforms shall be measured by a device with memory function, for example, a storage or digital oscilloscope, or a high speed data acquisition device. Accuracy of the oscilloscope or data acquisition system should be at least 0.2% of full scale. The analogue to A/D of the measurement device shall have at least 12 bit resolution (in order to maintain the required measurement accuracy).		P

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Clause	Requirement - Test	Result - Remark	Verdict								
	Voltage transducers (or voltage transformers) and current transducers (or current transformers) are the required sensors for measurement. The accuracy of the transducers should be 0.5 % of full scale or better. It is necessary to select the transducer measuring range depending on the normal value of the signal to be measured. The selected measuring range shall not exceed 150 % of the normal value of the measured signal. The transducer accuracy requirements are shown in Table 1 Table 1 – Accuracy of measurements <table><tr><th>Measurement device</th><th>Accuracy</th></tr><tr><td>Data acquisition device</td><td>0,2 % full scale</td></tr><tr><td>Voltage transducer</td><td>0,5 % full scale</td></tr><tr><td>Current transducer</td><td>0,5 % full scale</td></tr></table>	Measurement device	Accuracy	Data acquisition device	0,2 % full scale	Voltage transducer	0,5 % full scale	Current transducer	0,5 % full scale		P
Measurement device	Accuracy										
Data acquisition device	0,2 % full scale										
Voltage transducer	0,5 % full scale										
Current transducer	0,5 % full scale										
4.3.2	DC source		P								
	A PV array, PV array simulator or controlled DC source with PV characteristics may be used as the DC power source to supply input energy for the LVRT test. As the EUT input source, the DC power source shall be capable of supplying the EUT maximum input power and other power levels during the test, at minimum and maximum input operating voltages of the EUT.	PV array simulator used as the DC power source to supply input energy.	P								
	The PV simulator should emulate the current/voltage characteristic of the PV module or PV array for which the EUT is designed. The response time of a PV simulator should not be longer than the MPP tracking response time of EUT.		P								
	For a EUT under test without galvanic isolation between the DC side and AC side, the output of the PV simulator shall not be earthed.		P								
	The equivalent capacitance between the output of the PV simulator and earth should be as low as possible in order to minimize the impact on the EUT.		P								
	A PV array used as the EUT input source shall be capable of matching the EUT input power levels specified by the test conditions. It is necessary to select a period of time in which the solar irradiance is stable and does not vary by more than 5 % during the test.		P								
4.3.3	Short-circuit emulator	The grid simulator used to achieve LVRT function.	N/A								

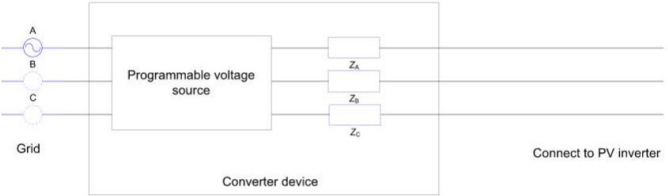
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Clause	Requirement - Test	Result - Remark	Verdict
	As part of the grid simulator device, the short-circuit emulator is used to create the voltage drops due to short-circuits between the two or three phases, or between one or two phases to ground, via the impedance network Z_1 and Z_2 as shown in the test device layout in Figure 2.  Figure 2 – Short-circuit emulator		N/A
	The impedance Z_1 is used to limit the effect of the short circuit on the utility service that powers the test circuit. The sizing of Z_1 shall therefore account for all test sequences to be performed and limit the short-circuit current taken from the grid to values that do not cause an excessive reduction of the grid voltage. Considering an acceptable voltage reduction of at most 5 % when performing the test, the minimum value of Z_1 shall be at least $20 \times Z_{\text{Grid}}$, where Z_{Grid} is the grid short-circuit impedance measured at the test circuit connection point.		N/A
	To ensure that the test is realistic, however, the apparent short-circuit power (S_{EUT}) available at the EUT connection node N_{EUT} should be at least equal to $3 \times P_n$, where P_n is the rated power of the EUT (minimum value $S_{\text{EUT}} > 3 \times P_n$, recommended $S_{\text{EUT}} = 5$ to $6 \times P_n$). This means that during the short-circuit tests, the contribution of current through Z_1 and Z_2 from the grid remains dominant compared to the current contributed by the EUT. In this way, the inverter current does not create a significant voltage rise for the duration of the test relative to the no-load drop.		N/A
	The two conditions described above define the minimum and maximum limits of Z_1. The two conditions combined also define the limit criteria for the choice of a grid infrastructure suitable for performing the test with the impedance circuit. If the grid infrastructure cannot meet the above requirements, an alternative test circuit utilizing a back-to-back converter is allowed, as shown in Figure 2 and may be added to reduce the grid short-circuit impedance Z_{Grid}.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict																																																											
	Generally, the X/R value of inductor Z_1 and Z_2 for the short-circuit emulator may close to the transmission line impedance values for different countries and regions. It is also appropriate that the inductive impedances Z_1 and Z_2 should be characterised by an X/R ratio equal to at least 3, in order to reproduce the typical minimum values of X/R found in HV as well as MV power lines.		N/A																																																											
	A bypass connection (Switch S_1) of Z_1 is usually used to prevent overheating of the impedance Z_1 before and after the execution of each test sequence.		N/A																																																											
	The voltage drop is created by connecting the impedance Z_2 by the switch S_2 . If the voltage drop is required to be created twice in a short period (for double drop tests), a parallel switch S_2' is normally used. The value of $Z_2/(Z_1+Z_2+Z_{Grid})$ shall be adjusted to the required voltage magnitudes. For example, when the required voltage magnitude is 50 % of the rated voltage, the value of $Z_2/(Z_1+Z_2+Z_{Grid})$ should be about 0.5.		N/A																																																											
	The switch S_2 shall be able to accurately control the time between connection and disconnection of Z_2 for single phase, two-phase or three-phase tests. If the phase of switch S_2 cannot be independently controlled, the serial switch S_1 may be used to choose the fault phase. S_2 is used to select whether the fault is to earth or not. All switches may be either mechanical circuit breakers or power electronic devices.		N/A																																																											
	The status of switch S_1 and S_2 should be set before performing the test. The status of switches corresponding to fault types is shown in Table 2.		N/A																																																											
	The test report shall specify the values of impedances Z_1 and Z_2 , the related X/R ratio, and a description of the circuit used. In addition, the grid short-circuit power available at the voltage level at which the test is performed shall be documented.		N/A																																																											
	The status of switches and fault types are shown in Table 2. Table 2 – Fault type and switch status <table><tr><th rowspan="2">Fault type</th><th colspan="4">Switch status</th></tr><tr><th>Phase A of B_1</th><th>Phase B of B_1</th><th>Phase C of B_1</th><th>B_2</th></tr><tr><td>Phase A to ground</td><td>Closed</td><td>Open</td><td>Open</td><td>Closed</td></tr><tr><td>Phase B to ground</td><td>Open</td><td>Closed</td><td>Open</td><td>Closed</td></tr><tr><td>Phase C to ground</td><td>Open</td><td>Open</td><td>Closed</td><td>Closed</td></tr><tr><td>Phase A and B to ground</td><td>Closed</td><td>Closed</td><td>Open</td><td>Closed</td></tr><tr><td>Phase B and C to ground</td><td>Open</td><td>Closed</td><td>Closed</td><td>Closed</td></tr><tr><td>Phase C and A to ground</td><td>Closed</td><td>Open</td><td>Closed</td><td>Closed</td></tr><tr><td>Phase A and B</td><td>Closed</td><td>Closed</td><td>Open</td><td>Open</td></tr><tr><td>Phase B and C</td><td>Open</td><td>Closed</td><td>Closed</td><td>Open</td></tr><tr><td>Phase C and A</td><td>Closed</td><td>Open</td><td>Closed</td><td>Open</td></tr><tr><td>Phase A, B and C</td><td>Closed</td><td>Closed</td><td>Closed</td><td>–</td></tr></table> During the period of voltage drop, S_1 should be opened first. S_2 should be closed after S_1 is opened. The time interval between the above two actions shall be very short. During the period of voltage recovery, S_2 should be opened first. S_1 should be closed after S_2 is opened. The time interval between the above two actions shall be very short.	Fault type	Switch status				Phase A of B_1	Phase B of B_1	Phase C of B_1	B_2	Phase A to ground	Closed	Open	Open	Closed	Phase B to ground	Open	Closed	Open	Closed	Phase C to ground	Open	Open	Closed	Closed	Phase A and B to ground	Closed	Closed	Open	Closed	Phase B and C to ground	Open	Closed	Closed	Closed	Phase C and A to ground	Closed	Open	Closed	Closed	Phase A and B	Closed	Closed	Open	Open	Phase B and C	Open	Closed	Closed	Open	Phase C and A	Closed	Open	Closed	Open	Phase A, B and C	Closed	Closed	Closed	–		N/A
Fault type	Switch status																																																													
	Phase A of B_1	Phase B of B_1	Phase C of B_1	B_2																																																										
Phase A to ground	Closed	Open	Open	Closed																																																										
Phase B to ground	Open	Closed	Open	Closed																																																										
Phase C to ground	Open	Open	Closed	Closed																																																										
Phase A and B to ground	Closed	Closed	Open	Closed																																																										
Phase B and C to ground	Open	Closed	Closed	Closed																																																										
Phase C and A to ground	Closed	Open	Closed	Closed																																																										
Phase A and B	Closed	Closed	Open	Open																																																										
Phase B and C	Open	Closed	Closed	Open																																																										
Phase C and A	Closed	Open	Closed	Open																																																										
Phase A, B and C	Closed	Closed	Closed	–																																																										
4.3.4	Converter based grid simulator		P																																																											

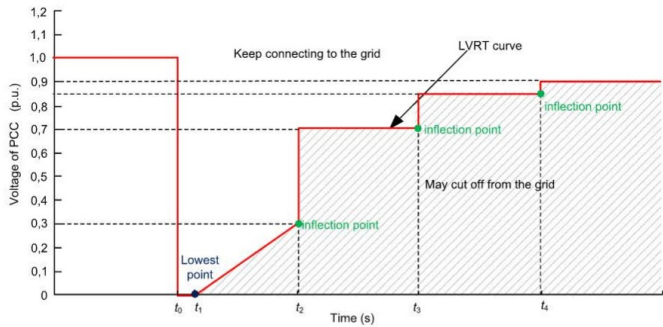
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Clause	Requirement - Test	Result - Remark	Verdict
	The test circuit mentioned in 4.3.3 is recommended for simulation of grid faults. However, if the test conditions cannot be met, an alternative test circuit utilizing a back-to-back converter is allowed, as shown in Figure 3.  Figure 3 – Converter device example IEC		P
	The test circuit essentially comprises a voltage source with a low internal resistance combined with broadband amplifiers (linear or forced switching type) capable of faithfully reproducing three sinusoidal voltages with controlled harmonic content, and adjustable amplitude, fundamental frequency and phase relationship within broad margins.		P
	When the converter is used, it shall meet the following requirements:		P
	a) It shall be capable of independently controlling the three phases in terms of amplitude and phase angle. b) It shall incorporate impedances Z_A, Z_B and Z_C, that can be adjusted in order to reproduce the ohmic and inductive components of short-circuit impedances that are typical of the grid. c) It shall be capable of reproducing the phase voltages and relative phase angles that occur on the LV side of transformers in the event of each of the various fault types. (See Annex A for the vector representations for each fault).		P
	If the programmable voltage source is a bi-directional, controlled capable of replicating the influence of short-circuit impedances Z_A, Z_B, Z_C may be omitted.		P
5	Test		P
5.1	Test protocol		P
	The LVRT test protocol is designed to verify that the EUT responds appropriately to voltage drops (due to grid faults). During the test, the EUT shall demonstrate that it can: • Appropriately detect the simulated fault. • Ride through the event and continue operation as specified in the applicable curves. • Not suffer any damage from the event.		P

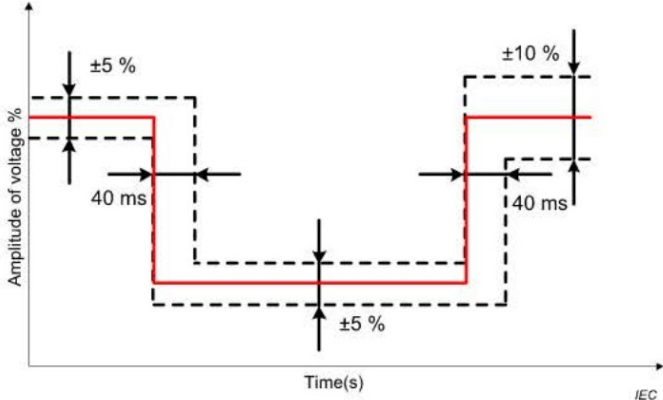
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Clause	Requirement - Test	Result - Remark	Verdict																																																														
	The response to the voltage drop specified operating period with two output power ranges a) between $0.1 P_n$ and $0.3 P_n$; b) above $0.9 P_n$; and with two fault conditions : c) three-phase drop; d) two-phase drop or single-phase drop. The tests should be carried out at least twice at each test point listed in Table 3. Table 3 – Test specification for LVRT (indicative) (1 of 2) <table> <tr> <th>Drop times</th><th>Drop depth^b</th><th>Drop phase^c</th><th>EUT output conditions^d</th></tr> <tr> <td rowspan="16">Single drop</td><td rowspan="8">A_1</td><td rowspan="2">Three-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Single-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="8">...</td><td rowspan="2">Three-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Single-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> </table> Table 3 (2 of 2) <table> <tr> <th>Drop times</th><th>Drop depth^b</th><th>Drop phase^c</th><th>EUT output conditions^d</th></tr> <tr> <td rowspan="16">Double drop^a</td><td rowspan="8">A_1</td><td rowspan="2">Three-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Single-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="8">...</td><td rowspan="2">Three-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Two-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> <tr> <td rowspan="2">Single-phase to ground</td><td>Full load (above $0.9 P_n$)</td></tr> <tr> <td>Part load ($0.1 P_n$ and $0.3 P_n$)</td></tr> </table> a. Double drop test may be required in some countries or regions. For devices under test not being required for double drop test, above testing points can be omitted. b. Drop depth is the residual voltage during the LVRT testing period which can be decided according to the requirement specified by different countries or regions (See Clause B.2 for drop depth ratio calculation.) c. Drop phase can be decided according to the requirement specified by different countries or regions; the value of two-phase voltage should be line voltage. d. The test should be carried out under specified K-factor provided by local manufacture	Drop times	Drop depth ^b	Drop phase ^c	EUT output conditions ^d	Single drop	A_1	Three-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Single-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	...	Three-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Single-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Drop times	Drop depth ^b	Drop phase ^c	EUT output conditions ^d	Double drop ^a	A_1	Three-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Single-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	...	Three-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Two-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)	Single-phase to ground	Full load (above $0.9 P_n$)	Part load ($0.1 P_n$ and $0.3 P_n$)		P
Drop times	Drop depth ^b	Drop phase ^c	EUT output conditions ^d																																																														
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5.2	Test curve		P																																																														

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Clause	Requirement - Test	Result - Remark	Verdict
	The LVRT response characteristic shall meet the requirements of the LVRT curve specified by different countries and regions as needed. An example LVRT curve is shown in Figure 4.  Figure 4 – LVRT curve example		P
	The example curve shows that the EUT should keep operating during operating conditions indicated in the area above the LVRT curve. Specifically, the EUT should keep operating for $(t_1 - t_0)$ seconds without disconnecting from the grid when the interconnection voltage drops to 0 % of rated voltage; for $(t_2 - t_0)$ seconds when the voltage drops to 30 % of rated voltage; and for $(t_3 - t_0)$ seconds when the voltage drops to 70 % of rated voltage. The EUT should disconnect from the grid during operating conditions indicated within the shaded areas.		P
	The example shows two types of points on the LVRT curve: the lowest point and the inflection point. Tests shall be carried out at both types of points.		P
5.3	Test procedure		P
5.3.1	Pre-test		P
	Prior to the fault simulation tests, the EUT should run in normal operating mode. The selected LVRT curve should be used to identify voltage drop points, including the lowest point and the inflection point, as well as other random points in the curve. Selection of the drop time should follow the requirement of the applicable country or region.		P
5.3.2	No-load test		P
	Prior to the load test, adjust the fault emulator to simulate symmetrical and asymmetrical voltage drops without EUT connection, and validate that the measured results are as intended. This step ensures that the amplitude of voltage and drop duration can match the requirements in Figure 5.		P
5.3.3	Tolerance		P
	The tolerances for drop depth and duration during the no-load test shall reference the requirement of Figure 6 in IEC 61400-21 :2008, and not exceed the values shown in Figure 5		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The tolerance for voltage magnitude is $\pm 5\%$ of rated voltage for the period before and during the voltage drop. The tolerance for voltage magnitude is $\pm 10\%$ of rated voltage during the period after voltage is recovered. The tolerances shall be measured between 0 and $+5\%$ of rated voltage for the lowest point and the inflection point under no-load conditions.		P
	The duration of each voltage drop is determined according to the requirements of the applicable LVRT curve. The tolerance range for both drop duration and rise time prefers 40ms.  Figure 5 – Tolerance of voltage drop		P
5.3.4	Load test		P
	Tests under load shall be carried out after the no-load test results successfully meet the performance requirements. The parameters of the grid fault simulator should be consistent with the no-load test.		P
	With the EUT connected to the grid fault simulator device and the PV simulator (or PV array), the output power should be set to $(0.1-0.3) P_n$ and above $0.9P_n$ separately. Additional load tests at other power levels should be performed as determined by the specific regional requirements.		P
	During the LVRT test, MP1, MP2, and MP3 (shown in Figure 1) shall be selected as the test points for measuring and recording the values of voltage and current.		P
	The waveform and data of the measured voltage and current at the measuring points shall be recorded by the data acquisition device from time A prior to the voltage drop to time B after the subsequent voltage rise. For "A" and "B", specific data should be determined by different countries or regions.		P
6	Assessment criteria		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The various assessment criteria is determined by the requirements of the different countries or regions. The characteristics and performance criteria for utilization are shown in Annex B, and can be referenced by a local user.		P

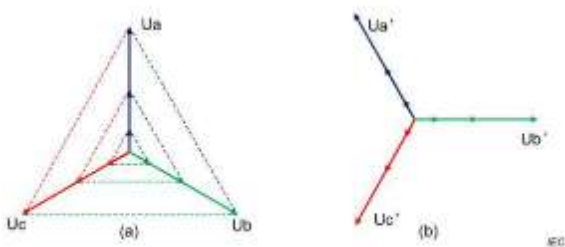
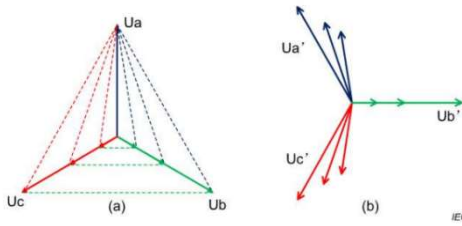
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Clause	Requirement - Test	Result - Remark	Verdict																																
Annex A	Circuit faults and voltage drops (informative)		P																																
A.1	Fault types		P																																
	The grid faults of high voltage power transmission line are commonly divided into four different types: single-phase grounded fault, two-phase short circuit fault, two-phase grounded fault, and three-phase short circuit fault. The most common one is the single-phase grounded fault, which accounting for over 90 % of the total number of the faults.		P																																
	Considering the different fault phases, the short circuit paths for all types of fault are shown in Table A.1. Table A.1 – Short-circuit paths for different fault types <table border="1"> <thead> <tr> <th>Type No.</th><th>Short circuit type</th><th>Equivalent diagram</th><th>Mathematical formulae</th></tr> </thead> <tbody> <tr> <td>1</td><td>Single-phase (A) short circuit grounded fault</td><td></td><td> $V_a = 0$ $I_b \neq 0$ $I_a = I_b = 0$ </td></tr> <tr> <td>2</td><td>Single-phase (B) short circuit grounded fault</td><td></td><td> $V_b = 0$ $I_a \neq 0$ $I_b = I_a = 0$ </td></tr> <tr> <td>3</td><td>Single-phase (C) short circuit grounded fault</td><td></td><td> $V_c = 0$ $I_a \neq 0$ $I_c = I_a = 0$ </td></tr> <tr> <td>4</td><td>Two-phase (AB) short circuit isolated fault</td><td></td><td> $V_a = V_b \neq 0$ $I_b = 0$ $I_a = I_b = 0$ </td></tr> <tr> <td>5</td><td>Two-phase (BC) short circuit isolated fault</td><td></td><td> $V_b = V_c \neq 0$ $I_b = 0$ $I_b + I_c = 0$ </td></tr> <tr> <td>6</td><td>Two-phase (CA) short circuit isolated fault</td><td></td><td> $V_c = V_a \neq 0$ $I_b = 0$ $I_b + I_c = 0$ </td></tr> <tr> <td>7</td><td>Two-phase (AB) short circuit grounded fault</td><td></td><td> $V_a = V_b = 0$ $I_b = 0$ $I_a = I_b \neq 0$ </td></tr> </tbody> </table>	Type No.	Short circuit type	Equivalent diagram	Mathematical formulae	1	Single-phase (A) short circuit grounded fault		$V_a = 0$ $I_b \neq 0$ $I_a = I_b = 0$	2	Single-phase (B) short circuit grounded fault		$V_b = 0$ $I_a \neq 0$ $I_b = I_a = 0$	3	Single-phase (C) short circuit grounded fault		$V_c = 0$ $I_a \neq 0$ $I_c = I_a = 0$	4	Two-phase (AB) short circuit isolated fault		$V_a = V_b \neq 0$ $I_b = 0$ $I_a = I_b = 0$	5	Two-phase (BC) short circuit isolated fault		$V_b = V_c \neq 0$ $I_b = 0$ $I_b + I_c = 0$	6	Two-phase (CA) short circuit isolated fault		$V_c = V_a \neq 0$ $I_b = 0$ $I_b + I_c = 0$	7	Two-phase (AB) short circuit grounded fault		$V_a = V_b = 0$ $I_b = 0$ $I_a = I_b \neq 0$		P
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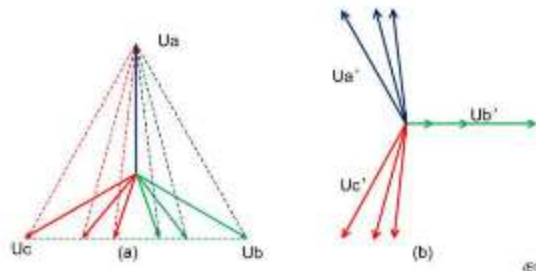
IEC TS 62910

Clause	Requirement - Test	Result - Remark	Verdict										
	<table border="1"> <tr> <td>8</td><td>Two-phase (BC) short circuit grounded fault</td><td> $\begin{aligned} \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_B + \bar{I}_C &\neq 0 \end{aligned}$ </td><td rowspan="3">P</td></tr> <tr> <td>9</td><td>Two-phase (CA) short circuit grounded fault</td><td> $\begin{aligned} \bar{V}_C - \bar{V}_A &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_C + \bar{I}_A &\neq 0 \end{aligned}$ </td></tr> <tr> <td>10</td><td>Three-phase short-circuit fault</td><td> $\begin{aligned} \bar{V}_A - \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A + \bar{I}_B + \bar{I}_C &= 0 \end{aligned}$ </td></tr> </table> NOTE 1 $\bar{V}_A$, $\bar{V}_B$ and $\bar{V}_C$ mean fault voltage of phase A, phase B and phase C at fault point separately. NOTE 2 $\bar{I}_A$, $\bar{I}_B$ and $\bar{I}_C$ mean fault current of phase A, phase B and phase C at fault point separately. NOTE 3 Type No. 1, 2, 3, 7, 8 and 9 are not applicable for IT systems.	8	Two-phase (BC) short circuit grounded fault	$\begin{aligned} \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_B + \bar{I}_C &\neq 0 \end{aligned}$	P	9	Two-phase (CA) short circuit grounded fault	$\begin{aligned} \bar{V}_C - \bar{V}_A &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_C + \bar{I}_A &\neq 0 \end{aligned}$	10	Three-phase short-circuit fault	$\begin{aligned} \bar{V}_A - \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A + \bar{I}_B + \bar{I}_C &= 0 \end{aligned}$		
8	Two-phase (BC) short circuit grounded fault	$\begin{aligned} \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_B + \bar{I}_C &\neq 0 \end{aligned}$	P										
9	Two-phase (CA) short circuit grounded fault	$\begin{aligned} \bar{V}_C - \bar{V}_A &= 0 \\ \bar{I}_A &= 0 \\ \bar{I}_C + \bar{I}_A &\neq 0 \end{aligned}$											
10	Three-phase short-circuit fault	$\begin{aligned} \bar{V}_A - \bar{V}_B - \bar{V}_C &= 0 \\ \bar{I}_A + \bar{I}_B + \bar{I}_C &= 0 \end{aligned}$											
A.2	Voltage drops		P										
A .2.1	General		P										
	When a fault occurs, the voltage amplitude in the faulted phase should be decreased. When a fault occurs between two phases, the phase angle should be changed on inverter output side. Due to the different types of line-transformer connections, the magnitude and phase of inverter AC voltage will vary. Figure A.1 shows the circuit topology under the fault condition. Figure A.1 – Grid fault diagram As indicated in Table A.1, the value of fault phase voltage at the fault point is zero. (If the grid fault type is two-phase short circuit fault without ground, the line voltage between two fault phases should be zero.) Because PCC is the common connection point of the infinite grid, Z_i between the fault point and PCC could be treated as infinite. The voltage drop amplitude and phase deviation in PV inverter AC side have been determined by the value of Z_p and type of transformer.		P										

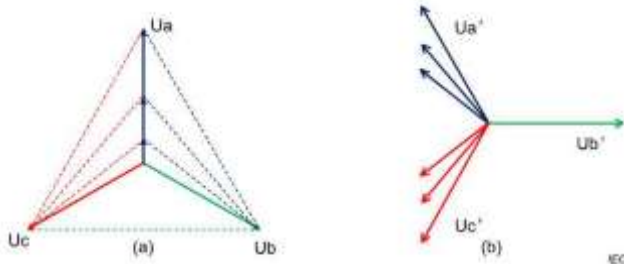
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Clause	Requirement - Test	Result - Remark	Verdict																																																																																									
	The transformer "T" represents the voltage and phase transformation being equivalent to all the transformers between the fault point and the PV inverter, because one or more transformers are connected. The equivalent transformer "T" has only two types -Y/Y or Y/Δ. In order to simplify the analysis, the transformer windings could be considered as one of two types, Yn/Yn12 and Δ/Yn11, with a ratio of 1.		P																																																																																									
A.2.2	Three-phase short-circuit fault		P																																																																																									
	Figure A.2 illustrates the change in inverter AC voltage magnitude and phase when a three phase short-circuit fault occurs:  Figure A.2 – Diagram of voltage vector for three-phase short-circuit fault		P																																																																																									
	Figure A.2(a) shows the angle and phase state with a Yn/Yn12 transformer connection. Figure A.2(b) shows the angle and phase state with a Δ/Yn11 transformer connection. The corresponding relationship between the fault phase and the other two phases is shown in the following Table A .2. Table A.2 – Amplitude and phase changes in three-phase short-circuit fault <table><tr><th rowspan="3">Residual voltage of fault phase %</th><th colspan="6">With the Yn/Yn12 transformer</th><th colspan="6">With the Δ/Yn11 transformer</th></tr><tr><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th></tr><tr><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th></tr><tr><td>100</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>30</td><td>1</td><td>30</td><td>1</td><td>30</td></tr><tr><td>50</td><td>0,5</td><td>0</td><td>0,5</td><td>0</td><td>0,5</td><td>0</td><td>0,5</td><td>30</td><td>0,5</td><td>30</td><td>0,5</td><td>30</td></tr><tr><td>20</td><td>0,2</td><td>0</td><td>0,2</td><td>0</td><td>0,2</td><td>0</td><td>0,2</td><td>30</td><td>0,2</td><td>30</td><td>0,2</td><td>30</td></tr><tr><td>0</td><td>0</td><td>–</td><td>0</td><td>–</td><td>0</td><td>–</td><td>0</td><td>–</td><td>0</td><td>–</td><td>0</td><td>–</td></tr></table> NOTE Am. means amplitude and Ph. means the initial phase.	Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ/Yn11 transformer						Phase A		Phase B		Phase C		Phase A		Phase B		Phase C		Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	100	1	0	1	0	1	0	1	30	1	30	1	30	50	0,5	0	0,5	0	0,5	0	0,5	30	0,5	30	0,5	30	20	0,2	0	0,2	0	0,2	0	0,2	30	0,2	30	0,2	30	0	0	–	0	–	0	–	0	–	0	–	0	–		P
Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ/Yn11 transformer																																																																																					
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	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.																																																																																
100	1	0	1	0	1	0	1	30	1	30	1	30																																																																																
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20	0,2	0	0,2	0	0,2	0	0,2	30	0,2	30	0,2	30																																																																																
0	0	–	0	–	0	–	0	–	0	–	0	–																																																																																
A .2.3	Two-phase short-circuit fault with ground		P																																																																																									
	There are three possible two-phase short-circuit earth faults, depending on the fault phases. Taking the two-phase (BC) short circuit fault with ground for example, the change in inverter AC voltage amplitudes and phases are shown below:  Figure A.3 – Diagram of voltage vector of two-phase (BC) short-circuit fault with ground		P																																																																																									

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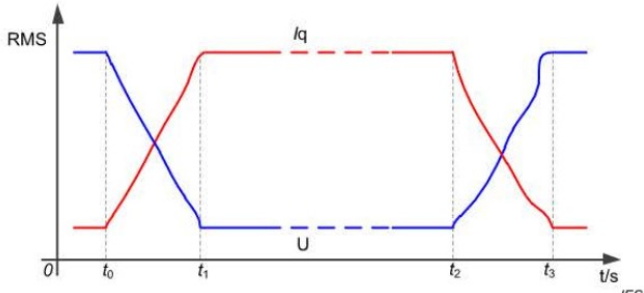
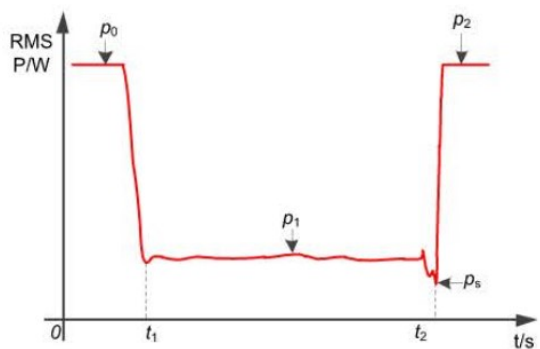
Clause	Requirement - Test	Result - Remark	Verdict																																																																																									
	Figure A.3(a) shows the angle and phase state with a Yn/Yn12 transformer connection. Figure A.3(b) shows the angle and phase state with a Δ/Yn11 transformer connection. The corresponding relationship between the fault phase and the other two phases is shown in the following Table A.3. Table A.3 – Amplitude and phase changes in two-phase (BC) short-circuit fault with ground <table><tr><th rowspan="3">Residual voltage of fault phase %</th><th colspan="6">With the Yn/Yn12 transformer</th><th colspan="6">With the Δ/Yn11 transformer</th></tr><tr><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th></tr><tr><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th></tr><tr><td>100</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>30</td><td>1</td><td>30</td><td>1</td><td>30</td></tr><tr><td>50</td><td>1</td><td>0</td><td>0.5</td><td>0</td><td>0.5</td><td>0</td><td>0.76</td><td>19</td><td>0.5</td><td>30</td><td>0.76</td><td>41</td></tr><tr><td>20</td><td>1</td><td>0</td><td>0.2</td><td>0</td><td>0.2</td><td>0</td><td>0.64</td><td>9</td><td>0.2</td><td>30</td><td>0.64</td><td>51</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>–</td><td>0</td><td>–</td><td>0.58</td><td>0</td><td>0</td><td>–</td><td>0.58</td><td>60</td></tr></table> NOTE Am. means amplitude and Ph. means the initial phase.	Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ /Yn11 transformer						Phase A		Phase B		Phase C		Phase A		Phase B		Phase C		Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	100	1	0	1	0	1	0	1	30	1	30	1	30	50	1	0	0.5	0	0.5	0	0.76	19	0.5	30	0.76	41	20	1	0	0.2	0	0.2	0	0.64	9	0.2	30	0.64	51	0	1	0	0	–	0	–	0.58	0	0	–	0.58	60		P
Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ /Yn11 transformer																																																																																					
	Phase A		Phase B		Phase C		Phase A		Phase B		Phase C																																																																																	
	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.																																																																																
100	1	0	1	0	1	0	1	30	1	30	1	30																																																																																
50	1	0	0.5	0	0.5	0	0.76	19	0.5	30	0.76	41																																																																																
20	1	0	0.2	0	0.2	0	0.64	9	0.2	30	0.64	51																																																																																
0	1	0	0	–	0	–	0.58	0	0	–	0.58	60																																																																																
A .2.4	Two-phase short-circuit fault without ground		P																																																																																									
	There are three possible two-phase short-circuit earth faults, depending on the fault phases. Taking the two-phase (BC) short circuit fault for example, the change in inverter AC voltage amplitudes and phases are shown below:  Figure A.4 – Diagram of voltage vector of two-phase (BC) short-circuit fault		P																																																																																									
	Figure A.4(a) shows the angle and phase state with a Yn/Yn12 transformer connection. Figure A.4(b) shows the angle and phase state with a Δ/Yn11 transformer connection. The corresponding relationship between the fault phase and the other two phases is shown in the following Table A.4. Table A.4 – Amplitude and phase changes in two-phase (BC) short-circuit fault <table><tr><th rowspan="3">Residual voltage of fault phase %</th><th colspan="6">With the Yn/Yn12 transformer</th><th colspan="6">With the Δ/Yn11 transformer</th></tr><tr><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th></tr><tr><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th></tr><tr><td>100</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>30</td><td>1</td><td>30</td><td>1</td><td>30</td></tr><tr><td>50</td><td>1</td><td>0</td><td>0.66</td><td>19</td><td>0.66</td><td>-19</td><td>0.9</td><td>16</td><td>0.5</td><td>30</td><td>0.9</td><td>44</td></tr><tr><td>20</td><td>1</td><td>0</td><td>0.53</td><td>41</td><td>0.53</td><td>-41</td><td>0.87</td><td>7</td><td>0.2</td><td>30</td><td>0.87</td><td>53</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0.5</td><td>60</td><td>0.5</td><td>-60</td><td>0.866</td><td>0</td><td>0</td><td>-</td><td>0.866</td><td>60</td></tr></table> NOTE Am. means amplitude and Ph. means the initial phase.	Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ /Yn11 transformer						Phase A		Phase B		Phase C		Phase A		Phase B		Phase C		Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	100	1	0	1	0	1	0	1	30	1	30	1	30	50	1	0	0.66	19	0.66	-19	0.9	16	0.5	30	0.9	44	20	1	0	0.53	41	0.53	-41	0.87	7	0.2	30	0.87	53	0	1	0	0.5	60	0.5	-60	0.866	0	0	-	0.866	60		P
Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ /Yn11 transformer																																																																																					
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20	1	0	0.53	41	0.53	-41	0.87	7	0.2	30	0.87	53																																																																																
0	1	0	0.5	60	0.5	-60	0.866	0	0	-	0.866	60																																																																																
A .2.5	Single-phase short-circuit fault with ground		P																																																																																									

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Clause	Requirement - Test	Result - Remark	Verdict																																																																																									
	There are three possible single-phase short-circuit faults to ground, depending on the fault phases. Taking the single-phase (A) short circuit fault for example, the change in inverter AC voltage amplitudes and phases are shown below:  Figure A.5 – Diagram of voltage vector of single-phase (A) short-circuit fault with ground		P																																																																																									
	Figure A.5(a) shows the angle and phase state with a Yn/Yn12 transformer connection. Figure A.5(b) shows the angle and phase state with a Δ/Yn11 transformer connection. The corresponding relationship between the fault phase and the other two phases is shown in the following Table A.5. Table A.5 – Amplitude and phase changes in single-phase (A) short-circuit fault with ground <table><tr><th rowspan="3">Residual voltage of fault phase %</th><th colspan="6">With the Yn/Yn12 transformer</th><th colspan="6">With the Δ/Yn11 transformer</th></tr><tr><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th><th colspan="2">Phase A</th><th colspan="2">Phase B</th><th colspan="2">Phase C</th></tr><tr><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th><th>Am.</th><th>Ph.</th></tr><tr><td>100</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>30</td><td>1</td><td>30</td><td>1</td><td>30</td></tr><tr><td>50</td><td>0,5</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0,76</td><td>41</td><td>0,5</td><td>30</td><td>0,76</td><td>19</td></tr><tr><td>20</td><td>0,2</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0,64</td><td>51</td><td>0,2</td><td>30</td><td>0,64</td><td>9</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0,58</td><td>60</td><td>0</td><td>–</td><td>0,58</td><td>0</td></tr></table> NOTE Am. means amplitude and Ph. means the initial phase.	Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ/Yn11 transformer						Phase A		Phase B		Phase C		Phase A		Phase B		Phase C		Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	Am.	Ph.	100	1	0	1	0	1	0	1	30	1	30	1	30	50	0,5	0	1	0	1	0	0,76	41	0,5	30	0,76	19	20	0,2	0	1	0	1	0	0,64	51	0,2	30	0,64	9	0	1	0	1	0	1	0	0,58	60	0	–	0,58	0		P
Residual voltage of fault phase %	With the Yn/Yn12 transformer						With the Δ/Yn11 transformer																																																																																					
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100	1	0	1	0	1	0	1	30	1	30	1	30																																																																																
50	0,5	0	1	0	1	0	0,76	41	0,5	30	0,76	19																																																																																
20	0,2	0	1	0	1	0	0,64	51	0,2	30	0,64	9																																																																																
0	1	0	1	0	1	0	0,58	60	0	–	0,58	0																																																																																

IEC TS 62910			
Clause	Requirement - Test	Result - Remark	Verdict
Annex B	Determination of critical performance values in LVRT testing (informative)		P
B.1	General		P
	This Annex provides suggested methods for determining several of the critical performance values in LVRT testing. Different countries and regions may choose alternate methods according to the requirements of their standards.		P
B.2	Drop depth ratio.		P
	As the voltage of the test circuit may deviate from the nominal voltage of system, the rated voltage of the EUT should be used as the reference voltage for calculations of the voltage drop depth ratio, as shown in Formula B.1. As such it is not recommended to use the value of the actual voltage measured prior to the drop test to calculate drop depth. $A_n = \frac{U_{dip}}{U_n} \quad (B.1)$ where A_n is the residual voltage ratio; U_{dip} is the actual voltage during the drop test; U_n is the rated AC voltage of EUT.		P
8.3	Ride-through time		P
	Over the voltage drop period, the EUT shall meet the ride through time requirements corresponding with the applicable voltage drop depths. These requirements will differ depending on countries and regions, however, the LVRT performance should meet or exceed the most demanding requirements for the specified region. LVRT functions tested successfully according to specific ride through requirements should only be applied in corresponding countries and regions where those requirements are applicable.		P
B.4	Reactive current	As require by applicant, reactive current is not requirement over the duration of the voltage drop.	N/A
	If the EUT generates reactive current as a function of voltage drop depth over the duration of the voltage drop, the incremental voltage changes in the un-fault phases caused by the increased reactive current shall not exceed any values specified by the most demanding requirements of the different countries or regions.		N/A

IEC TS 62910

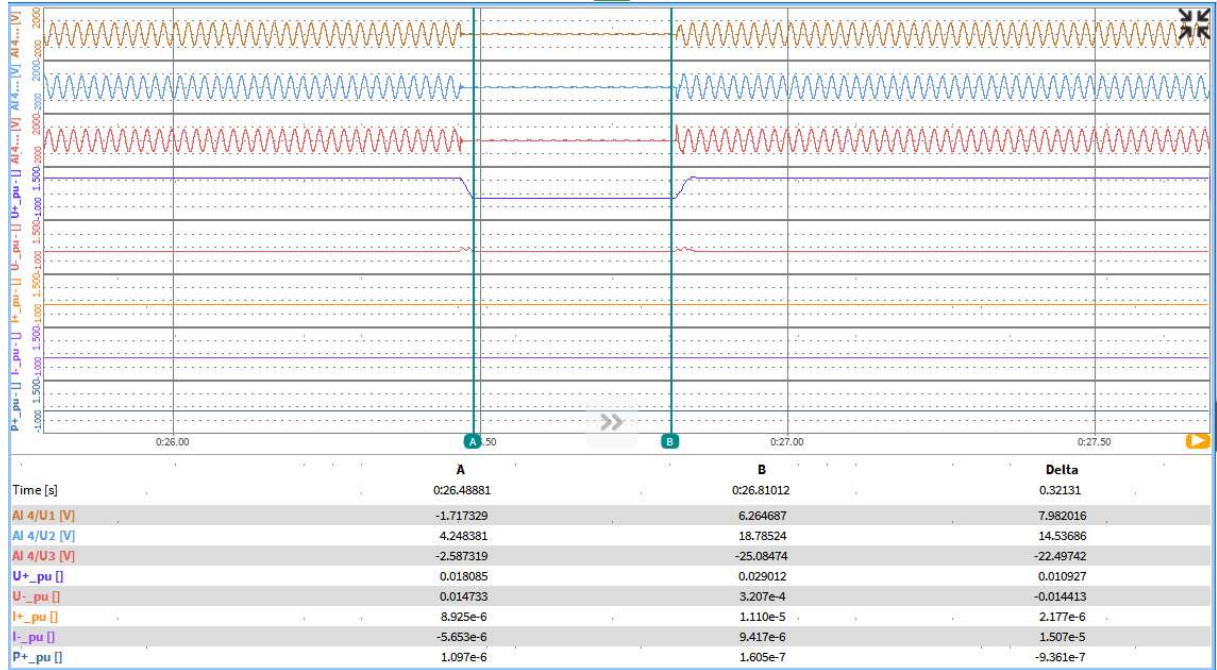
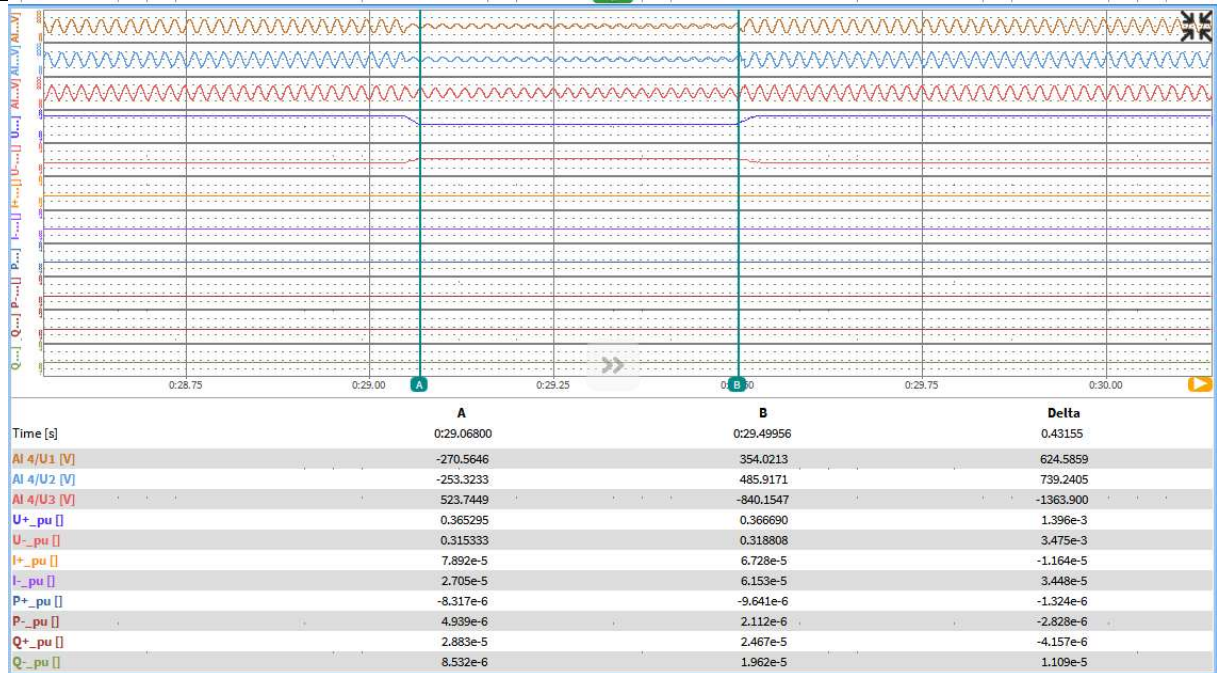
Clause	Requirement - Test	Result - Remark	Verdict
	If it is required that the reactive output current of the EUT should change dynamically according to the voltage change during the drop period, the time period for estimating the value of reactive current should be selected between the beginning of the voltage drop and the beginning of the voltage recovery. This is shown as the time between t_1 and t_2 in Figure B.1. In general, time period between t_2 and t_3 is not over 20 ms.  Figure B.1 – Determination of reactive current output The output of reactive current may fluctuate during test. This fluctuation may result in reactive current values that are higher or lower than the standard requirement during the test, especially during the voltage drop period. Therefore, the reactive current value measurement should be averaged over the whole drop period.		N/A
B.5	Active power		P
	If active power control characteristics are required by the local standard during LVRT events, it is necessary to characterize active powers (p_0) before, during (p_1) and after (p_2) the voltage drop, as shown in Figure B.2.		P
	Active power (p_1) may fluctuate during the voltage drop interval, especially at point (p_s) where system voltage recovery begins. It is therefore misleading to use the value of active power recorded at p_s for active power control assessment. It is suggested instead that an average value of active power be determined over the time between t_1 and t_2 to assess the characteristics of active power recovery  Figure B.2 – Determination of active power recovery		P

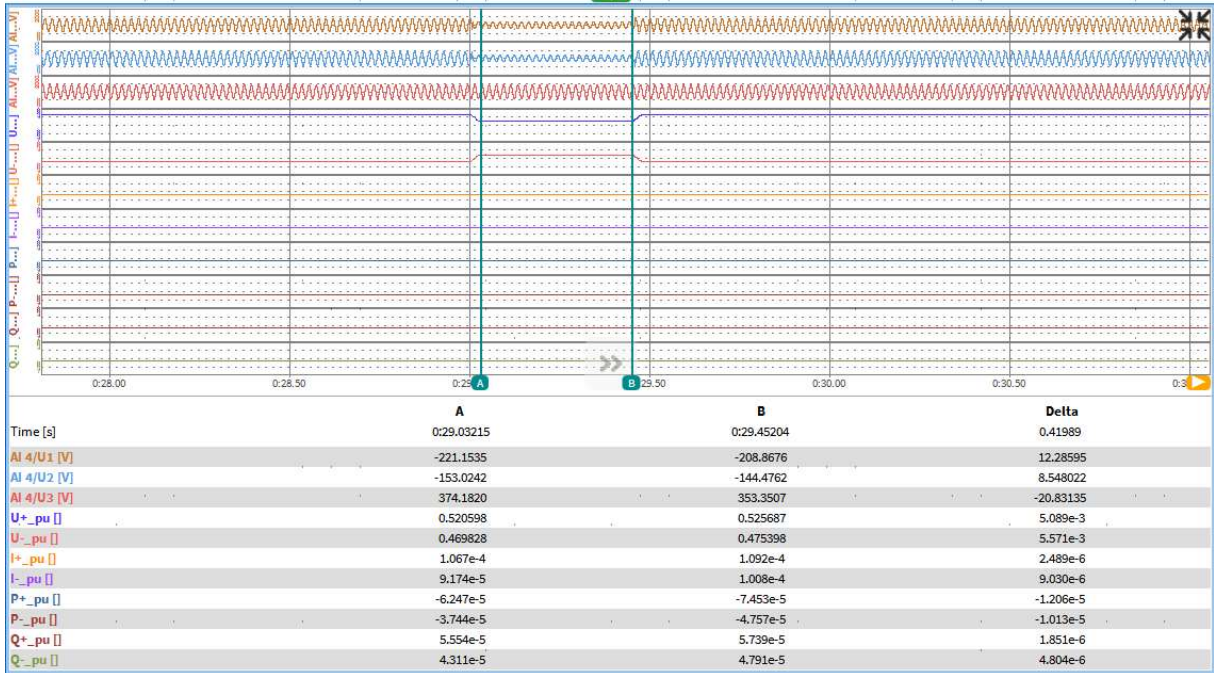
5.3.1 Pre-test (Grid simulator setting)									P
Figure	Fault Depth	Fault Duration (ms)	L1		L2		L3		Pos.pu
			pu	Degree	pu	Degree	pu	Degree	
A.2.2 (b)	5%	250	0.05	0	0.05	240	0.05	120	0.050
	20%	770	0.20	0	0.20	240	0.20	120	0.200
	50%	1800	0.50	0	0.50	240	0.50	120	0.500
	85%	3000	0.85	0	0.85	240	0.85	120	0.850
A.2.3 (b)	5%	250	0.05	0	0.59	268	0.59	92	0.366
	20%	770	0.20	0	0.64	261	0.64	99	0.467
	50%	1800	0.50	0	0.76	251	0.76	109	0.666
	85%	3000	0.85	0	0.93	243	0.93	117	0.900
A.2.4 (b)	5%	250	0.05	0	0.87	268	0.87	92	0.521
	20%	770	0.20	0	0.87	263	0.87	97	0.600
	50%	1800	0.50	0	0.90	254	0.90	106	0.750
	85%	3000	0.85	0	0.97	244	0.97	116	0.925
A.2.5 (b)	5%	250	1.00	0	0.59	212	0.59	148	0.683
	20%	770	1.00	0	0.64	218	0.64	142	0.733
	50%	1800	1.00	0	0.76	229	0.76	131	0.833
	85%	3000	1.00	0	0.92	237	0.92	123	0.950
Note: $\Delta/Yn11$ transformer connection shows the angle and phase state of A.2.2(b), A.2.3(b), A.2.4(b), A.2.5(b). SC: short circuit SC-GND: short circuit with ground SC(no ground): short circuit without ground									

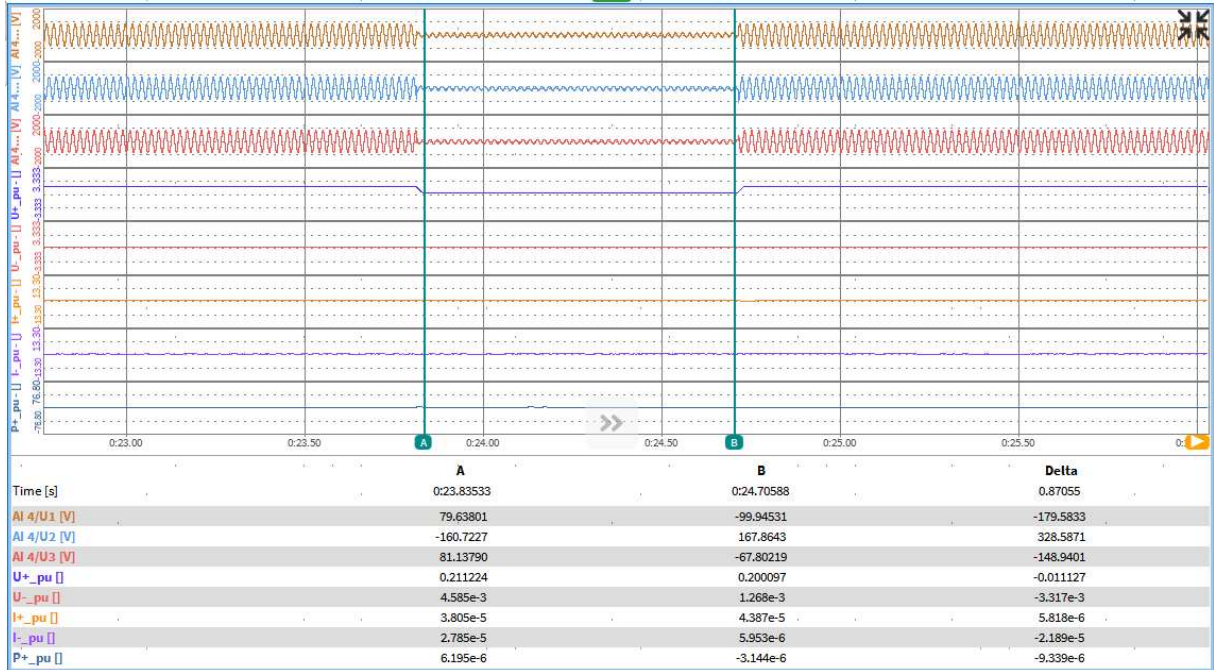
5.3.2(b)		No load Test ($\Delta/Yn11$ transformer)					P
Model: SG3125HV-32							
Test	Voltage Depth [pu]	Fault type	Measured voltage. Pos [pu]	Fault duration [ms]			Verdict
				Drop	Maintain	Restore	
2.1.1	0.05	A.2.2 (b)	0.048	16.1	321	19.0	P
2.1.2		A.2.3 (b)	0.365	19.8	431	17.5	P
2.1.3		A.2.4 (b)	0.520	16.0	419	19.7	P
2.1.4		A.2.5 (b)	0.677	18.4	415	19.7	P
2.2.1	0.20	A.2.2 (b)	0.211	19.6	870	16.8	P
2.2.2		A.2.3 (b)	0.460	14.7	961	18.3	P
2.2.3		A.2.4 (b)	0.593	18.2	962	15.9	P
2.2.4		A.2.5 (b)	0.722	18.2	950	18.2	P
2.3.1	0.50	A.2.2 (b)	0.500	13.2	1930	27.5	P
2.3.2		A.2.3 (b)	0.658	13.2	1920	17.5	P
2.3.3		A.2.4 (b)	0.745	19.3	1890	19.2	P
2.3.4		A.2.5 (b)	0.829	14.0	1860	17.5	P
2.4.1	0.85	A.2.2 (b)	0.850	14.9	3110	14.9	P
2.4.2		A.2.3 (b)	0.899	14.0	3103	14.1	P
2.4.3		A.2.4 (b)	0.925	16.1	3082	14.1	P
2.4.4		A.2.5 (b)	0.947	16.7	3085	16.7	P

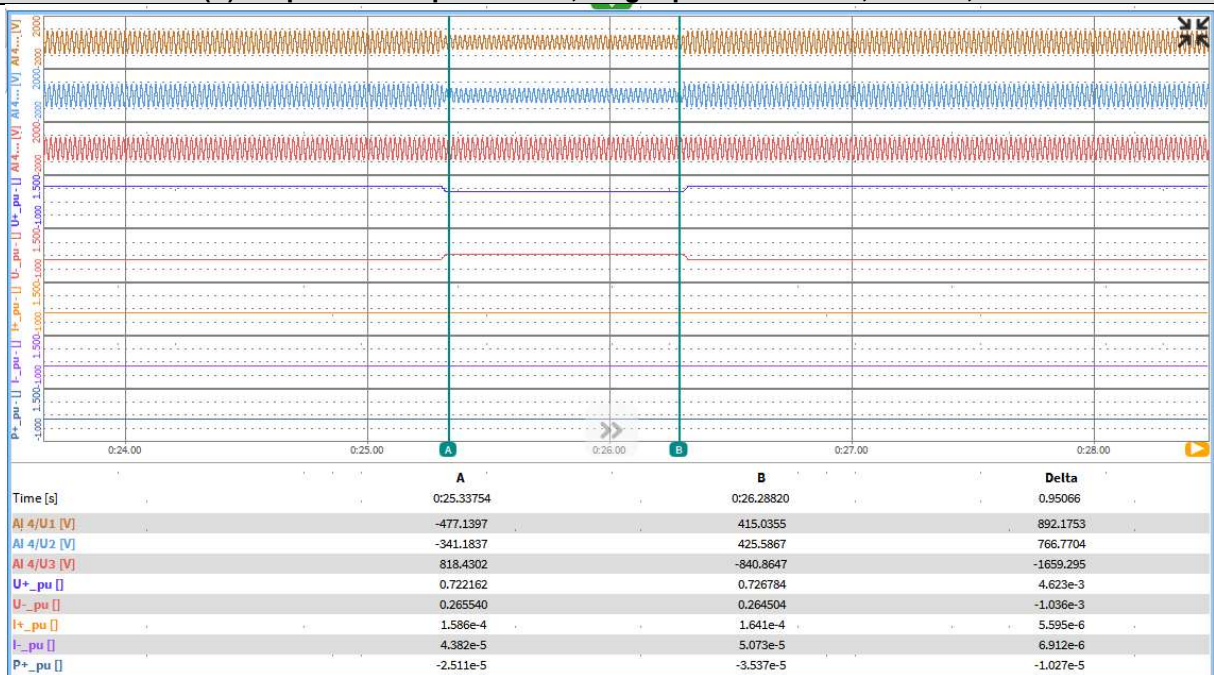
5.4.3(b)		LVRT Test (Load test - Δ/Yn11 transformer connection)				P
Model: SG3125HV-32						
Appendix: Annex D (Load test)						
Test	Voltage Depth [pu]	Fault type	Fault duration [ms]	P set point [P _{rE}]	Set point [Ki]	P/F
5.1.1	0.05	A.2.2 (b)	250	20%	2	P
5.1.2				100%		P
5.1.3		A.2.3 (b)	250	20%		P
5.1.4				100%		P
5.1.5		A.2.4 (b)	250	20%		P
5.1.6				100%		P
5.1.7		A.2.5 (b)	250	20%		P
5.1.8				100%		P
5.2.1	0.20	A.2.2 (b)	770	20%	2	P
5.2.2				100%		P
5.2.3		A.2.3 (b)	770	20%		P
5.2.4				100%		P
5.2.5		A.2.4 (b)	770	20%		P
5.2.6				100%		P
5.2.7		A.2.5 (b)	770	20%		P
5.2.8				100%		P
5.3.1	0.50	A.2.2 (b)	1800	20%	2	P
5.3.2				100%		P
5.3.3		A.2.3 (b)	1800	20%		P
5.3.4				100%		P
5.3.5		A.2.4 (b)	1800	20%		P
5.3.6				100%		P
5.3.7		A.2.5 (b)	1800	20%		P
5.3.8				100%		P
5.4.1	0.85	A.2.2 b	3000	20%	2	P
5.4.2				100%		P
5.4.3		A.2.3 b	3000	20%		P
5.4.4				100%		P
5.4.5		A.2.4 b	3000	20%		P
5.4.6				100%		P
5.4.7		A.2.5 b	3000	20%		P
5.4.8				100%		P

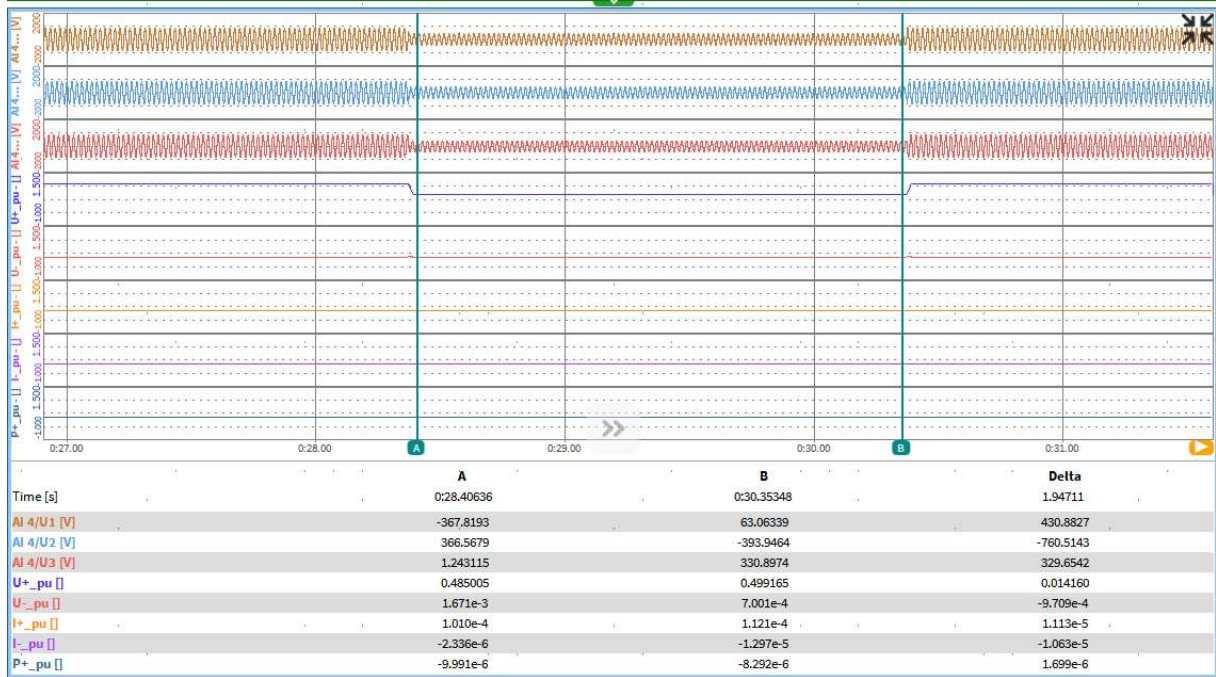
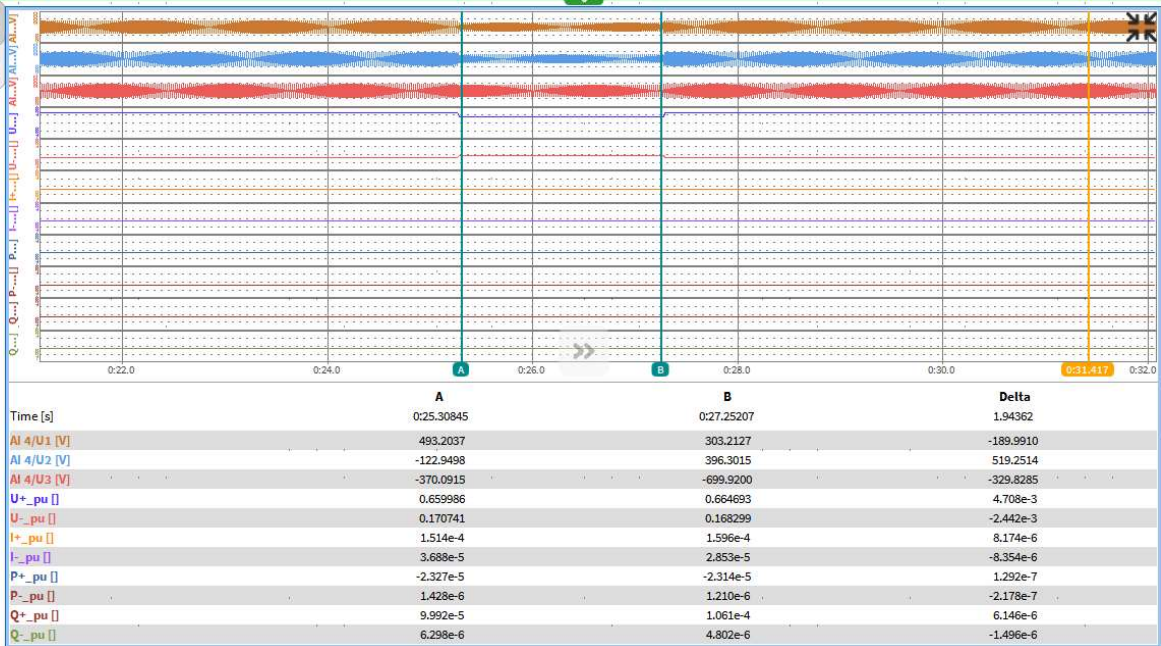
5.1(b)	LVRT Test ($\Delta/Yn11$ transformer)					P
Model	SG3125HV-32					
Test number	Required fault		Measured fault		Percentage of current after fault [%I _r]	Duration of restoring settling [ms]
	Voltage pos. [pu]	Duration [ms]	Voltage pos. [pu]	Duration [ms]		
5.1.1	0.05	250	0.061	359	103	82
5.1.2			0.053	338	104	243
5.1.3			0.390	399	69.2	257
5.1.4			0.389	385	67.0	298
5.1.5			0.539	421	44.2	43
5.1.6			0.539	394	46.1	267
5.1.7			0.693	371	49.4	110
5.1.8			0.693	371	50.5	277
5.2.1	0.20	770	0.211	827	107	65
5.2.2			0.231	834	108	272
5.2.3			0.487	919	68.8	111
5.2.4			0.486	923	66.0	306
5.2.5			0.613	916	49.8	142
5.2.6			0.611	912	49.6	247
5.2.7			0.742	914	51.4	108
5.2.8			0.742	905	51.6	292
5.3.1	0.50	1650	0.513	1880	103	140
5.3.2			0.525	1912	100	237
5.3.3			0.687	1910	64	135
5.3.4			0.689	1864	64	282
5.3.5			0.764	1873	49	145
5.3.6			0.764	1870	49	255
5.3.7			0.839	1834	30	105
5.3.8			0.841	1810	31	130
5.4.1	0.85	3000	0.850	3022	29	215
5.4.2			0.855	3080	31	145
5.4.3			0.909	3045	19	175
5.4.4			0.912	3093	19	102
5.4.5			0.930	3028	14.1	178
5.4.6			0.937	3057	14.2	122
5.4.7			0.952	3088	10.1	156
5.4.8			0.957	3082	10.1	114

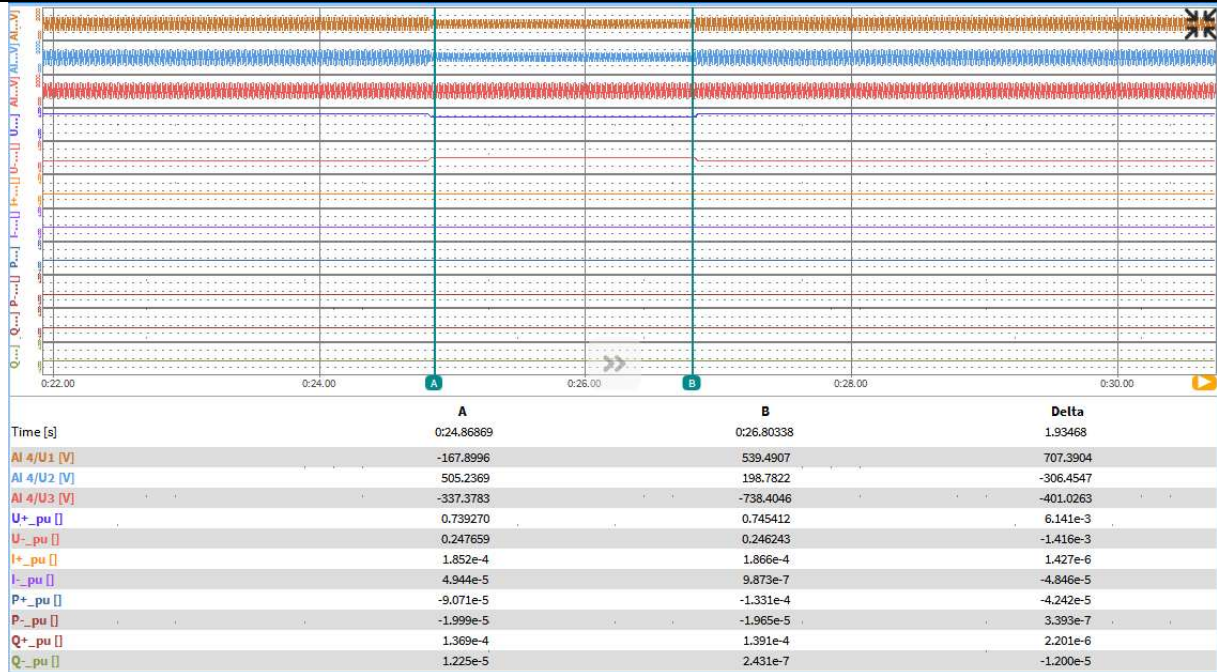
Test 2.1.1**A.2.2(b): Depth of fault phase:5%, three-phase SC fault, $\Delta/Yn11$, 0% load****Test 2.1.2****A.2.3(b): Depth of fault phase:5%, two-phase SC-GND, $\Delta/Yn11$, 0% load**

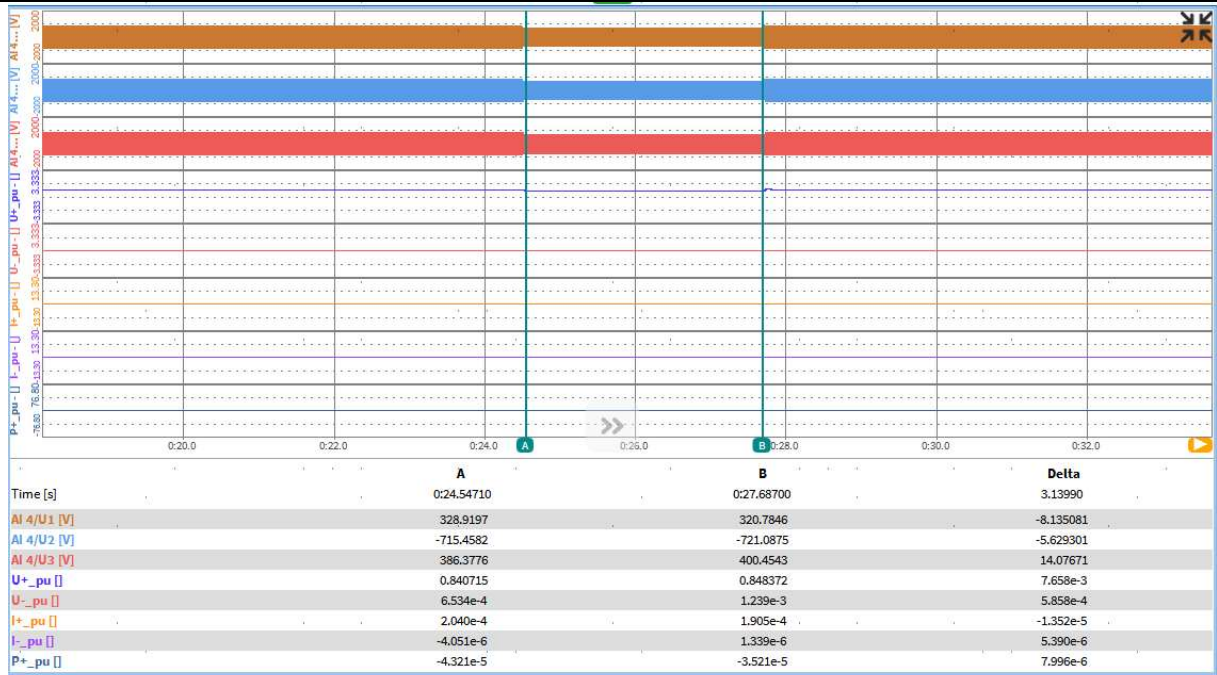
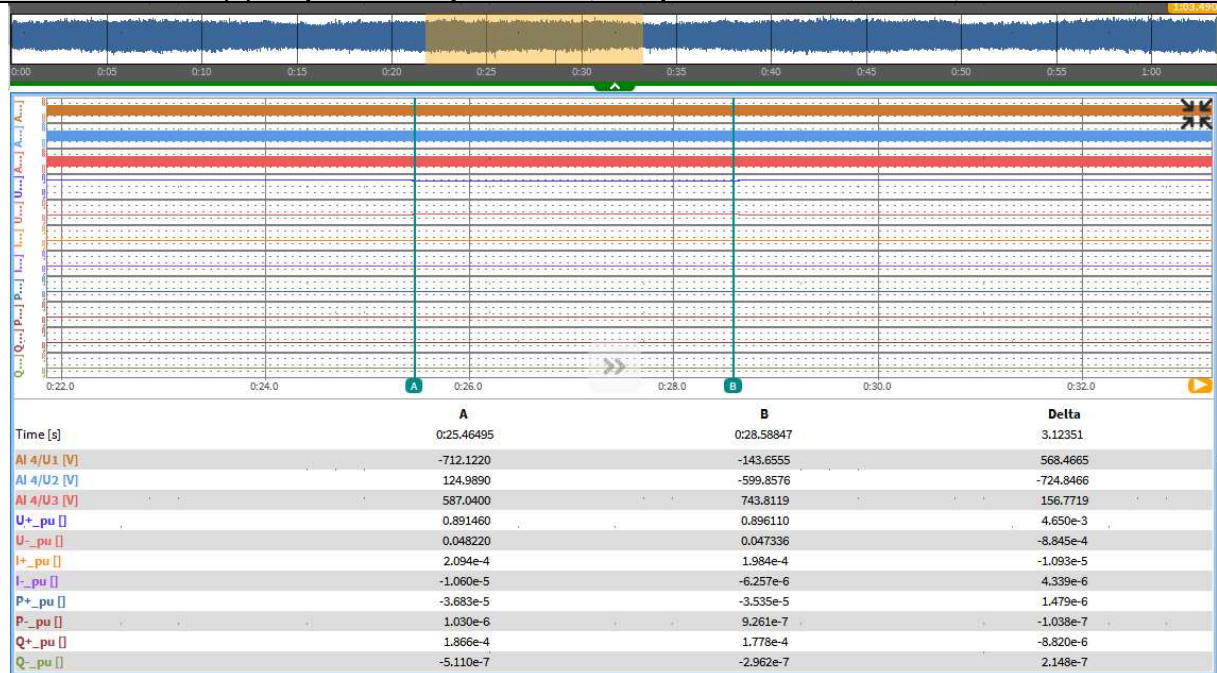
Test 2.1.3**A.2.4(b): Depth of fault phase:5%, two-phase SC(no ground), $\Delta/Yn11$, 0% load****Test 2.1.4****A.2.5(b): Depth of fault phase:5%, single-phase SC-GND, $\Delta/Yn11$, 0% load**

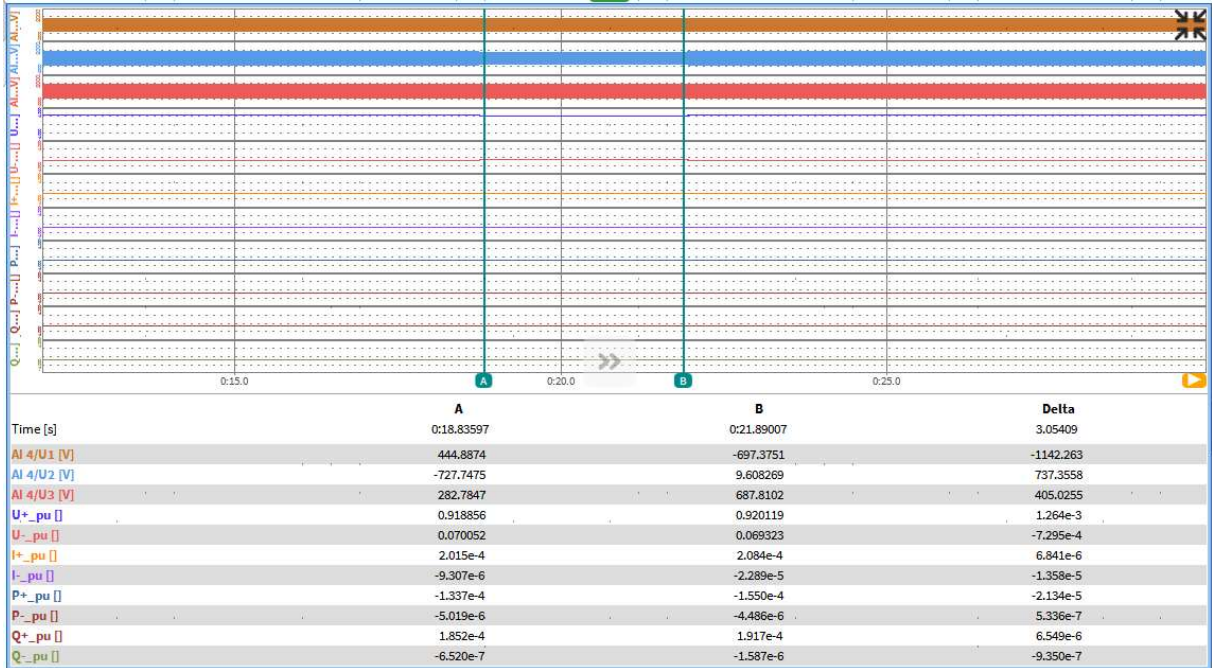
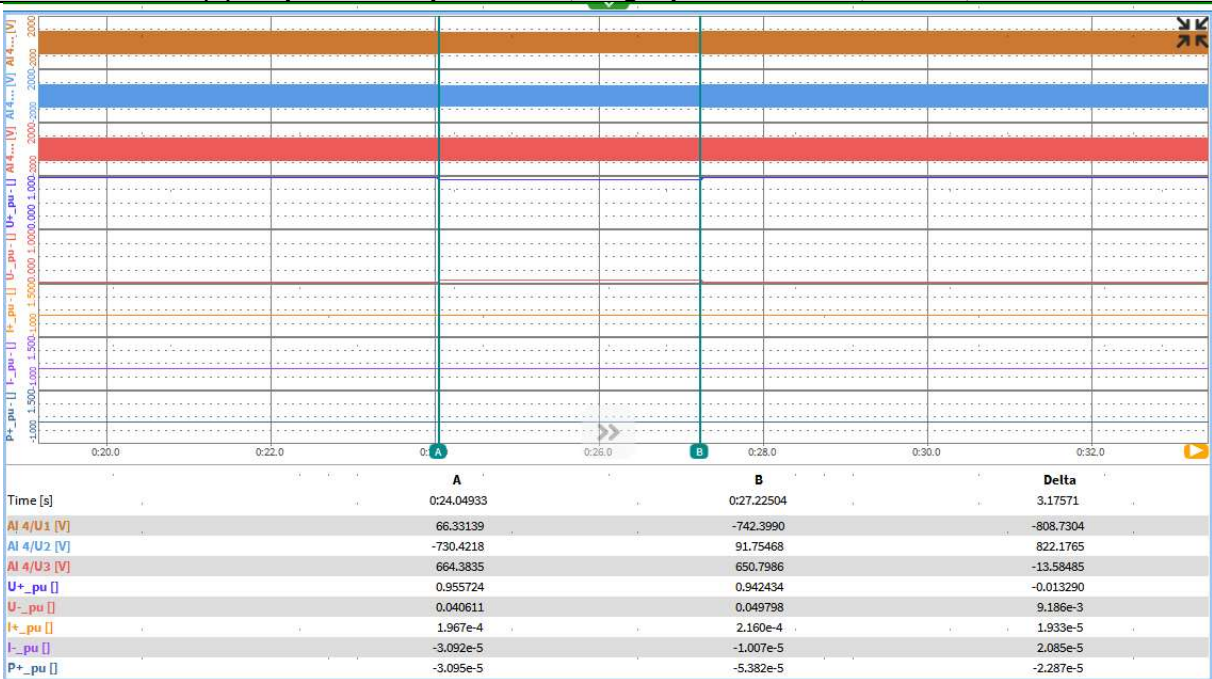
Test 2.2.1**A.2.2(b): Depth of fault phase:20%, three-phase SC fault, $\Delta/Yn11$, 0% load****Test 2.2.2****A.2.3(b): Depth of fault phase:20%, two-phase SC-GND, $\Delta/Yn11$, 0% load**

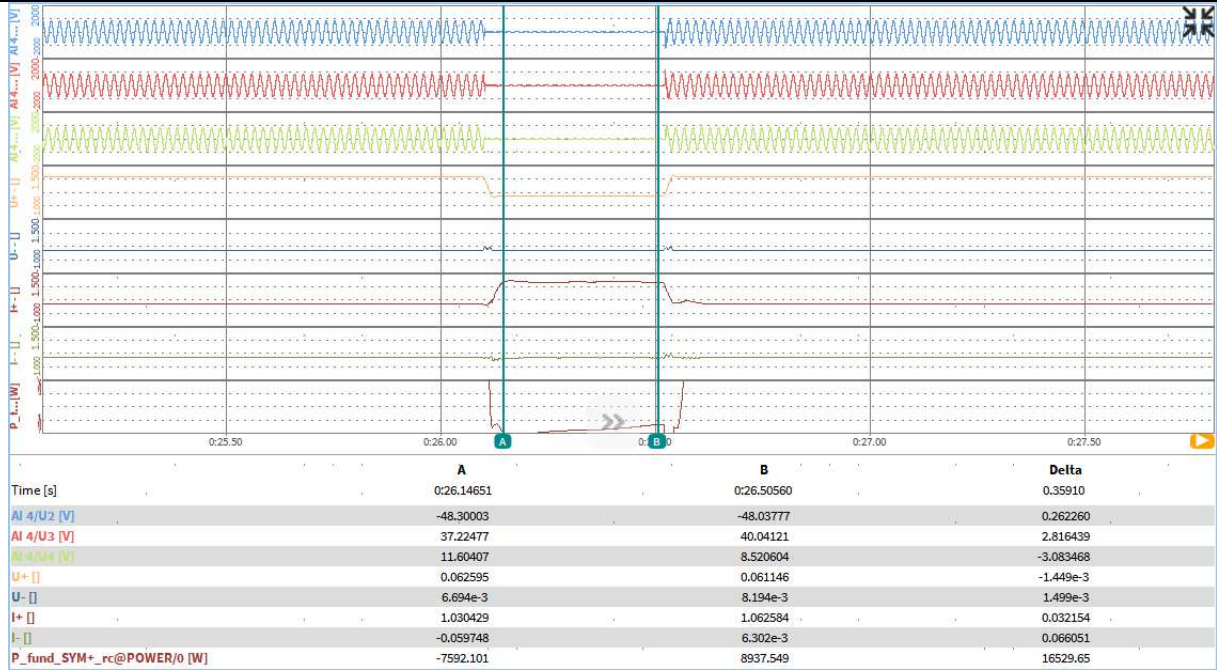
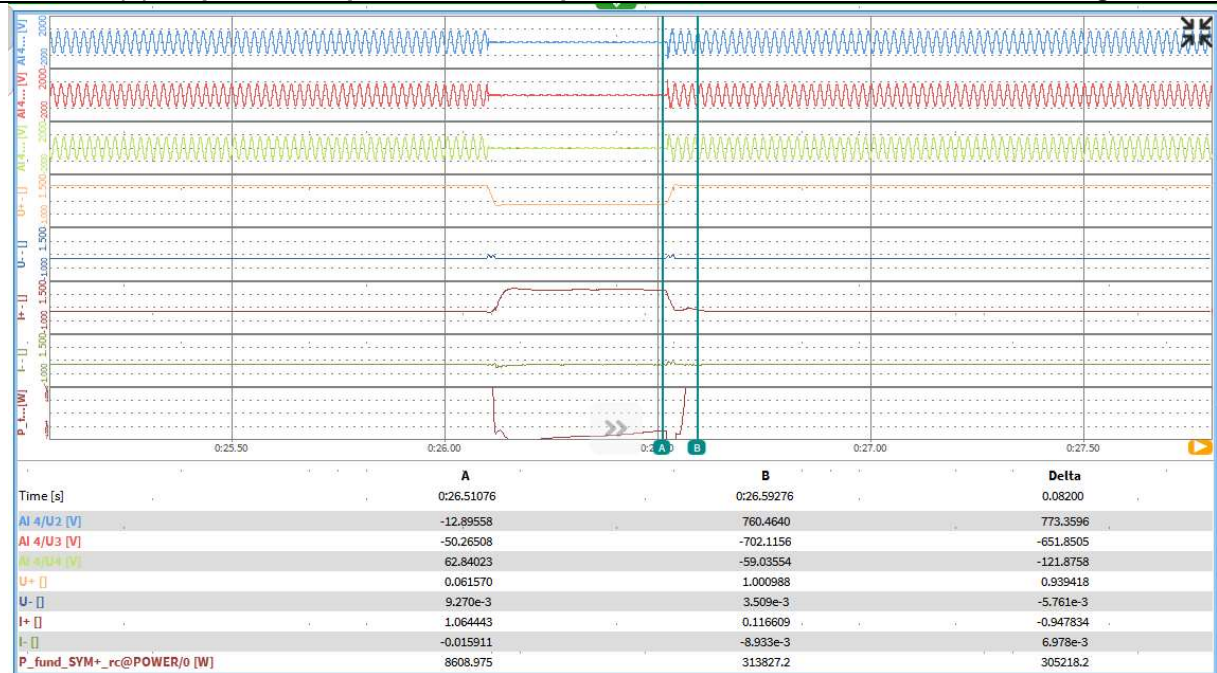
Test 2.2.3**A.2.4(b): Depth of fault phase:20%, two-phase SC(no ground), $\Delta/Yn11$, 0% load****Test 2.2.4****A.2.5(b): Depth of fault phase:20%, single-phase SC-GND, $\Delta/Yn11$, 0% load**

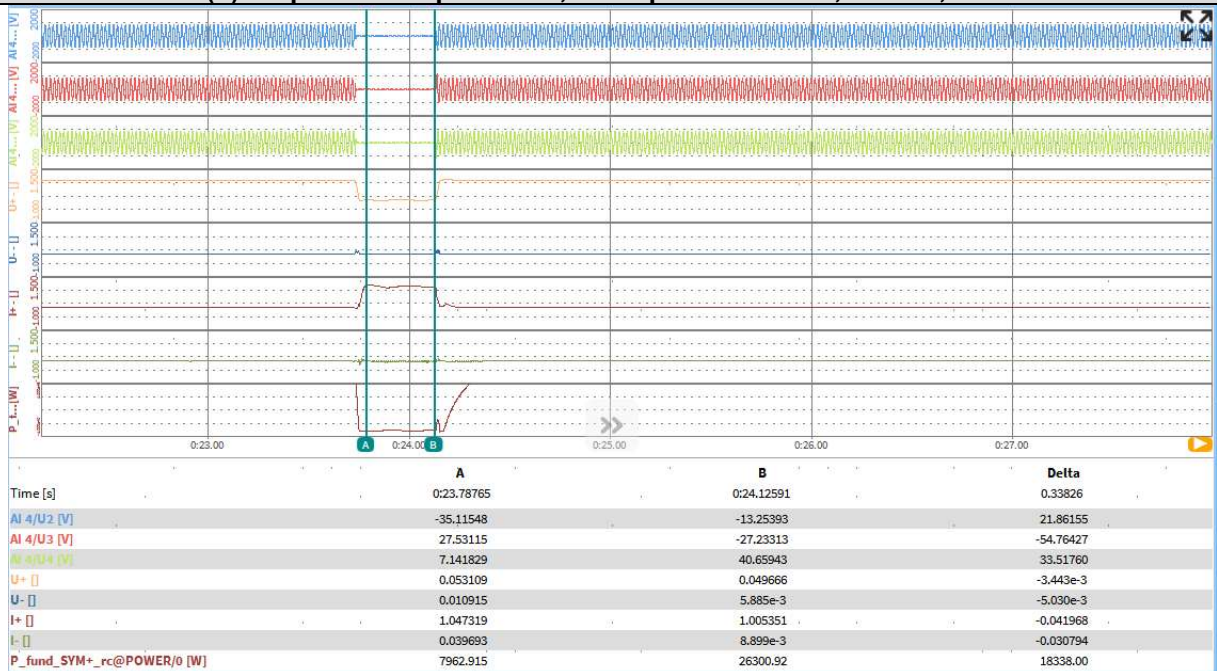
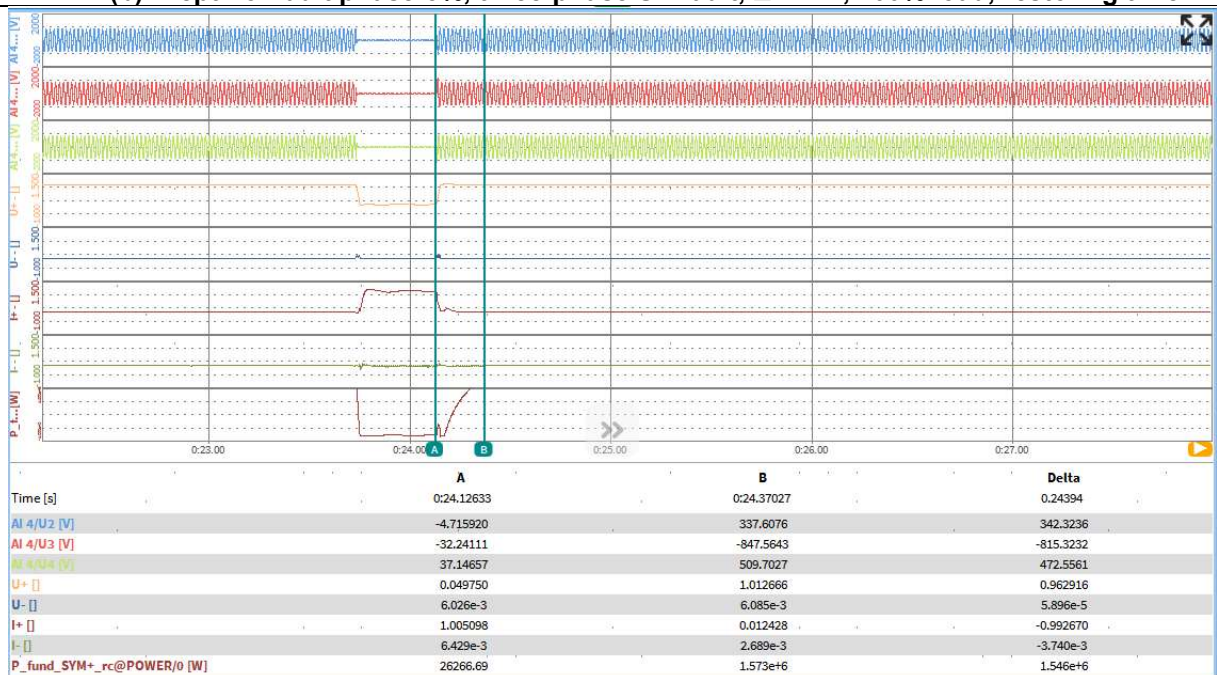
Test 2.3.1**A.2.2(b): Depth of fault phase:50%, three-phase SC fault, $\Delta/Yn11$, 0% load****Test 2.3.2****A.2.3(b): Depth of fault phase:50%, two-phase SC-GND, $\Delta/Yn11$, 0% load**

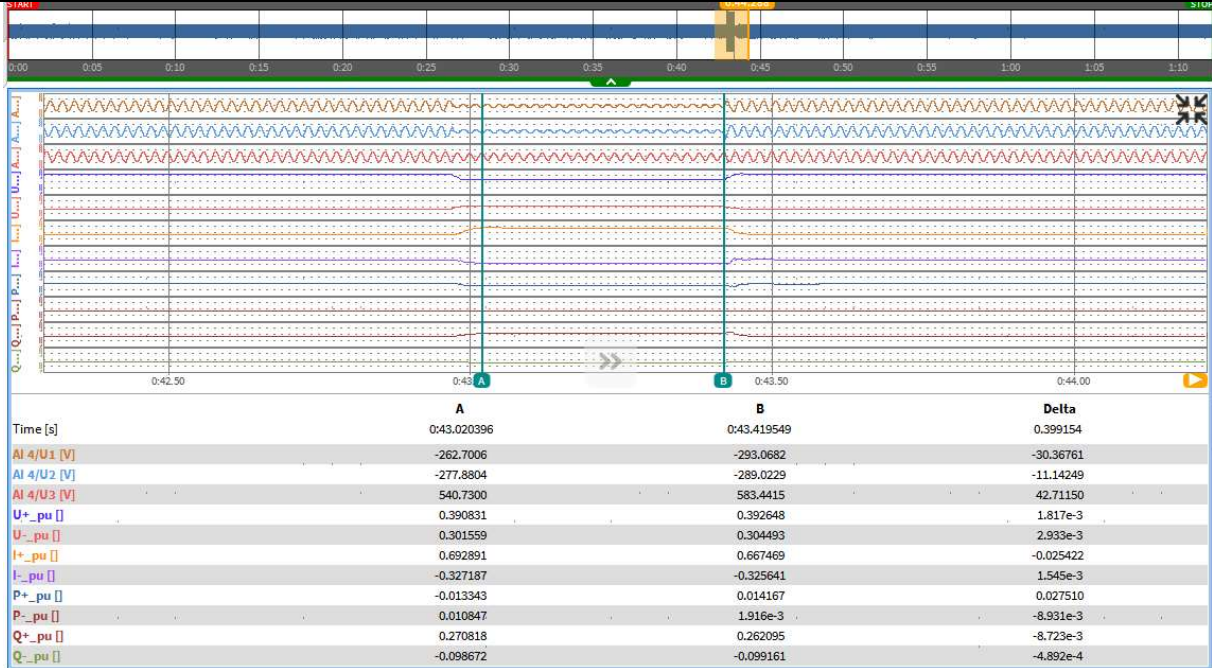
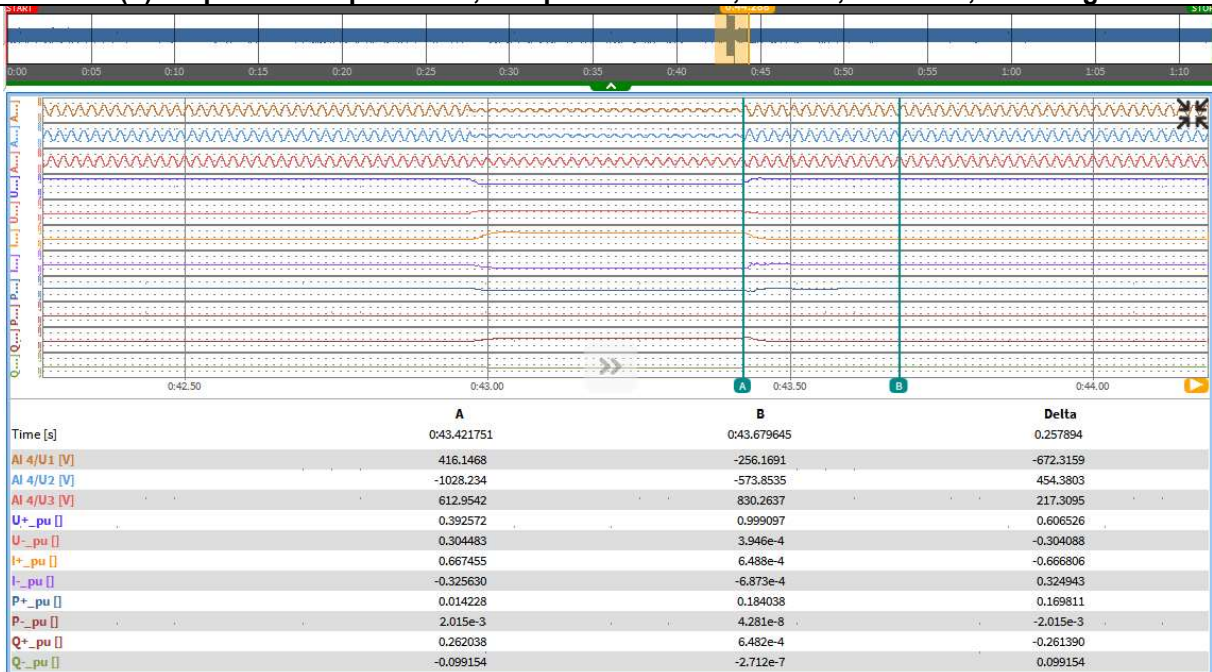
Test 2.3.3**A.2.4(b): Depth of fault phase:50%, two-phase SC(no ground), $\Delta/Yn11$, 0% load****Test 2.3.4****A.2.5(b): Depth of fault phase:50%, single-phase SC-GND, $\Delta/Yn11$, 0% load**

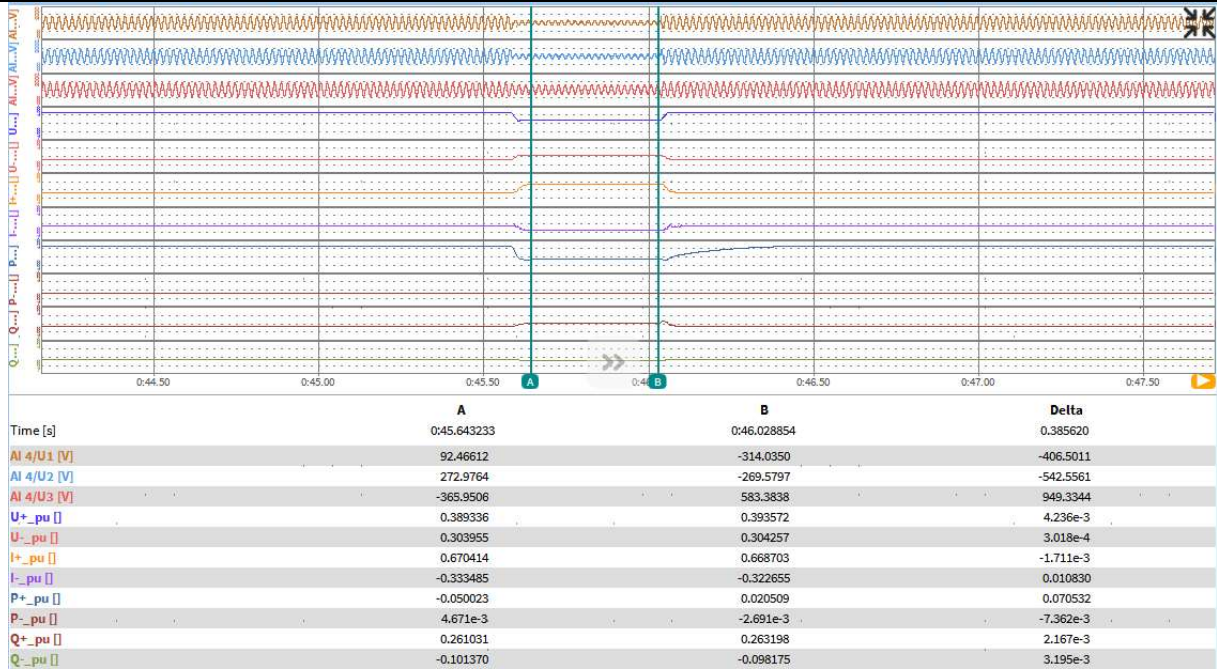
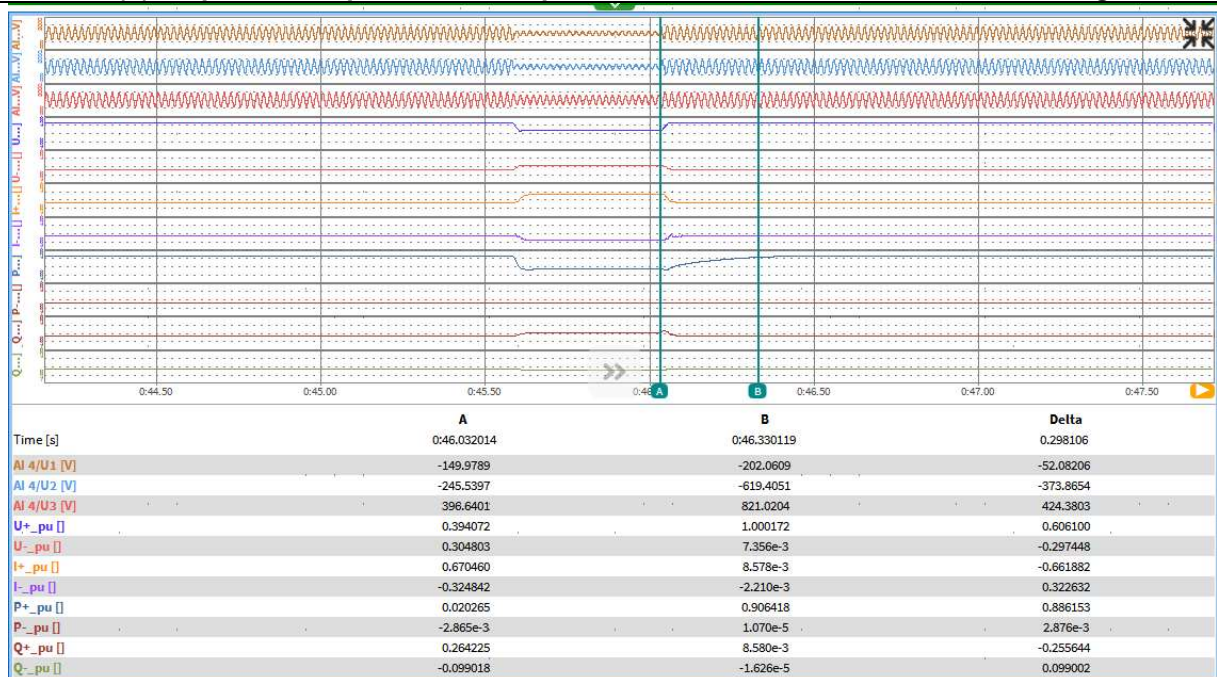
Test 2.4.1**A.2.2(b): Depth of fault phase:85%, three-phase SC fault, $\Delta/Yn11$, 0% load****Test 2.4.2****A.2.3(b): Depth of fault phase:85%, two-phase SC-GND, $\Delta/Yn11$, 0% load**

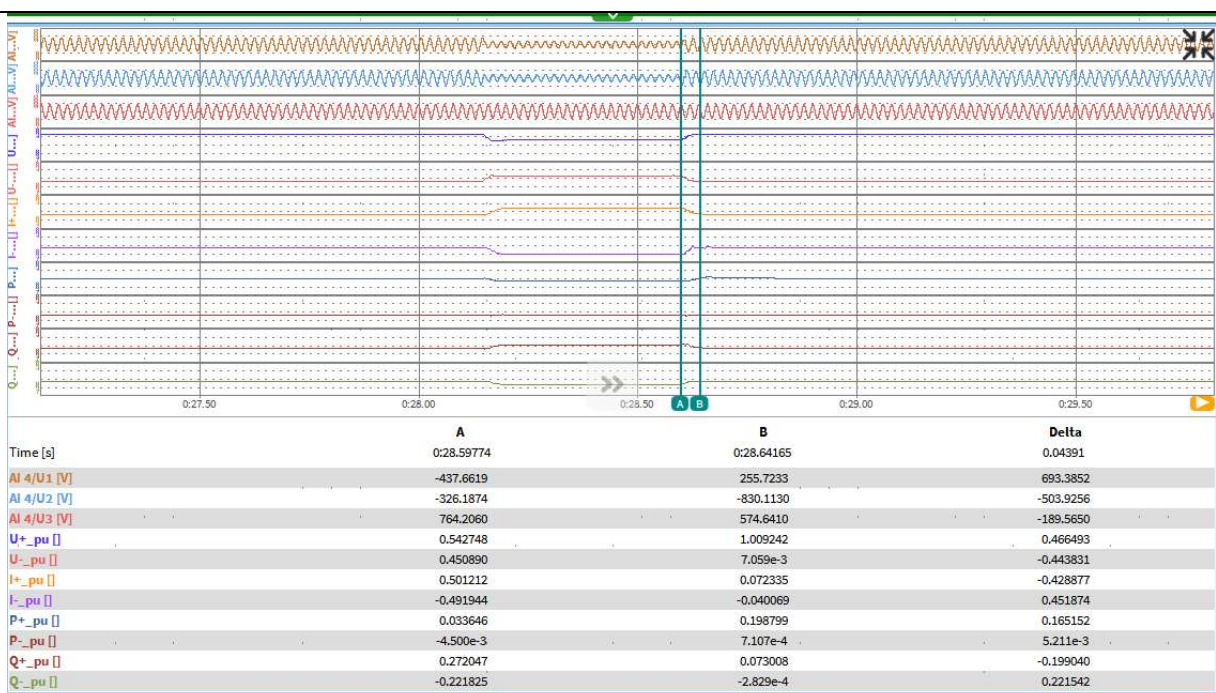
Test 2.4.3**A.2.4(b): Depth of fault phase:85%, two-phase SC(no ground), $\Delta/Yn11$, 0% load****Test 2.4.4****A.2.4(b): Depth of fault phase:85%, single-phase SC-GND, $\Delta/Yn11$, 0% load**

Test 5.1.1**A.2.2(b): Depth of fault phase:5%, three-phase SC fault, $\Delta/Yn11$, 20% load****Test 5.1.1****A.2.2(b): Depth of fault phase:5%, three-phase SC fault, $\Delta/Yn11$, 20% load, restoring time**

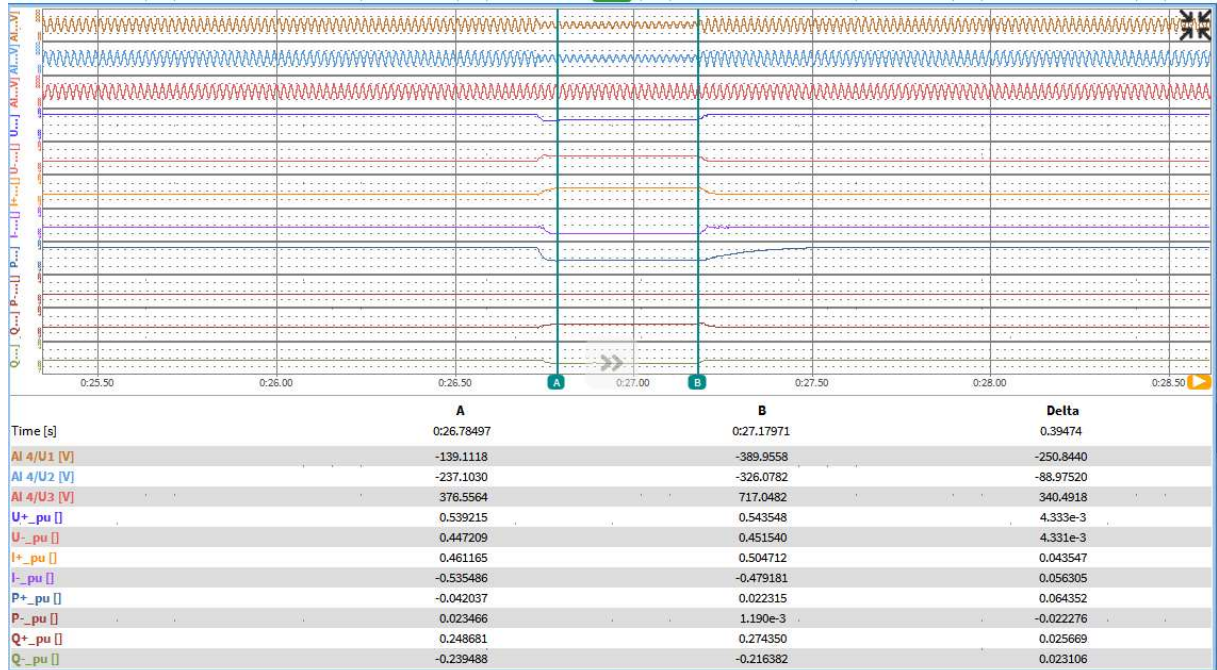
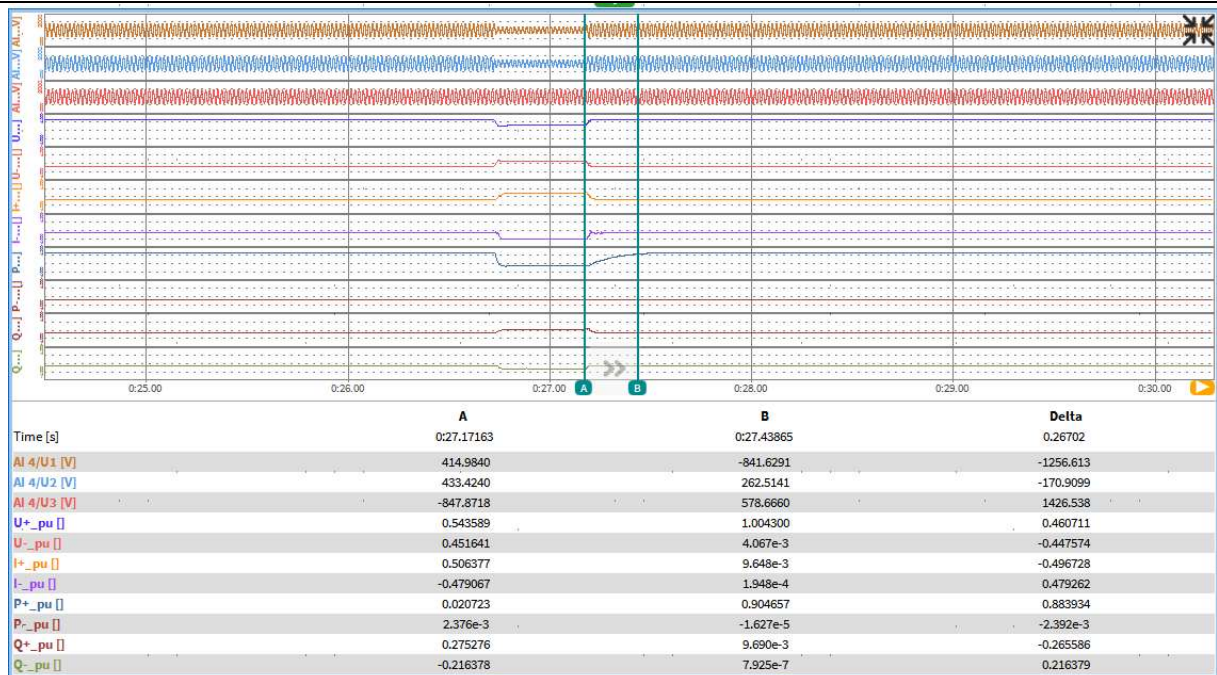
Test 5.1.2**A.2.2(b): Depth of fault phase:5%, three-phase SC fault, $\Delta/Yn11$, 100% load****Test 5.1.2****A.2.2(b): Depth of fault phase:5%, three-phase SC fault, $\Delta/Yn11$, 100% load, restoring time**

Test 5.1.3**A.2.3(b): Depth of fault phase:5%, two-phase SC-GND, $\Delta/Yn11$, 20% load****Test 5.1.3****A.2.3(b): Depth of fault phase:5%, two-phase SC-GND, $\Delta/Yn11$, 20% load, restoring time**

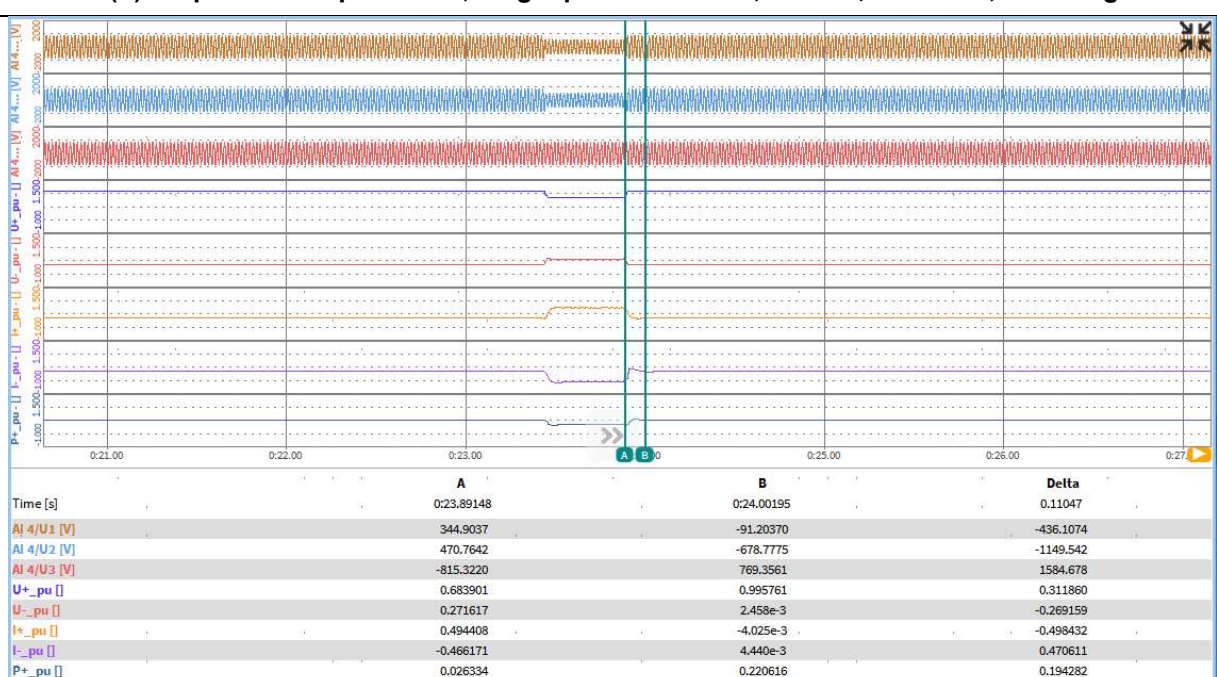
Test 5.1.4**A.2.3(b): Depth of fault phase:5%, two-phase SC-GND, $\Delta/Yn11$, 100% load****Test 5.1.4****A.2.3(b): Depth of fault phase:5%, two-phase SC-GND, $\Delta/Yn11$, 100% load, restoring time**

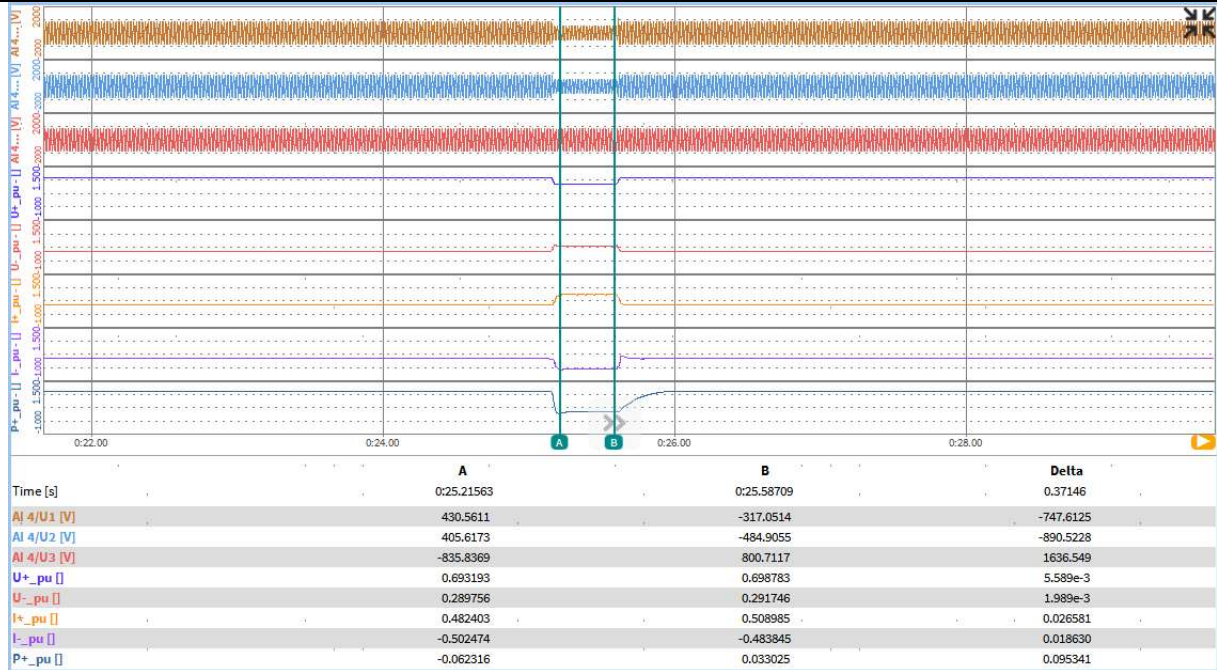
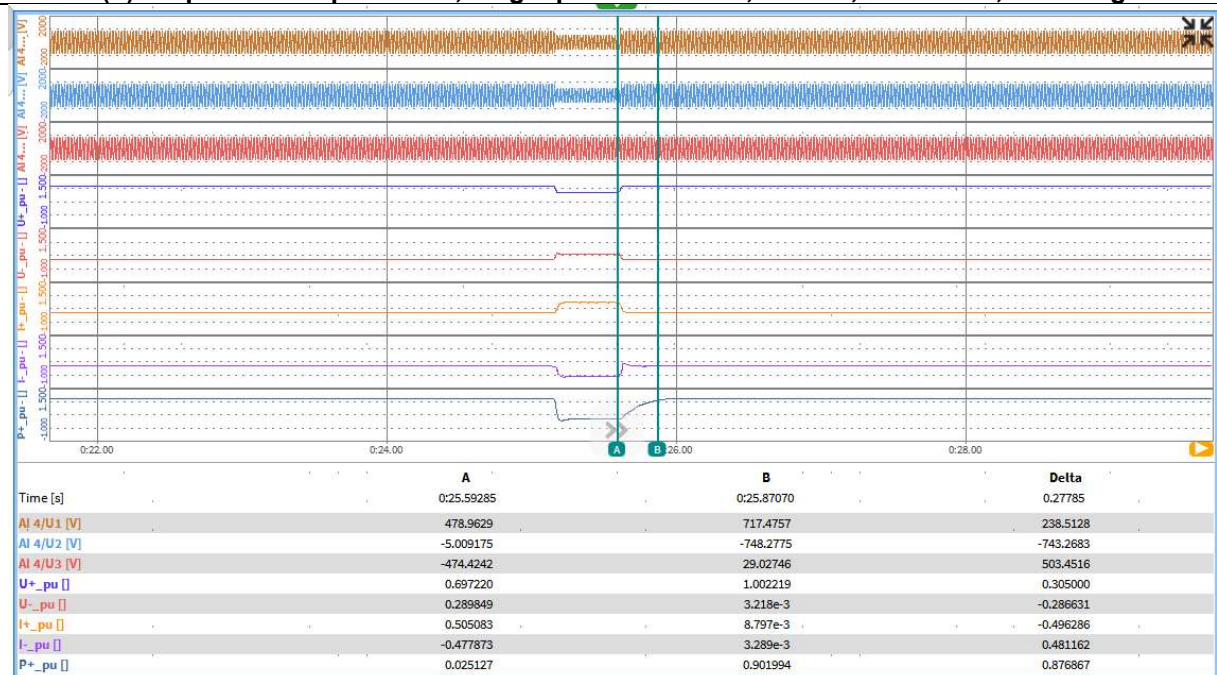
Test 5.1.5**A.2.4(b): Depth of fault phase:5%, two-phase SC(no ground), $\Delta/Yn11$, 20% load****A.2.4(b): Depth of fault phase:5%, two-phase SC(no ground), $\Delta/Yn11$, 20% load, restoring time**

Test 5.1.6

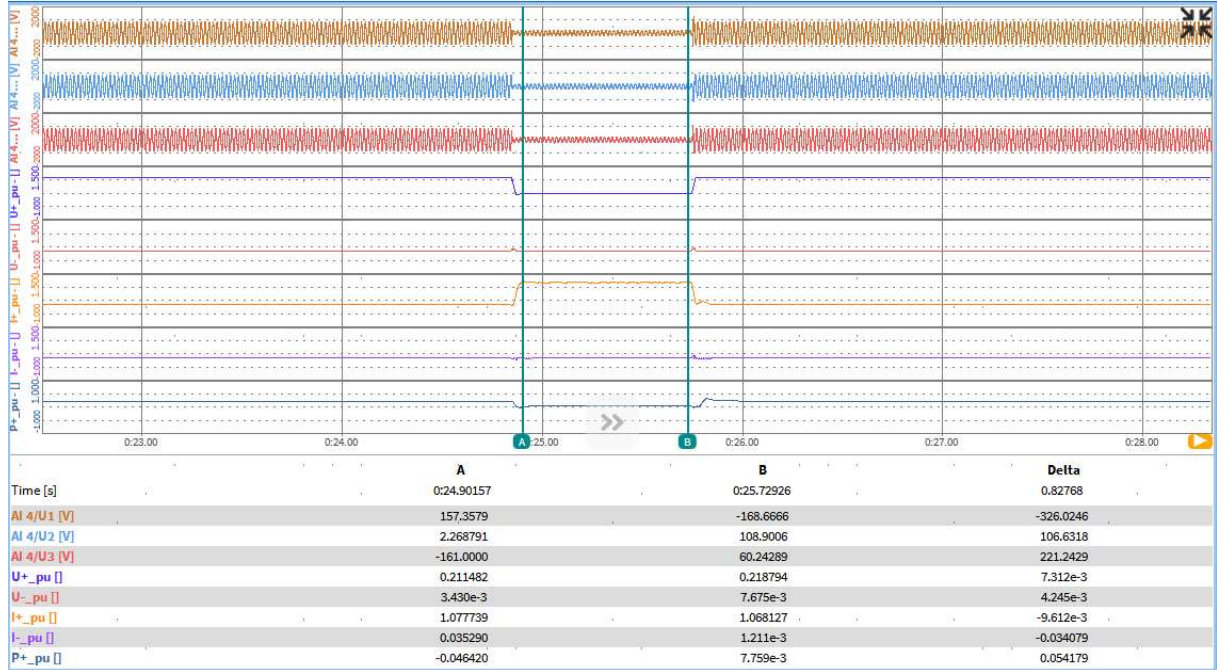
A.2.4(b): Depth of fault phase:5%, two-phase SC(no ground), $\Delta/Yn11$, 100% loadA.2.4(b): Depth of fault phase:5%, two-phase SC(no ground), $\Delta/Yn11$, 100% load, restoring time

Test 5.1.7

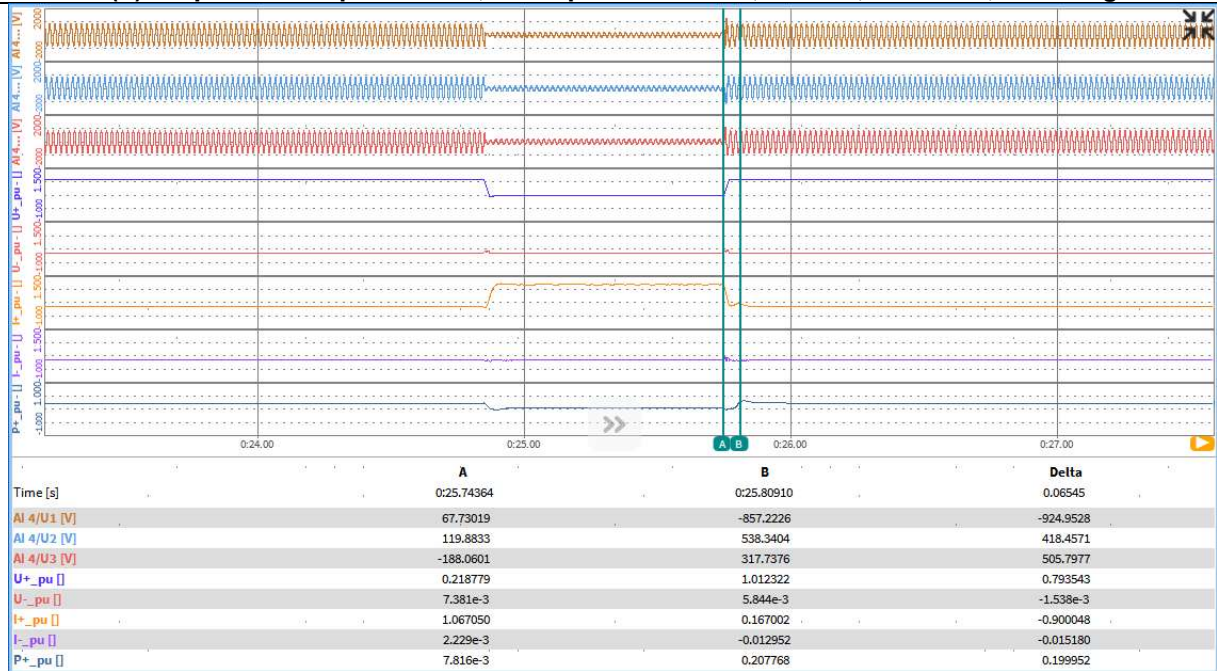
A.2.5(b): Depth of fault phase:5%, single-phase SC-GND, $\Delta/Yn11$, 20% loadA.2.5(b): Depth of fault phase:5%, single-phase SC-GND, $\Delta/Yn11$, 20% load, restoring time

Test 5.1.8**A.2.5(b): Depth of fault phase:5%, single-phase SC-GND, $\Delta/Yn11$, 100% load****Test 5.1.8****A.2.5(b): Depth of fault phase:5%, single-phase SC-GND, $\Delta/Yn11$, 100% load, restoring time**

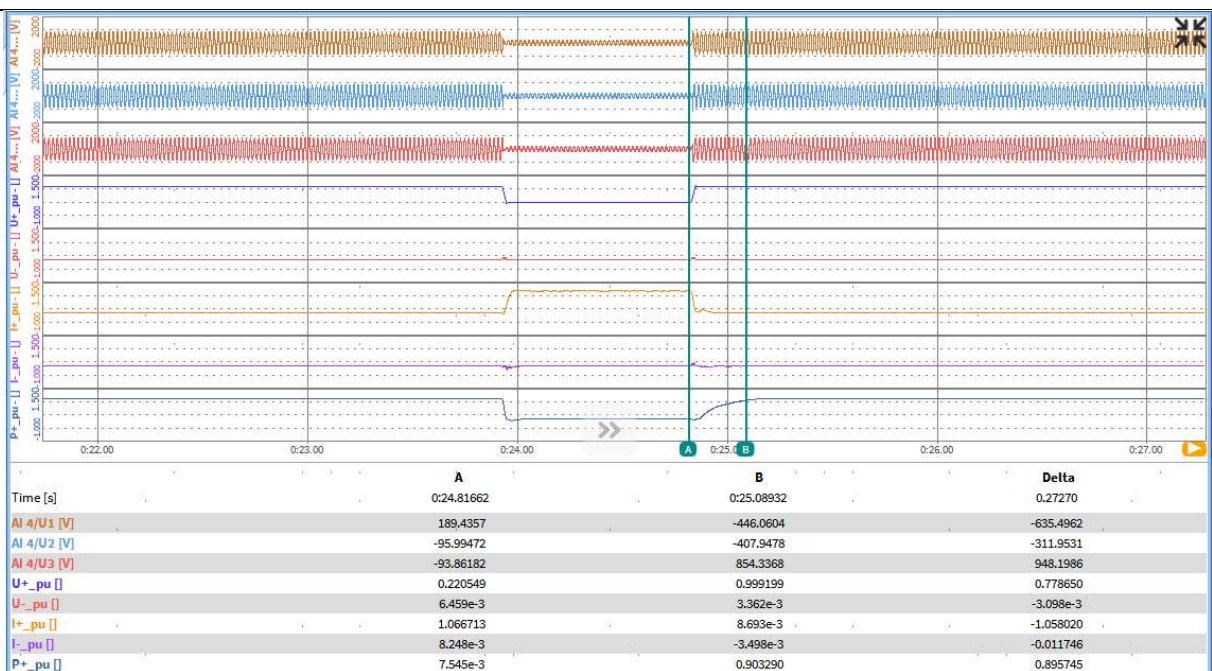
Test 5.2.1

A.2.2(b): Depth of fault phase:20%, three-phase SC fault, $\Delta/Yn11$, 20% load

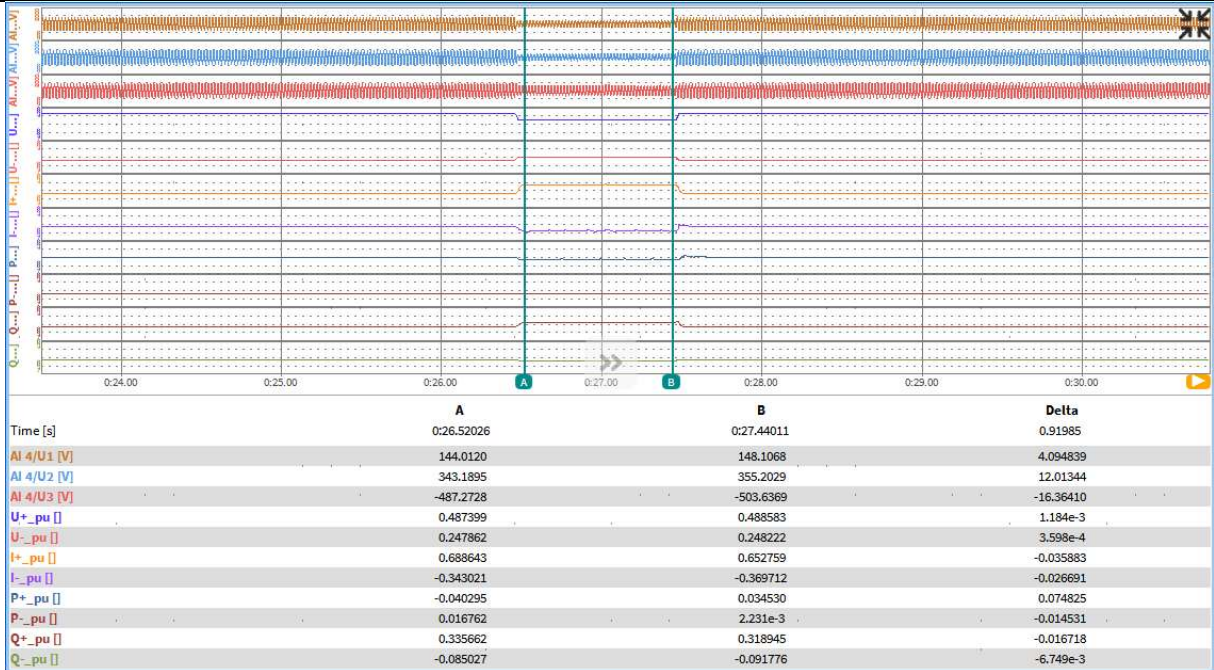
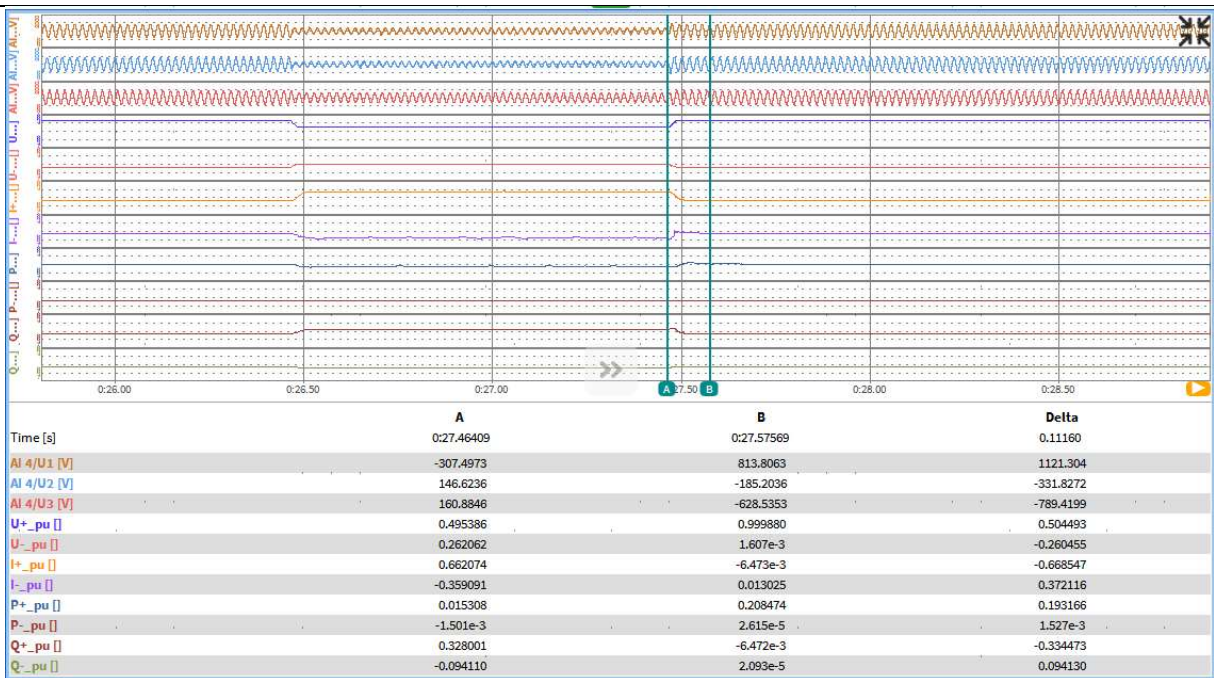
Test 5.2.1

A.2.2(b): Depth of fault phase:20%, three-phase SC fault, $\Delta/Yn11$, 20% load, restoring time

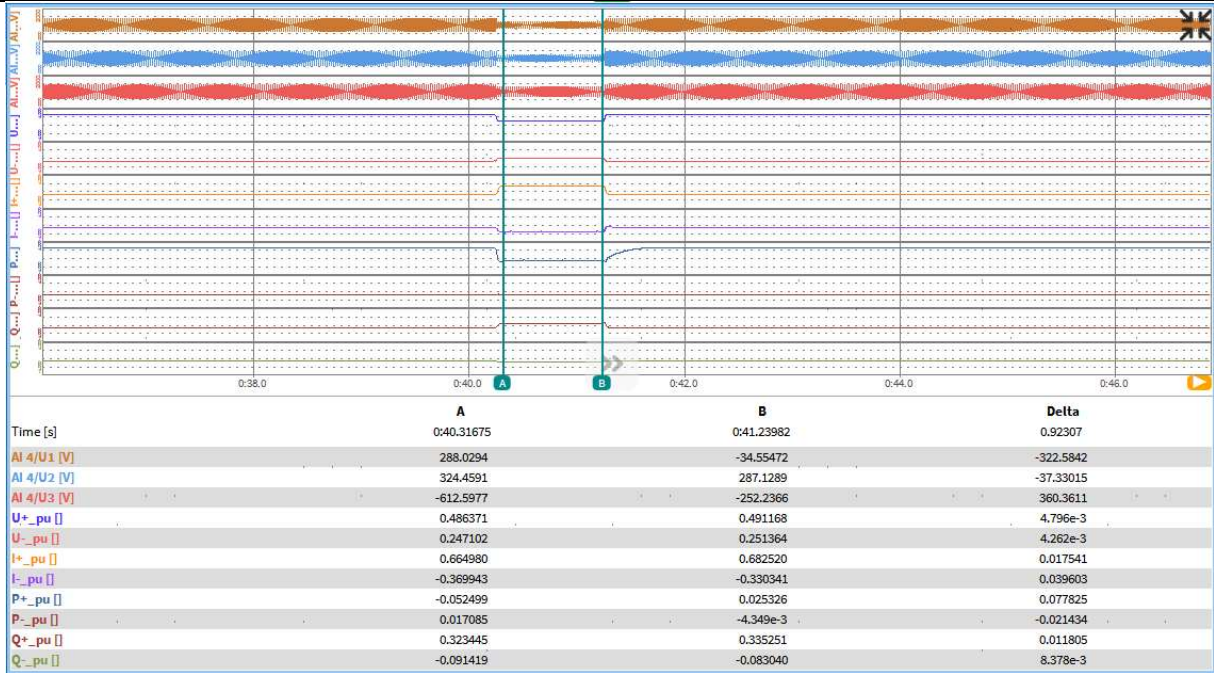
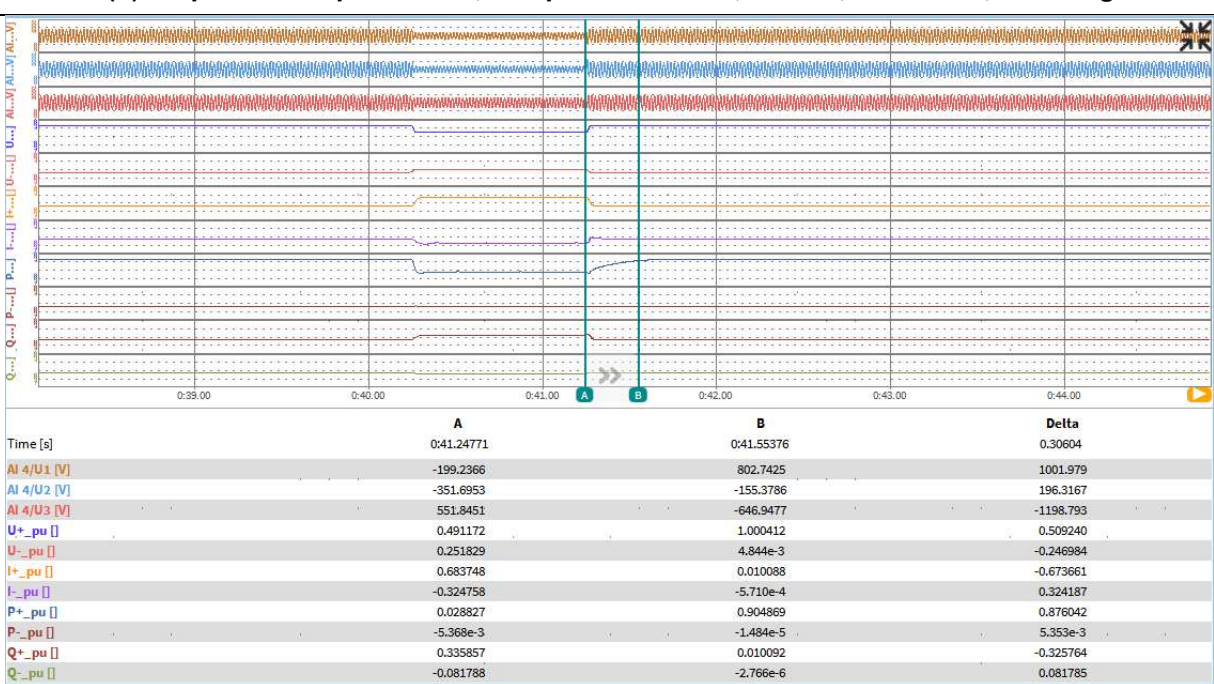
Test 5.2.2

A.2.2(b): Depth of fault phase:20%, three-phase SC fault, $\Delta/Yn11$, 100% loadA.2.2(b): Depth of fault phase:20%, three-phase SC fault, $\Delta/Yn11$, 100% load, restoring time

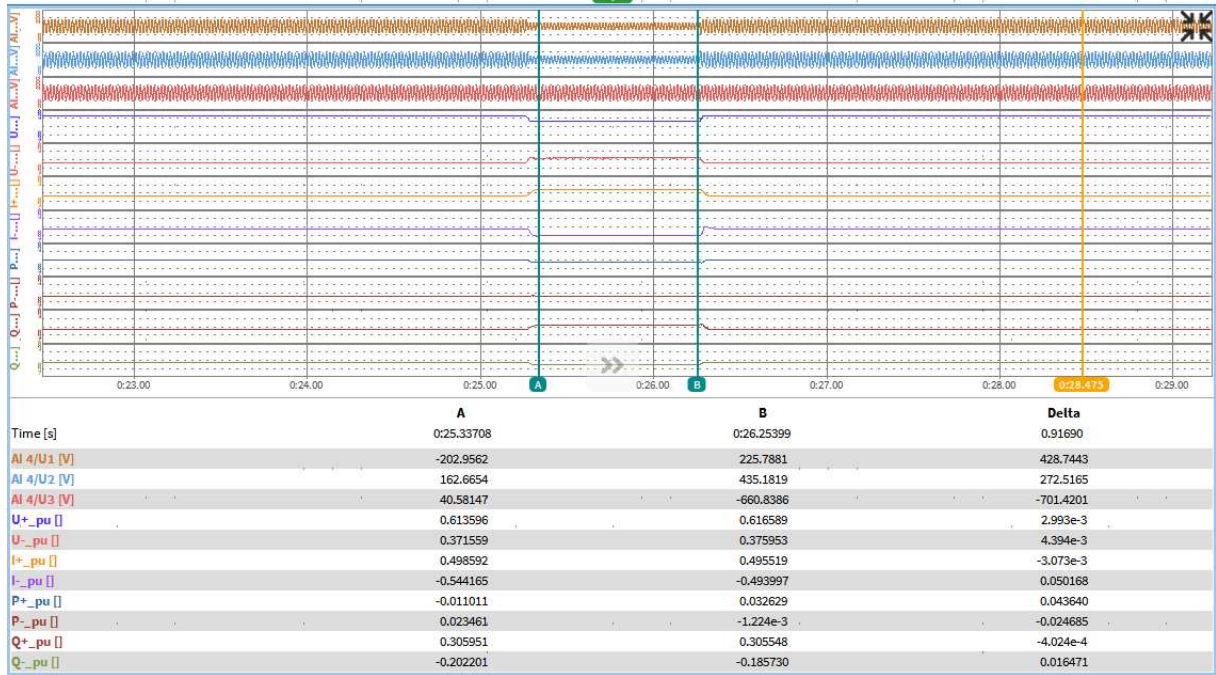
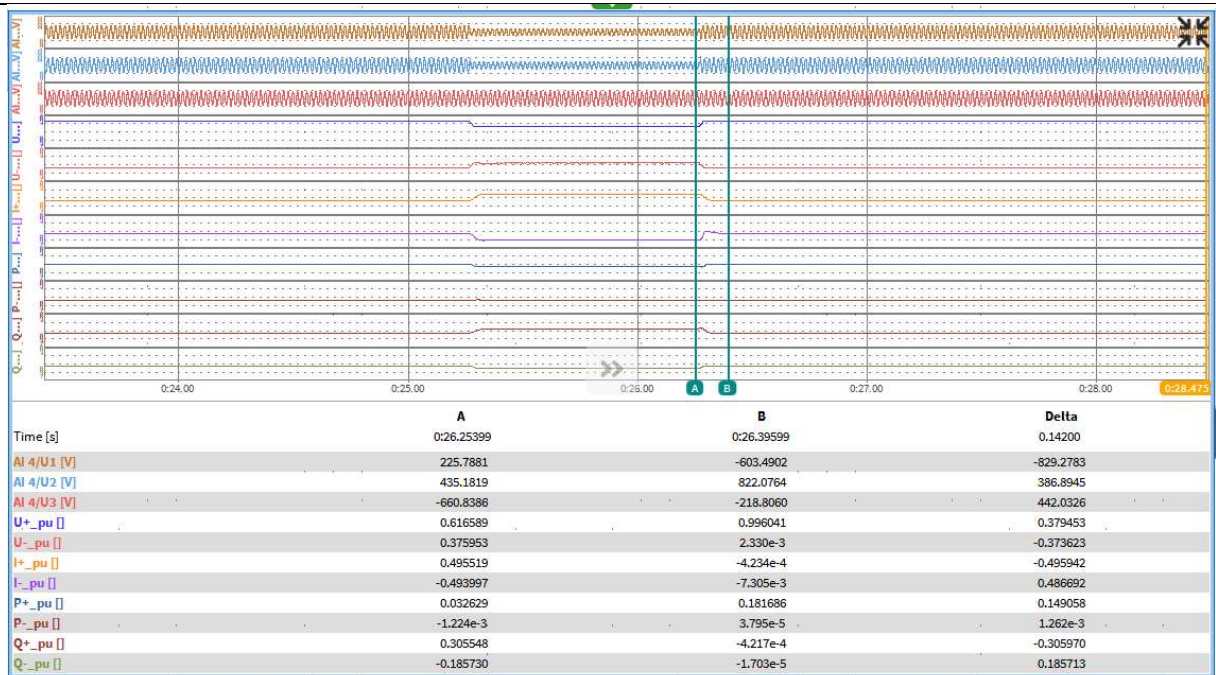
Test 5.2.3

A.2.3(b): Depth of fault phase:20%, two-phase SC-GND, $\Delta/Yn11$, 20% loadA.2.3(b): Depth of fault phase:20%, two-phase SC-GND, $\Delta/Yn11$, 20% load, restoring time

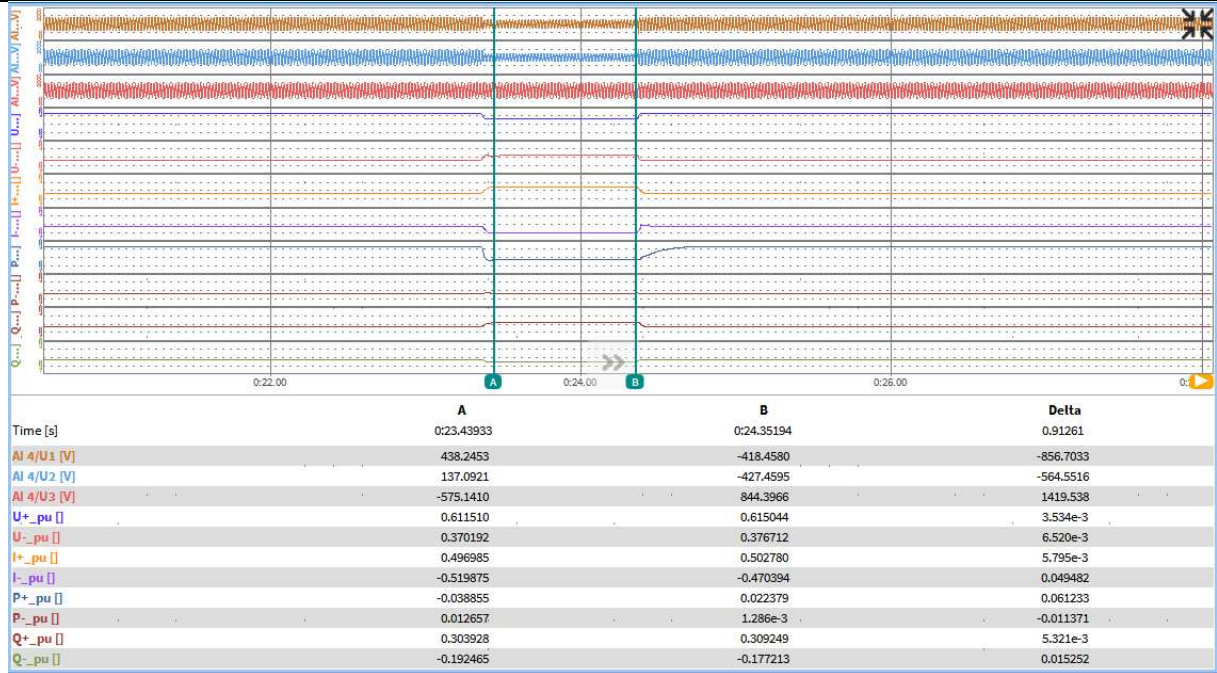
Test 5.2.4

A.2.3(b): Depth of fault phase:20%, two-phase SC-GND, $\Delta/Yn11$, 100% loadA.2.3(b): Depth of fault phase:20%, two-phase SC-GND, $\Delta/Yn11$, 100% load, restoring time

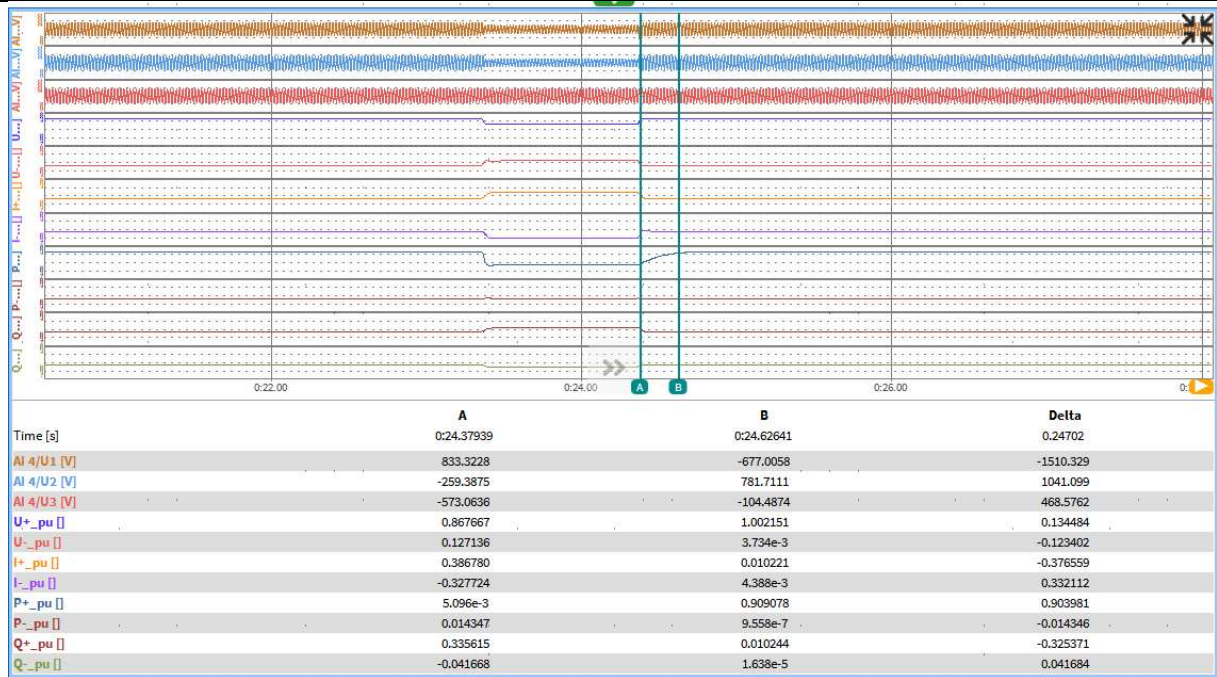
Test 5.2.5

A.2.4(b): Depth of fault phase:20%, two-phase SC(no ground), $\Delta/Yn11$, 20% loadA.2.4(b): Depth of fault phase:20%, two-phase SC(no ground), $\Delta/Yn11$, 20% load, restoring time

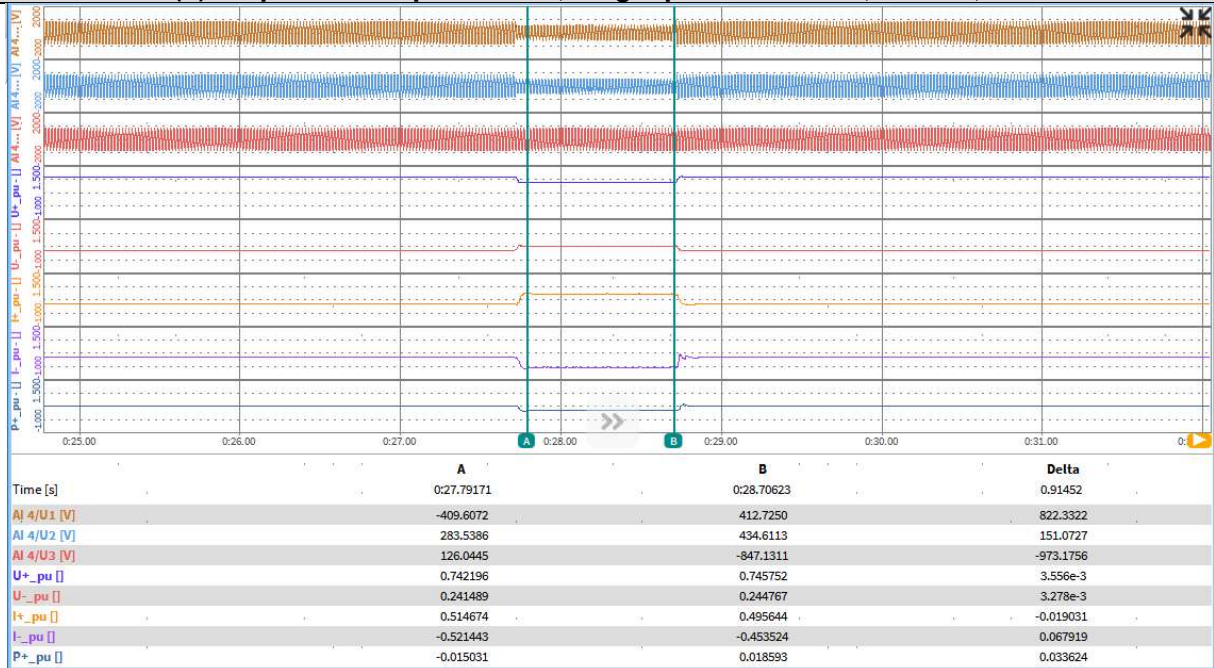
Test 5.2.6

A.2.4(b): Depth of fault phase:20%, two-phase SC(no ground), $\Delta/Yn11$, 100% load

A.2.4(b):

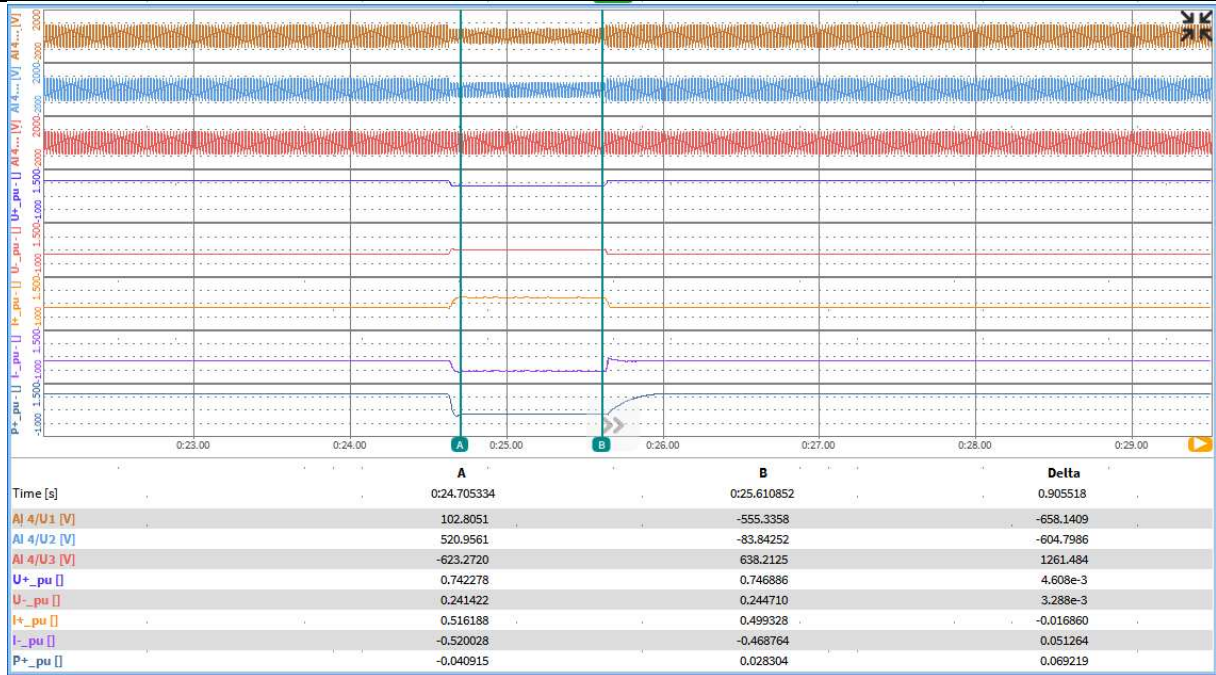
Depth of fault phase:20%, two-phase SC(no ground), $\Delta/Yn11$, 100% load, restoring time

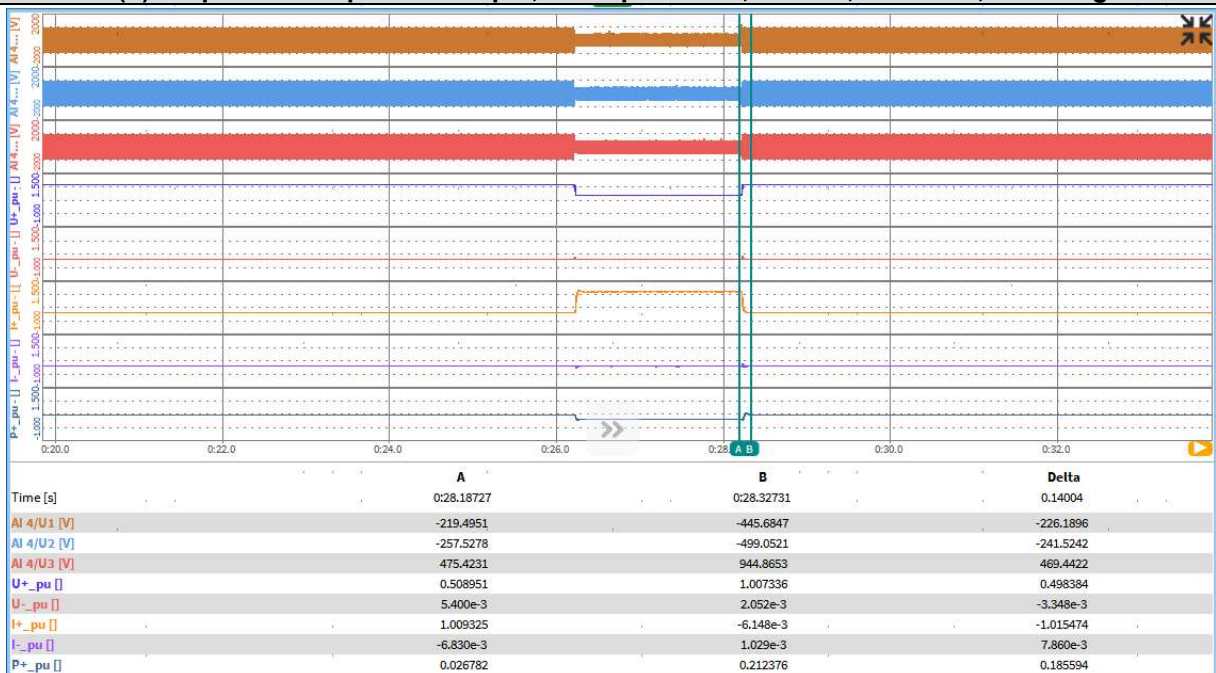
Test 5.2.7

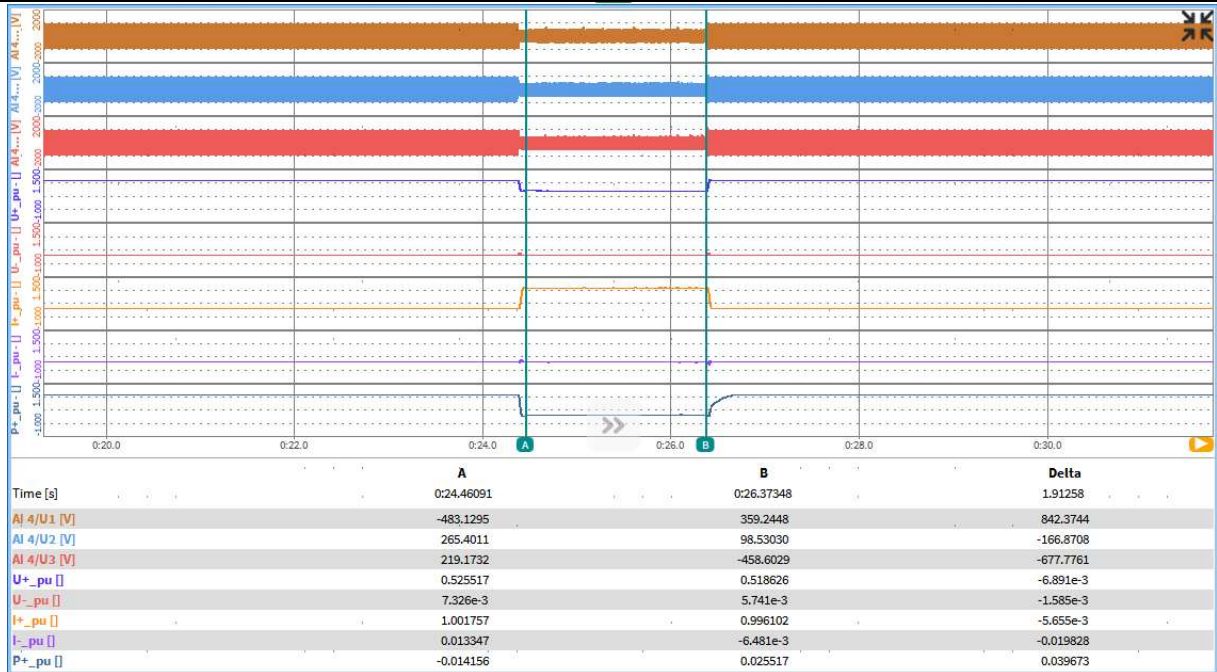
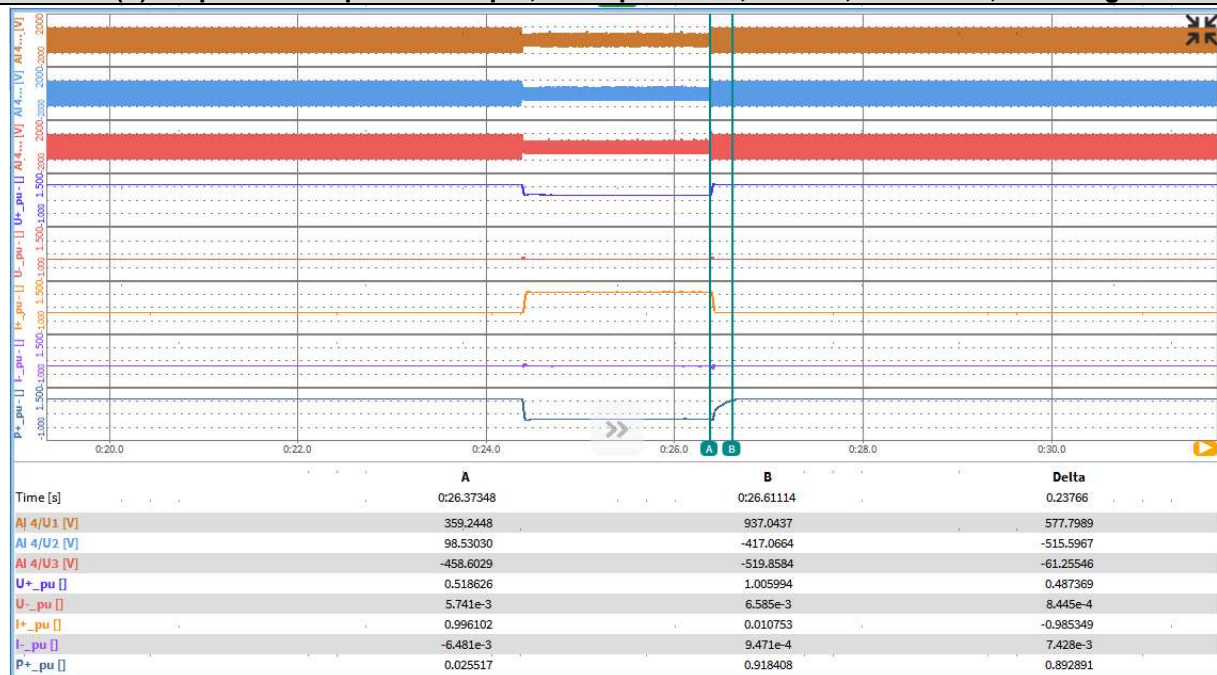
A.2.5(b): Depth of fault phase:20%, single-phase SC-GND, $\Delta/Yn11$, 20% load

A.2.5(b):

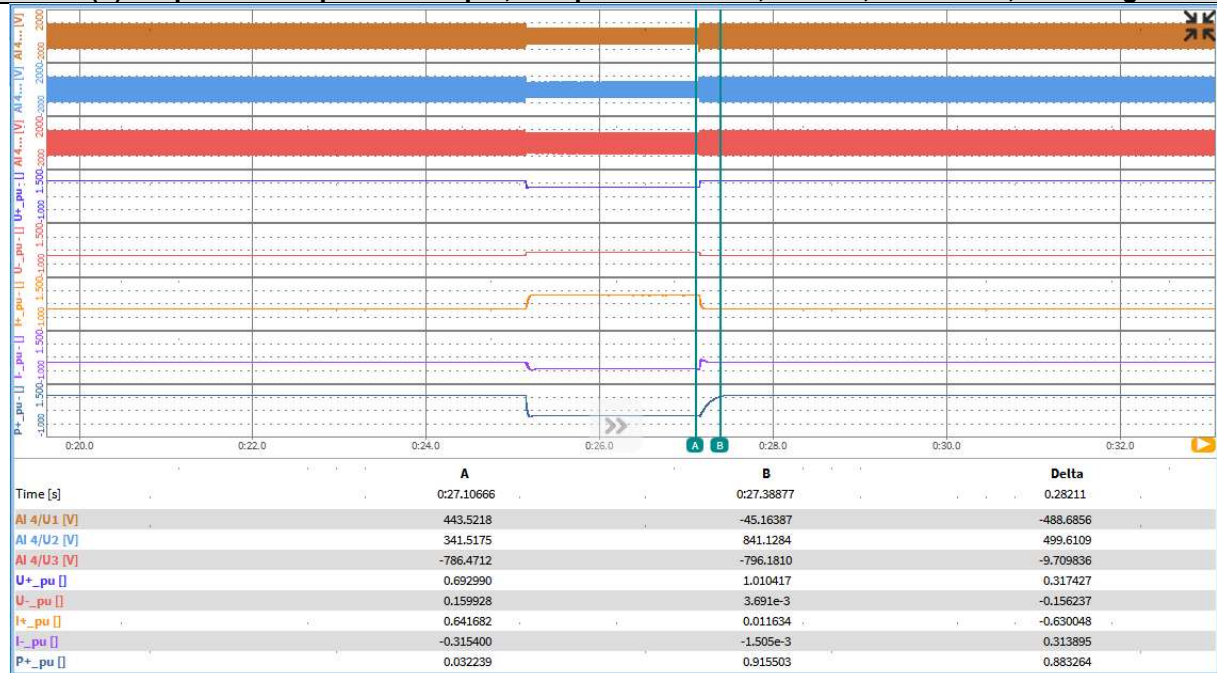
Depth of fault phase:20%, single-phase SC-GND, $\Delta/Yn11$, 20% load, restoring time

Test 5.2.8**A.2.5(b): Depth of fault phase:20%, single-phase SC-GND, $\Delta/Yn11$, 100% load****A.2.5(b):****Depth of fault phase:20%, single-phase SC-GND, $\Delta/Yn11$, 100% load, restoring time**

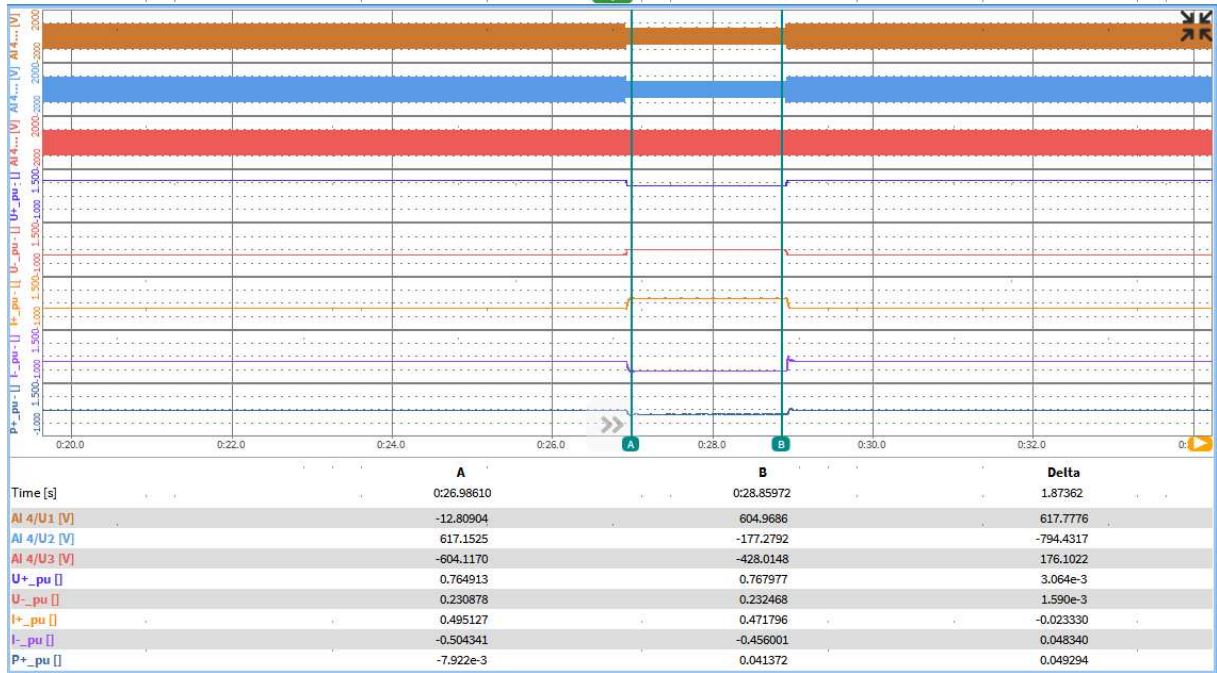
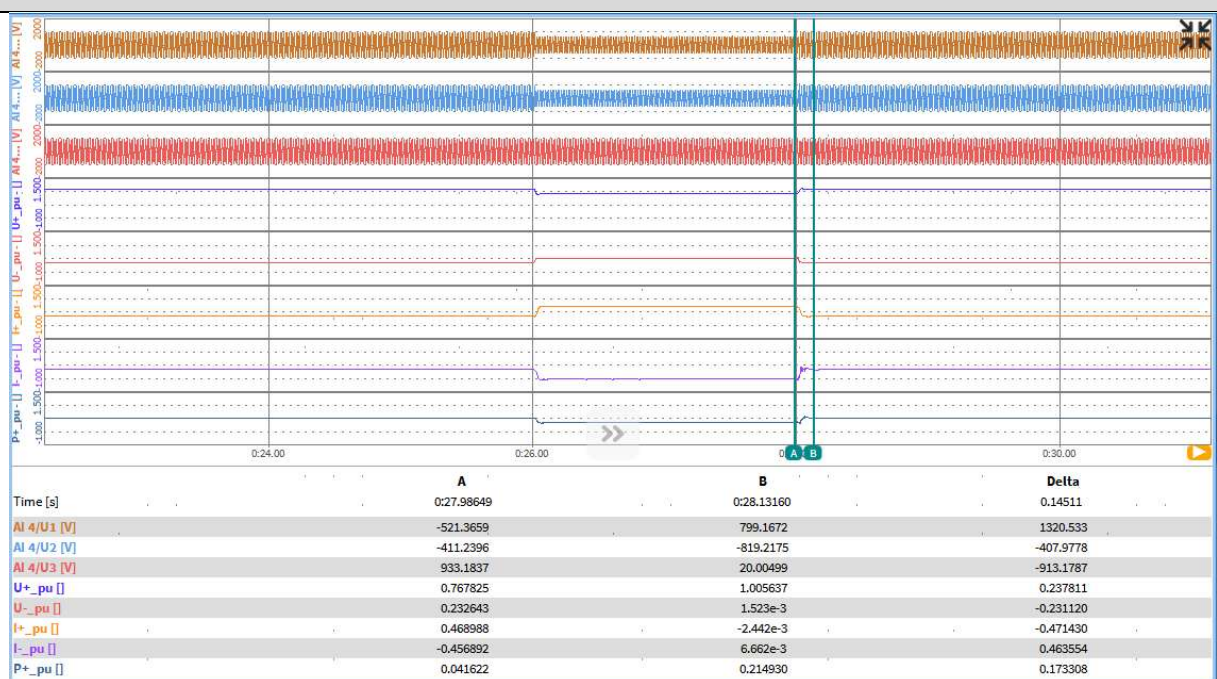
Test 5.2.1**A.2.2(b): Depth of fault phase:0.50 p.u, three-phase SC, $\Delta/Yn11$, 20% load****Test 5.2.1****A.2.2(b): Depth of fault phase:0.50 p.u, three-phase SC, $\Delta/Yn11$, 20% load, restoring time**

Test 5.2.2**A.2.2(b): Depth of fault phase:0.50 p.u, three-phase SC, $\Delta/Yn11$, 100% load****Test 5.2.2****A.2.2(b): Depth of fault phase:0.50 p.u, three-phase SC, $\Delta/Yn11$, 100% load, restoring time**

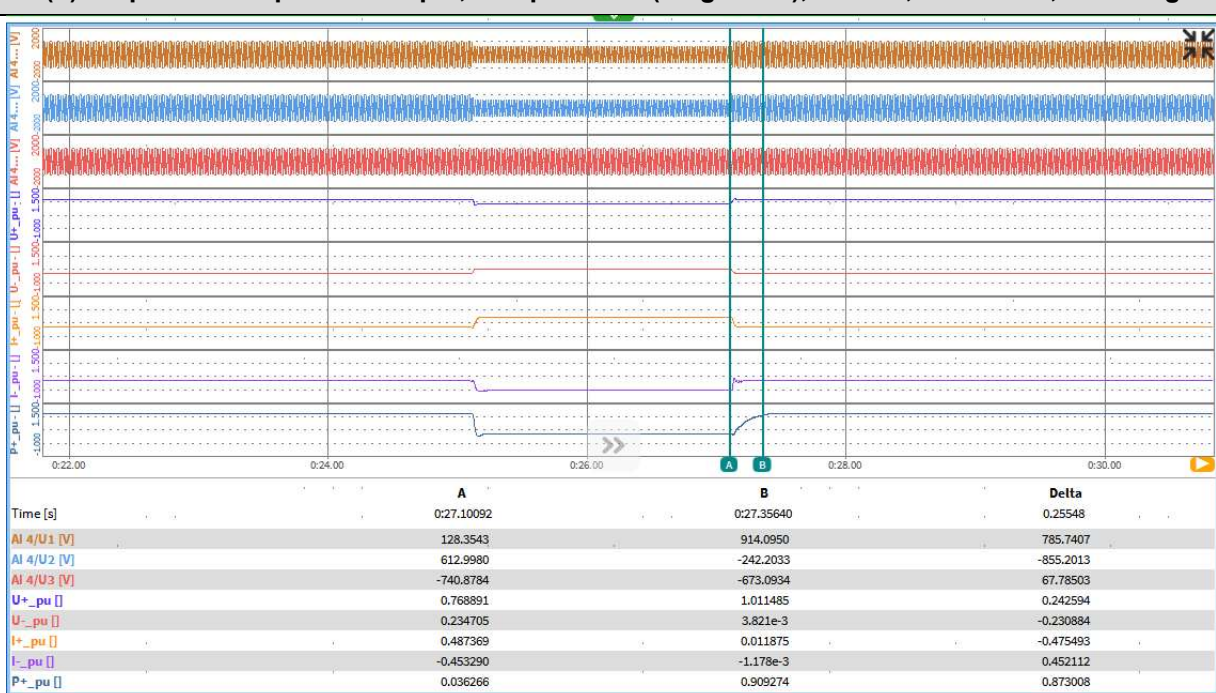
Test 5.2.3**A.2.3(b): Depth of fault phase:0.50 p.u, two-phase SC-Gnd, $\Delta/Yn11$, 20% load****Test 5.2.3****A.2.3(b): Depth of fault phase:0.50 p.u, two-phase SC-Gnd, $\Delta/Yn11$, 20% load, restoring time**

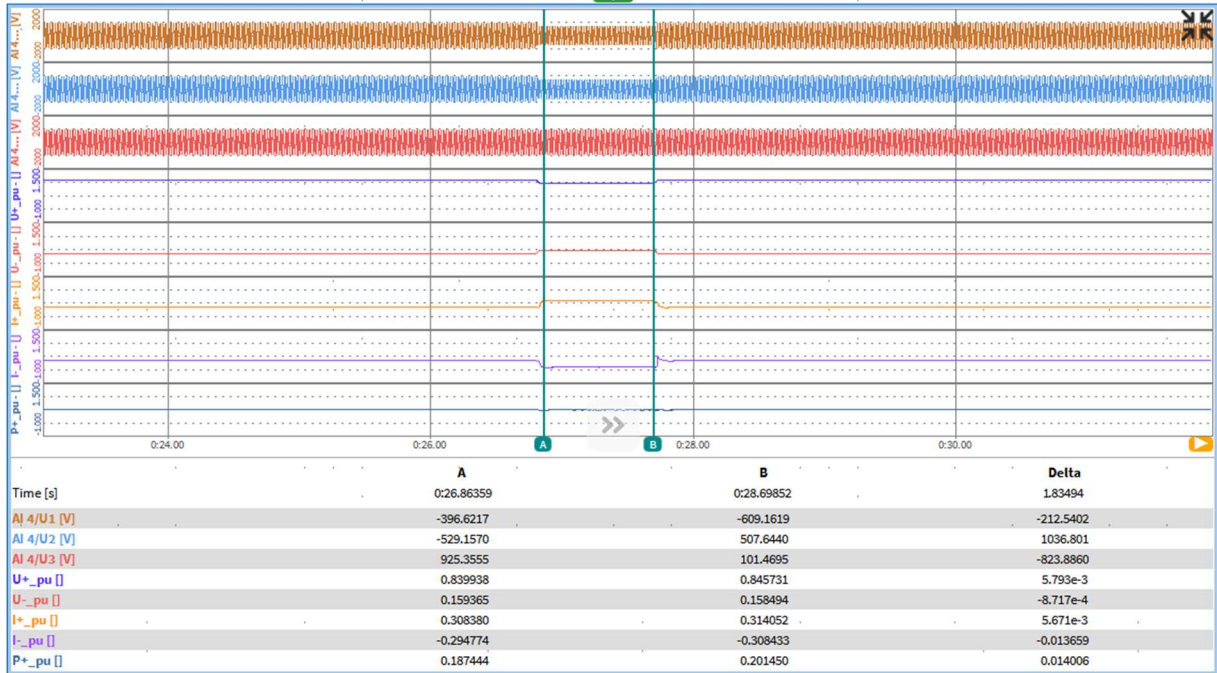
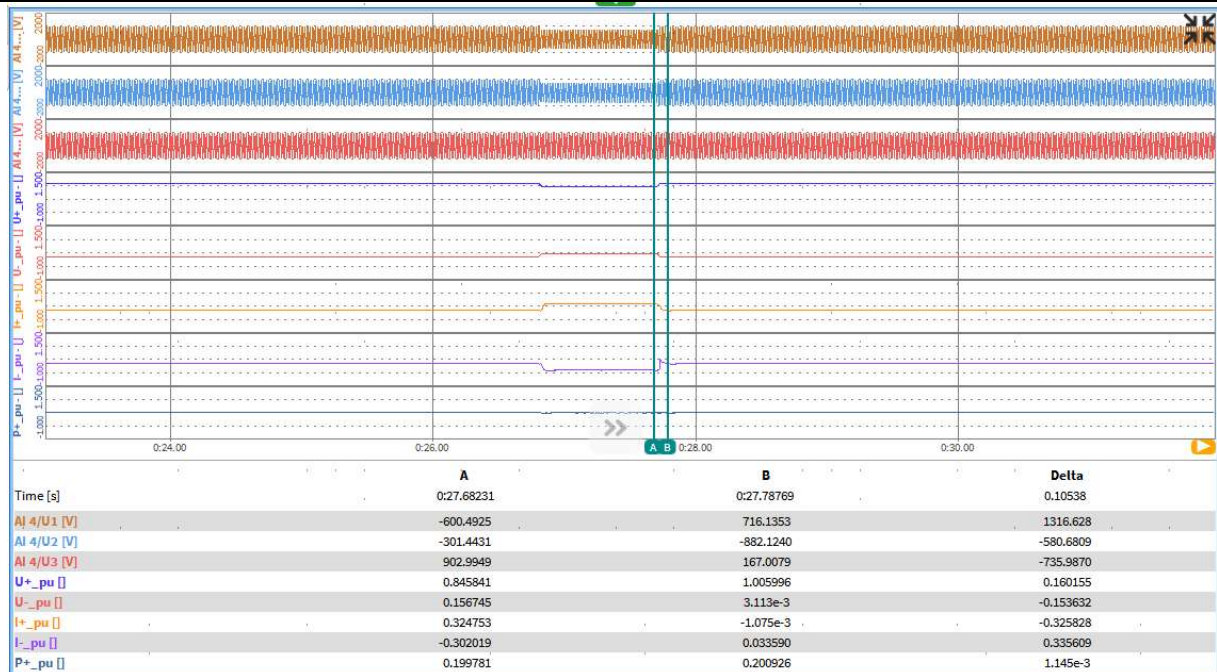
Test 5.2.4**A.2.3(b): Depth of fault phase:0.50 p.u, two-phase SC-Gnd, $\Delta/Yn11$, 100% load****Test 5.2.4****A.2.3(b): Depth of fault phase:0.50 p.u, two-phase SC-Gnd, $\Delta/Yn11$, 100% load, restoring time**

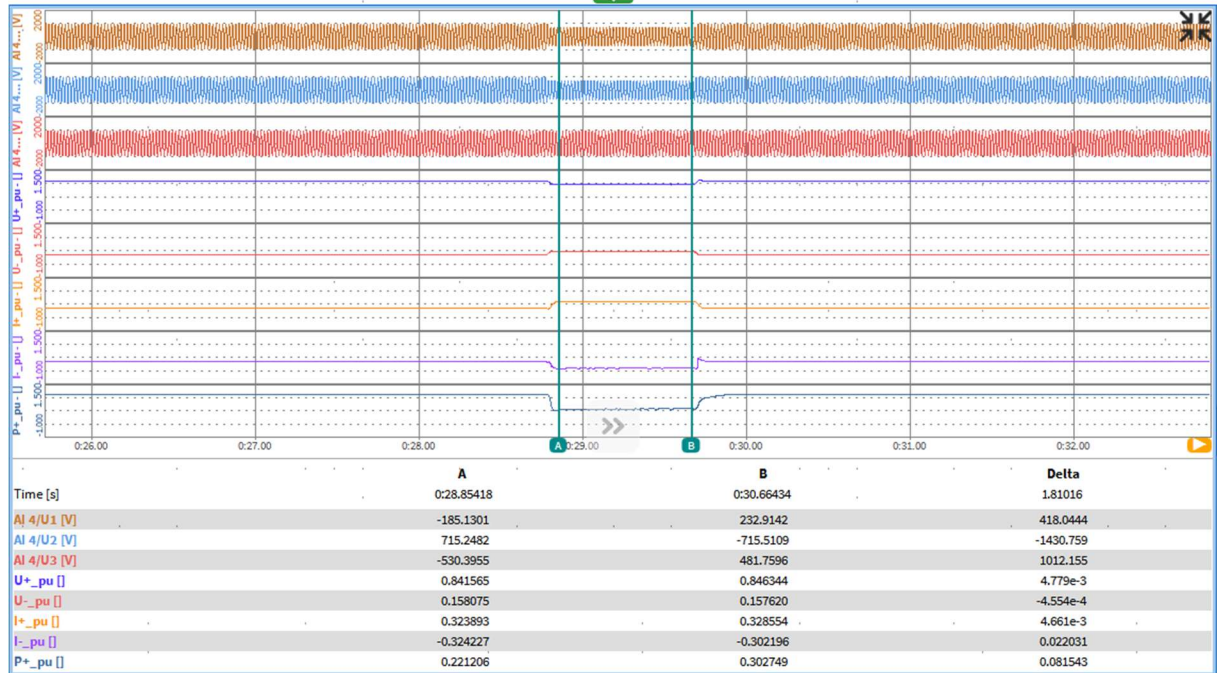
Test 5.2.5

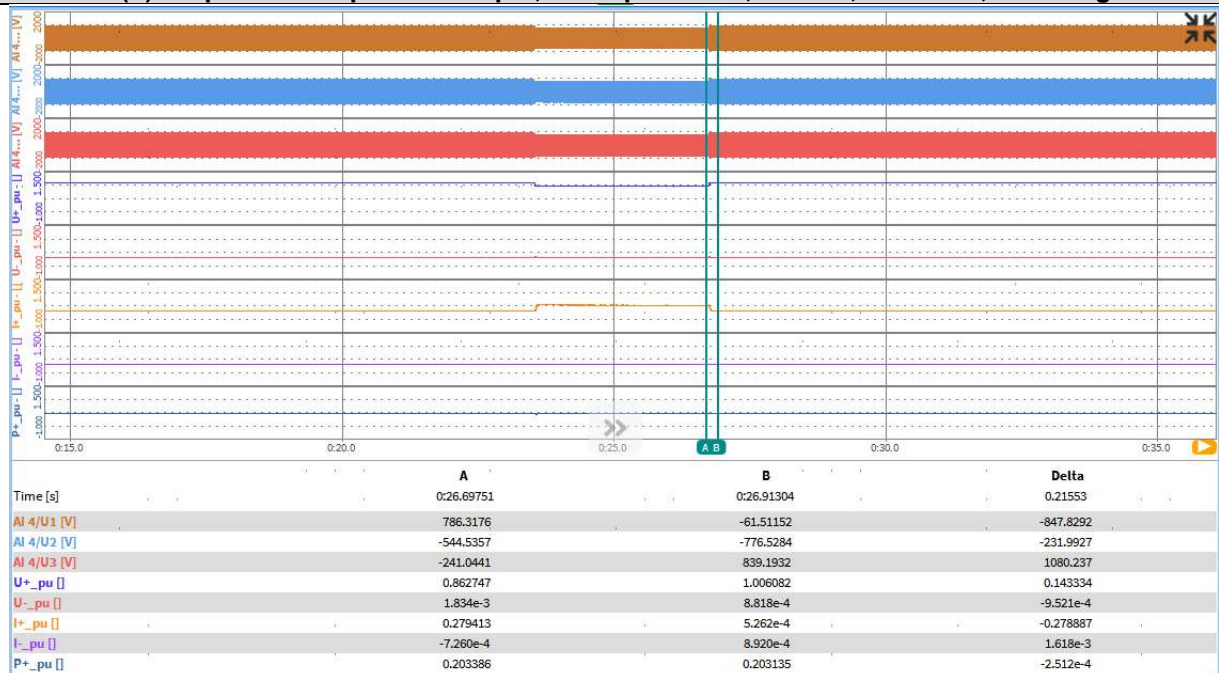
A.2.4(b): Depth of fault phase:0.50 p.u, two-phase SC(no ground), $\Delta/Yn11$, 20% loadA.2.4(b): Depth of fault phase:0.50 p.u, two-phase SC(no ground), $\Delta/Yn11$, 20% load, restoring time

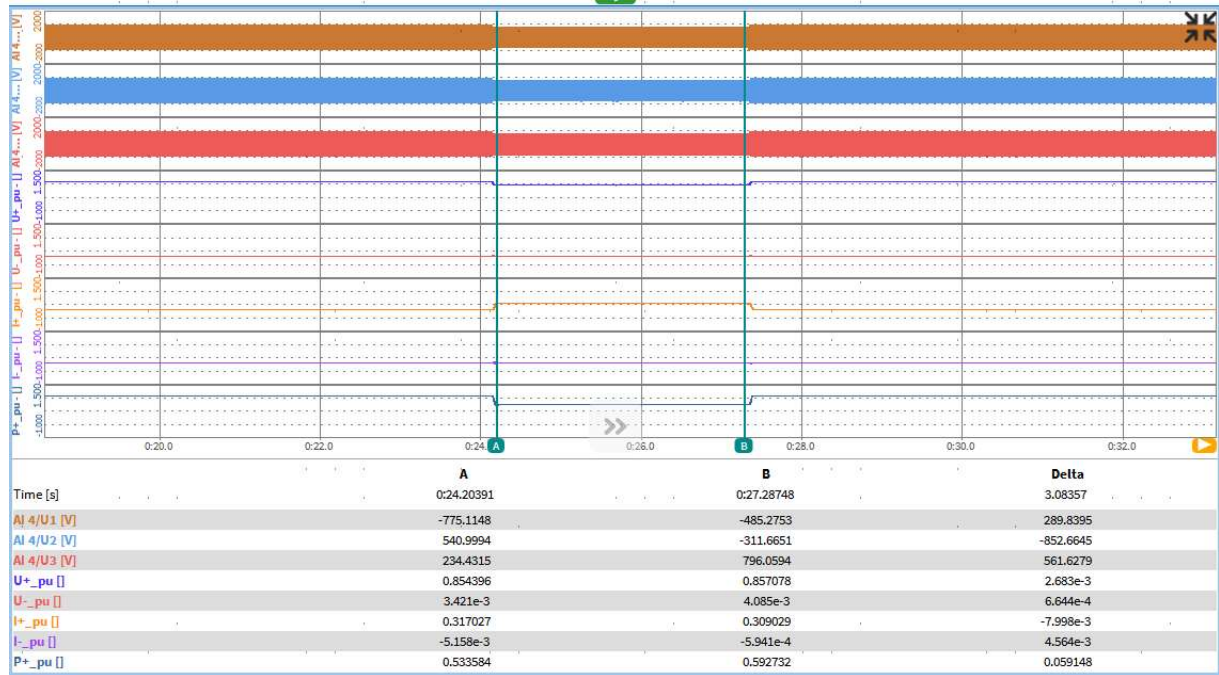
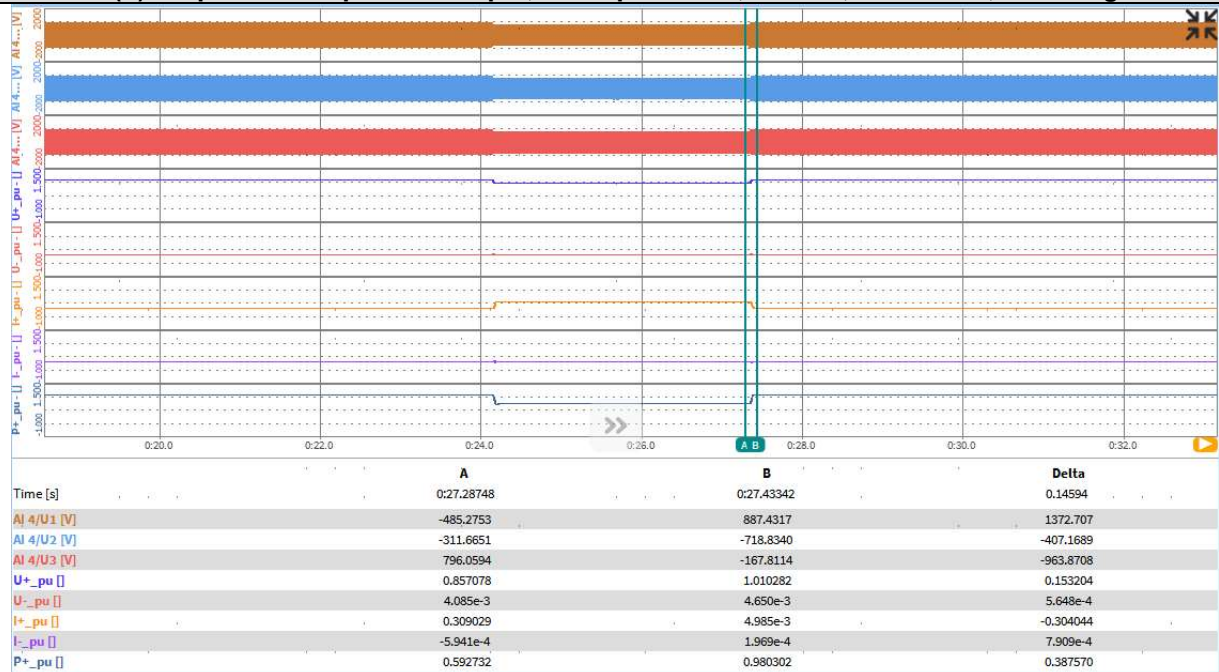
Test 5.2.6

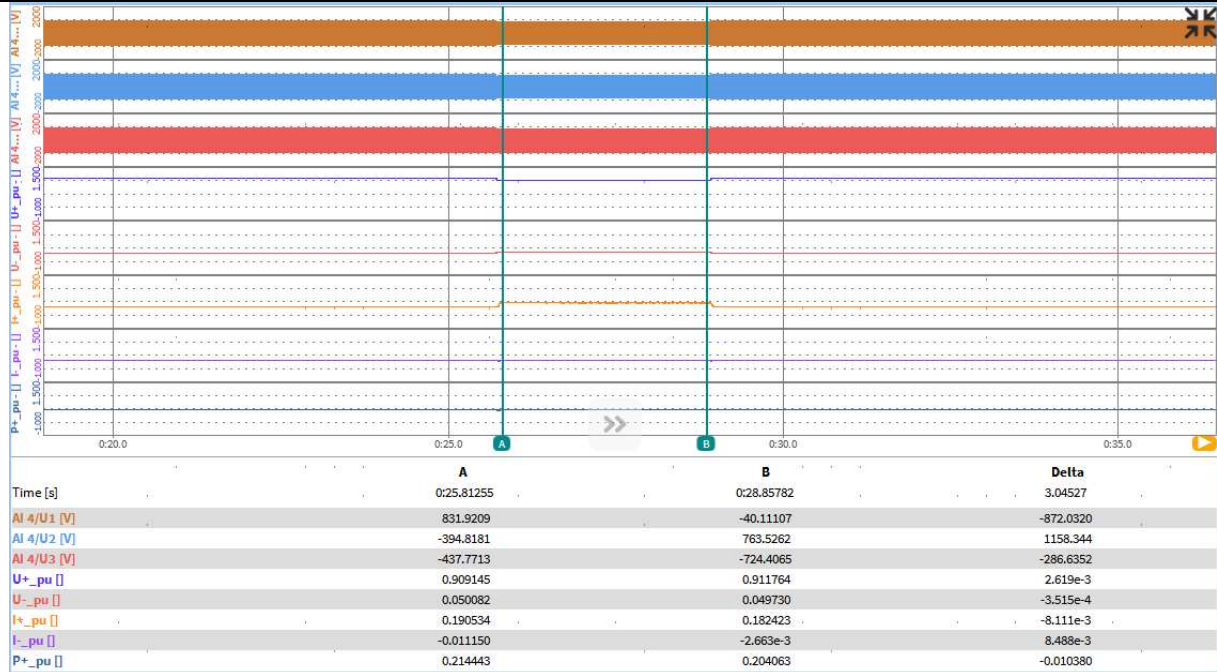
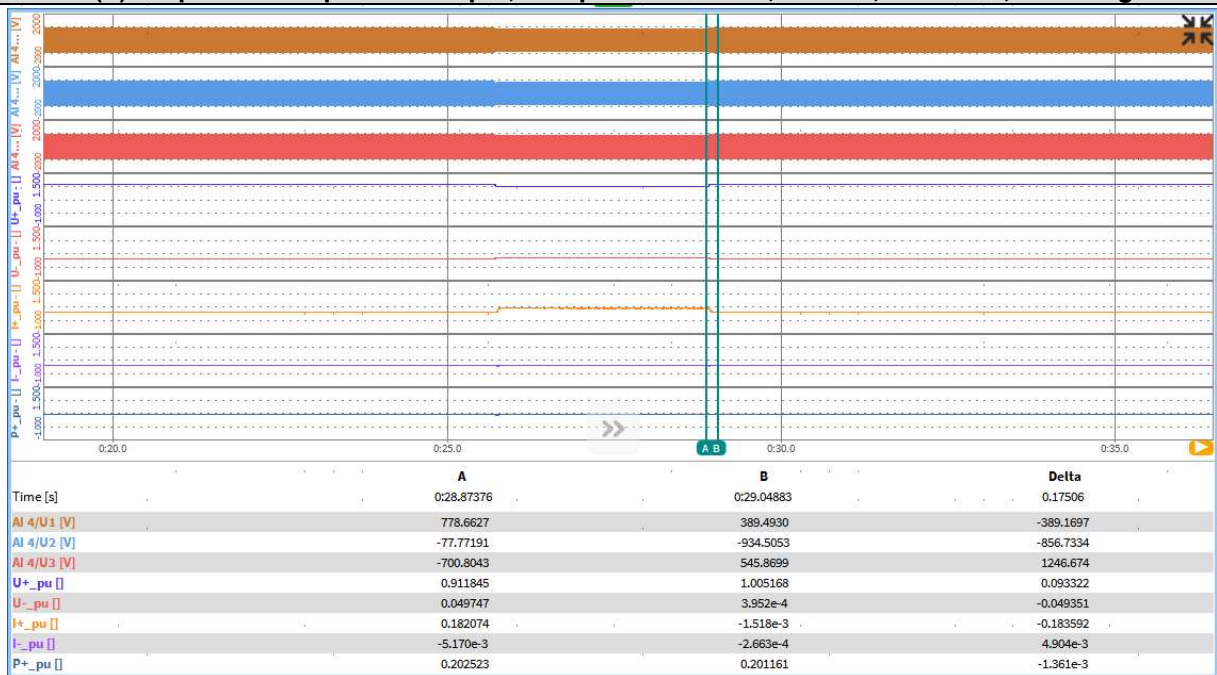
A.2.4(b): Depth of fault phase:0.50 p.u, two-phase SC(no ground), $\Delta/Yn11$, 100% loadA.2.4(b): Depth of fault phase:0.50 p.u, two-phase SC(no ground), $\Delta/Yn11$, 100% load, restoring time

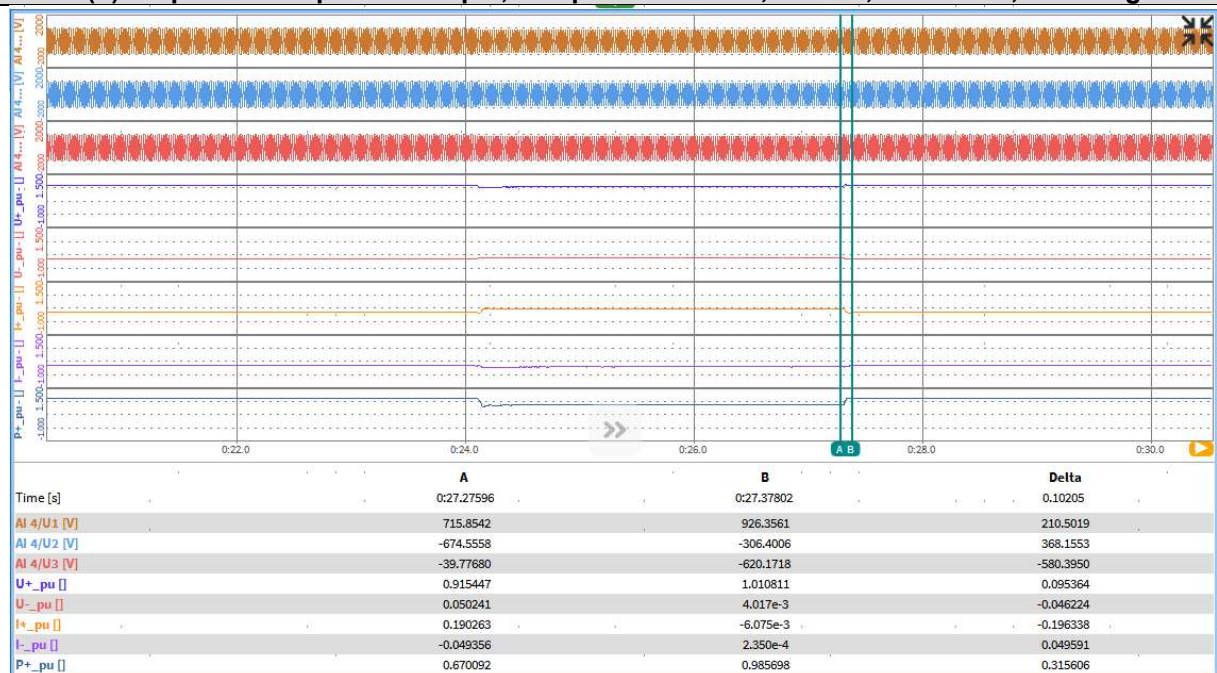
Test 5.2.7**A.2.5(b): Depth of fault phase:0.50 p.u, single-phase SC-Gnd, $\Delta/Yn11$, 20% load****Test 5.2.7****A.2.5(b): Depth of fault phase:0.50 p.u, single-phase SC-Gnd, $\Delta/Yn11$, 20% load, restoring time**

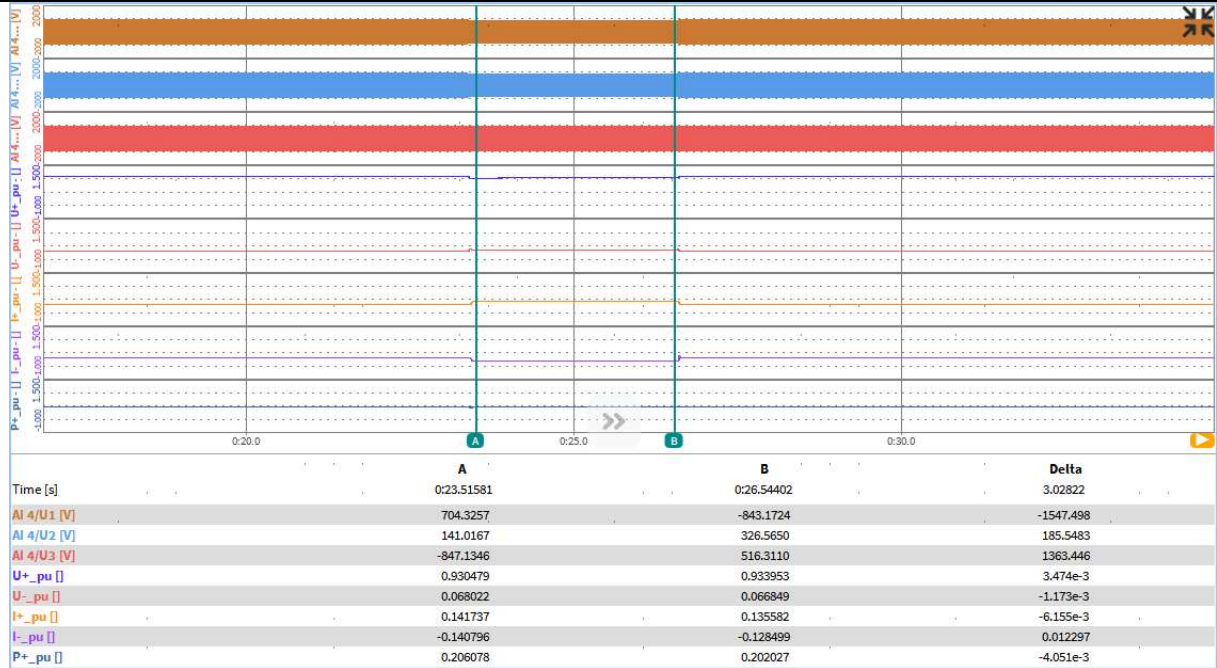
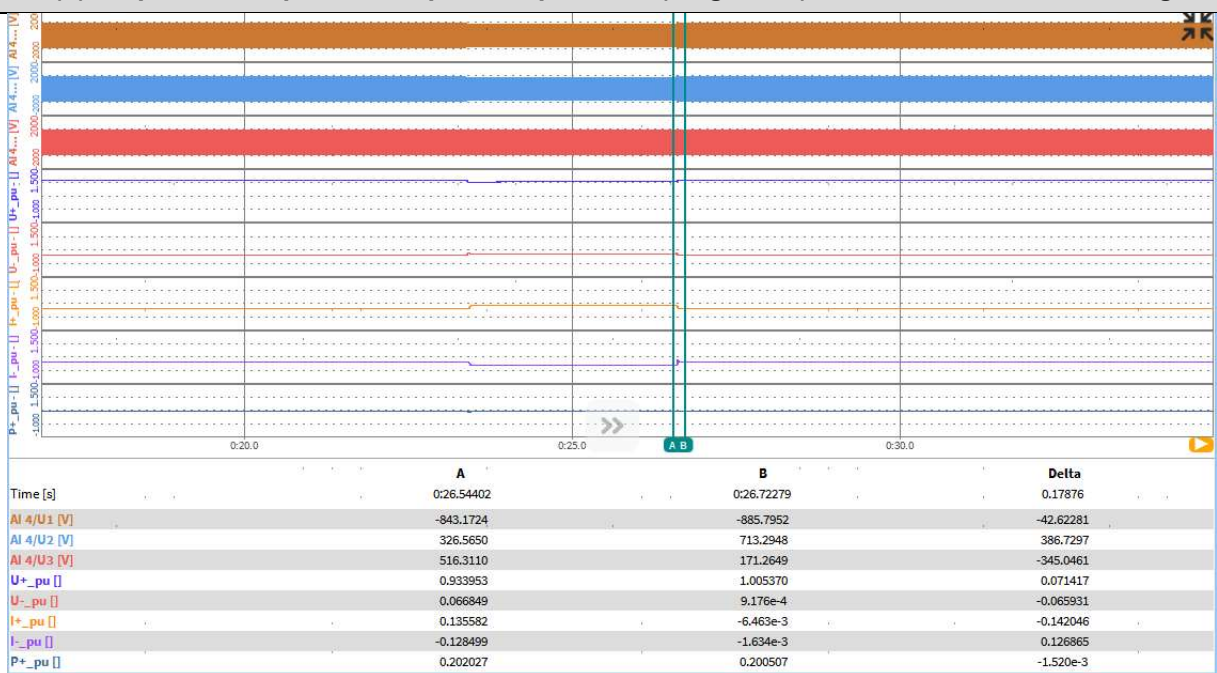
Test 5.2.8**A.2.5(b): Depth of fault phase:0.50 p.u, single-phase SC-Gnd, $\Delta/Yn11$, 100% load****Test 5.2.8****A.2.5(b): Depth of fault phase:0.50 p.u, single-phase SC-Gnd, $\Delta/Yn11$, 100% load, restoring time**

Test 5.3.1**A.2.2(b): Depth of fault phase:0.85 p.u, three-phase SC, $\Delta/Yn11$, 20% load****Test 5.3.1****A.2.2(b): Depth of fault phase:0.85 p.u, three-phase SC, $\Delta/Yn11$, 20% load, restoring time**

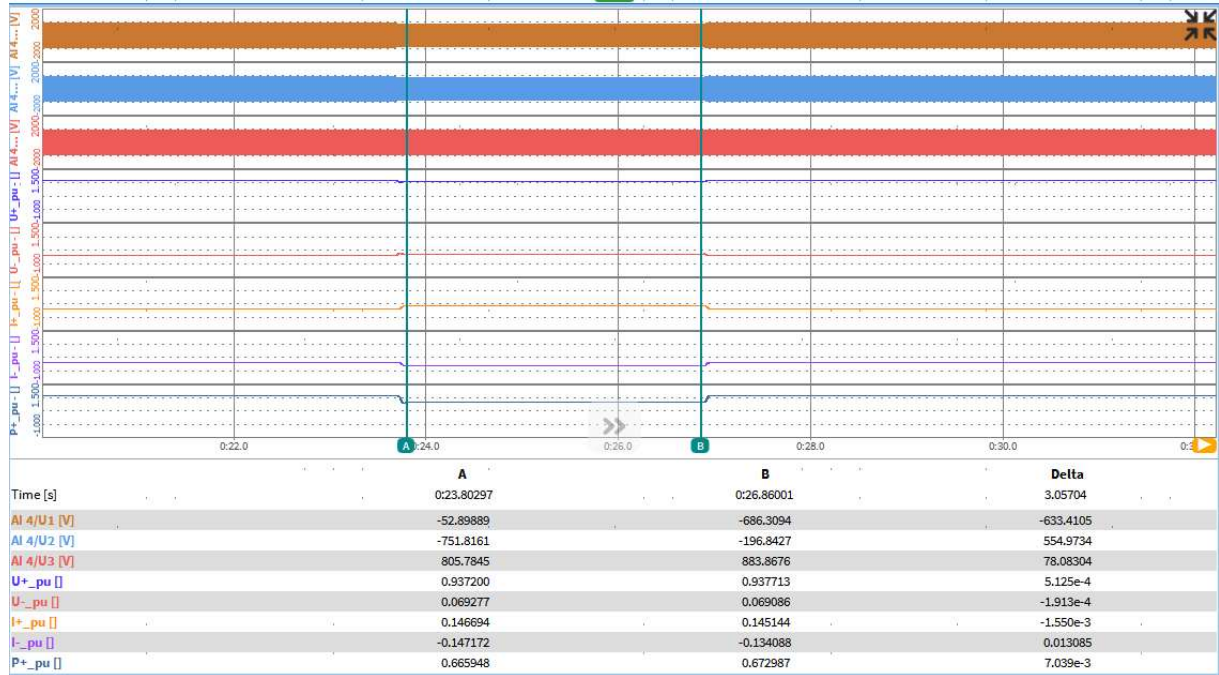
Test 5.3.2**A.2.2(b): Depth of fault phase:0.85 p.u, three-phase SC, Δ/Yn11, 100% load****Test 5.3.2****A.2.2(b): Depth of fault phase:0.85 p.u, three-phase SC, Δ/Yn11, 100% load, restoring time**

Test 5.3.3**A.2.3(b): Depth of fault phase:0.85 p.u, two-phase SC-GND, Δ/Y_n11 , 20% load****Test 5.3.3****A.2.3(b): Depth of fault phase:0.85 p.u, two-phase SC-GND, Δ/Y_n11 , 20% load, restoring time**

Test 5.3.4**A.2.3(b): Depth of fault phase:0.85 p.u, two-phase SC-GND, Δ/Y_{n11} , 100% load****Test 5.3.4****A.2.3(b): Depth of fault phase:0.85 p.u, two-phase SC-GND, Δ/Y_{n11} , 100% load, restoring time**

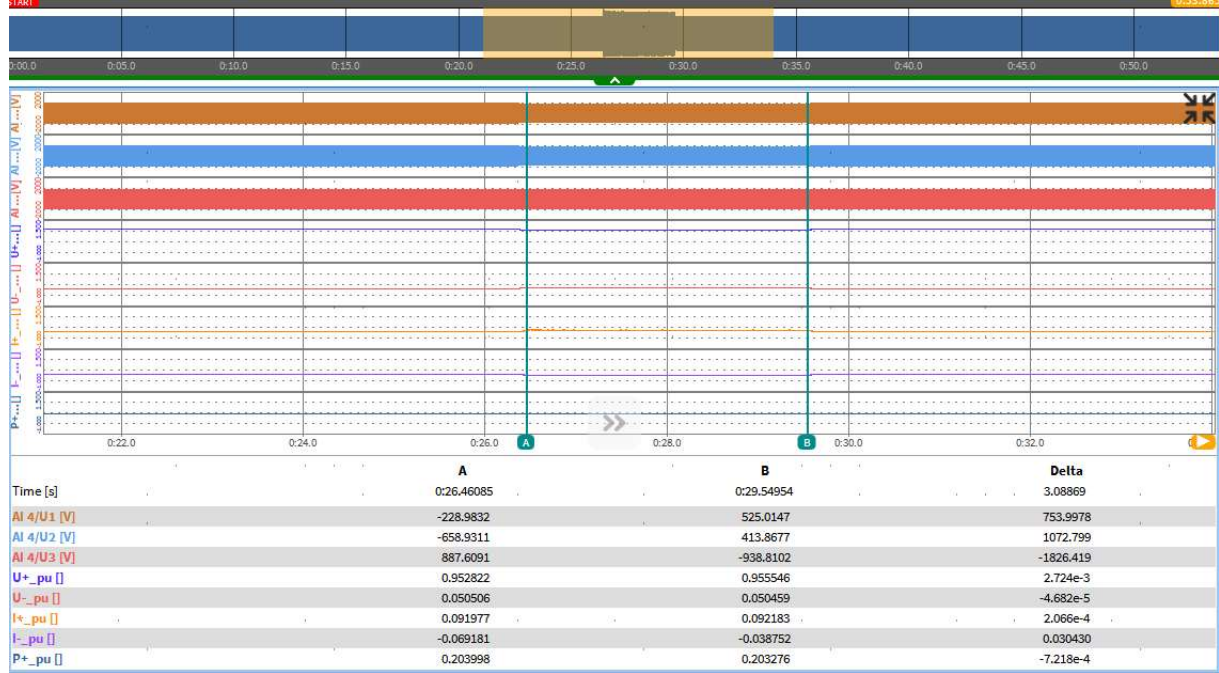
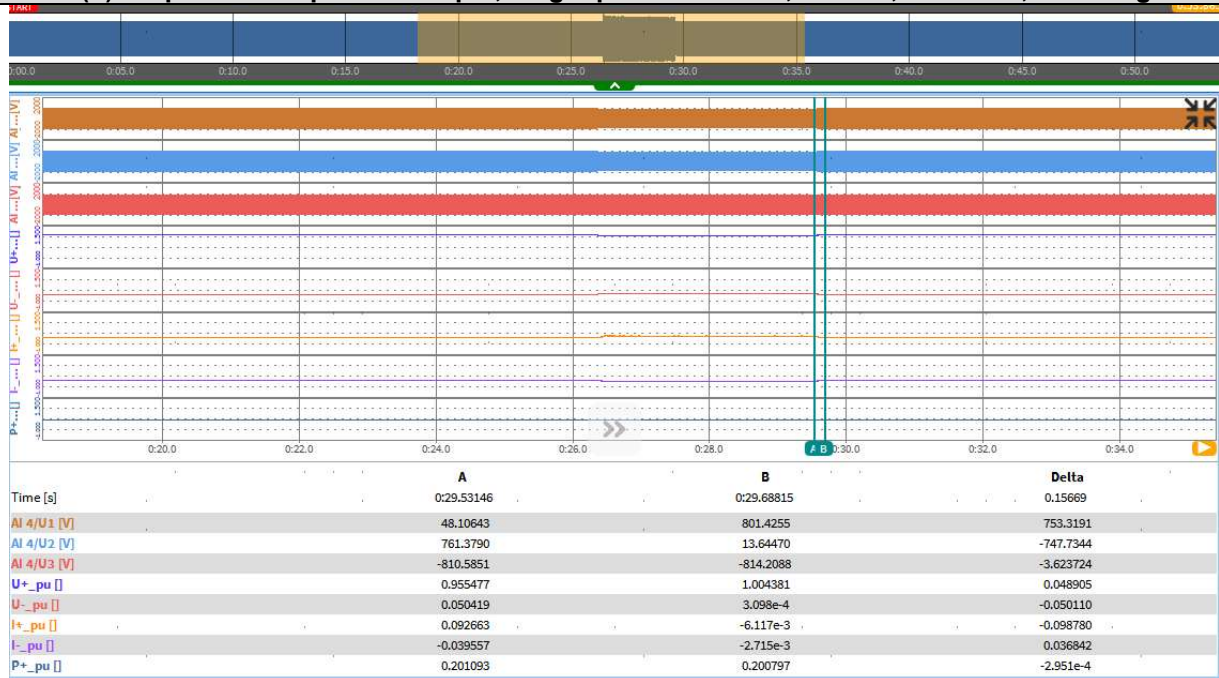
Test 5.3.5**A.2.4(b): Depth of fault phase:0.85 p.u, two-phase SC(no ground), $\Delta/Yn11$, 20% load****A.2.4(b): Depth of fault phase:0.85 p.u, two-phase SC(no ground), $\Delta/Yn11$, 20% load, restoring time**

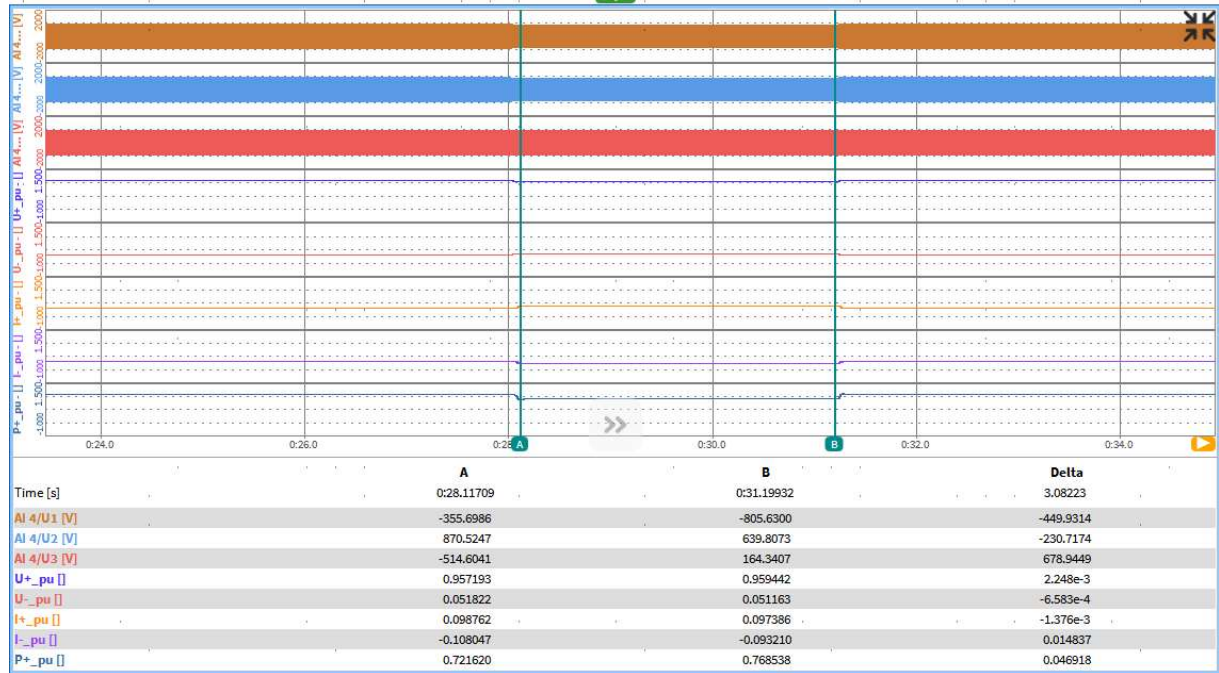
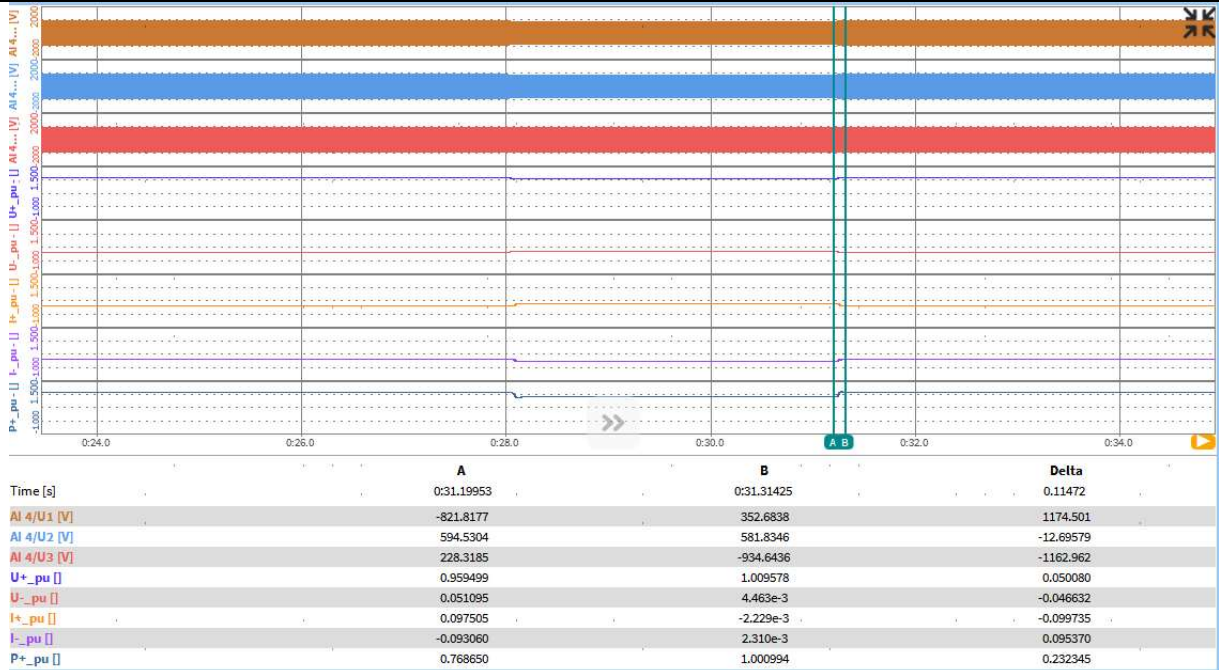
Test 5.3.6

A.2.4(b): Depth of fault phase:0.85 p.u, two-phase SC(no ground), $\Delta/Yn11$, 100% load

A.2.4(b):

Depth of fault phase:0.85 p.u, two-phase SC(no ground), $\Delta/Yn11$, 100% load, restoring time

Test 5.3.7**A.2.5(b): Depth of fault phase:0.85 p.u, single-phase SC-GND, $\Delta/Yn11$, 20% load****Test 5.3.7****A.2.5(b): Depth of fault phase:0.85 p.u, single-phase SC-GND, $\Delta/Yn11$, 20% load, restoring time**

Test 5.3.8**A.2.5(b): Depth of fault phase:0.85 p.u, single-phase SC-GND, $\Delta/Yn11$, 100% load****Test 5.3.8****A.2.5(b): Depth of fault phase:0.85 p.u, single-phase SC-GND, $\Delta/Yn11$, 100% load, restoring time**

Appendix: Pictures
Overall view –front



Overall view –back



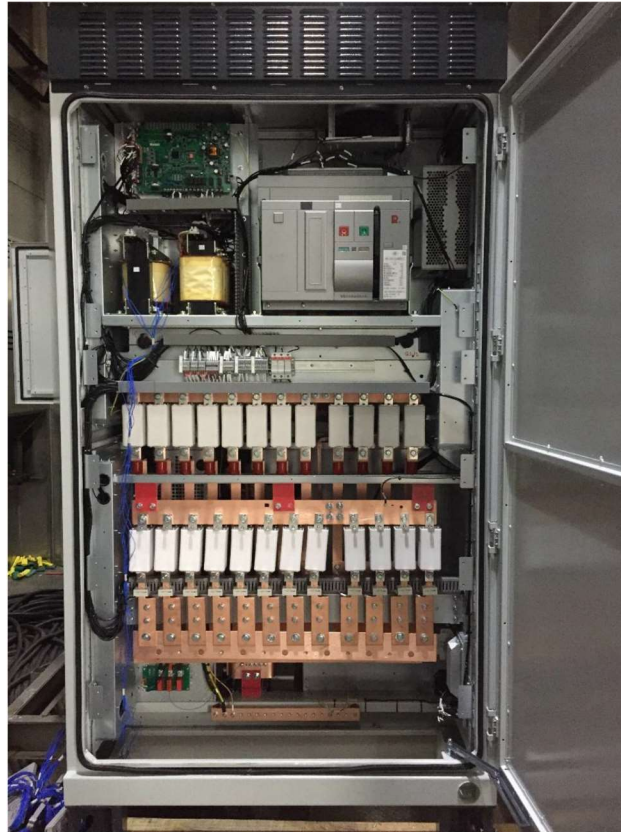
Overall view – right



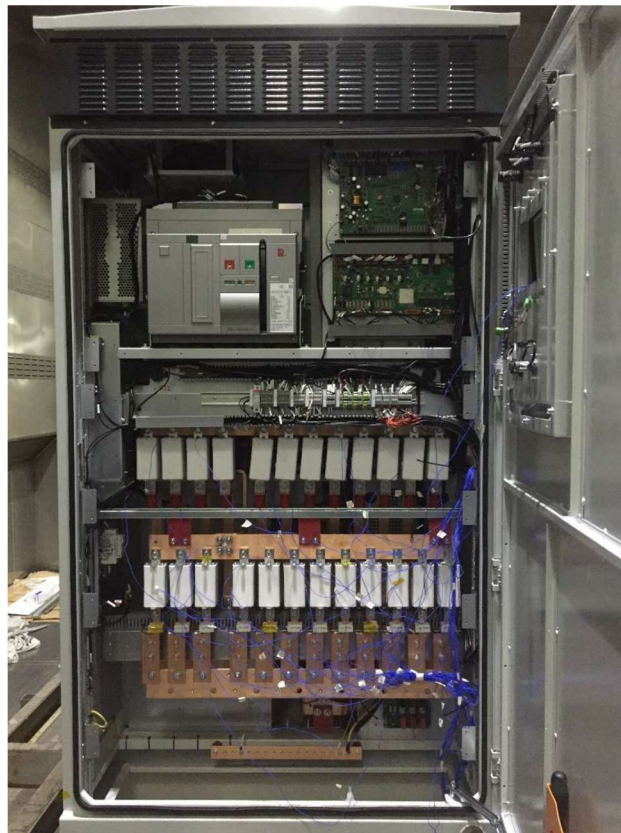
Overall view – left



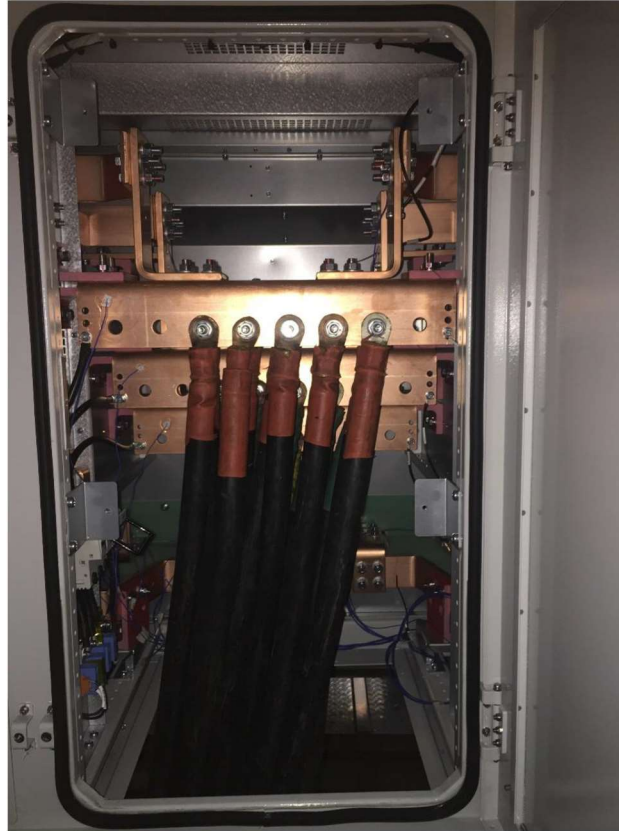
Inside view -1



Inside view -2



Inside view -3



Isolating switch I



Isolating switch II



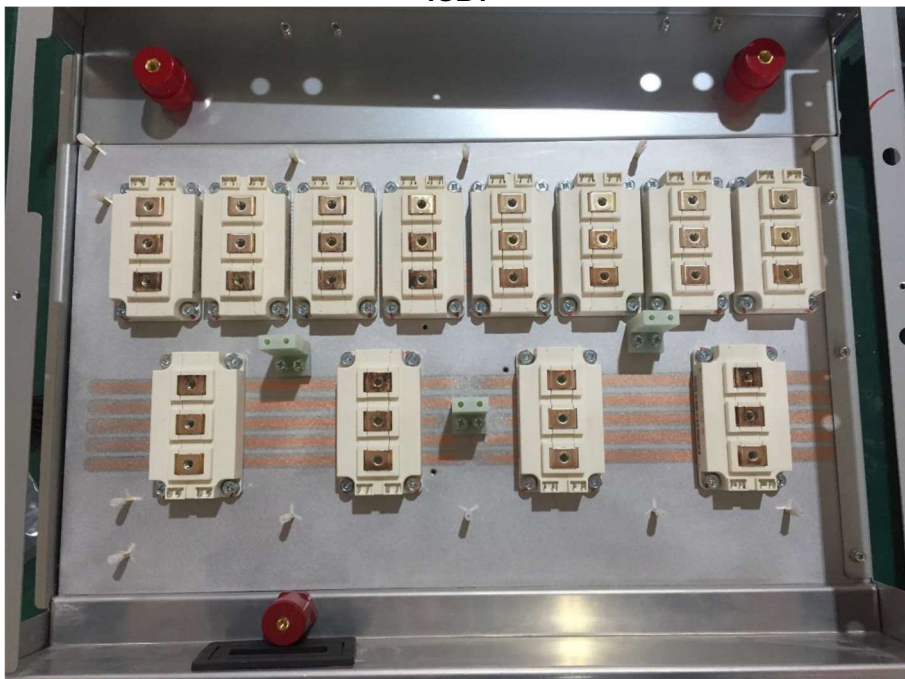
Isolating switch III



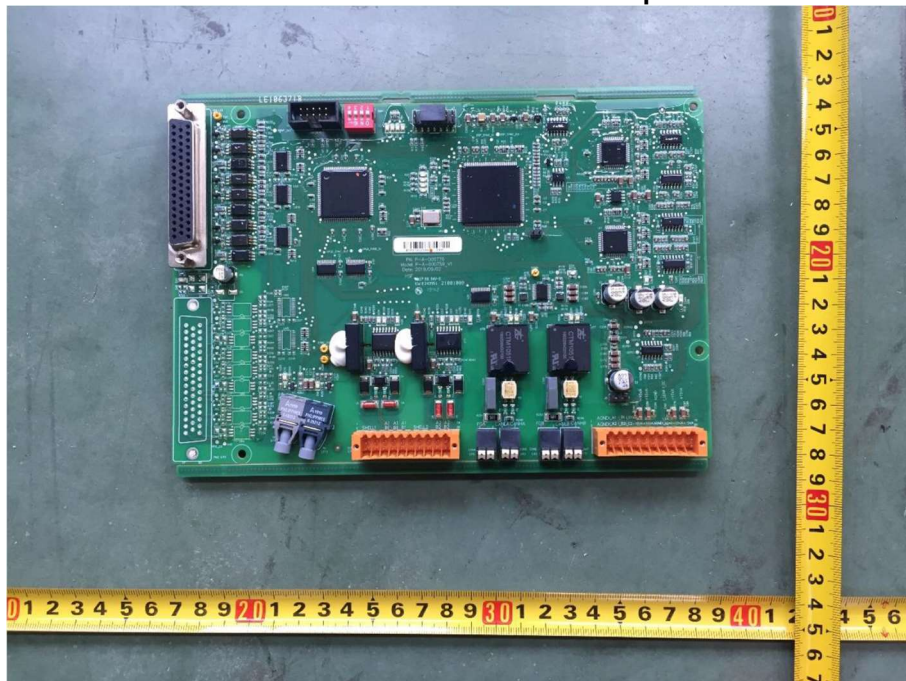
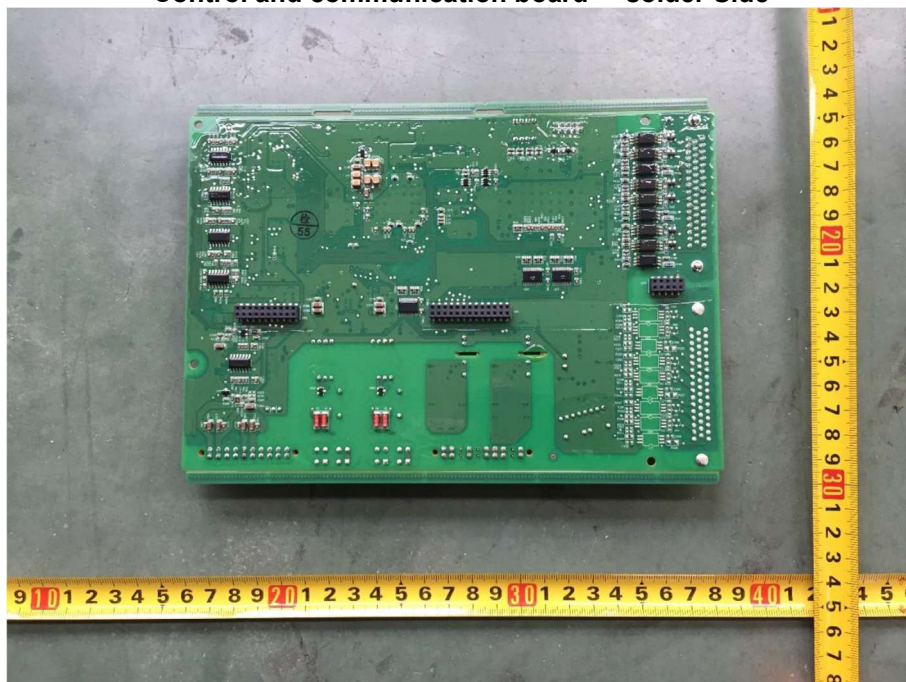
FUSE

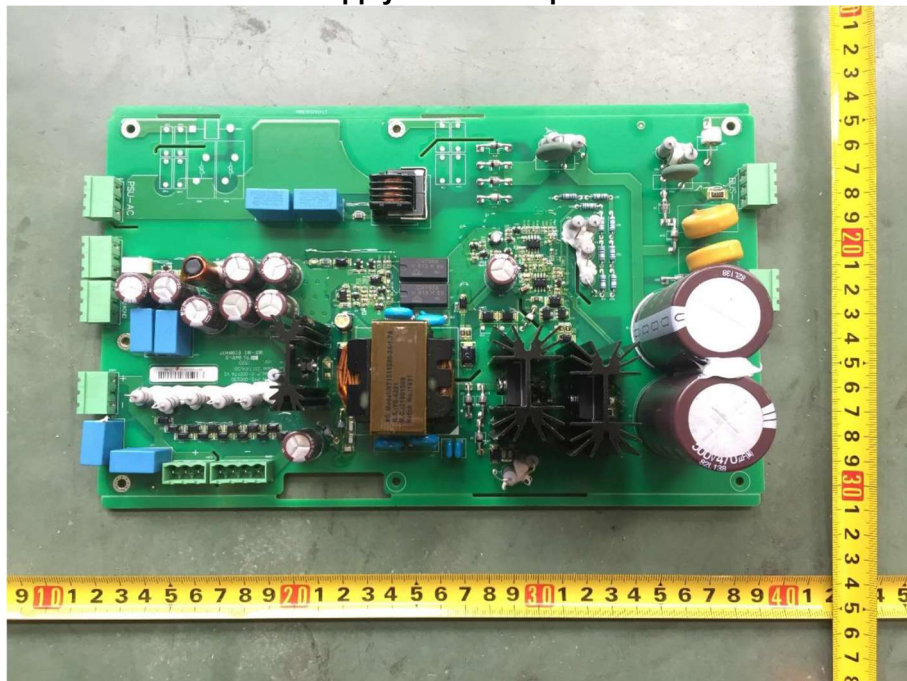
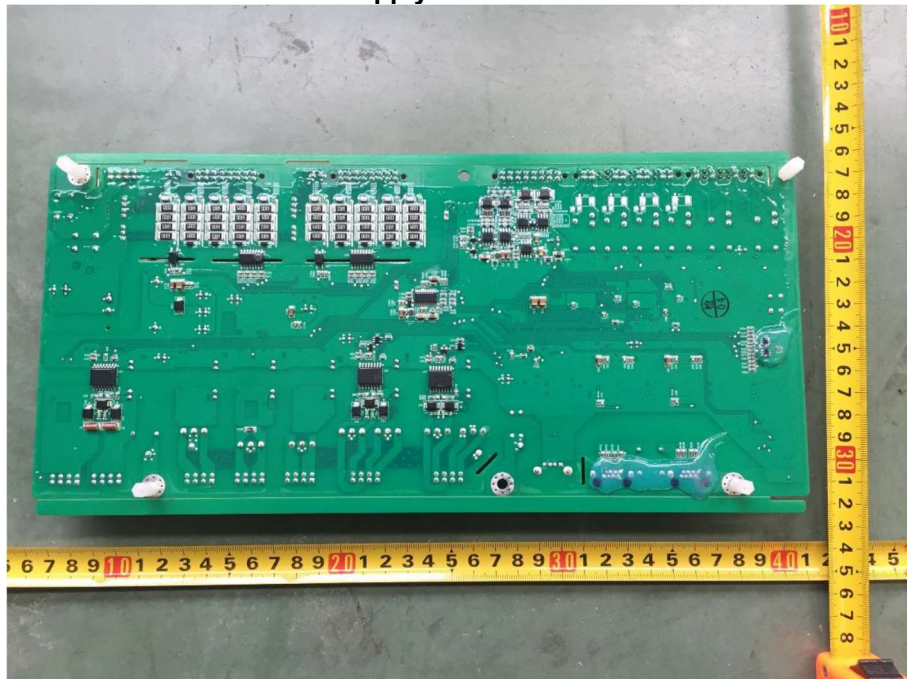


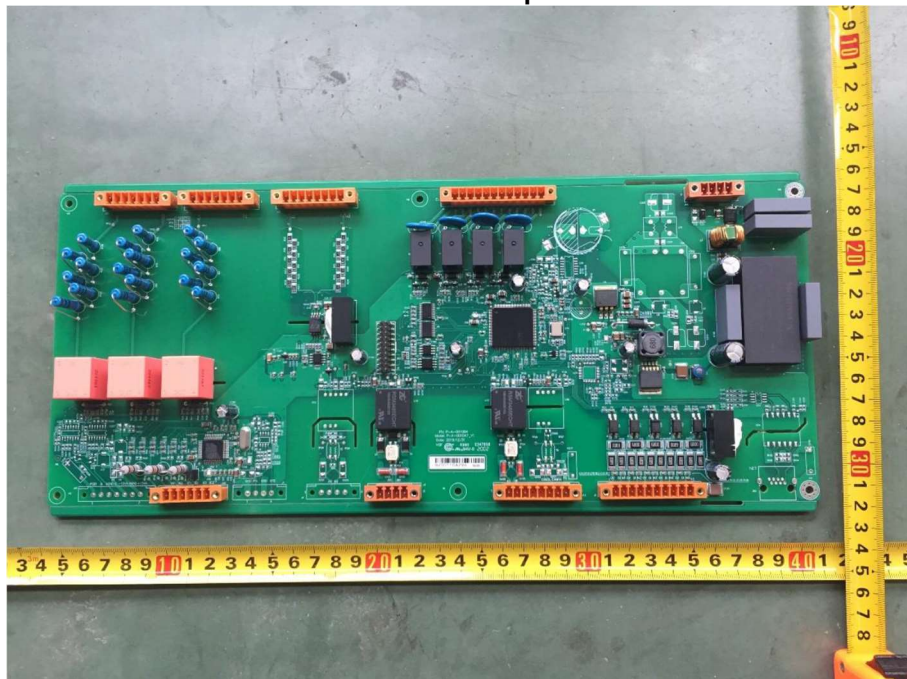
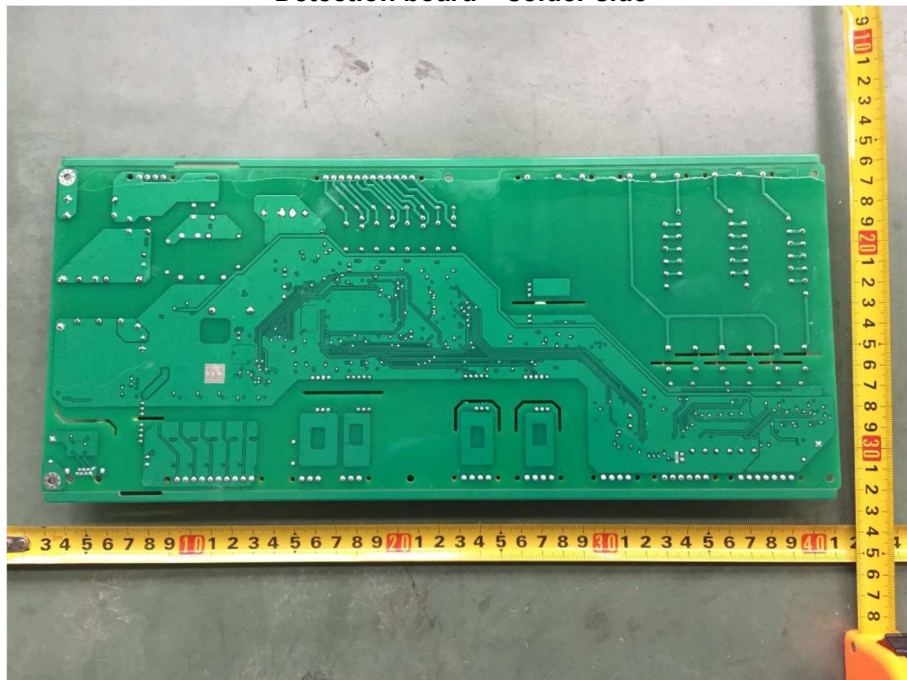
IGBT

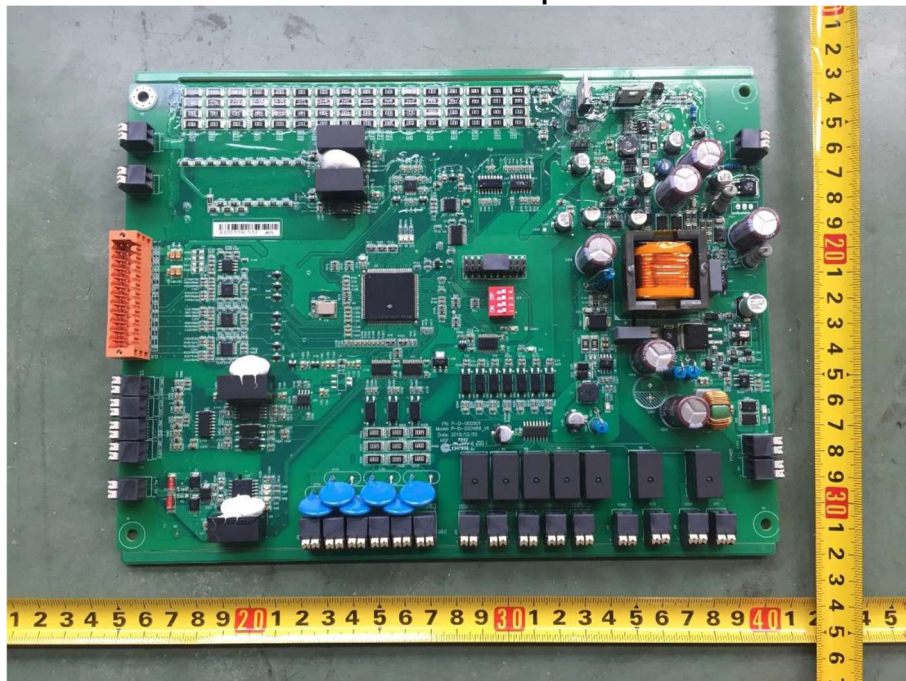
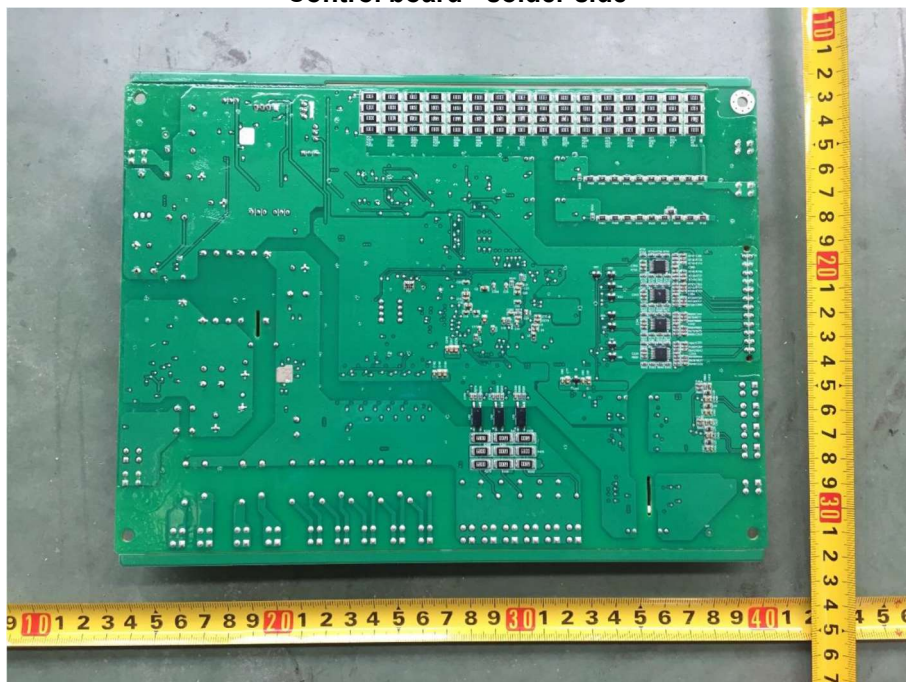


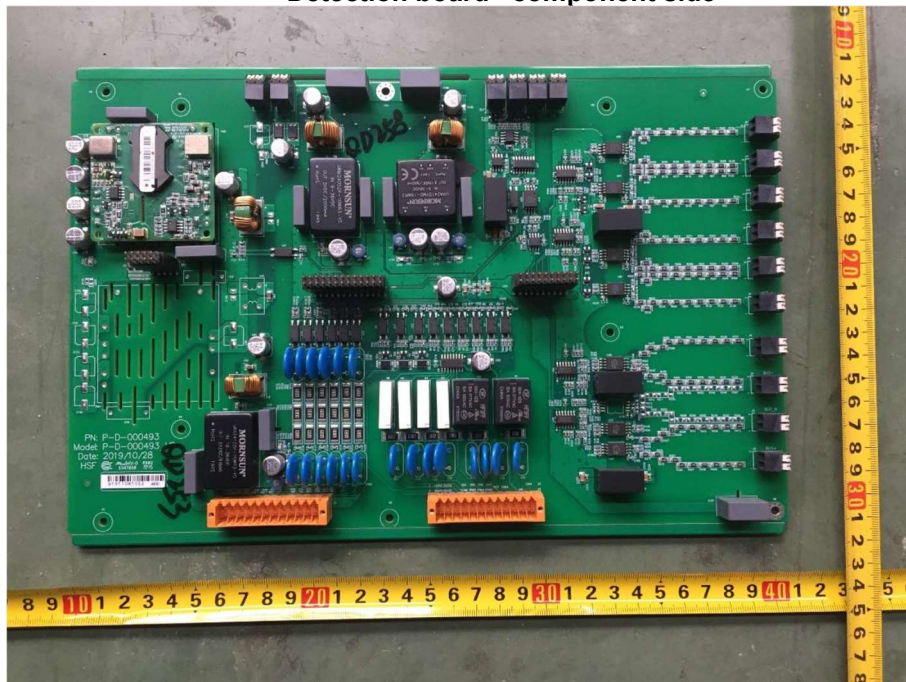
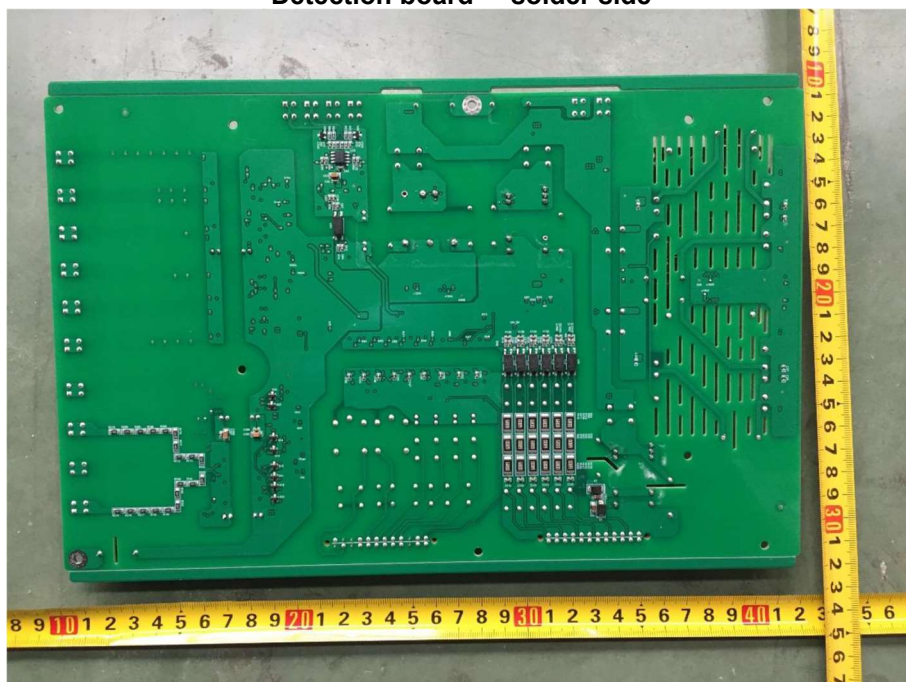
Inductor**Inside view - 4**

Control and communication board –component side**Control and communication board – solder Side**

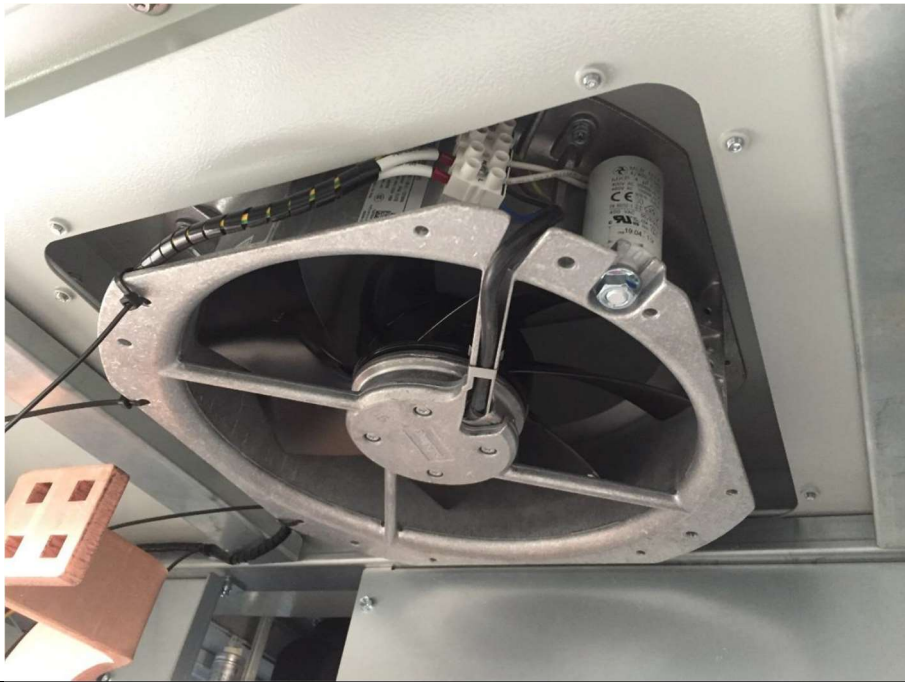
Power supply board- component side**Power supply board- solder side**

Detection board- component side**Detection board – solder side**

Control board - component side**Control board - solder side**

Detection board –component side**Detection board – solder side**

Internal FAN



----- End of test report-----