

Prüfbericht-Nr.: Test report no.:	CN230HHW 001	Auftrags-Nr.: Order no.:	244506083	Seite 1 von 30 Page 1 of 30
Kunden-Referenz-Nr.: Client reference no.:	2492816	Auftragsdatum: Order date:	2023-04-06	
Auftraggeber: Client:	Yi Energy Technology (Zhejiang) Co., Ltd. Room 109, Building 1, No. 55, Yifeng Road, Qiantang District, Hangzhou, Zhejiang P.R. China			
Prüfgegenstand: Test item:	Hybrid Inverter			
Bezeichnung / Typ-Nr.: Identification / Type no.:	HI-3P5K-H-Y1, HI-3P6K-H-Y1, HI-3P8K-H-Y1, HI-3P10K-H-Y1, HI-3P12K-H-Y1			
Auftrags-Inhalt: Order content:	A3 Certificate			
Prüfgrundlage: Test specification:	EN 50549-1: 2019			
Wareneingangsdatum: Date of sample receipt:	2023-06-07			
Prüfmuster-Nr.: Test sample no.:	A003579342-001			
Prüfzeitraum: Testing period:	2023-06-08 - 2023-10-10			
Ort der Prüfung: Place of testing:	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüflaboratorium: Testing laboratory:	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: Test result*:	Pass			
geprüft von: tested by:	Sky Shen		genehmigt von: authorized by:	Allen Hu
Datum: Date:	2023-10-20	Sky Shen	Ausstellungsdatum: Issue date:	2023-10-20
Stellung / Position:	Project Engineer		Stellung / Position:	Reviewer
Sonstiges / Other:	This report is based on VDE 4105 report No.CN23R6Z1 to do the difference item tests. See below for details.			
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:	Prüfmuster vollständig und unbeschädigt Test item complete and undamaged			
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the above mentioned test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

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Prüfbericht-Nr.: CN230HHW 001
Test report no.:

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Page 2 of 30

Anmerkungen

Remarks

1	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. <i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i>
2	Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben. Informationen zur Verifizierung der Authentizität unserer Dokumente erhalten Sie über folgenden Link: Einführung in digitale Signaturen <i>As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged. For information on verifying the authenticity of our documents, please visit the following link: Introduction to Digital Signature</i>
3	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. <i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i> <i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i>
4	Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019. <i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i>

TEST REPORT EN 50549-1: 2019 Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B	
Report Reference No.....	CN230HHW 001
Tested by (name + signature)	See cover page
Witnessed by (name + signature)....	See coverpage
Supervised by (name + signature) ..	See coverpage
Approved by (name + signature)	See cover page
Date of issue	See cover page
Testing Laboratory	TÜV Rheinland (Shanghai) Co., Ltd.
Address.....	No. 177, Lane 777, Guangzhong West Road, Jing'an District, Shanghai, China
Testing location/ procedure	CBTL ☐ TMP ☐ WMT ☐ SMT ☐ RMT ☐ CCATL ☐
Testing location/ address.....	No. 177, Lane 777, Guangzhong West Road, Jing'an District, Shanghai, China
Applicant's name	See cover page
Address.....	See cover page
Test specification:	
Standard	EN 50549-1: 2019
Test procedure	A3 certificate
Non-standard test method.....	N/A
Test Report Form No.....	MS-0024998-appendix 22_V.2
Test Report Form(s) Originator	TÜV Rheinland Group
Master TRF	2020-03
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Test item description	Hybrid Inverter
Trade Mark	
Manufacturer	Same as applicant.
Model/Type reference.....	HI-3P5K-H-Y1, HI-3P6K-H-Y1, HI-3P8K-H-Y1, HI-3P10K-H-Y1, HI-3P12K-H-Y1
Ratings.....	See model list and marking label on following pages.

Testing procedure and testing location:
☐ **CB Testing Laboratory:** See cover page

Testing location/ address.....: See cover page

☐ **Associated CB Test Laboratory:**

Testing location/ address.....:

Tested by (name + signature): See cover page

Approved by (+ signature).....: See cover page

☐ Testing procedure: TMP

Tested by (name + signature):

Approved by (+ signature).....:

Testing location/ address.....:

☐ Testing procedure: WMT

Tested by (name + signature):

Witnessed by (+ signature):

Approved by (+ signature).....:

Testing location/ address.....:

☐ Testing procedure: SMT

Tested by (name + signature):

Approved by (+ signature).....:

Supervised by (+ signature):

Testing location/ address.....:

☐ Testing procedure: RMT

Tested by (name + signature):

Approved by (+ signature).....:

Supervised by (+ signature):

Testing location/ address.....:

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

Attachment 1-test data

Attachment 2-Photo documents

Summary of testing
Tests performed (name of test and test clause):
Testing location:

All the test were performed on the model HI-3P12K-H-Y1 to represent other family models.

The laboratory described on page 2.

Clause	Test description	Remark
☒ 4.4.2, 4.4.4	Operating ranges	
☒ 4.4.3	Minimal requirement for active power delivery at under-frequency	
☒ 4.5.2	Rate of change of frequency (ROCOF) immunity	
☒ 4.5.3, 4.5.4, 4.7.4	Under and over voltage ride through (UVRT and OVRT)	
☒ 4.6.1	Power response to over-frequency	2)
☐ 4.6.2	Power response to under-frequency	1)
☒ 4.7.2.2	Capabilities	3)
☐ 4.7.2.3.2	Setpoint control modes	1)
☒ 4.7.2.3.3	Voltage related control mode (Q(U) curve)	
☒ 4.7.2.3.4	Power related control mode (cosφ(P) curve)	
☒ 4.7.3	Voltage related active power reduction (P(U) curve)	
☐ 4.8	<u>Harmonic emissions</u>	1)
☐ 4.8	<u>Voltage fluctuations (Flicker)</u>	1)
☐ 4.8	Voltage fluctuations (Rapid voltage change)	1)
☐ 4.8	<u>Unbalance</u>	1)
☐ 4.8	<u>DC injection</u>	1)
☒ 4.9.3	Requirements on voltage and frequency protection	
☒ 4.9.3.2, 4.9.3.3, 4.9.3.4	Under/over voltage protection	
☒ 4.9.3.5, 4.9.3.6	Under/over frequency protection	
☐ 4.9.4	Means to detect island situation (LoM)	1)
☒ 4.10	Connection and starting to generate electrical power	
☐ 4.11	Ceasing and reduction of active power on set point	1)
☐ 4.12	Remote information exchange	1)
☐ 4.13	Requirements regarding single fault tolerance of interface protection system and interface switch (Functional safety)	1)

1):Please refer to VDE 4105 report for details.

2) Please see below table for test 2, and refer to VDE 4105 report for other data.

3) Please see below table for test 1, and refer to VDE 4105 report for test 2.

Copy of marking plate:

YI ENERGY Product:Hybrid Inverter Model :HI-3P5K-H-Y1	
PV Input	Max.Input Voltage:1000 Vd.c.
	MPPT Range:200-950 Vd.c.
	Max.Input Current:14/28 Ad.c.
	Max.Short-circuit Current:17/34 Ad.c.
Battery	Voltage Range:170-600 Vd.c.
	Maximum Current:20 Ad.c.
	Type:Li-ion
On-gird	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:5 kW
	Max.Output Apparent Power:5 kVA
	Max.Output Current:8.3 A
	Max.Input Apparent Power:10 kVA
Back-up	Max.Input Current:15.2 A
	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:5 kW
Generator	Max.Output Apparent Power:10 kVA(10s)
	Input Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
Others	Max. Input Power: 5 kW
	Power Factor: ~1.0.8(lagging)-0.8(leading)
	Operating Temperature:-25~+60 °C
	Inverter Topology:Transformerless
	Enclosure:IP66
	Protection Class:I
	OVC AC III/DC II









S/N

Made in China

Yi Energy Technology (Zhejiang) Co., Ltd.
www.yienergy.com
1-109, No. 55, Yifeng Road, Xiasha, Qiantang District,
Hangzhou, Zhejiang

YI ENERGY Product:Hybrid Inverter Model :HI-3P6K-H-Y1	
PV Input	Max.Input Voltage:1000 Vd.c.
	MPPT Range:200-950 Vd.c.
	Max.Input Current:14/28 Ad.c.
	Max.Short-circuit Current:17/34 Ad.c.
Battery	Voltage Range:170-600 Vd.c.
	Maximum Current:20 Ad.c.
	Type:Li-ion
On-gird	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:6 kW
	Max.Output Apparent Power:6 kVA
	Max.Output Current:10 A
	Max.Input Apparent Power:12 kVA
Back-up	Max.Input Current:18.2 A
	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:6 kW
Generator	Max.Output Apparent Power:12 kVA(10s)
	Input Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
Others	Max. Input Power: 6 kW
	Power Factor: ~1.0.8(lagging)-0.8(leading)
	Operating Temperature:-25~+60 °C
	Inverter Topology:Transformerless
	Enclosure:IP66
	Protection Class:I
	OVC AC III/DC II









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Hangzhou, Zhejiang

YI ENERGY
Product: Hybrid Inverter
Model :HI-3P8K-H-Y1

PV Input	Max.Input Voltage:1000 Vd.c.
	MPPT Range:200-950 Vd.c.
	Max.Input Current:14/28 Ad.c.
Battery	Max.Short-circuit Current:17/34 Ad.c.
	Voltage Range:170-600 Vd.c.
	Maximum Current:30 Ad.c.
On-grid	Type:Li-ion
	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
Back-up	Output Rated Power:8 kW
	Max.Output Apparent Power:8 kVA
	Max.Output Current:13.3 A
Generator	Max.Input Apparent Power:16 kVA
	Max.Input Current:24.2 A
	Output Nominal Voltage:400/380 V, 3L/N/PE
Others	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:8 kW
	Max.Output Apparent Power:16 kVA(10s)
Generator	Input Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
	Max. Input Power: 8 kW
Others	Power Factor: ~1.0.8(lagging)-0.8(leading)
	Operating Temperature:-25~+60 °C
	Inverter Topology:Transformerless
Others	Enclosure:IP66
	Protection Class:I
	OVC AC III/DC II



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Hangzhou, Zhejiang

YI ENERGY
Product: Hybrid Inverter
Model :HI-3P10K-H-Y1

PV Input	Max.Input Voltage:1000 Vd.c.
	MPPT Range:200-950 Vd.c.
	Max.Input Current:14/28 Ad.c.
Battery	Max.Short-circuit Current:17/34 Ad.c.
	Voltage Range:170-600 Vd.c.
	Maximum Current:30 Ad.c.
On-grid	Type:Li-ion
	Output Nominal Voltage:400/380 V, 3L/N/PE
	Nominal Operating Frequency:50/60 Hz
Back-up	Output Rated Power:10 kW
	Max.Output Apparent Power:10 kVA
	Max.Output Current:16.7 A
Generator	Max.Input Apparent Power:16 kVA
	Max.Input Current:24.2 A
	Output Nominal Voltage:400/380 V, 3L/N/PE
Others	Nominal Operating Frequency:50/60 Hz
	Output Rated Power:10 kW
	Max.Output Apparent Power:16 kVA(10s)
Generator	Input Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
	Max. Input Power: 10 kW
Others	Power Factor: ~1.0.8(lagging)-0.8(leading)
	Operating Temperature:-25~+60 °C
	Inverter Topology:Transformerless
Others	Enclosure:IP66
	Protection Class:I
	OVC AC III/DC II



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Hangzhou, Zhejiang

YI ENERGY
Product: Hybrid Inverter
Model : HI-3P12K-H-Y1

PV Input	Max. Input Voltage: 1000 Vd.c.
	MPPT Range: 200-950 Vd.c.
	Max. Input Current: 14/28 Ad.c.
	Max. Short-circuit Current: 17/34 Ad.c.
Battery	Voltage Range: 170-600 Vd.c.
	Maximum Current: 30 Ad.c.
	Type: Li-ion
On-grid	Output Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
	Output Rated Power: 12 kW
	Max. Output Apparent Power: 12 kVA
	Max. Output Current: 17.4 A
Back-up	Max. Input Apparent Power: 16 kVA
	Max. Input Current: 24.2 A
	Output Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
	Output Rated Power: 12 kW
Generator	Max. Output Apparent Power: 16 kVA(10s)
	Input Nominal Voltage: 400/380 V, 3L/N/PE
	Nominal Operating Frequency: 50/60 Hz
	Max. Input Power: 12 kW
Others	Power Factor: ~1, 0.8(Lagging)-0.8(Leading)
	Operating Temperature: -25~+60 °C
	Inverter Topology: Transformerless
	Enclosure: IP66
	Protection Class: I
	OVC AC III/DC II



S/N

Made in China

Yi Energy Technology (Zhejiang) Co., Ltd.
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1-109, No. 55, Yifeng Road, Xiasha, Qiantang District,
Hangzhou, Zhejiang

Possible test case verdicts:

- test case does not apply to the test object : N/A
- test object was not evaluated for the requirement : N/E
- test object does meet the requirement : Pass (P)
- test object does not meet the requirement : Fail (F)

Testing:

- Date of receipt of test items..... : See cover page
- Date(s) of performance of tests..... : See cover page

General remarks:

"(see Attachment #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

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

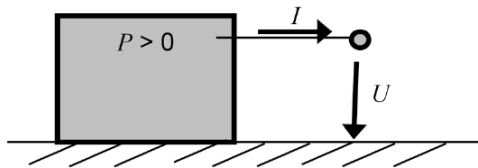
This report shall not be reproduced except in full without the written approval of the testing laboratory.

List of test equipment must be kept on file and available for review.

Additional test data and/or information provided in the attachments to this report.

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

Generator reference system:


Manufacturer's Declaration per sub-clause 6.2.5 of IEC 60335-1:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided :

- ☐ Yes
- ☒ Not applicable

Manufacturer's Declaration per sub-clause 6.2.5 of IEC 60335-1:

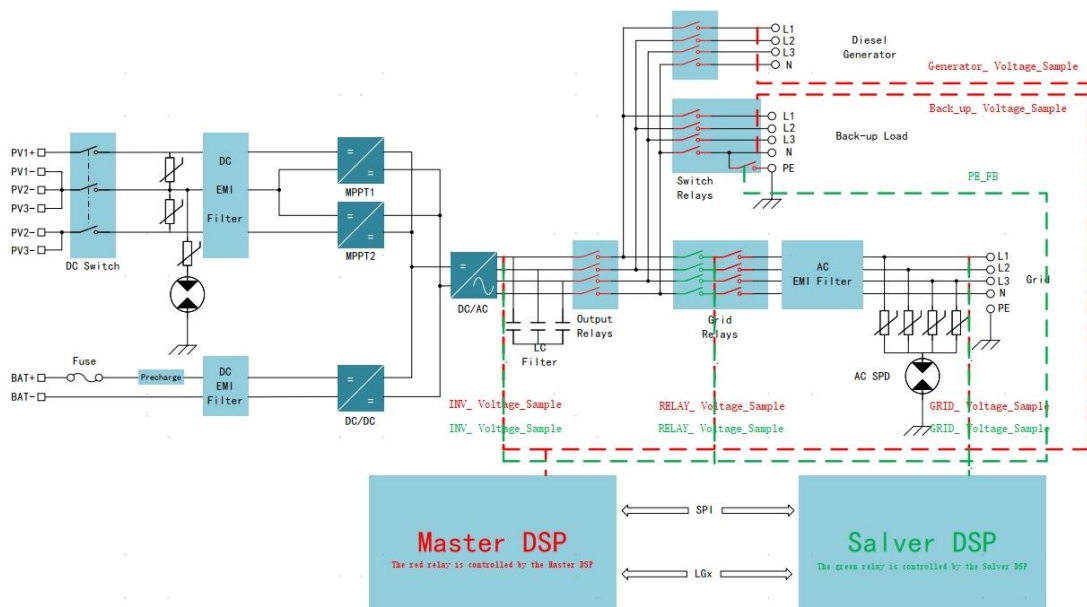
When differences exist; they shall be identified in the General product information section.

General product information:

The HI-3PxK-H-Y1 Series is a high-performance three-phase hybrid inverter with high reliability. The intelligent EMS function supports self-consumption, economic, and backup modes for multi-scenario applications. Monitoring management through APP Cloud allows users to remotely diagnose and track system's performance over time, offering superior energy production. This product can be configured with external wireless communication devices.

Block diagram:

Circuit Diagram



Block diagram

Protective function in PCE:

1. PV array insulation resistance detecting
2. Residual current monitoring
3. Over and under grid voltage / frequency protection
4. Anti-islanding protection
5. DC injection current protection
6. Over current protection
7. Over temperature protection and auto derating function
8. Relay self-checking function
9. RCMU self-checking function
10. Relays used in series as grid auto-disconnection devices for redundant NS protection
11. Short-circuit protection relies on external circuit breaks which are specified in the installation manual

Description of the differences of the models within a series:

All models are identical in hardware as well as software, except for electrical ratings, see the model list for details.

The product was tested on:

The tests had been performed on model HI-3P12K-H-Y1 are valid for other models since it is identical in hardware and just power derated by software except for electrical ratings.

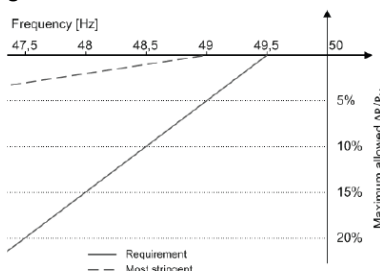
Model list:

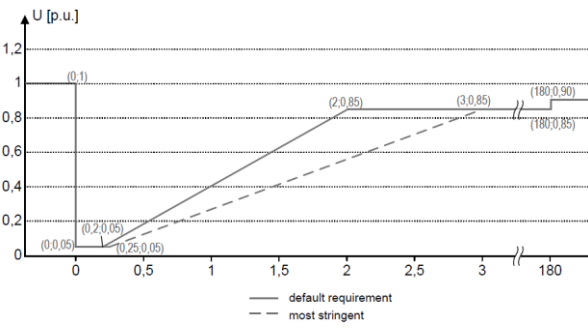
MODELS LIST	HI-3P5K-H- Y1	HI-3P6K-H- Y1	HI-3P8K-H- Y1	HI-3P10K-H- Y1	HI-3P12K-H- Y1
PV Input Data					
Max. PV Input Power(W)	7500	9000	12000	15000	15000
Max. PV Input Voltage(V)	1000				
Nominal PV Input Voltage(V)	650				
MPPT Voltage Range	200-950				
Full power MPPT Operating Range [V]	400-850	450-850	400-850	400-850	400-850
Number of MPPTs	2	2	2	2	2
Number of PV String per MPPT	1/1	1/1	1/1	1/2	1/2
Max. PV Input Current (A)	14/14	14/14	14/14	14/28	14/28
Max. Short Circuit current[A]	17/17	17/17	17/17	17/34	17/34
Battery					
Battery Type	Li-ion				
Voltage Range (V)	170-600				
Nominal Battery Voltage (V)	500				
Max. Charge Current (A)	20	20	30	30	30
Max. Discharge Current (A)	20	20	30	30	30
Rated Power (W)	5000	6000	8000	10000	10000
AC Input and Output (On-grid)					
Max. Output Apparent Power (VA)	5000	6000	8000	10000	12000
Max. Output Apparent Power (VA)	5500	6600	8800	11000	12000

Max. Input Apparent Power (VA)	12000	12000	16000	16000	16000
Nominal AC Voltage (V)	380/400, 3L/N/PE				
Nominal Grid Frequency (Hz)	50/60				
Max. Output Current (A)	8.3	10	13.3	16.7	17.4
Max. Input Current (A)	18.2	18.2	24.2	24.2	24.2
Power Factor	~1(0.8 leading ... 0.8 lagging)				
Total Harmonic Distortion (@nominal output)	<3%				
AC Output (Off-grid)					
Max. Output Apparent Power (VA)	5000	6000	8000	10000	12000
Peak Output Apparent Power (VA)	10000, 10s	12000, 10s	16000, 10s	16000, 10s	16000, 10s
Nominal AC Voltage (V)	380/400, 3L/N/PE				
Nominal AC Frequency (Hz)	50/60				
Max. Output Current (A)	8.3	10	13.3	16.7	17.4
Total Harmonic Distortion (@linear load)	<3%				
Protection					
PV String Input Reverse Polarity Protection	Integrated				
Anti-islanding Protection	Integrated				
Residual Current Monitoring Unit	Integrated				
AC Over Current Protection	Integrated				
AC Short Current Protection	Integrated				
AC OV and UV Protection	Integrated				
Surge Protection	DC Type II / AC Type III				
Diesel Generator					
Max. Input Power	5000	6000	8000	10000	12000
Nominal Input Voltage (V)	380/400, 3L/N/PE				
Nominal Input Frequency (Hz)	50/60				
General					
Dimension (W×H×D) [mm]	520×490×195				
Weight (kg)	28kg				

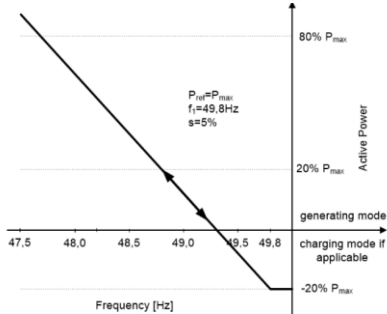
Mounting	Wall-Mounted
Protective class	Class I
Protection Degree	PD2 (internal), PD3 (external)
Operation Temperature (°C)	-25 to + 60 (>45, derating)
Relative Humidity	0-95%, no condensing
Altitude (m)	≤4000
Cooling	Natural convection
Protection Degree	IP66
Noise (dBA)	<40
User Interface	LED & App
Communication Interface	RS485, Wi-Fi/Ethernet/4G (optional)
Communication with Meter	RS485
Communication with BMS	RS485, CAN
Digital Input/output	DRM, 1 × DI, 2 × DO
Isolation Method	Transformer less

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
4	Requirements on generating plants		P
4.1	General		P
	This clause defines the requirements on generating plants to be operated in parallel with the distribution network. Where settings or a range of configurability is provided and respecting the legal framework the configurations and settings may be provided by the DSO. Where no settings are provided by the DSO, the specified default settings shall be used; if no default settings are provided, the producer shall propose settings and inform the DSO.	Noticed.	P
4.2	Connection scheme		P
	The generating plant shall be in compliance with the requirements of the DSO. Different requirements may be subject to agreement between the producer and the DSO depending on the power system needs.	Considered.	P
4.3	Choice of switchgear		P
4.3.1	General		N/A
	Switches shall be chosen based on the characteristics of the power system in which they are intended to be installed.	Disconnecting device is not integral part of the unit. The installation instructions specify a disconnection device for the final installation. The correct assembling is part of the installer.	N/A
4.3.2	Interface switch		P
	Switches shall be power relays, contactors or mechanical circuit breakers each having a breaking and making capacity corresponding to the rated current of the generating plant and corresponding to the short circuit contribution of the generating plant. NOTE For PV-inverters further requirements are stated in EN 62109-1 and -2 with respect to the interface switch.	The unit provides two integrated relays in series for phase. Each device can be switched.	P
4.4	Normal operating range		P
4.4.1	General		P
	Generating plants when generating power shall have the capability to operate in the operating ranges specified below regardless the topology and the settings of the interface protection.	See 4.4.2 to 4.4.4.	P
4.4.2	Operating frequency range		P

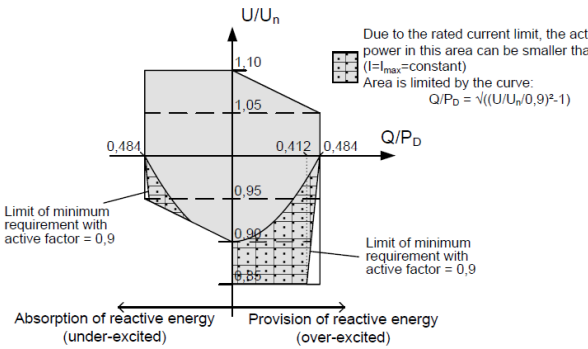
EN 50549-1: 2019																										
Clause	Requirement – Test	Result - Remark	Verdict																							
	The generating plant shall be capable to operate continuously when the frequency at the point of connection stays within the range of 49 Hz to 51 Hz. In the frequency range from 47 Hz to 52 Hz the generating plant should be capable to operate until the interface protection trips. Therefore, the generating plant shall at least be capable to operate in the frequency ranges and for the duration as for the minimum requirement indicated in Table 1. Table 1 — Minimum time periods for operation in under-frequency situation <table><tr><th rowspan="2">Frequency Range</th><th>Time period for operation</th><th>Time period for operation</th></tr><tr><th>Minimum requirement</th><th>Most stringent requirement</th></tr><tr><td>47,0 Hz – 47,5 Hz</td><td>not required</td><td>20 s</td></tr><tr><td>47,5 Hz – 48,5 Hz</td><td>30 min ^a</td><td>90 min</td></tr><tr><td>48,5 Hz – 49,0 Hz</td><td>30 min ^a</td><td>90 min ^a</td></tr><tr><td>49,0 Hz – 51,0 Hz</td><td>Unlimited</td><td>Unlimited</td></tr><tr><td>51,0 Hz – 51,5 Hz</td><td>30 min ^a</td><td>90 min</td></tr><tr><td>51,5 Hz – 52,0 Hz</td><td>not required</td><td>15 min</td></tr></table> ^a: Respecting the legal framework, it is possible that longer time periods are required by the relevant authority in some synchronous areas.	Frequency Range	Time period for operation	Time period for operation	Minimum requirement	Most stringent requirement	47,0 Hz – 47,5 Hz	not required	20 s	47,5 Hz – 48,5 Hz	30 min ^a	90 min	48,5 Hz – 49,0 Hz	30 min ^a	90 min ^a	49,0 Hz – 51,0 Hz	Unlimited	Unlimited	51,0 Hz – 51,5 Hz	30 min ^a	90 min	51,5 Hz – 52,0 Hz	not required	15 min	See appended table.	P
Frequency Range	Time period for operation		Time period for operation																							
	Minimum requirement	Most stringent requirement																								
47,0 Hz – 47,5 Hz	not required	20 s																								
47,5 Hz – 48,5 Hz	30 min ^a	90 min																								
48,5 Hz – 49,0 Hz	30 min ^a	90 min ^a																								
49,0 Hz – 51,0 Hz	Unlimited	Unlimited																								
51,0 Hz – 51,5 Hz	30 min ^a	90 min																								
51,5 Hz – 52,0 Hz	not required	15 min																								
4.4.3	Minimal requirement for active power delivery at under-frequencies		P																							
	A generating plant shall be resilient to reductions of frequency at the point of connection while reducing the maximum active power as little as possible. The admissible active power reduction due to under-frequency below 49,5 Hz is limited by a reduction rate of 10 % of the momentary power P_M per 1 Hz frequency drop as given by the full line in Figure 3.  Figure 3 — Maximum allowable power reduction in case of under-frequency	See appended table.	P																							
4.4.4	Continuous operating voltage range		P																							
	The generating plant when generating power shall be capable to operate continuously when the voltage at the point of connection stays within the range of 85 % U_n to 110 % U_n. In case of voltages below U_n, it is allowed to reduce the apparent power to maintain the current limits of the generating plant. The reduction shall be as small as technically feasible.	See appended table.	P																							
4.5	Immunity to disturbances		P																							

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
4.5.1	General		P
	The following withstand capabilities shall be fulfilled regardless the topology and the settings of the interface protection.	See 4.5.2 to 4.5.4.	P
4.5.2	Rate of change of frequency (ROCOF) immunity		P
	The generating modules in a generating plant shall have ROCOF immunity for a ROCOF equal or exceeding the value specified by the responsible party. If no ROCOF immunity value is specified, the following ROCOF immunity shall apply, making distinction between generating technologies: • Non-synchronous generating technology: at least 2 Hz/s • Synchronous generating technology: at least 1 Hz/s	See appended table.	P
4.5.3	Unde-voltage ride through (UVRT)		P
4.5.3.1	General		P
	Generating plants shall contribute to overall power system stability by providing also immunity towards dynamic voltage changes.		P
4.5.3.2	Generating plant with non-synchronous generating technology		P
	Generating modules shall be capable of remaining connected to the distribution network as long as the voltage at the point of connection remains above the voltage-time curve of Figure 6. The voltage is relative to U_n.  Figure 6 — Under-voltage ride through capability for non-synchronous generating technology	See appended table.	P
4.5.3	Generating plant with synchronous generating technology	Not such type of unit.	N/A

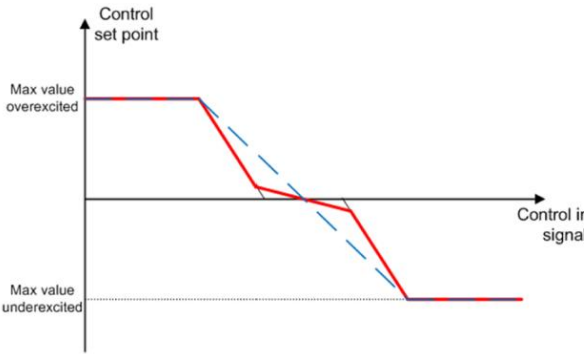
EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	Generating modules shall be capable of staying connected to the distribution network as long as the voltage at the point of connection remains above the voltage-time curve of Figure 7. The voltage is relative to U_n. Figure 7 — Under-voltage ride through capability for synchronous generating technology		N/A
4.5.4	Over-voltage ride through (OVRT)		P
	Generating modules, except for micro-generating plants, shall be capable of staying connected to the distribution network as long as the voltage at the point of connection remains below the voltage-time curve of Figure 8. Figure 8 — Over-voltage ride through capability	See appended table.	P
4.6	Active response to frequency deviation		P
4.6.1	Power response to over-frequency		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	The generating unit shall be capable of activating active power response to over-frequency at a programmable frequency threshold f_1 at least between and including 50.2 Hz and 52 Hz with a programmable droop in a range of at least 2 % to 12 %. The droop reference is P_{ref}. Unless defined differently by the responsible party: • $P_{ref}=P_{max}$, in the case of synchronous generating technology and electrical energy storage systems. • $P_{ref}=P_M$, the actual AC output power at the instant when the frequency reaches the threshold f_1, in the case of all other non-synchronous generating technology The resolution of the frequency measurement shall be ± 10 mHz or less. After activation, the active power frequency response shall be delivered with an accuracy of ± 10 % of the nominal power.	See appended table.	P
4.6.2	Power response to underfrequency		P
	The active power response to underfrequency shall be delivered at a programmable frequency threshold f_1 at least between and including 49.8 Hz and 46.0 Hz with a programmable droop in a range of at least 2 % to 12 %. The generating unit shall be capable of activating active power response to underfrequency as fast as technically feasible with an intrinsic dead time that shall be as short as possible with a maximum of 2 s and with a step response time of maximum 30 s unless another value is defined by the relevant party. After activation, the programmed droop with an accuracy of ± 10 % of the nominal power. The resolution of the frequency measurement shall be ± 10 mHz or less.  Figure 11 — Example of active power frequency response to underfrequency in case of storage device with 20 % power charging at passing of threshold frequency f_1	See appended table.	P
4.7	Power response to voltage changes		P
4.7.1	General		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	The capability to contribute to voltage support by means of management of reactive and/or active power by the generating plant may be required by the DSO.	See appended table.	P
4.7.2	Voltage support by reactive power		P
4.7.2.1	General		P
	Generating plants shall not lead to voltage variations out of acceptable limits. These limits should be defined by national regulation. Generating units and plants shall be able to contribute to meet this requirement during normal network operation.	See 4.7.2.2 to 4.7.2.3.	P
4.7.2.2	Capabilities	See below.	P
	Unless specified differently below, for specific generating technologies, generating plants shall be able to operate with active factors as defined by the DSO and the responsible party from active factor = $0.90_{\text{underexcited}}$ to active factor = $0.90_{\text{overexcited}}$ Figure 12 — Reactive power capability at nominal voltage	See appended table.	P
	The reactive power capability shall be evaluated at the terminals of the/each generating unit CHP generating units with a capacity ≤ 150 kVA shall be able to operate with active factors as defined by the DSO from $\cos \varphi = 0.95_{\text{under-excited}}$ to $\cos \varphi = 0.95_{\text{over-excited}}$.	Not such type of unit.	N/A
	Generating units with an induction generator coupled directly to the grid and used in generating plants above micro generating level, shall be able to operate with active factors as defined by the DSO from $\cos \varphi = 0.95_{\text{under-excited}}$ to $\cos \varphi = 1$ at the terminals of the unit. Deviating from 4.7.2.3 only the $\cos \varphi$ set point mode is required. Deviating from the accuracy requirements below, the accuracy is only required at active power P_D .	Not such type of unit.	N/A

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	Generating units with an induction generator coupled directly to the grid and used in micro generating plants shall operate with an active factor above 0,95 at the terminals of the generating unit. A controlled voltage support by reactive power is not required from this technology.	Not such type of unit.	N/A
	Generating units with linear generators, coupled directly and synchronously to the grid shall operate with an active factor above 0,95 at the terminals of the generating unit, and therefore a controlled voltage support by reactive power is not required from this technology.	Not such type of unit.	N/A
	When operating above the apparent power threshold S_{min} equal to 10 % of the maximum apparent power S_{max} or the minimum regulating level of the generating plant, whichever is the higher value, the reactive power capability shall be provided with an accuracy of $\pm 2 \% S_{max}$. Up to this apparent power threshold S_{min}, deviations above 2 % are permissible. For generating units with a reactive power capability according Figure 12 the reactive power capability at active power P_D shall be at least according Figure 13. For generating units with a reduced reactive power capability Figure 13 is only applicable up to the maximum reactive power capability.  Figure 13 — Reactive power capability at active power P_D in the voltage range (positive sequence component of the fundamental)	See appended table.	P
4.7.2.3	Control modes.		P
4.7.2.3.1	General		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	If actually required, the form of the contribution to voltage control shall be specified by the DSO. The control modes are exclusive; only one mode may be active at a time. • Q setpoint mode • Q (U) • Cos φ setpoint mode • Cos φ (P)	See 4.7.2.3.2 to 4.7.3.	P
4.7.2.3.2	Setpoint control modes (Cos φ setpoint mode)		P
	Q setpoint mode and cos φ setpoint mode control the reactive power output and the cos φ of the output respectively, according to a set point set in the control of the generating plant/unit. In the case of change of the set point local or by remote control the settling time for the new set point shall be less than one minute.	See appended table.	P
4.7.2.3.3	Voltage related control modes (Q (U))		P
	The voltage related control mode Q (U) controls the reactive power output as a function of the voltage. There is no preferred state of the art for evaluating the voltage. Therefore it is the responsibility of the generating plant designer to choose a method. One of the following methods should be used: • the positive sequence component of the fundamental; • the average of the voltages measured independently for each phase to neutral or phase to phase; • phase independently the voltage of every phase to determine the reactive power for every phase. For voltage related control modes, a characteristic with a minimum and maximum value and three connected lines according to Figure 16 shall be configurable.	See appended table.	P
4.7.2.3.4	Power related Control mode:		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	The power related control modes Q (P) and $\cos \varphi$ (P) control the reactive power output and the $\cos \varphi$ of the output respectively as a function of the active power output. For power related control modes, a characteristic with a minimum and maximum value and three connected lines shall be configurable in accordance with Figure 16.  Figure 16 — Example characteristics for Q respectively $\cos \varphi$ control mode	See appended table.	P
4.7.3	Voltage related active power reduction		P
	In order to avoid disconnection due to a maximum voltage protection (see 4.9.3.3 and 4.9.3.4), generating plants/units are allowed to reduce active power output as a function of this rising voltage. The final implemented logic can be chosen by the manufacturer. Nevertheless, this logic shall not cause steps or oscillations in the output power.	The interface protection device was incorporated into the microgenerator control system. See appended table.	P
4.7.4	Short circuit current requirements on generating plants		P
4.7.4.1	General	Type A of unit.	N/A
	Generating modules classified as type B modules according to COMMISSION REGULATION 2016/631 shall comply with the requirements of 4.7.4.2 and 4.7.4.3. Generating modules classified as type A according to COMMISSION REGULATION 2016/631 should comply with these requirements. The actual behaviour of type A modules shall be specified in the connection agreement.		N/A
4.7.4.2	Generating plant with non-synchronous generating technology		P
4.7.4.2.1	Voltage support during faults and voltage steps		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN 50549-2 applies.	Considered to type A of unit.	P
4.7.4.2.2	Zero current mode for converter connected generating technology		P
	If UVRT capability (see 4.5.3) is provided additional to the requirements of 4.5, generating units connected to the grid by a converter shall have the capability to reduce their current as fast as technically feasible down to or below 10 % of the rated current when the voltage is outside of a static voltage range. Generating units based on a doubly fed induction machine can only reduce the positive sequence current below 10 % of the rated current. Negative sequence current shall be tolerated during unbalanced faults. In case this current reduction is not sufficient, the DSO should choose suitable interface protection settings.	See appended table.	P
	The static voltage range shall be adjustable from 20 % to 100 % of U_n for the undervoltage boundary and from 100 % to 130 % of U_n for the overvoltage boundary. The default setting shall be 50% of U_n for the undervoltage boundary and 120% of U_n for the overvoltage boundary. Each phase to neutral voltage or if no neutral is present each phase to phase voltage shall be evaluated. At voltage re-entry into the voltage range, 90% of pre-fault power or available power, whichever is the smallest, shall be resumed as fast as possible, but at the latest according to 4.5.3 and 4.5.4.	See appended table.	P
4.7.4.2.3	Induction generator based units	Not such type of unit.	N/A
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN50549-2 applies.		N/A
4.7.4.3	Generating plant with synchronous generating technology - Synchronous generator based units	Not such type of unit.	N/A

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN50549-2 applies.		N/A
4.8	EMC and power quality		P
	Similar to any other apparatus or fixed installation, generating units shall comply with the requirements on electromagnetic compatibility established in Directive 2014/30/EU or 2014/53/EU, whichever applies. EMC limits and tests, described in EN 61000 series, have been traditionally developed for loads, without taking into account the particularities of generating units, such as their capability to create overvoltages or high frequency disturbances due to the presence of power converters, which were either impossible or less frequent in case of loads.	See EMC report No. CN232XT8 001.	P
	• Harmonic emissions;	See appended table.	P
	• Flicker and voltage fluctuations;	See appended table.	P
	• DC injection;	See appended table.	P
	• Short and long duration overvoltages emission;		N/A
	• Switching frequency emission;		N/A
	• Immunity to voltage dips and short interruptions;		N/A
	• Immunity to frequency variation		N/A
	• Immunity to harmonics and inter-harmonics;	See appended table.	P
	• Unbalance.	See appended table.	P
4.9	Interface protection		P
4.9.1	General		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	This automatic means of disconnection has following main objectives: - prevent the power production of the generating plant to cause an overvoltage situation in the distribution network it is connected to. Such overvoltages could result in damages to the equipment connected to the distribution network as well as the distribution network itself; - detect unintentional island situations and disconnect the generating plant in this case. This is contributing to prevent damage to other equipment, both in the producers' installations and the distribution network due to out of phase re-closing and to allow for maintenance work after an intentional disconnection of a section of the distribution network; - assist in bringing the distribution network to a controlled state in case of voltage or frequency deviations beyond corresponding regulation values.	The integrated protection provided to detect abnormal condition (Out of range for AC voltage, frequency, and unintentional island). It can disconnect from grid while abnormal condition is happened.	P
	It is not the purpose of the interface protection system to: - disconnect the generating plant from the distribution network in case of faults internal to the power generating plant. Protection against internal faults (short-circuits) shall be coordinated with network protection, according to DSO protection criteria. Protection against e.g. overload, electric shock and against fire hazards shall be implemented additionally according to HD 60364-1 and local requirements; - prevent damages to the generating unit due to incidents (e.g. short circuits) on the distribution network	See above.	P
4.9.2	Void		N/A
4.9.3	Requirements on voltage and frequency protection	.	P
4.9.3.1	General		P

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Clause	Requirement – Test	Result - Remark	Verdict
	Part or all of the following described functions may be required by the DSO. The protection functions shall evaluate at least all phases where generating units, covered by this protection system, are connected to. In case of three phase generating units/plants and in all cases when the protection system is implemented as an external protection system in a three phase power supply system, all phase to phase voltages and, if a neutral conductor is present, all phase to neutral voltages shall be evaluated. The minimum required accuracy for protection is: ● for frequency measurement ± 0.05 Hz; ● for voltage measurement $\pm 1\%$ of U_n.	The frequency range, voltage range, observation time, and power gradient can be adjustable in display panel. It can be protected by password, and adjusted by local distributor.	P
4.9.3.2	Undervoltage protection [27]		P
	The protection shall comply with EN 60255-127. The evaluation of the r.m.s. or the fundamental value is allowed.	See appended table.	P
4.9.3.3	Overvoltage protection [59]		P
	The protection shall comply with EN 60255-127. The evaluation of the r.m.s. or the fundamental value is allowed.	See appended table.	P
4.9.3.4	Overvoltage 10 min mean protection		P
	The calculation of the 10 min value shall comply with the 10 min aggregation of EN 61000-4-30 Class S, but deviating from EN 61000-4-30 as a moving window is used. Therefore the function shall be based on the calculation of the square root of the arithmetic mean of the squared input values over 10 min. The calculation of a new 10 min value at least every 3 s is sufficient, which is then to be compared with the threshold value.	See appended table.	P
4.9.3.5	Underfrequency protection [81<]		P
	Underfrequency protection may be implemented with two completely independent protection thresholds, each one able to be activated or not.	See appended table.	P
4.9.3.6	Overfrequency protection [81>]		P
	Underfrequency protection may be implemented with two completely independent protection thresholds, each one able to be activated or not.	See appended table.	P
4.9.4	Means to detect island situation		P
4.9.4.1	General		P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	Besides the passive observation of voltage and frequency further means to detect an island might be required by the DSO. Detecting islanding situations shall not be contradictory to the immunity requirements of 4.5.	Considered. Active method of anti-islandinf detection is AFD.	P
4.9.3.2	Active methods tested with a resonant circuit		P
	These are methods which pass the resonant circuit test according to Clause 5 or for PV inverters according to EN 62116.	See appended table.	P
4.9.4.3	Switch to narrow frequency band (see Annex E and Annex F)		P
	In case of local phenomena (e.g. a fault or the opening of circuit breaker along the line) the DSO in coordination with the responsible party may require a switch to a narrow frequency band to increase the interface protection relay sensitivity. In the event of a local fault it is possible to enable activation of the restrictive frequency window (using the two underfrequency/overfrequency thresholds described in 4.9.2.5 and 4.9.2.6) correlating its activation with another additional protection function.	The settings of field can be readable on the display panel. See instruction manual.	P
4.9.5	Digital input to the interface protection		N/A
	If required by the DSO, the interface protection shall have at least two configurable digital inputs. These inputs can for example be used to allow transfer trip or the switching to the narrow frequency band.	Must be taken under consideration for the installation.	N/A
4.10	Connection and starting to generate electrical power		P
4.10.1	General		P
	Connection and starting to generate electrical power is only allowed after voltage and frequency is within the allowed voltage range and the allowed frequency range for at least the specified observation time. It shall be impossible to overrule these conditions. The setting of the conditions depends on whether the connection is due to a normal operational start-up or an automatic reconnection after tripping of the interface protection.	Considered.	P
4.10.2	Automatic reconnection after tripping		P

EN 50549-1: 2019																								
Clause	Requirement – Test	Result - Remark	Verdict																					
	The frequency range, the voltage range, the observation time shall be adjustable in the range according to Table 3 column 2. If no settings are specified by the DSO and the responsible party, the default settings for the reconnection after tripping of the interface protection are according to Table 3 column 3. Table 3 — Automatic reconnection after tripping <table><tr><th>Parameter</th><th>Range</th><th>Default setting</th></tr><tr><td>Lower frequency</td><td>47,0Hz – 50,0Hz</td><td>49,5Hz</td></tr><tr><td>Upper frequency</td><td>50,0Hz – 52,0Hz</td><td>50,2Hz</td></tr><tr><td>Lower voltage</td><td>50% – 100% U_n</td><td>85 % U_n</td></tr><tr><td>Upper voltage</td><td>100% – 120% U_n</td><td>110 % U_n</td></tr><tr><td>Observation time</td><td>10s – 600s</td><td>60s</td></tr><tr><td>Active power increase gradient</td><td>6% – 3000%/min</td><td>10%/min</td></tr></table>	Parameter	Range	Default setting	Lower frequency	47,0Hz – 50,0Hz	49,5Hz	Upper frequency	50,0Hz – 52,0Hz	50,2Hz	Lower voltage	50% – 100% U _n	85 % U _n	Upper voltage	100% – 120% U _n	110 % U _n	Observation time	10s – 600s	60s	Active power increase gradient	6% – 3000%/min	10%/min	See appended table.	P
Parameter	Range	Default setting																						
Lower frequency	47,0Hz – 50,0Hz	49,5Hz																						
Upper frequency	50,0Hz – 52,0Hz	50,2Hz																						
Lower voltage	50% – 100% U _n	85 % U _n																						
Upper voltage	100% – 120% U _n	110 % U _n																						
Observation time	10s – 600s	60s																						
Active power increase gradient	6% – 3000%/min	10%/min																						
4.10.3	Starting to generate electrical power		P																					
	The frequency range, the voltage range, the observation time shall be adjustable in the range according to Table 4 column 2. If no settings are specified by the DSO and the responsible party, the default settings for connection or starting to generate electrical power due to normal operational start-up or activity are according to Table 4 column 3. Table 4 — Starting to generate electrical power <table><tr><th>Parameter</th><th>Range</th><th>Default setting</th></tr><tr><td>Lower frequency</td><td>47,0Hz – 50,0Hz</td><td>49,5Hz</td></tr><tr><td>Upper frequency</td><td>50,0Hz – 52,0Hz</td><td>50,1Hz</td></tr><tr><td>Lower voltage</td><td>50% – 100% U_n</td><td>85 % U_n</td></tr><tr><td>Upper voltage</td><td>100% – 120% U_n</td><td>110 % U_n</td></tr><tr><td>Observation time</td><td>10s – 600s</td><td>60s</td></tr><tr><td>Active power increase gradient</td><td>6% – 3000%/min</td><td>disabled</td></tr></table>	Parameter	Range	Default setting	Lower frequency	47,0Hz – 50,0Hz	49,5Hz	Upper frequency	50,0Hz – 52,0Hz	50,1Hz	Lower voltage	50% – 100% U _n	85 % U _n	Upper voltage	100% – 120% U _n	110 % U _n	Observation time	10s – 600s	60s	Active power increase gradient	6% – 3000%/min	disabled	See appended table.	P
Parameter	Range	Default setting																						
Lower frequency	47,0Hz – 50,0Hz	49,5Hz																						
Upper frequency	50,0Hz – 52,0Hz	50,1Hz																						
Lower voltage	50% – 100% U _n	85 % U _n																						
Upper voltage	100% – 120% U _n	110 % U _n																						
Observation time	10s – 600s	60s																						
Active power increase gradient	6% – 3000%/min	disabled																						
4.10.4	Synchronisation		P																					
	Synchronizing a generating plant/unit with the distribution network shall be fully automatic i.e. it shall not be possible to manually close the switch between the two systems to carry out synchronization.	Complied. See appended table.	P																					
4.11	Ceasing and reduction of active power on set point		P																					
4.11.1	Ceasing active power		P																					
	Generating plants with a maximum capacity of 0.8 kW or more shall be equipped with a logic interface (input port) in order to cease active power output within five seconds following an instruction being received at the input port.	See appended table.	P																					
4.11.2	Reduction of active power on set point		P																					

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
	A generation unit/plant shall be capable of carrying out the power output reduction to the respective limit within an envelope of not faster than 0.66% P_n/s and not slower than 0.33% P_n/s with an accuracy of 5 % of nominal power. Generating plants are permitted to disconnect from the network at a limit value below it minimum regulating level. If required by the DSO, this includes remote operation.	See appended table.	P
4.12	Remote information exchange		P
	Generating plants whose power is above a threshold to be determined by the DSO and the responsible party shall have the capacity to be monitored by the DSO or TSO control centre or control centres as well as receive operation parameter settings for the functions specified in this European Standard from the DSO or TSO control centre or control centres. This information exchange is aimed at allowing the DSO and/or the TSO to improve, optimize and make safer the operation of their respective networks.	Considered.	P
4.13	Requirements regarding single fault tolerance of interface protection system and interface switch		P
	If required in 4.3.2, the interface protection system and the interface switch shall meet the requirements of single fault tolerance. A single fault shall not lead to a loss of the safety functions. Faults of common cause shall be taken into account if the probability for the occurrence of such a fault is significant. Whenever reasonably practical, the individual fault shall be displayed and lead to the disconnection of the power generating unit or system.	See appended table.	P
Annex A (informative)	Interconnection guidance	Must be taken under consideration for the installation.	N/A
Annex B (informative)	Void		N/A
Annex C (informative)	Parameter Table	Considered, see 4.3 to 4.13.	P
Annex D (informative)	List of national requirements applicable for generating plants	Must be taken under consideration for the installation.	N/A
Annex E (informative)	Loss of Mains and overall power system security	Noticed.	P
Annex F (informative)	Examples of protection strategies	Noticed.	P

EN 50549-1: 2019			
Clause	Requirement – Test	Result - Remark	Verdict
Annex G (normative)	Abbreviations	Noticed.	P
Annex H (informative)	Relationship between this European standard and the COMMISSION REGULATION (EU) 2016/631	Noticed.	P

- End of test report -

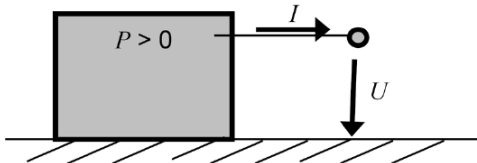
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Test Engineer:	Sky Shen	Reviewer:	Allen Hu
Signature:	<i>Sky Shen</i>	Signature:	<i>Allen Hu</i>

Testing Location:	
Name:	TÜV Rheinland (Shanghai) Co., Ltd.
Address:	TÜV Rheinland Building, No. 177, Lane 777, West Guangzhong Road, Jingan District, Shanghai 200072, P.R. China

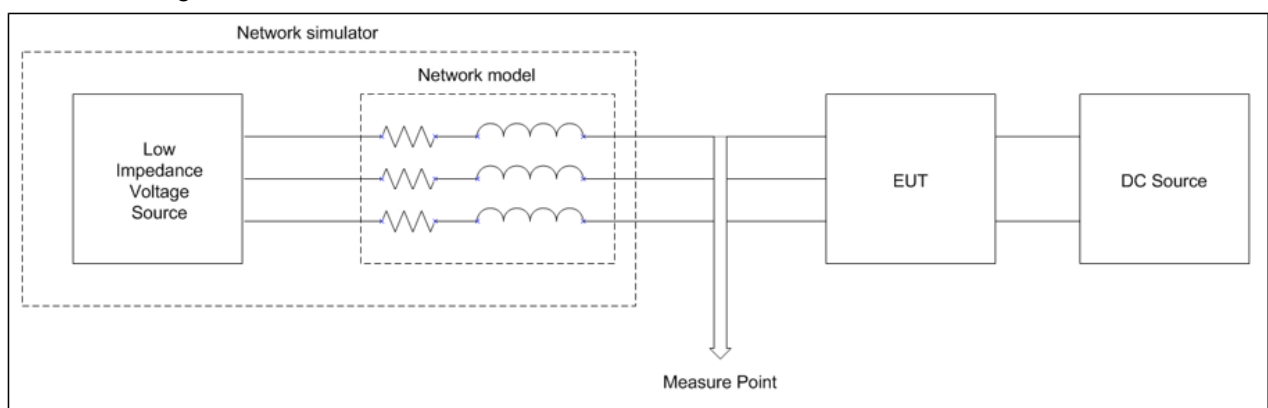
Test Sample No.:	A003499676-001
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Test Condition:	Generator reference system applied in test: 
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Test Date:	2023-06-08 - 2023-10-10
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Product Information:

Test bench diagram:



A network model (grid impedance simulator) only connected in test bench in flicker test (<75A condition), in the other tests the network model is bypassed.

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Absatz	EN 50549-1	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Evaluation

Test requests	Clause	Test items	Remark	Evaluation
Power Quality	4.4.2, 4.4.3, 4.4.4	Normal operating range	Operation range	P
Grid Support	4.5.3, 4.5.4, 4.7.4	Fault Voltage-Ride Through	FVRT	P
	4.6.1	Power response to over-frequency	LFSM-O	P
	4.7.2.2	Capabilities	Operation range, P&Q range	P
	4.7.2.3.3	Voltage related control mode	Q(U)	P
	4.7.2.3.4	Power related control mode	cosφ(P)	P
	4.7.3	Voltage related active power reduction	P(U)	P
	4.10	Connection and starting to generate electrical power	Connection and reconnection	P
NS Protection	4.5.2	Rate of change of frequency immunity	RoCoF	P
	4.9.3.2, 4.9.3.3	Under/over voltage protection	OV/UV	P
	4.9.3.5, 4.9.3.6	Under/over frequency protection	OF/UF	P

4.4.2, 4.4.3, 4.4.4	TABLE: Normal operating range (Operation range)					P
Test Conditions		Measurements		Target value		Limit
U/Un	f [Hz]	Pmax/Pn	U/Un	f [Hz]	Pmax/Pn	Pmax/Pn
85%	47.5	85.3%	85.0%	47.5	100%	≥85%
85%	48.5	85.3%	85.0%	48.5	100%	≥85%
110%	51.0	97.4%	110.0%	51.0	100%	100%±5%
110%	51.5	97.3%	110.0%	51.5	100%	--
100%	50.0	97.1%	100.0%	50.0	100%	100%±5%
100%	49.0	97.1%	100.0%	49.0	100%	100%±5%
100%	47.5	97.1%	100.0%	47.5	100%	80%-105%
Note(s): * Function of interface protection and activating active power response to over/under frequency and voltage shall be disable.						

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4.5.2	TABLE: Rate of change of frequency immunity (ROCOF)	P
Test Condition	Measurement	Limit
+ 2 Hz/s	Connect	Connect
- 2 Hz/s	Connect	Connect
+ 1 Hz/s	N/A	Connect
- 1 Hz/s	N/A	Connect

Note(s):

☒ Non-synchronous generating technology: at least 2 Hz/s

☐ Synchronous generating technology: at least 1 Hz/s

* Function of interface protection and activating active power response to over/under frequency shall be disable.

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4.5.3, 4.7.3, 4.7.4		TABLE: Fault Voltage Ride-Through (FVRT)				P
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.1
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	10:25:06
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		166
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	166
	8	Fault duration in empty load test	Total	--	ms	166
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.15
	10		Pos.		p.u.	0.15
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.98
	13	Active power	Total	t1-10s to t1	p.u.	0.98
	14		Pos.			0.98
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.01
	16		Pos.			-0.01
	17	Cosφ	--	t1-10s to t1	--	1.000
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.01

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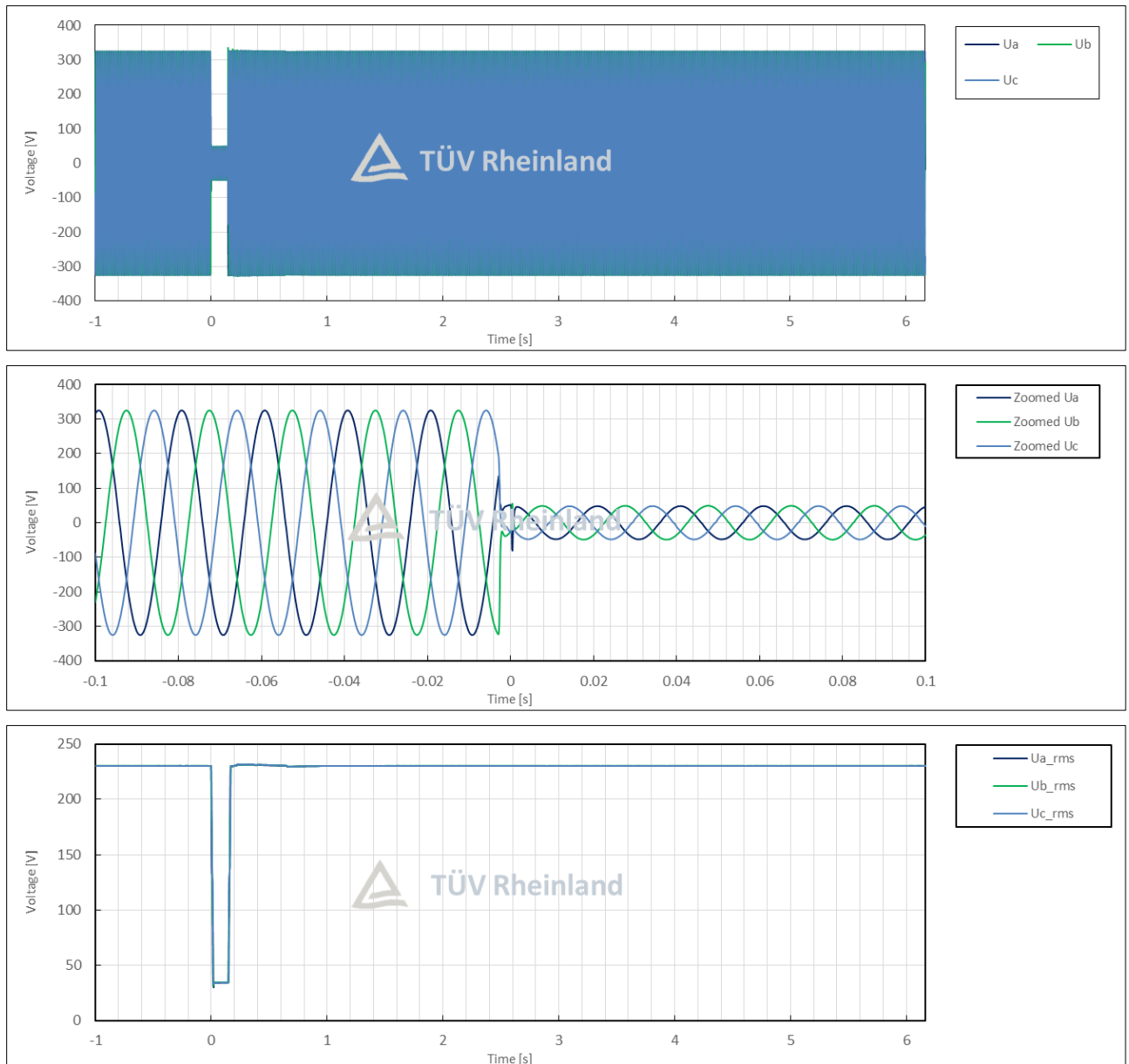
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	20		Phase 2			0.01
	21		Phase 3			0.01
	22	Line current	Phase 1	t1+100ms	p.u.	0.01
	23		Phase 2			0.01
	24		Phase 3			0.01
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.98
	29		Pos.			0.98
	39	Active power rising time	Pos.	--	s	0.149
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.01
	32		Pos.			-0.01
	33	Reactive power rising time	Pos.	--	s	N/A
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

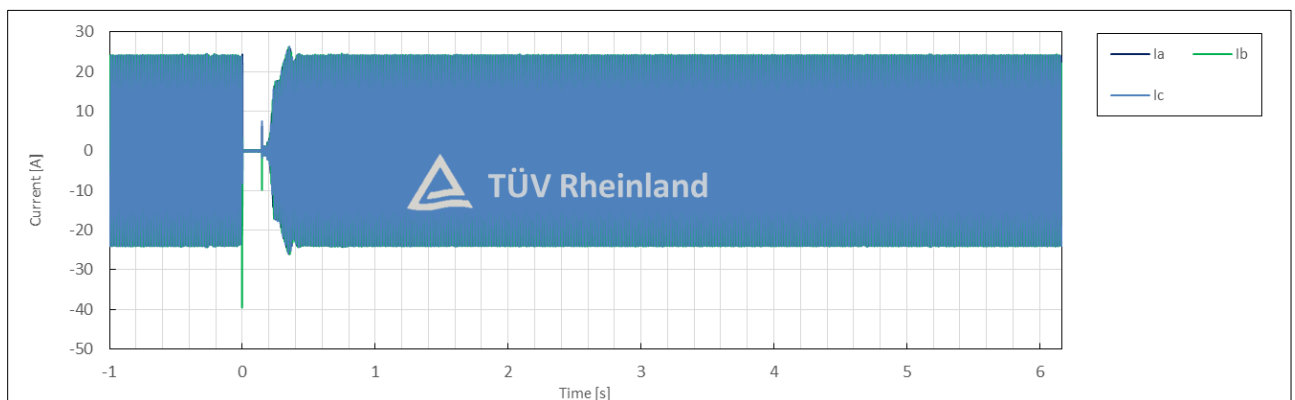
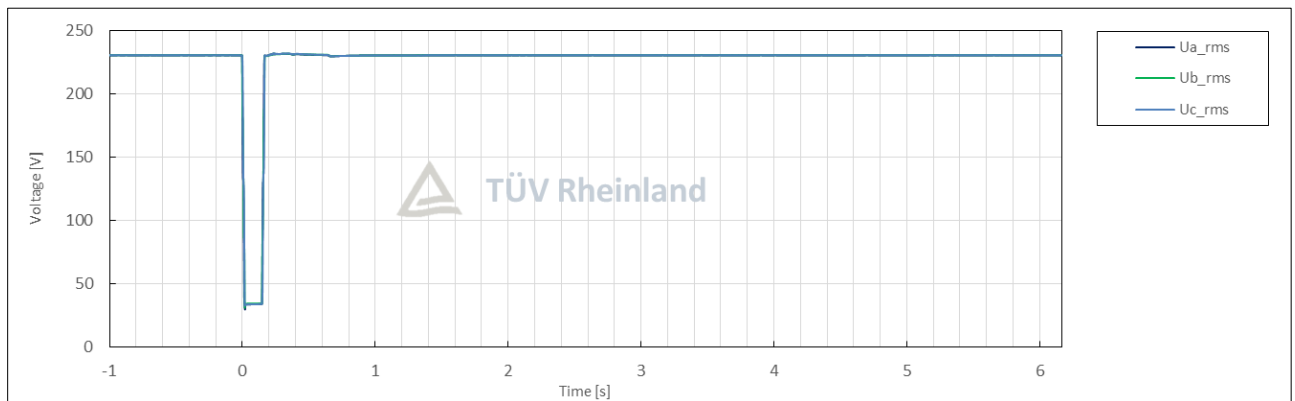
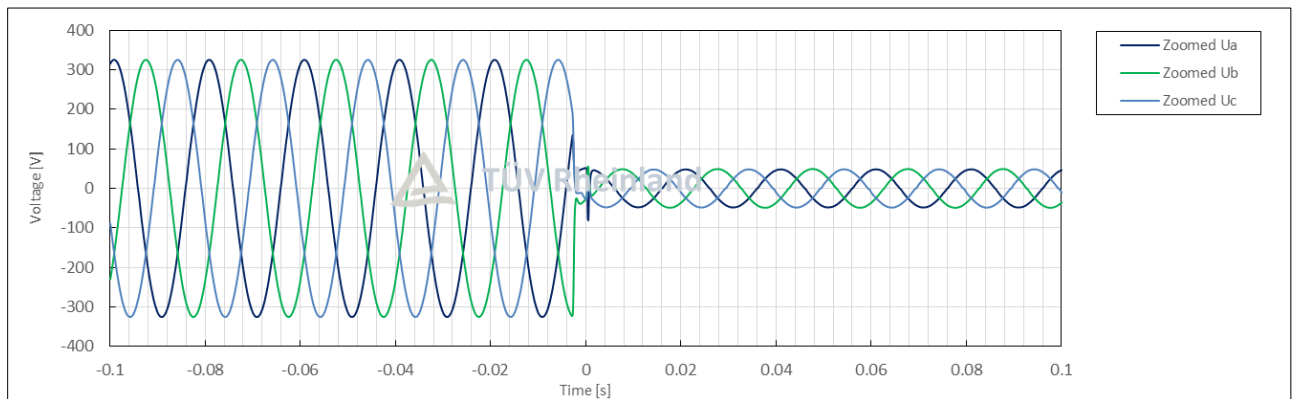
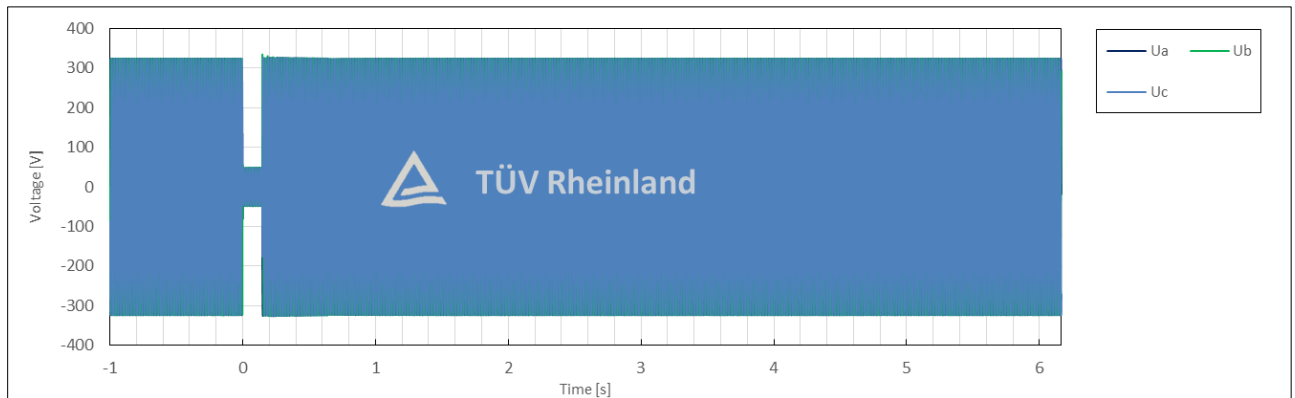
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Test No. 1.1 idle test

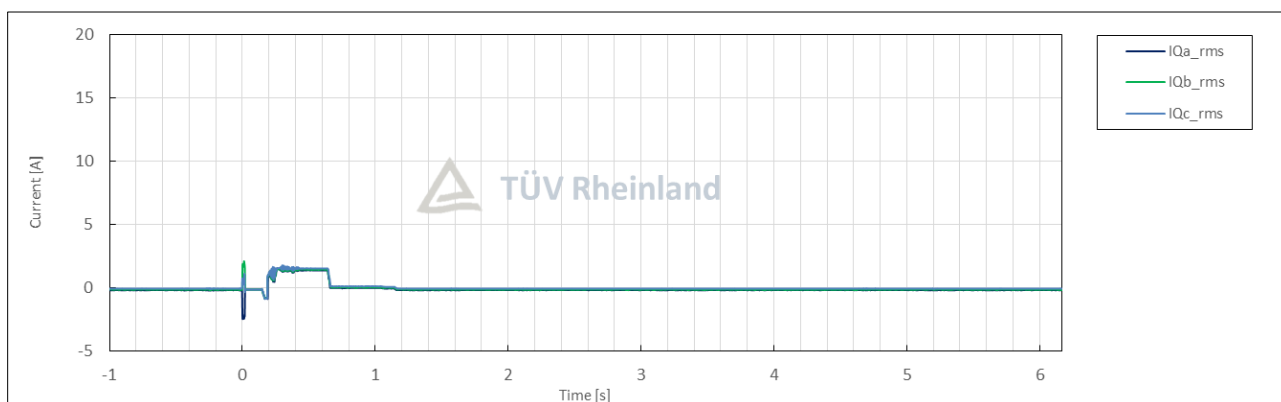
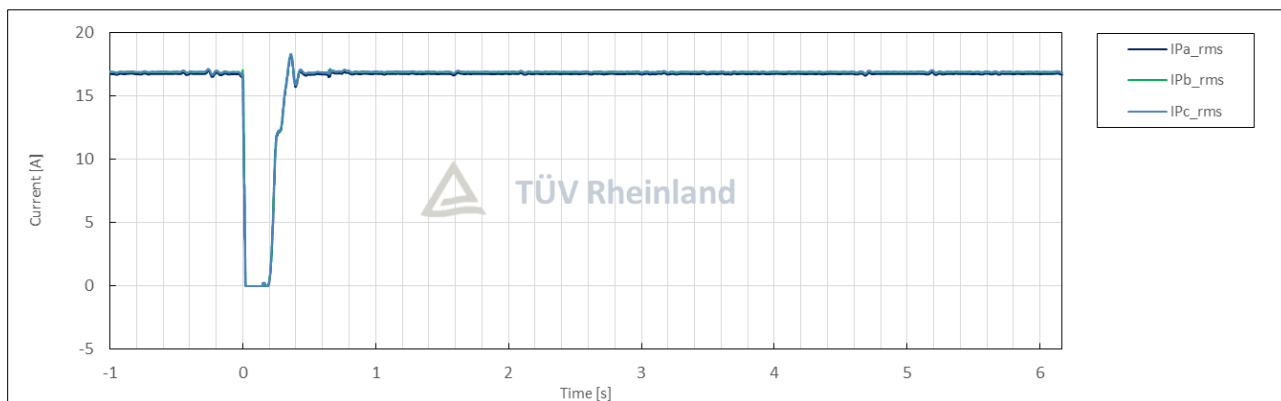
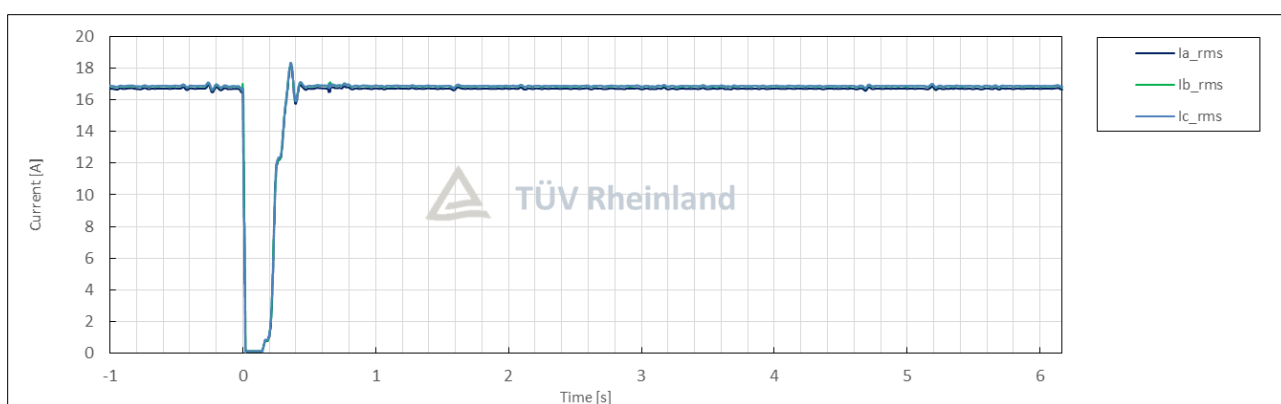
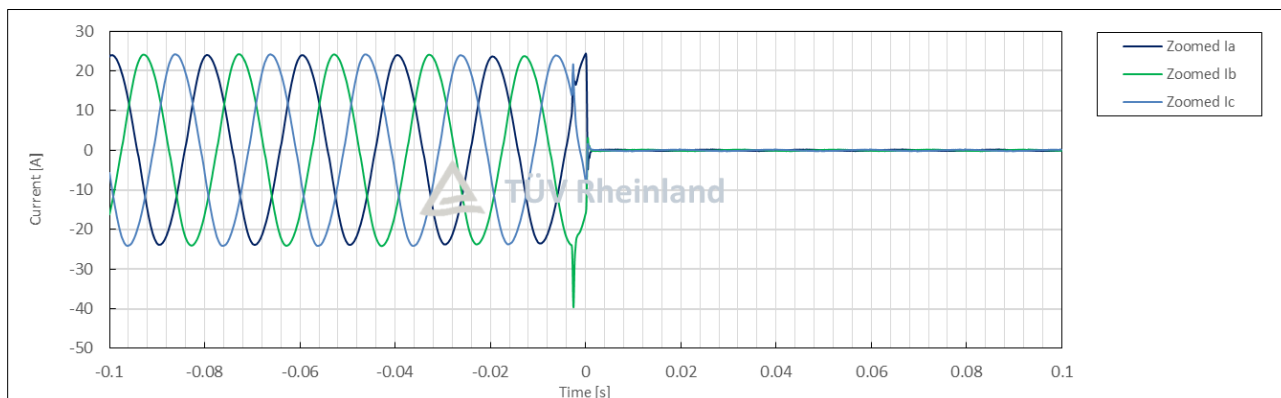


Test No. 1.1 with PGU



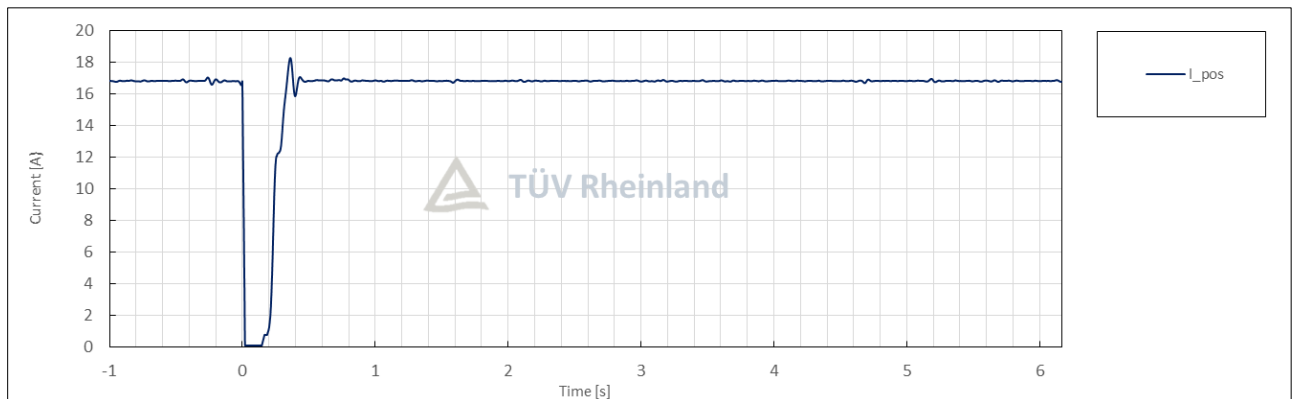
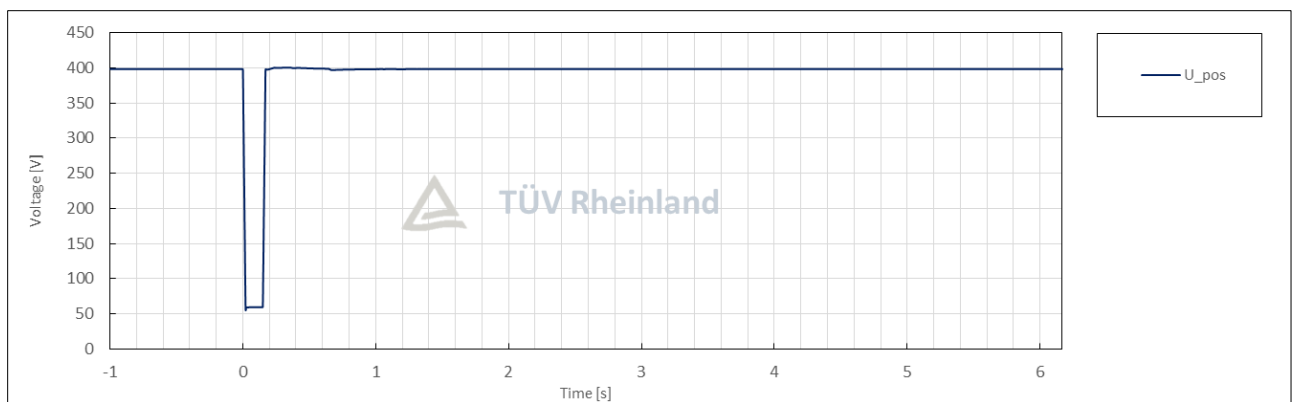
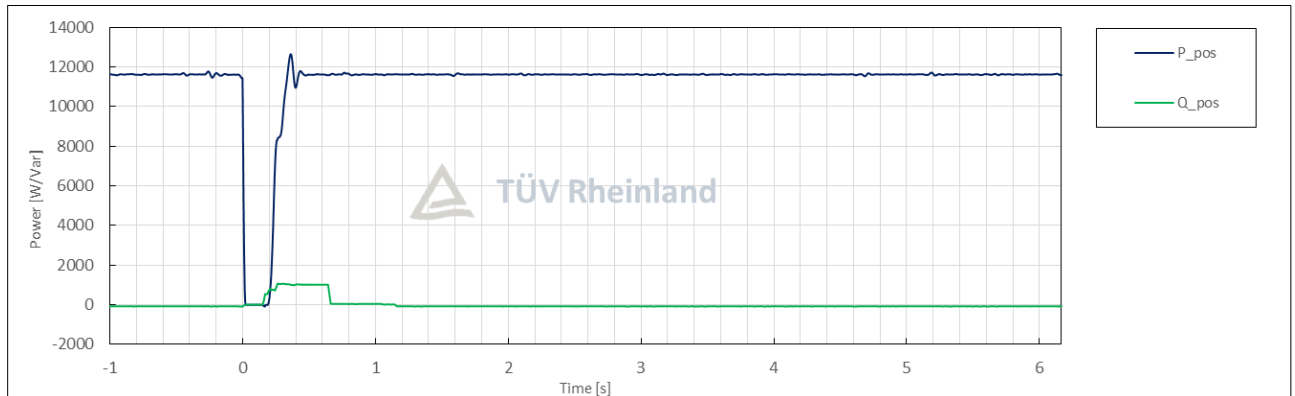
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Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.2
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	10:25:53
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		166
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	166
	8	Fault duration in empty load test	Total	--	ms	166
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.15
	10		Pos.		p.u.	0.15
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.50
	13	Active power	Total	t1-10s to t1	p.u.	0.50
	14		Pos.			0.50
	15	Reactive power	Total	t1-10s to t1	p.u.	0.00
	16		Pos.			0.00
	17	Cos ϕ	--	t1-10s to t1	--	1.000
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.01

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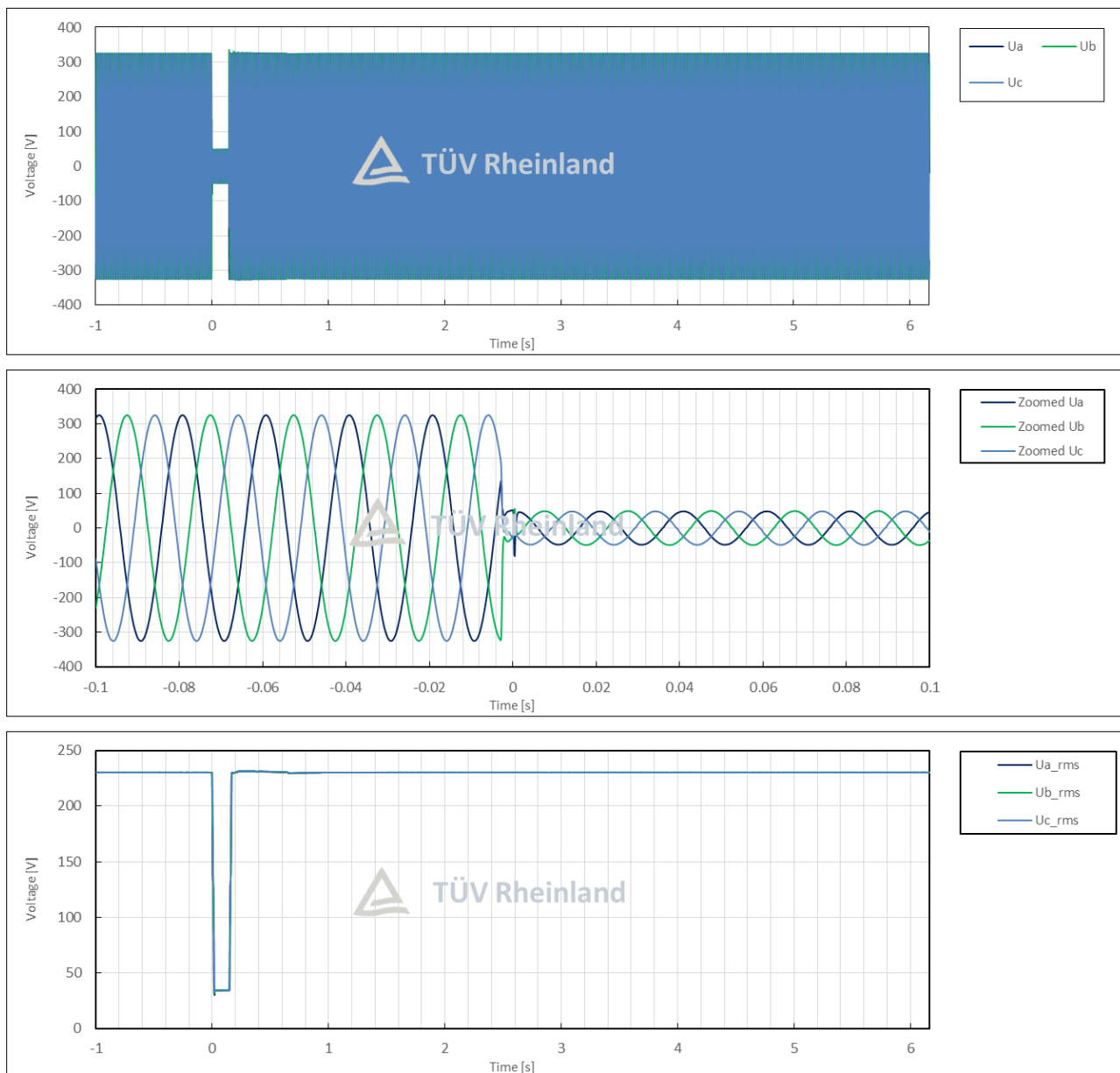
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	20		Phase 2			0.01
	21		Phase 3			0.01
	22	Line current	Phase 1	t1+100ms	p.u.	0.01
	23		Phase 2			0.01
	24		Phase 3			0.01
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.50
	29		Pos.			0.50
	39	Active power rising time	Pos.	--	s	0.303
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.00
	32		Pos.			0.00
	33	Reactive power rising time	Pos.	--	s	N/A
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

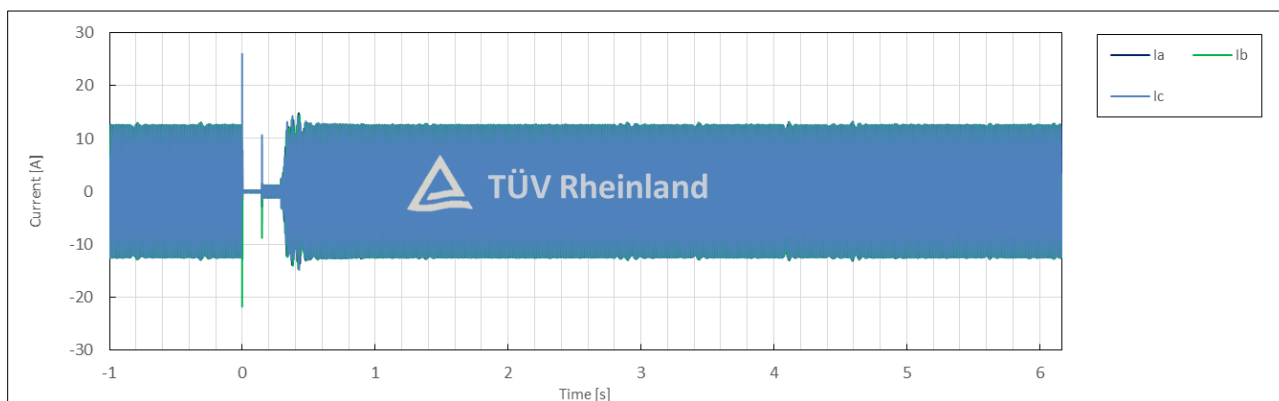
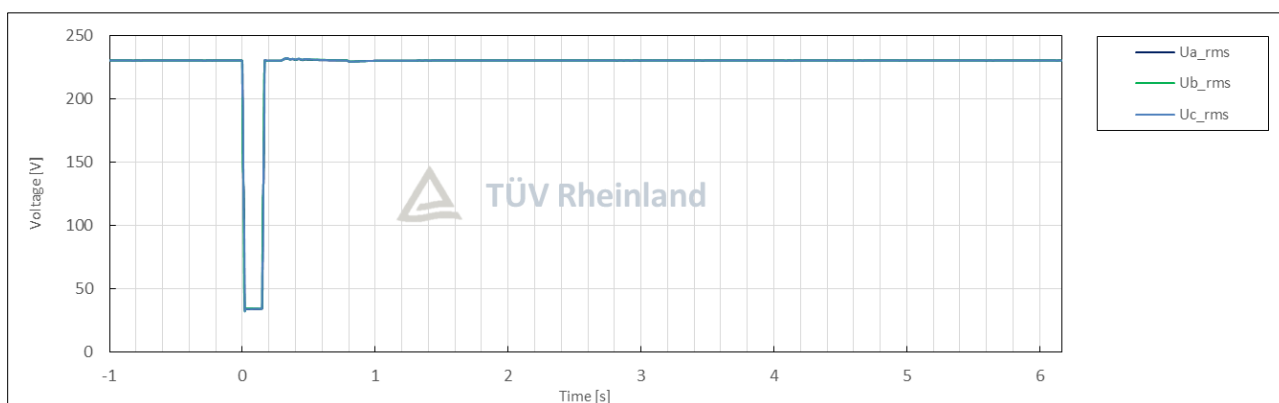
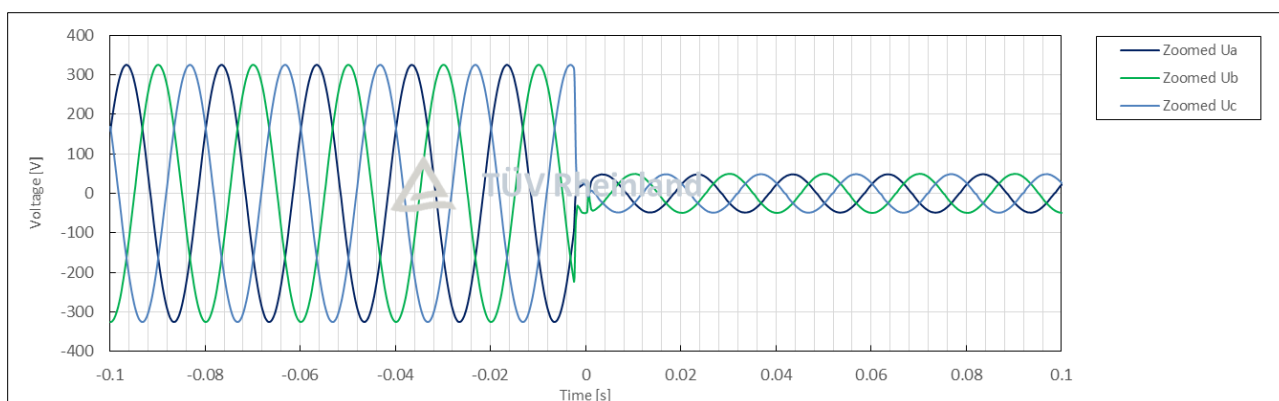
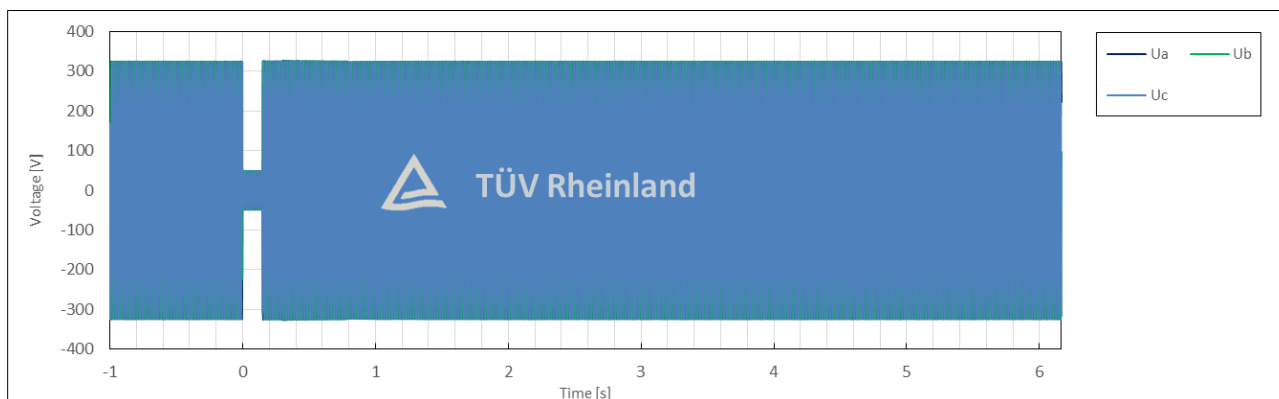
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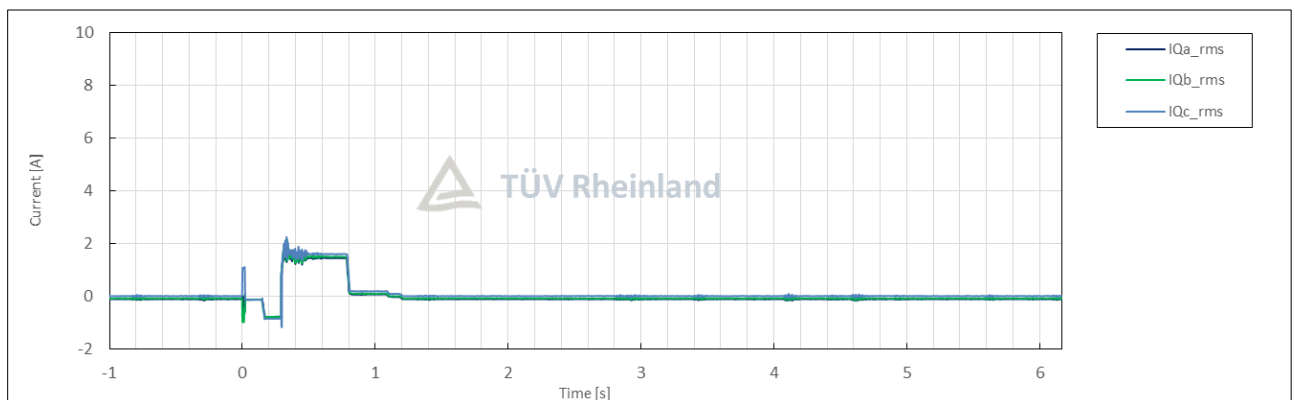
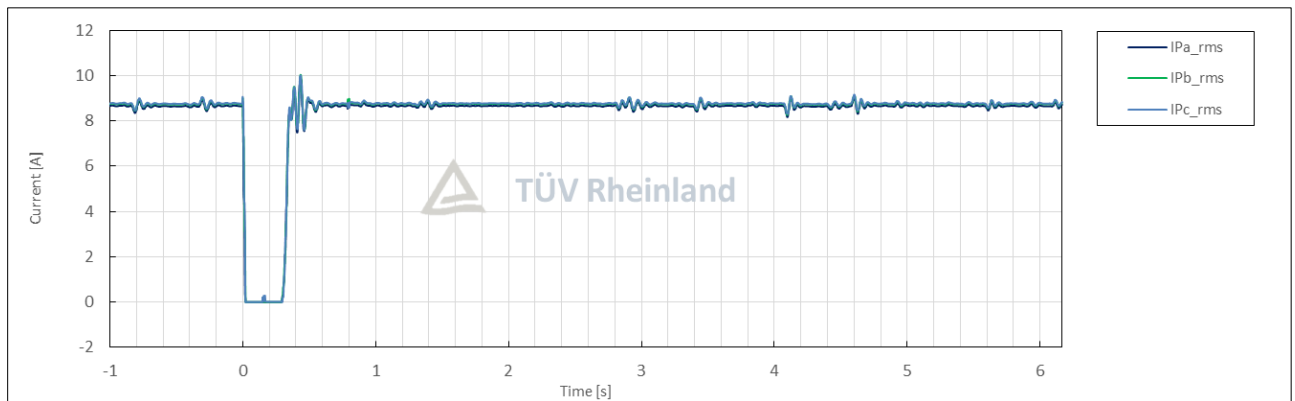
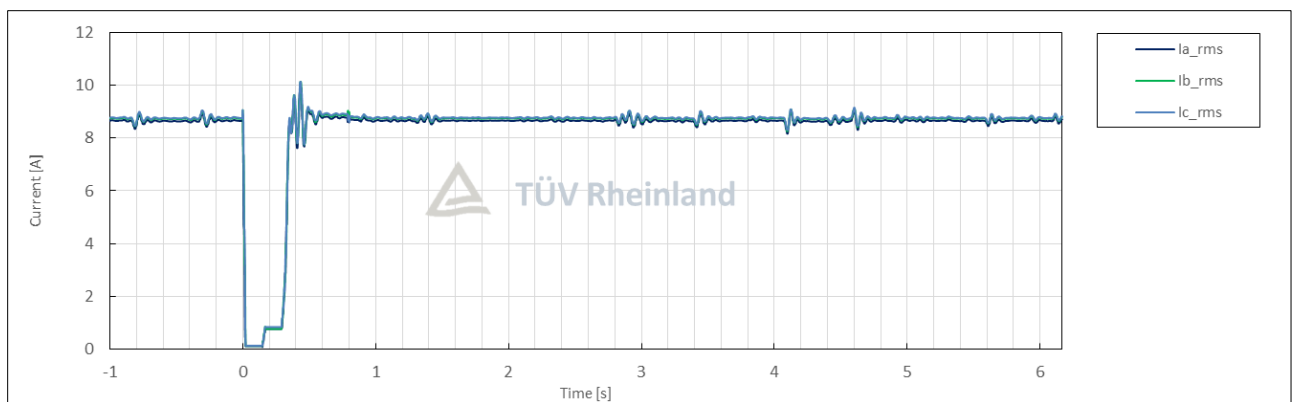
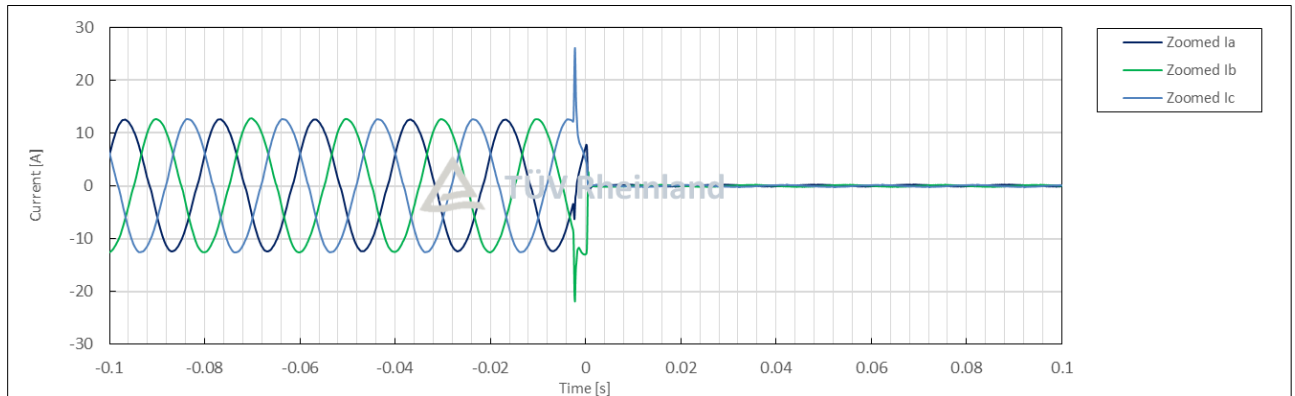
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Test No. 1.2 idle test



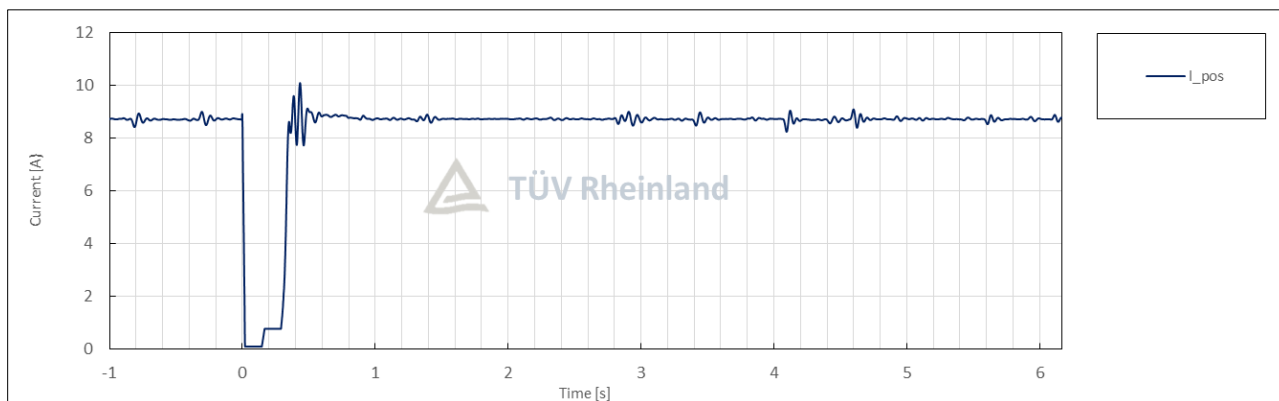
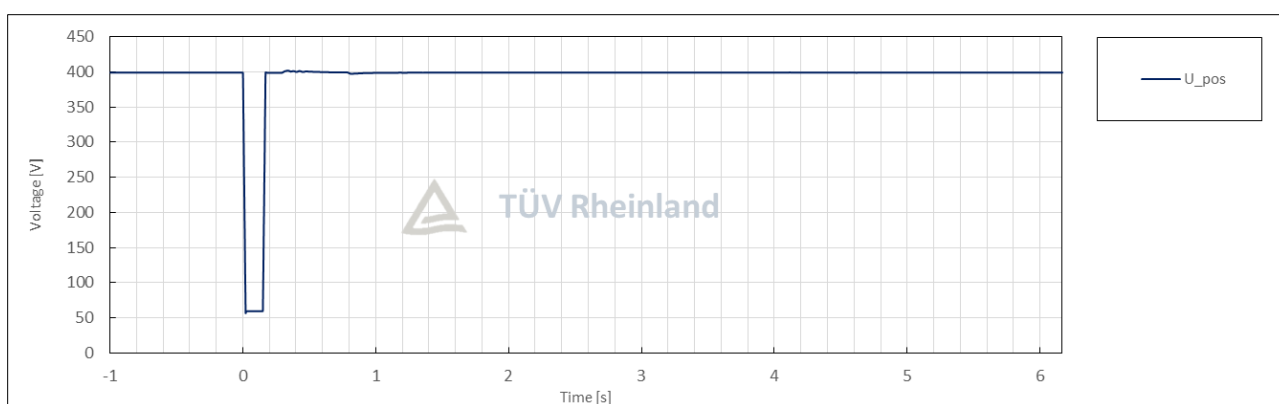
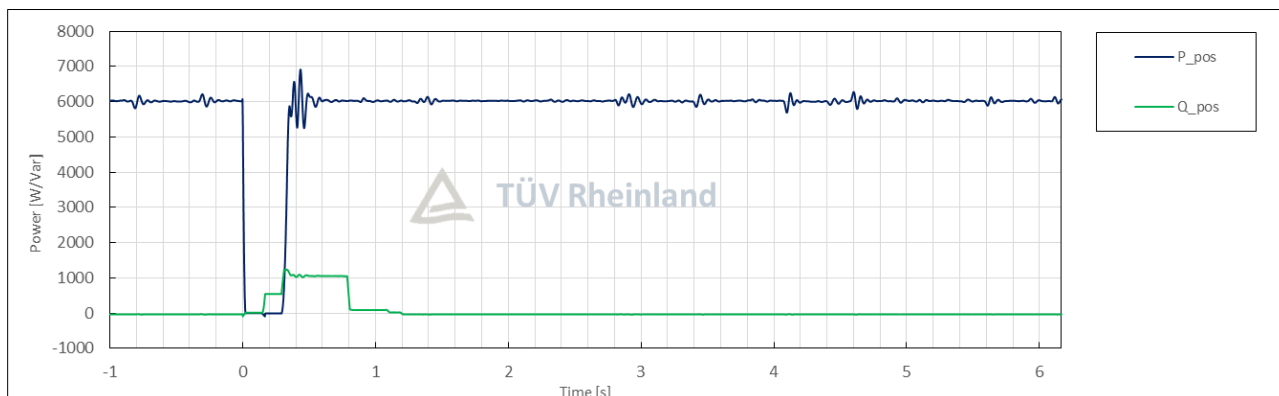
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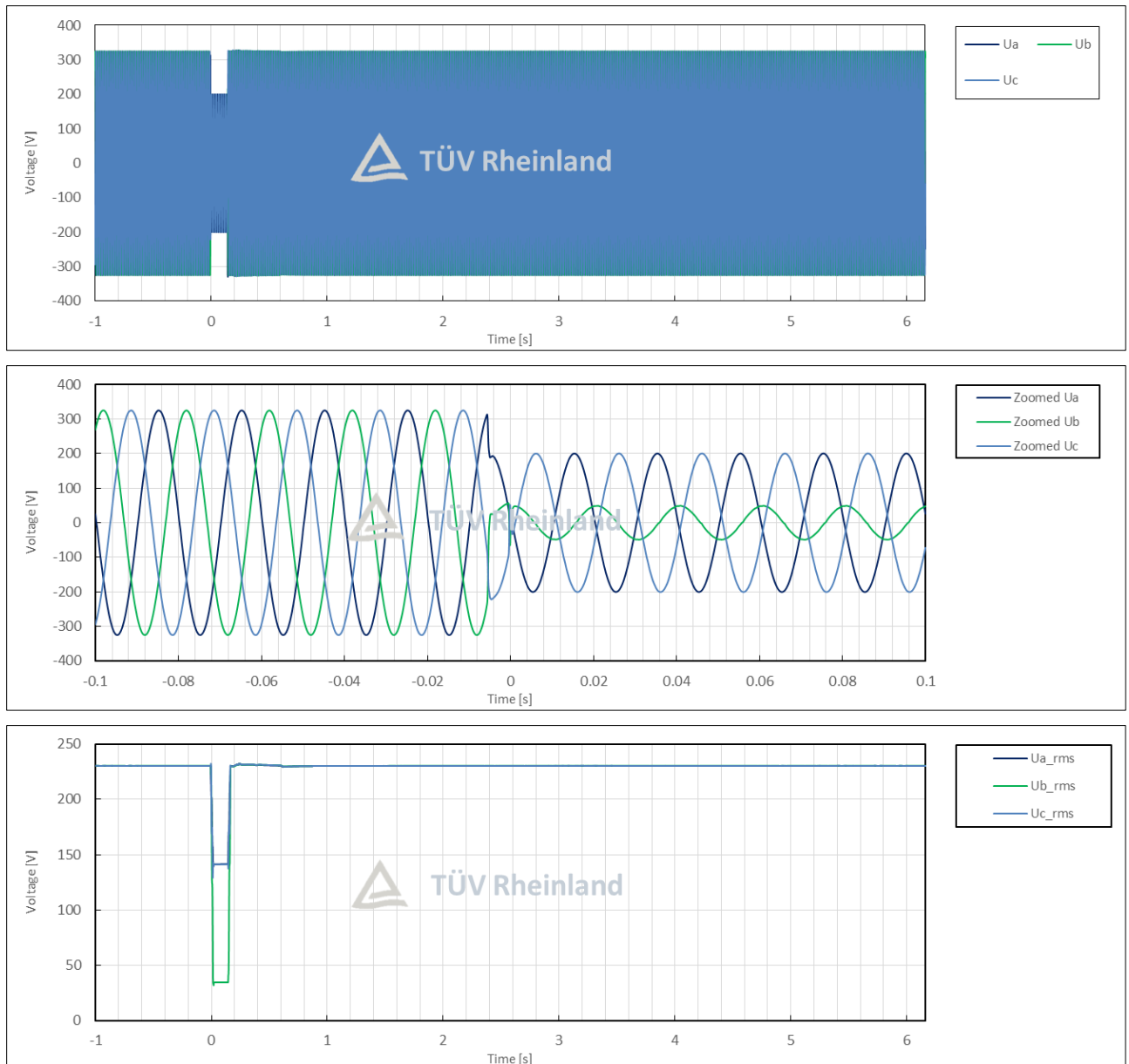
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.3
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	10:26:57
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		163
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	163
	8	Fault duration in empty load test	Total	--	ms	163
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.15
	10		Pos.		p.u.	0.43
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.98
	13	Active power	Total	t1-10s to t1	p.u.	0.98
	14		Pos.			0.98
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.01
	16		Pos.			-0.01
	17	Cos ϕ	--	t1-10s to t1	--	1.000
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.03

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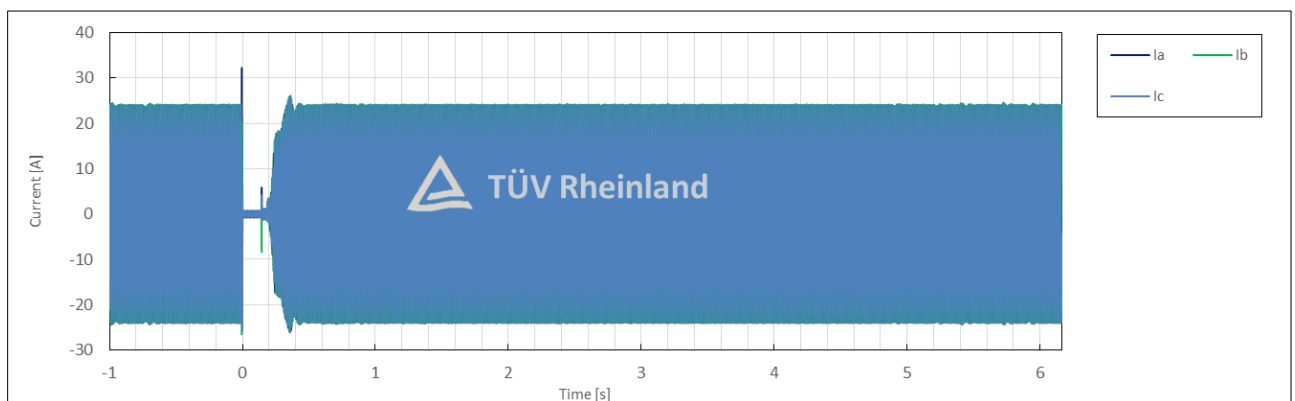
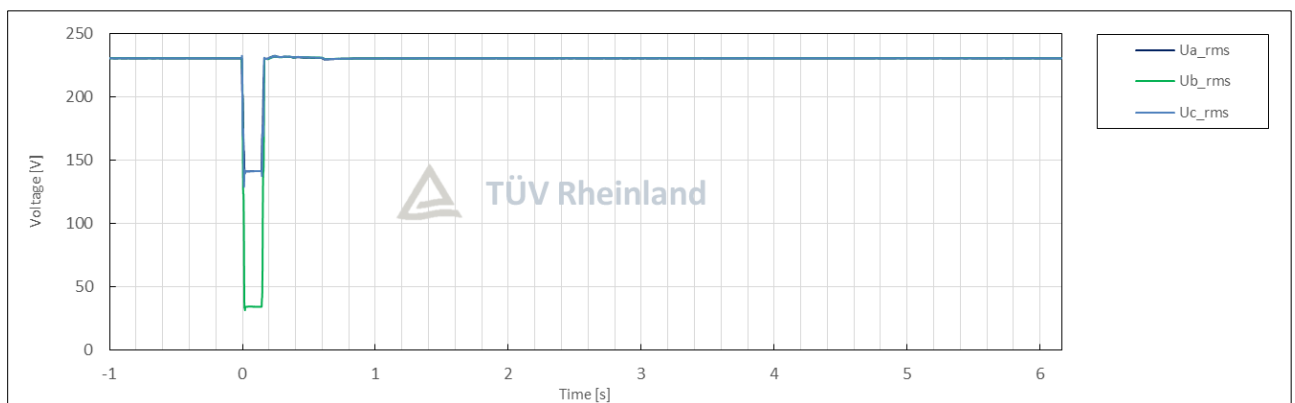
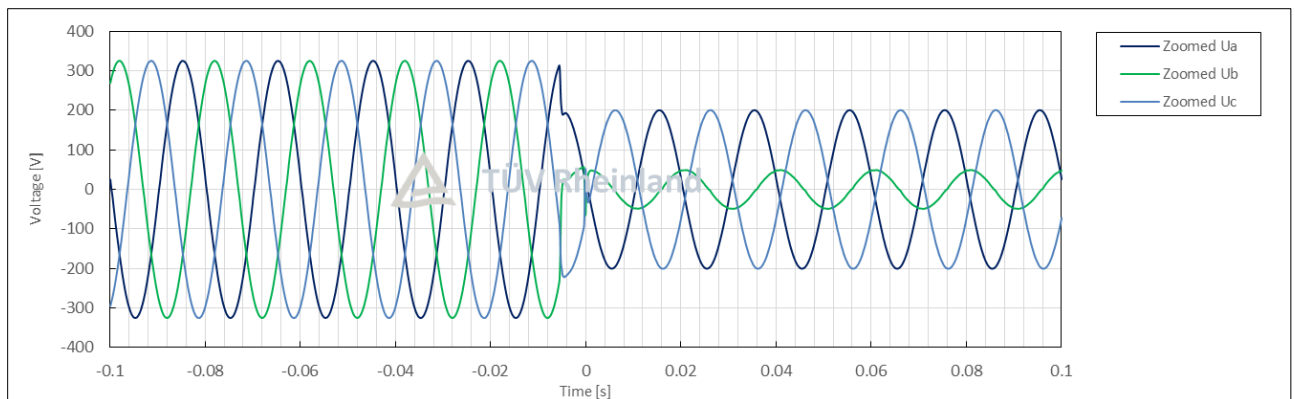
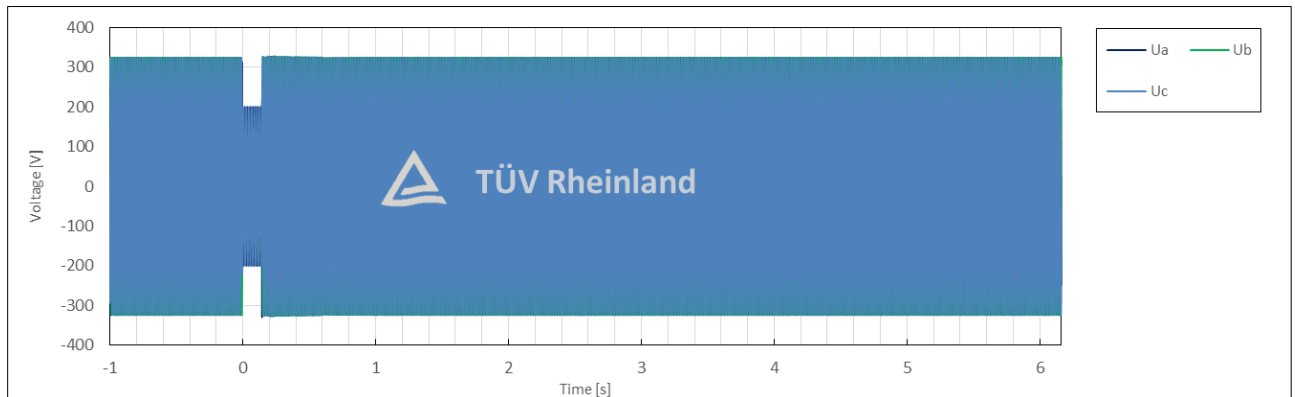
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	20		Phase 2			0.01
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.01
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.98
	29		Pos.			0.98
	39	Active power rising time	Pos.	--	s	0.159
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.01
	32		Pos.			-0.01
	33	Reactive power rising time	Pos.	--	s	N/A
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

Test No. 1.3 idle test

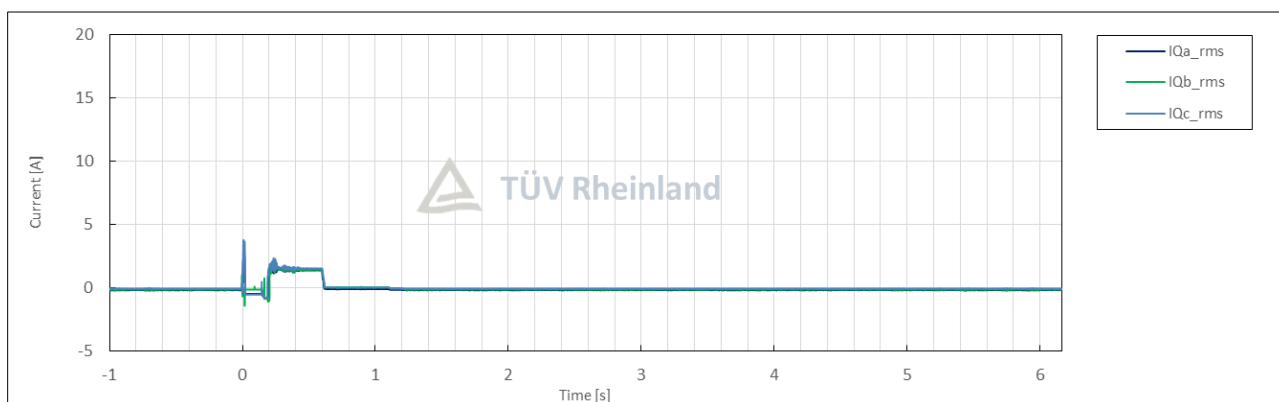
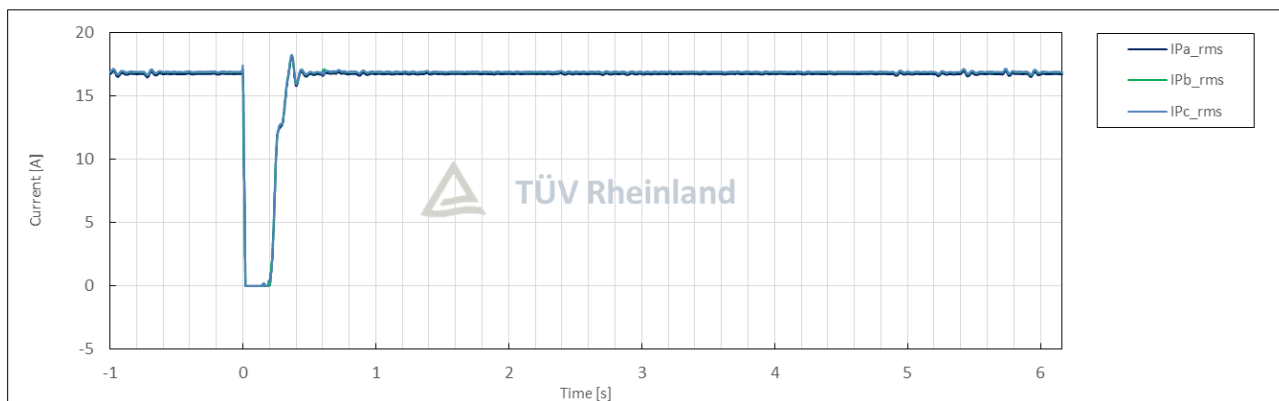
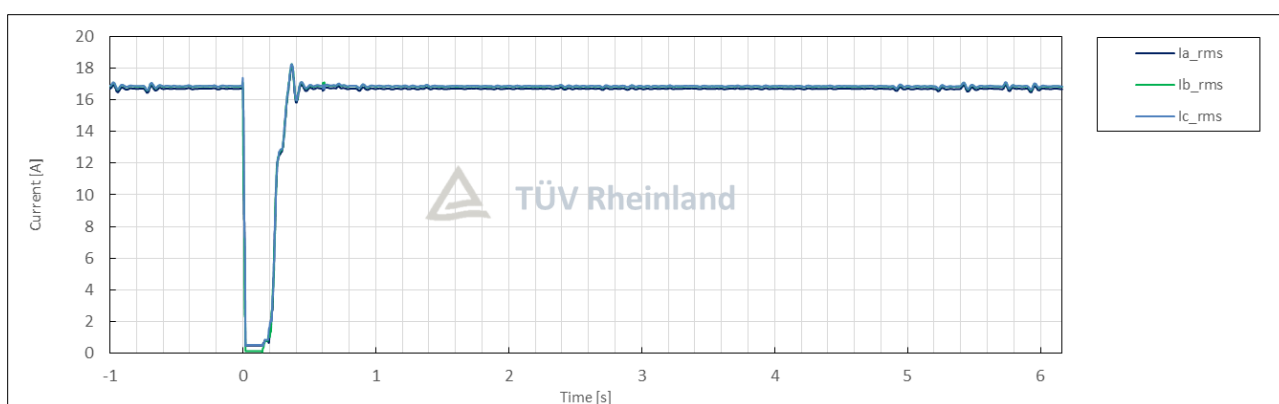
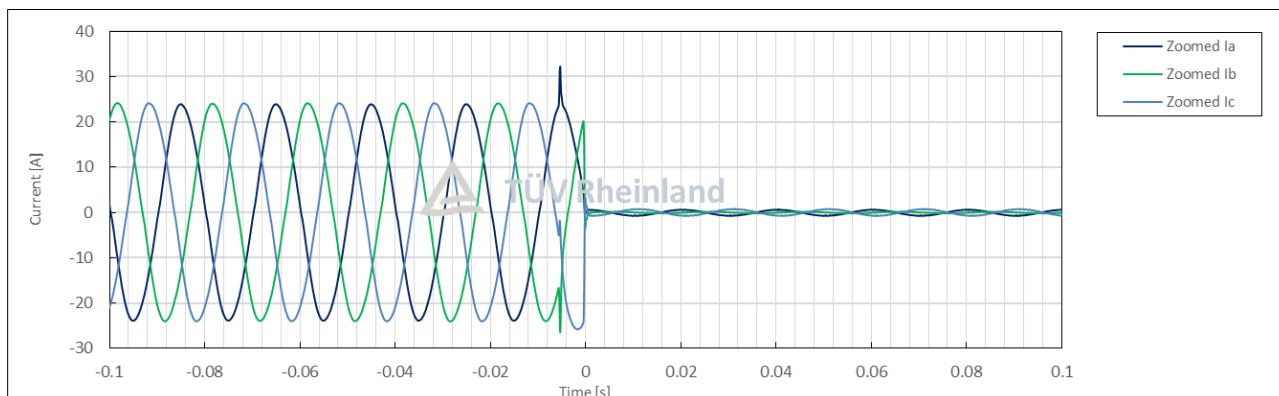


Test No. 1.3 with PGU



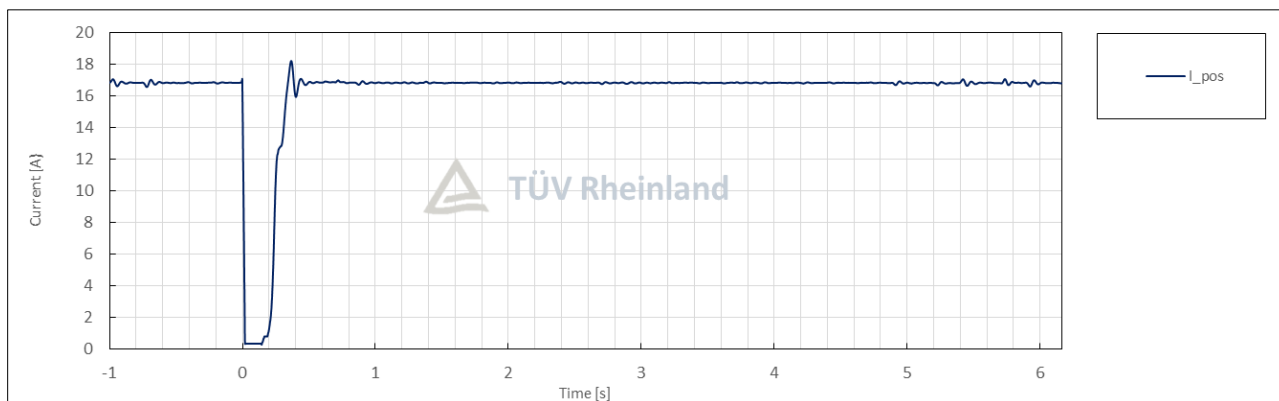
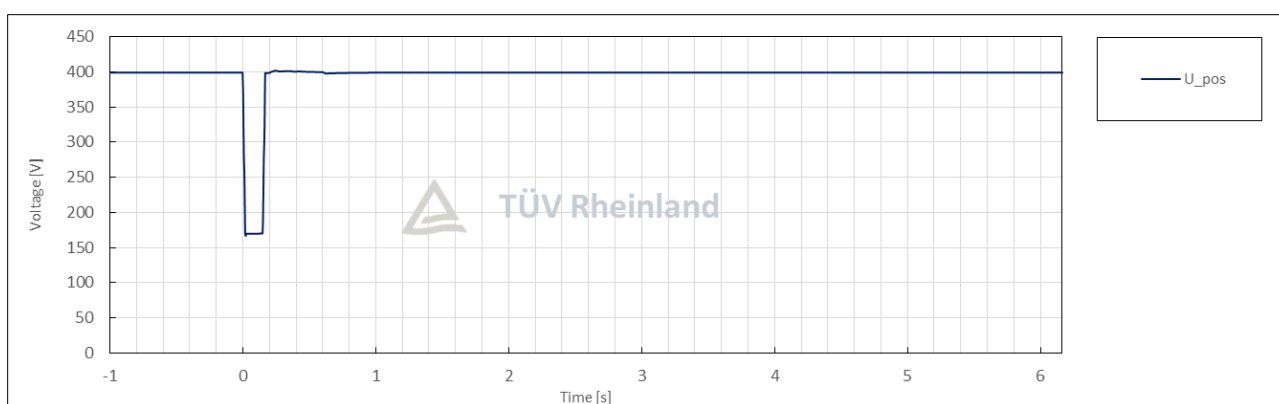
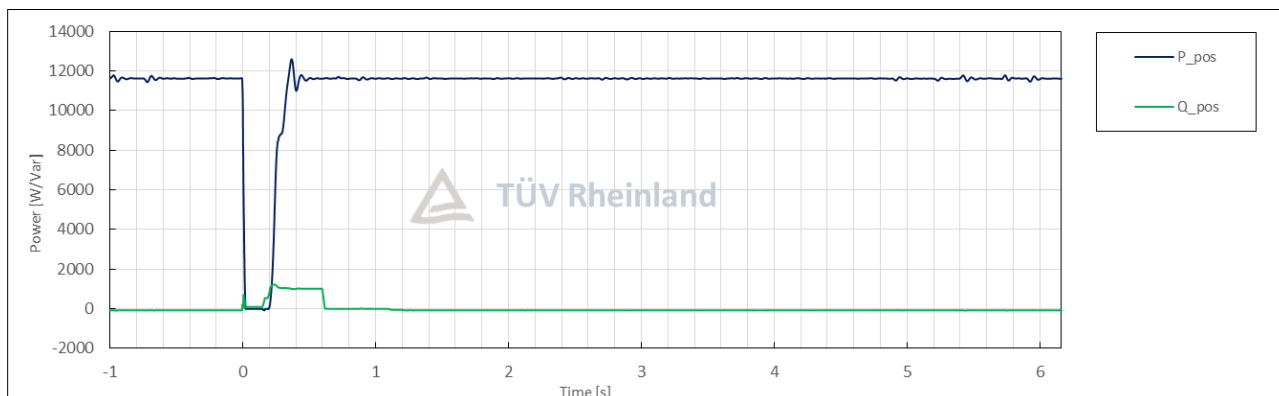
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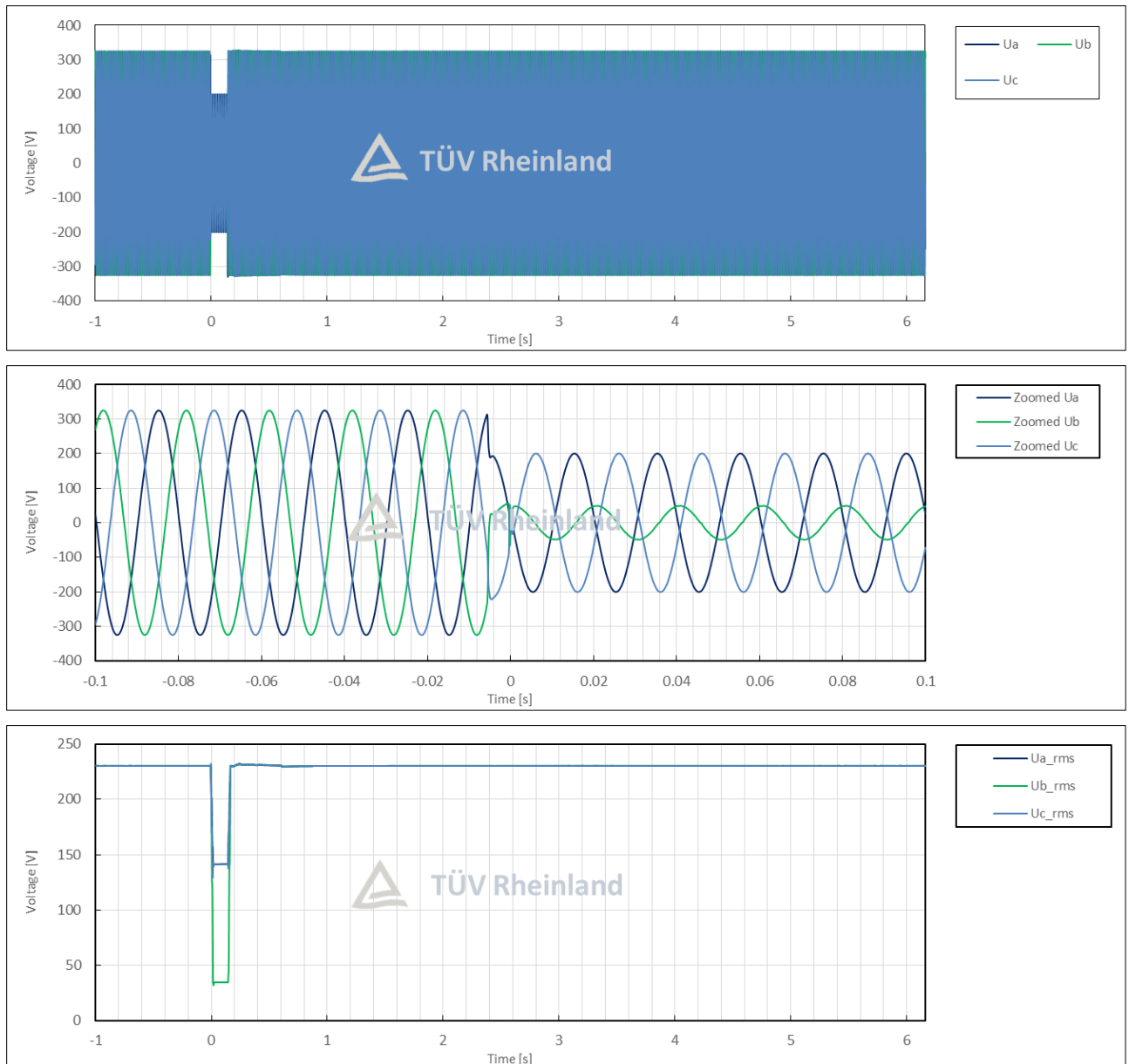
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	1.4
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	10:28:28
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		163
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	163
	8	Fault duration in empty load test	Total	--	ms	163
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.15
	10		Pos.		p.u.	0.43
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.50
	13	Active power	Total	t1-10s to t1	p.u.	0.50
	14		Pos.			0.50
	15	Reactive power	Total	t1-10s to t1	p.u.	0.00
	16		Pos.			0.00
	17	Cos ϕ	--	t1-10s to t1	--	1.000
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.03

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	20		Phase 2			0.01
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.01
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.50
	29		Pos.			0.50
	39	Active power rising time	Pos.	--	s	0.207
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.00
	32		Pos.			0.00
	33	Reactive power rising time	Pos.	--	s	N/A
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

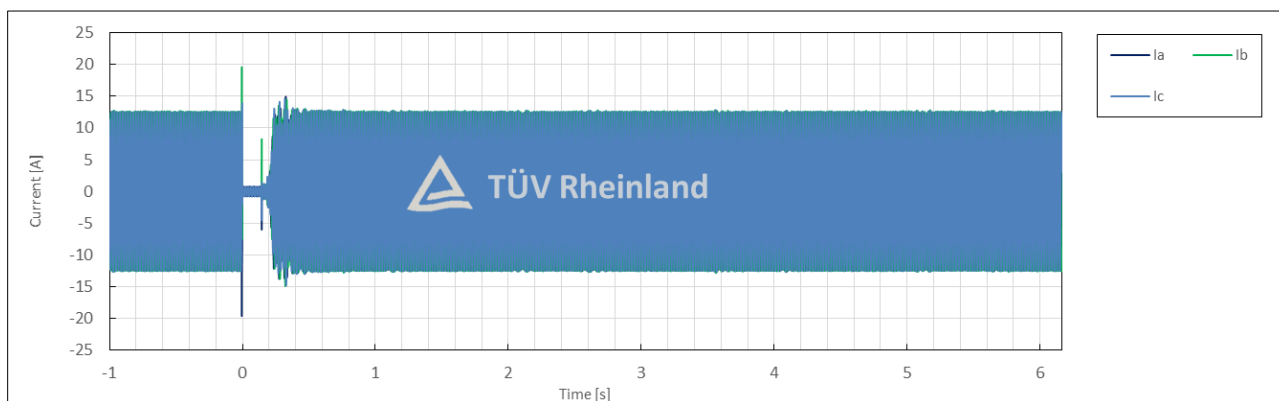
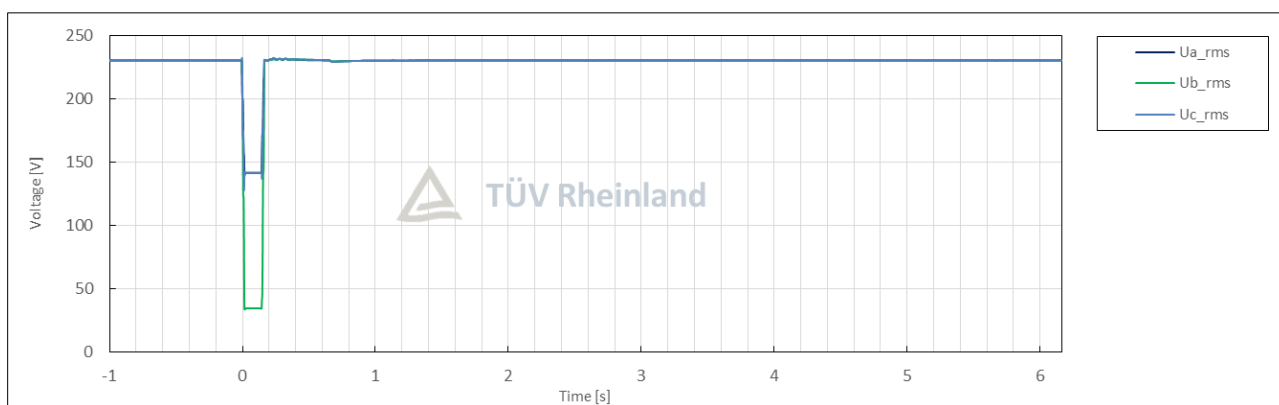
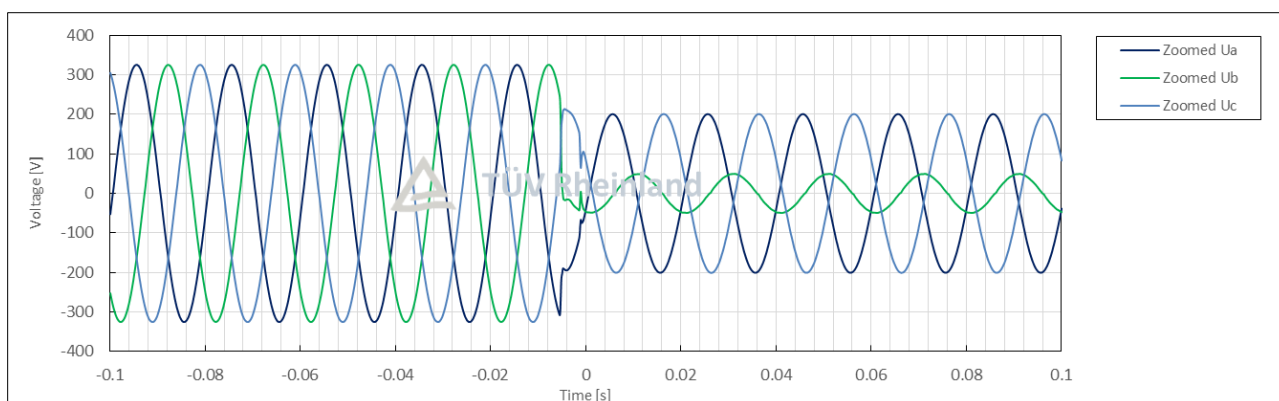
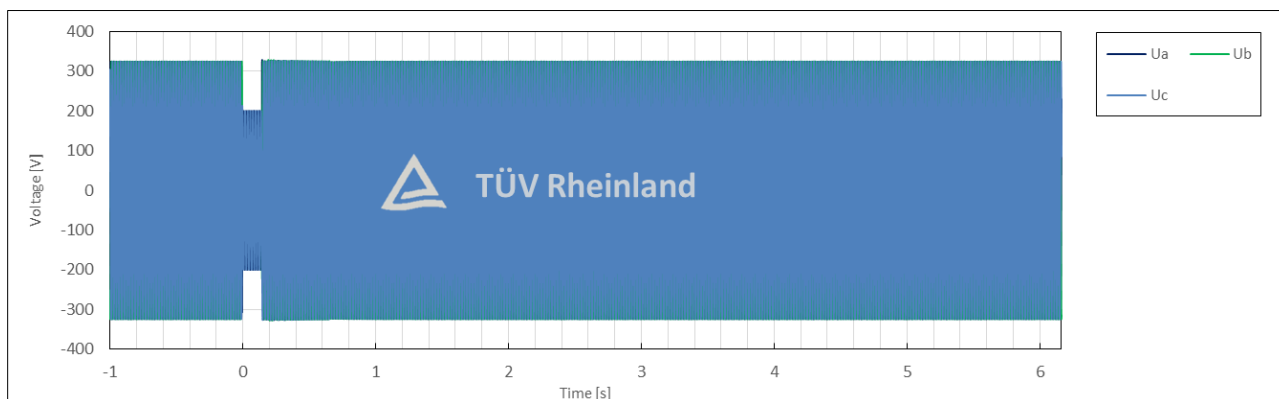
Test No. 1.4 idle test

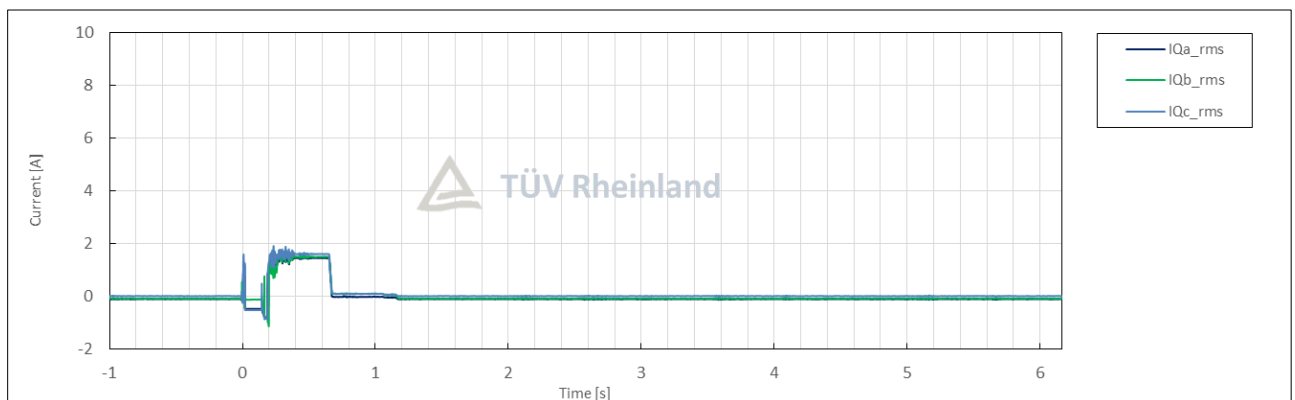
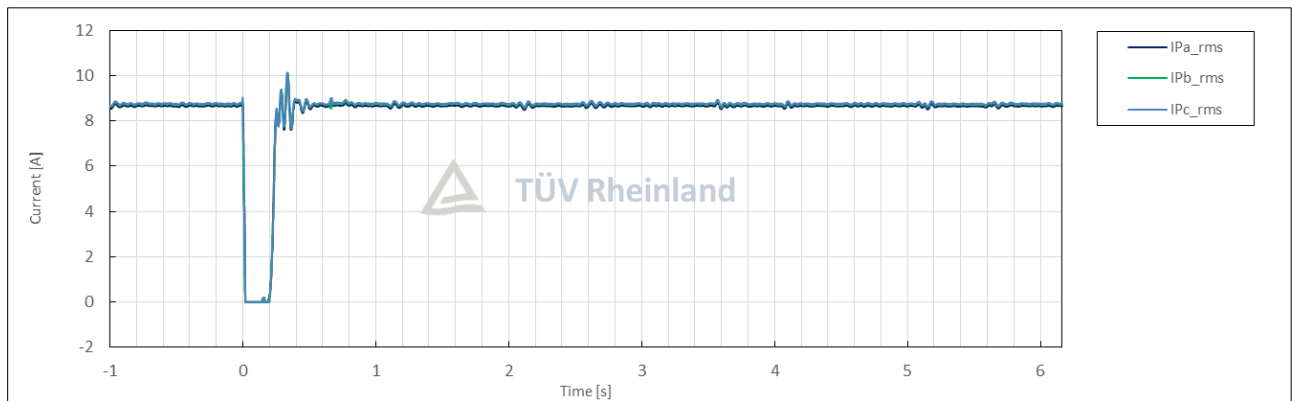
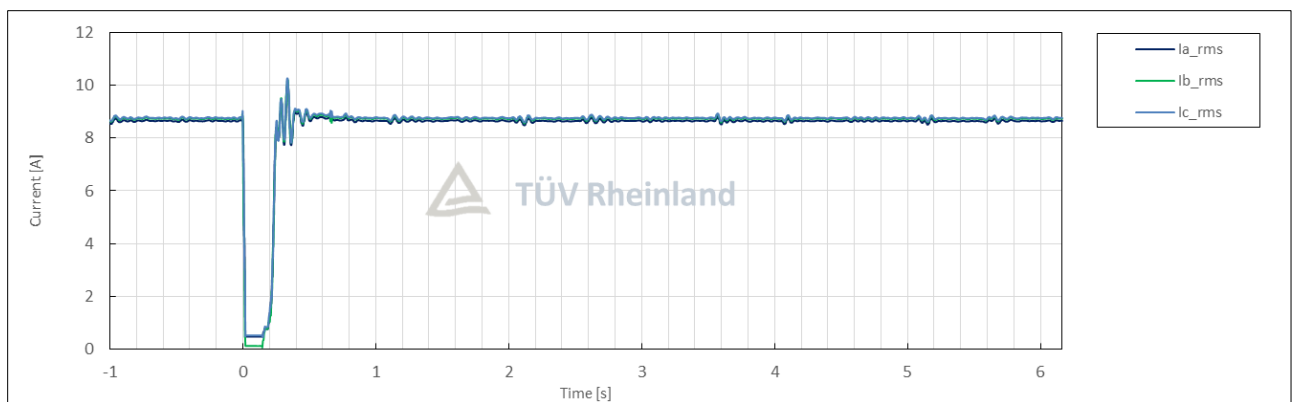
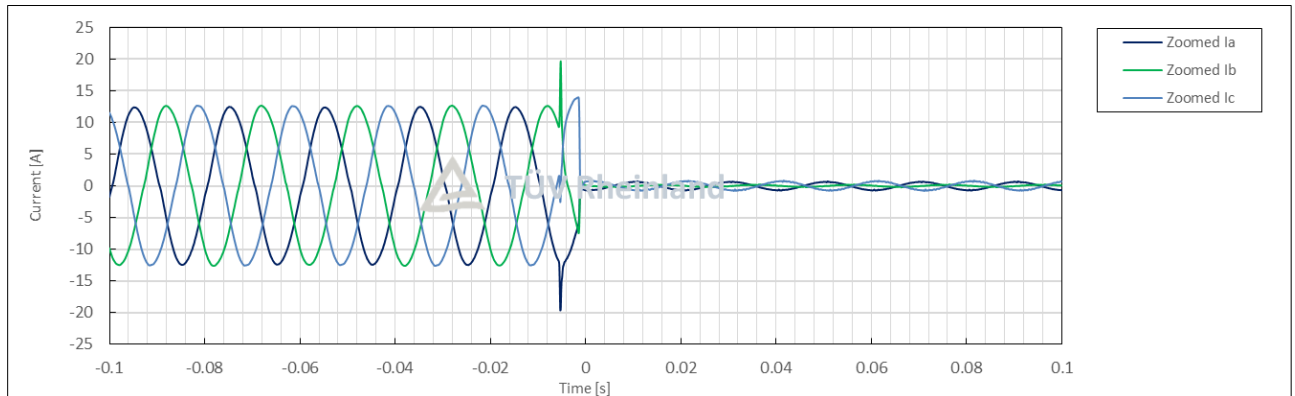


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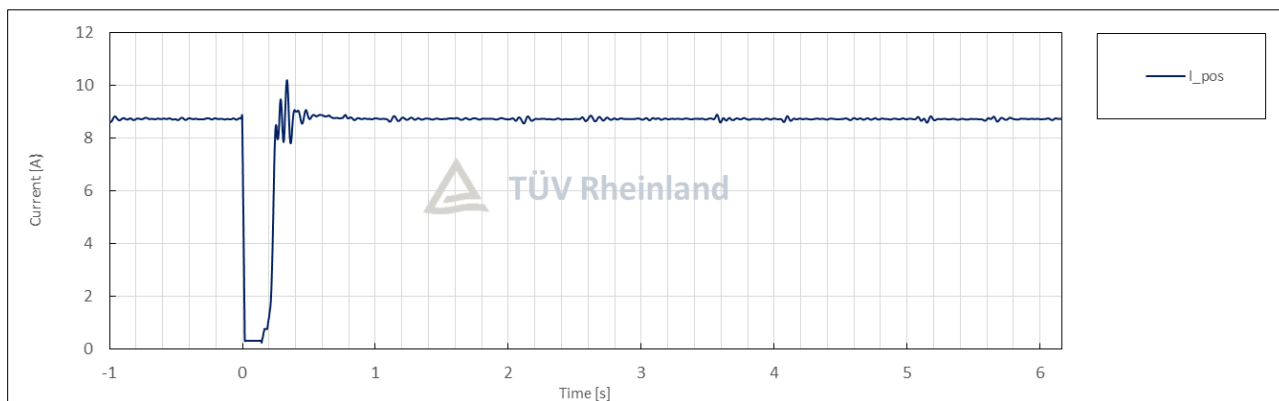
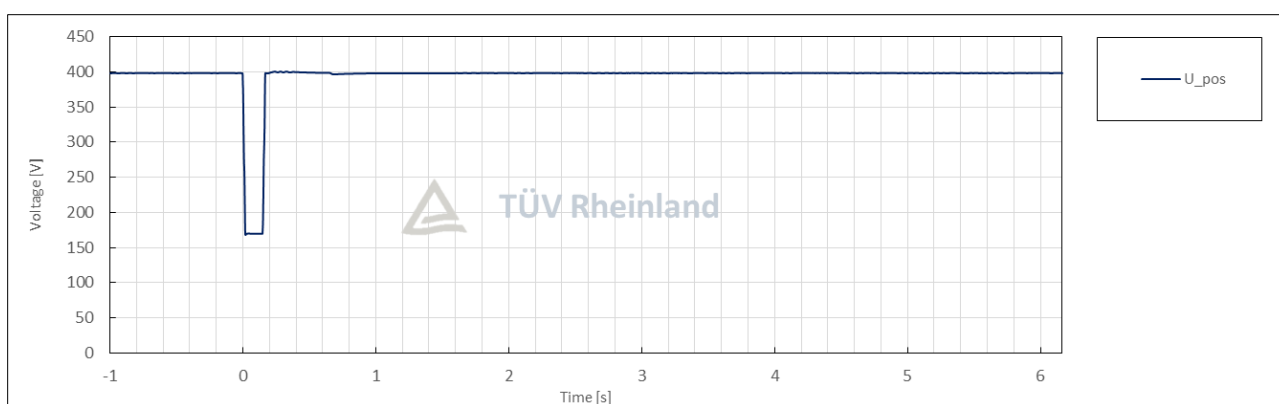
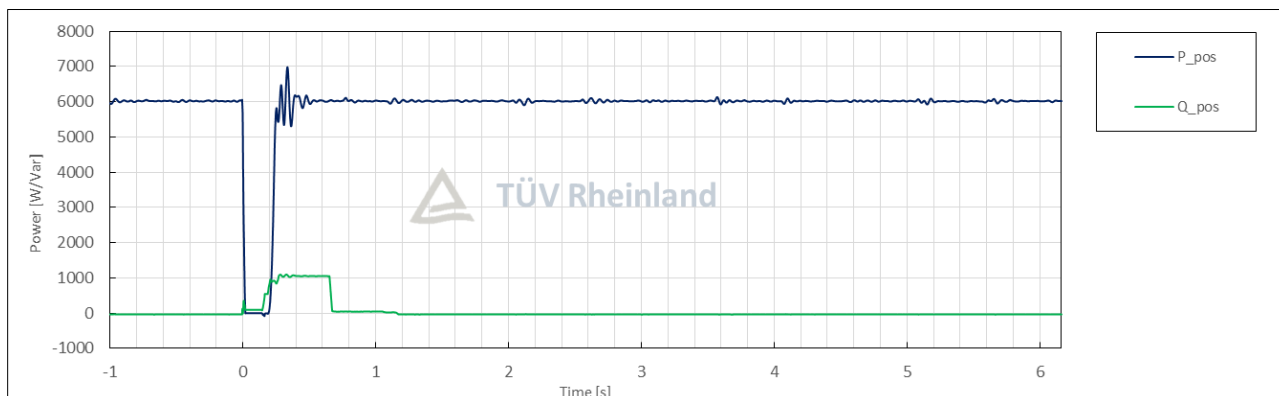
Test No. 1.4 with PGU





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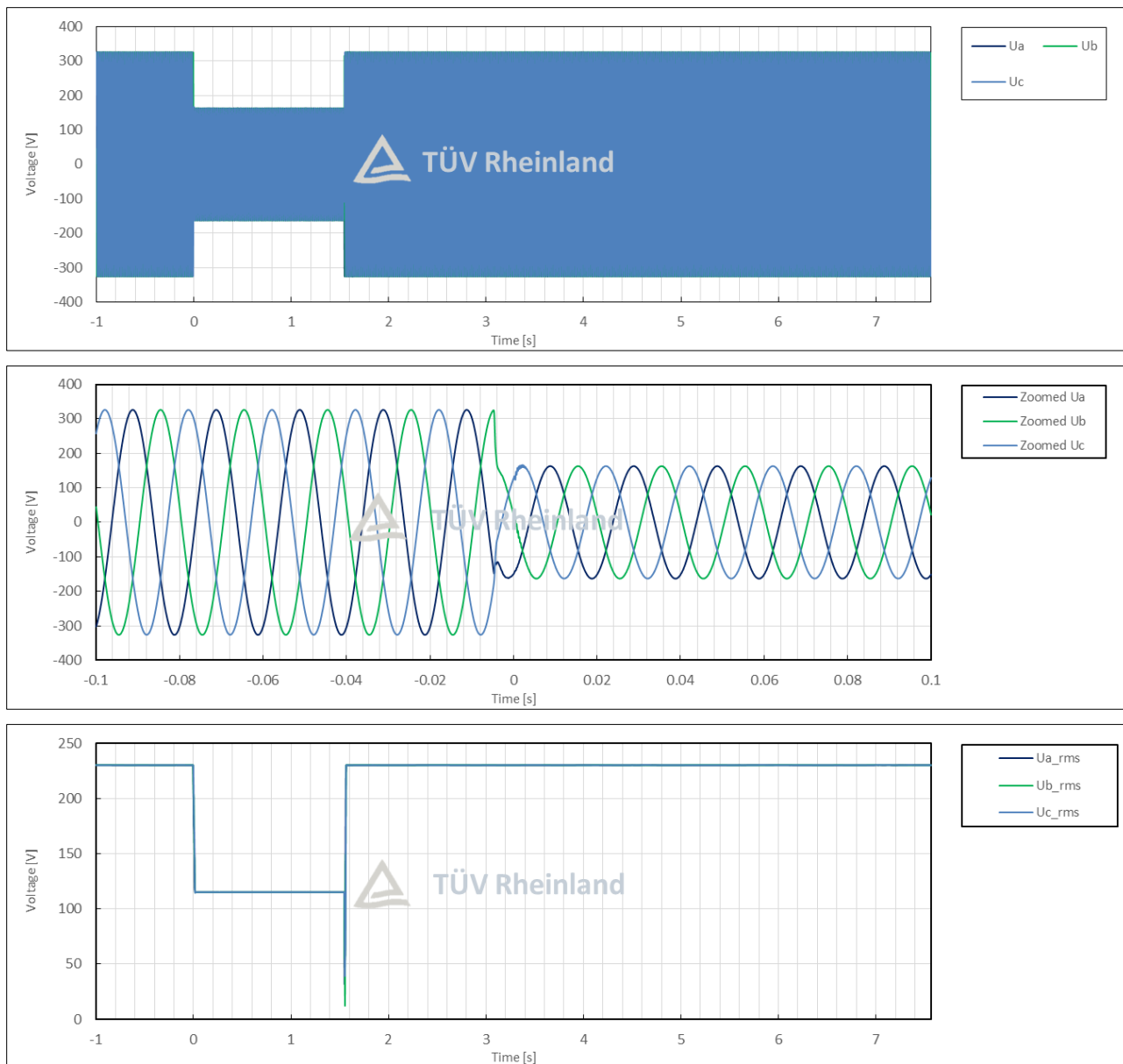
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.1
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:41:49
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1565
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1565
	8	Fault duration in empty load test	Total	--	ms	1565
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.50
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.12
	13	Active power	Total	t1-10s to t1	p.u.	1.01
	14		Pos.			1.01
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos φ	--	t1-10s to t1	--	0.903
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03

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	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.03
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	1.01
	29		Pos.			1.01
	39	Active power rising time	Pos.	--	s	0.921
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.41
	32		Pos.			-0.41
	33	Reactive power rising time	Pos.	--	s	9.1
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

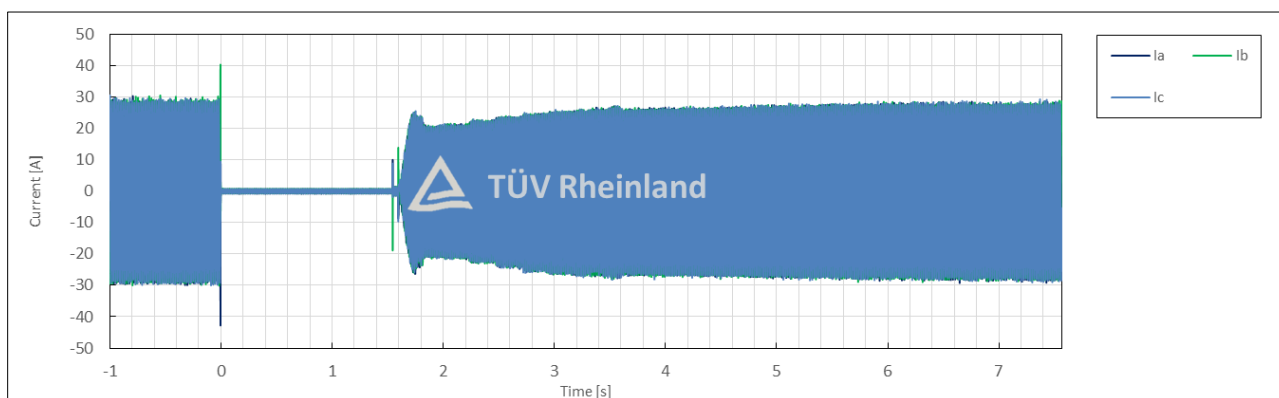
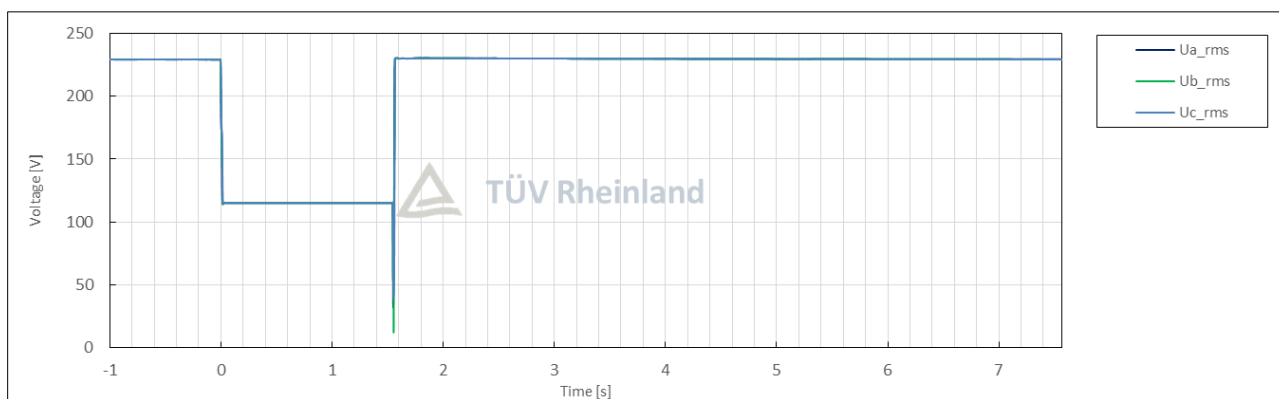
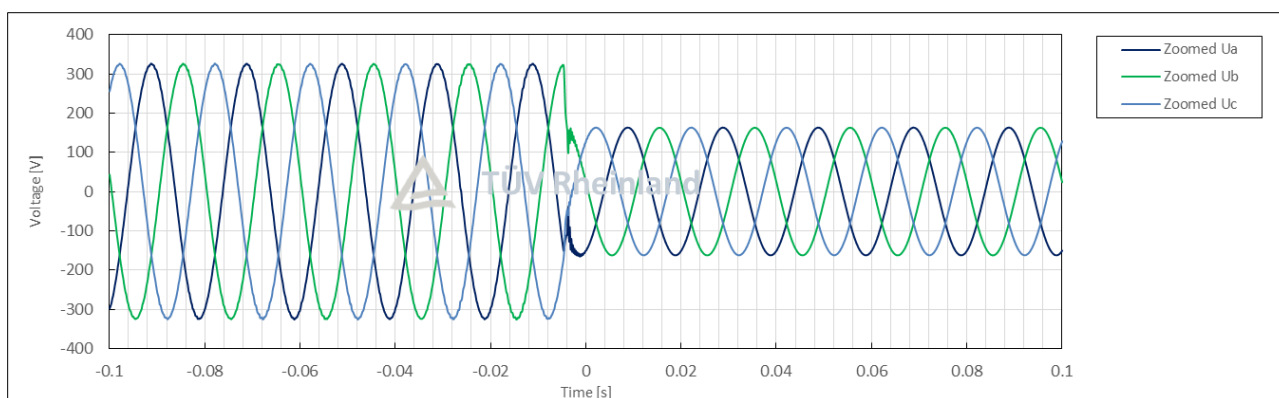
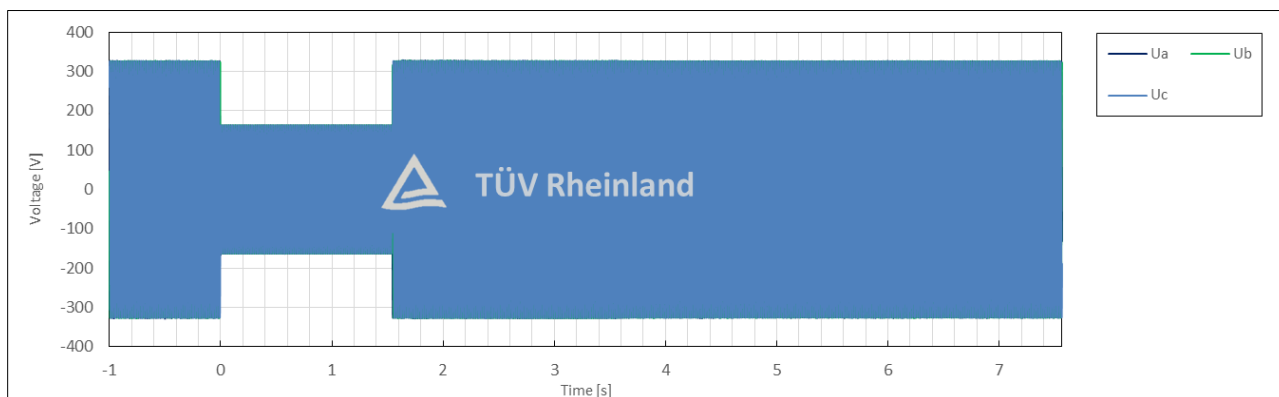
Test No. 2.1 idle test



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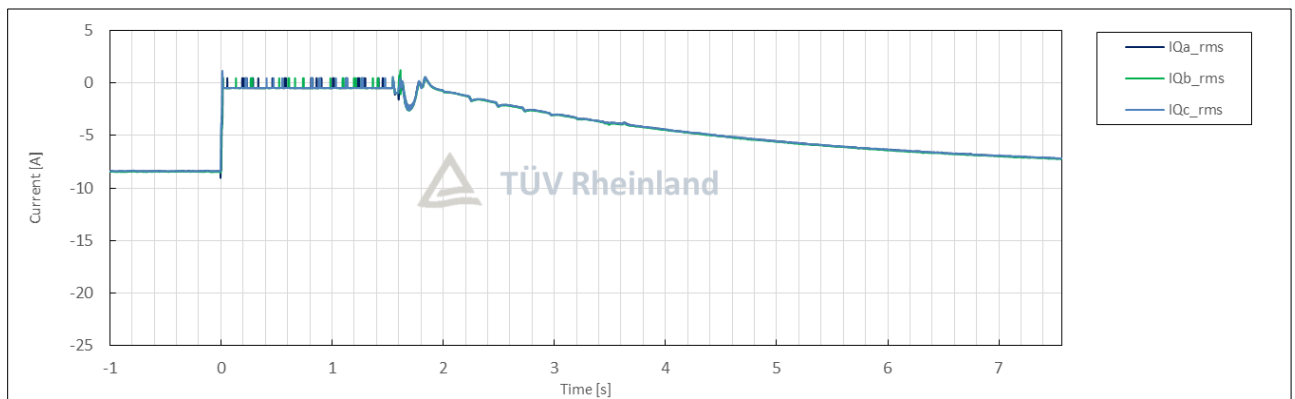
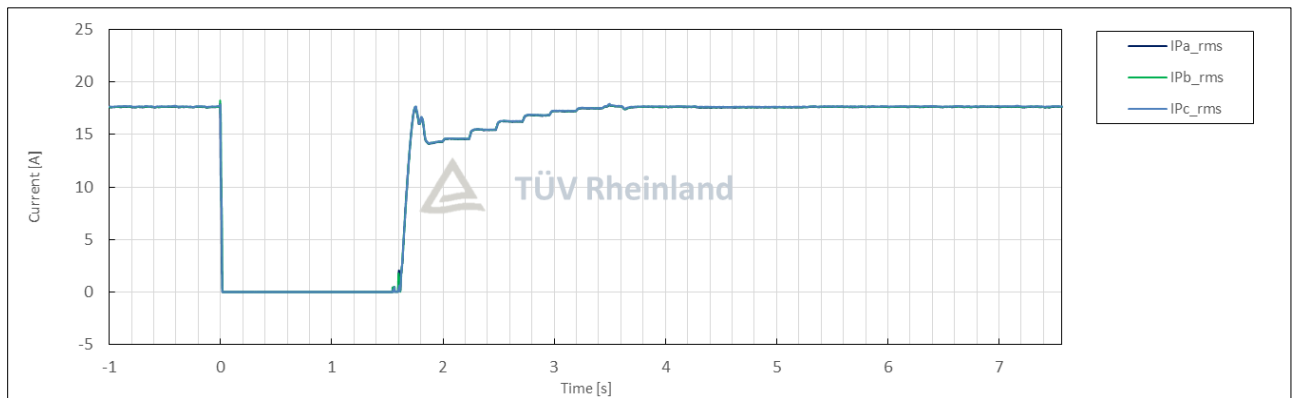
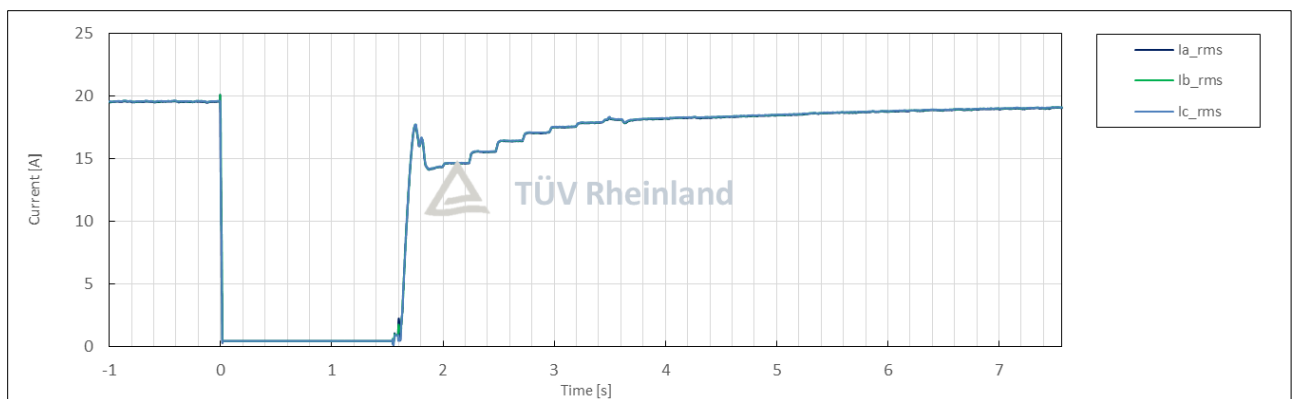
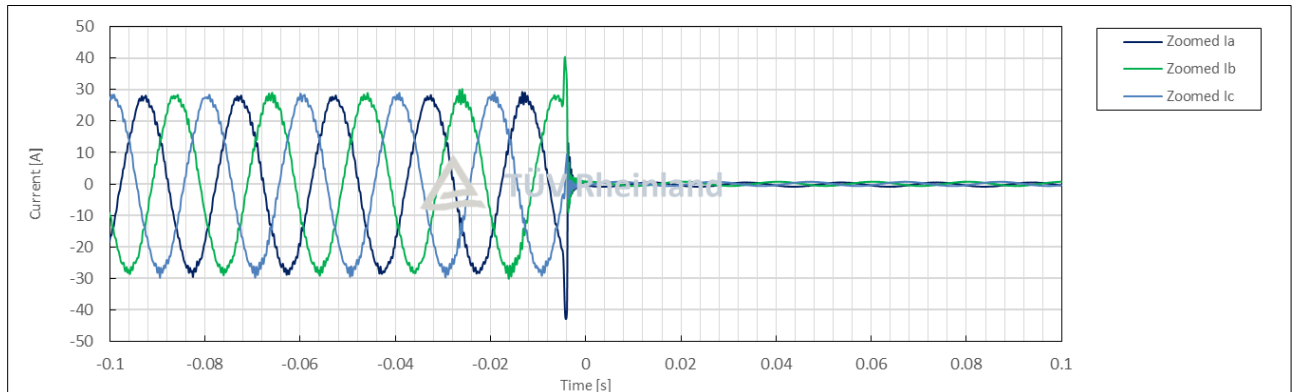
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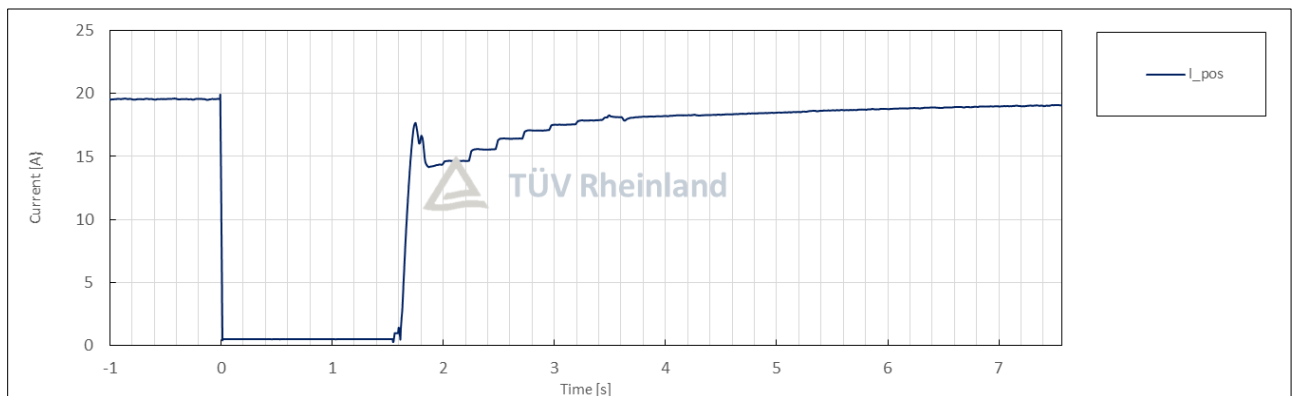
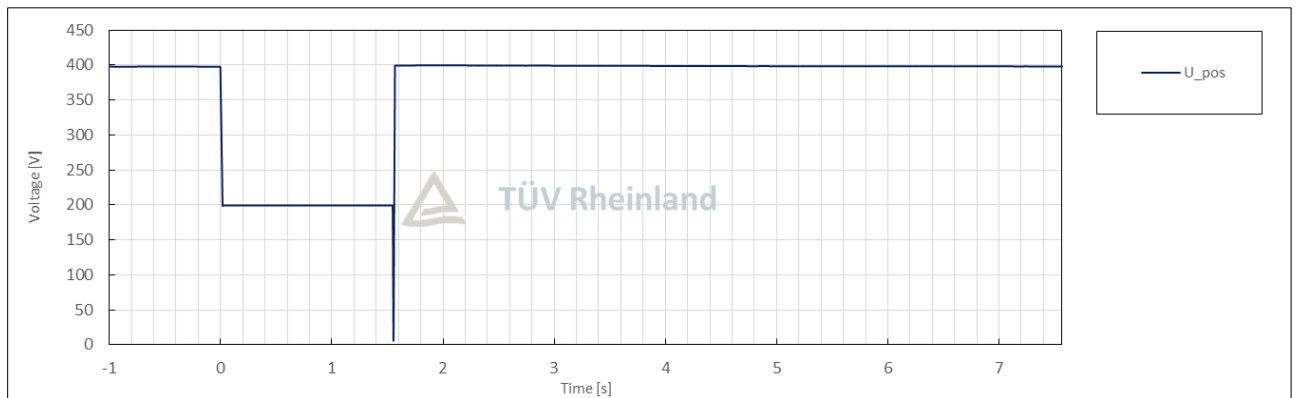
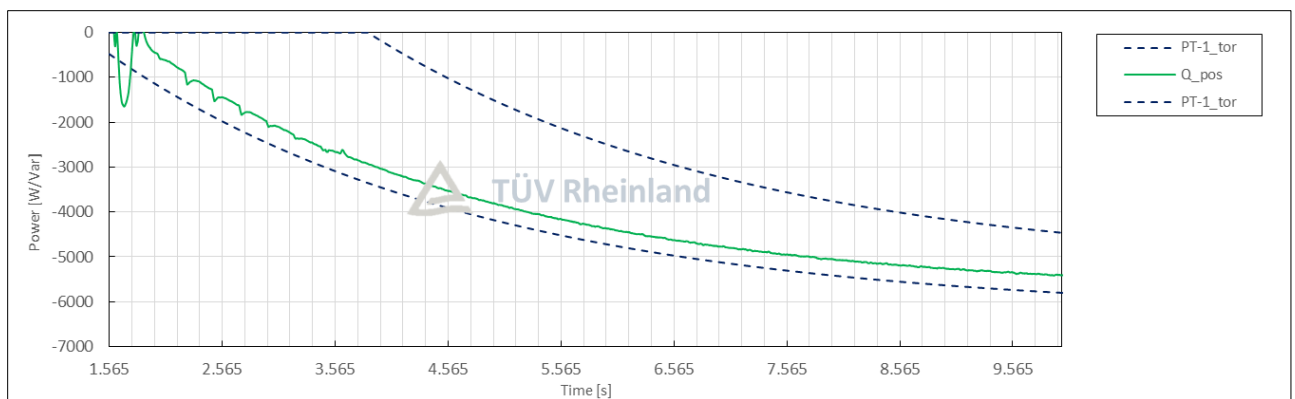
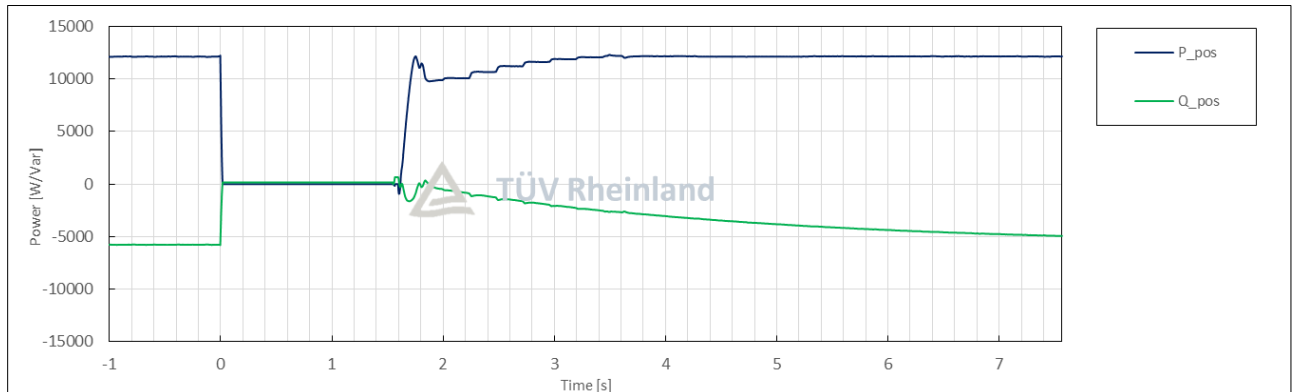
Test No. 2.1 with PGU



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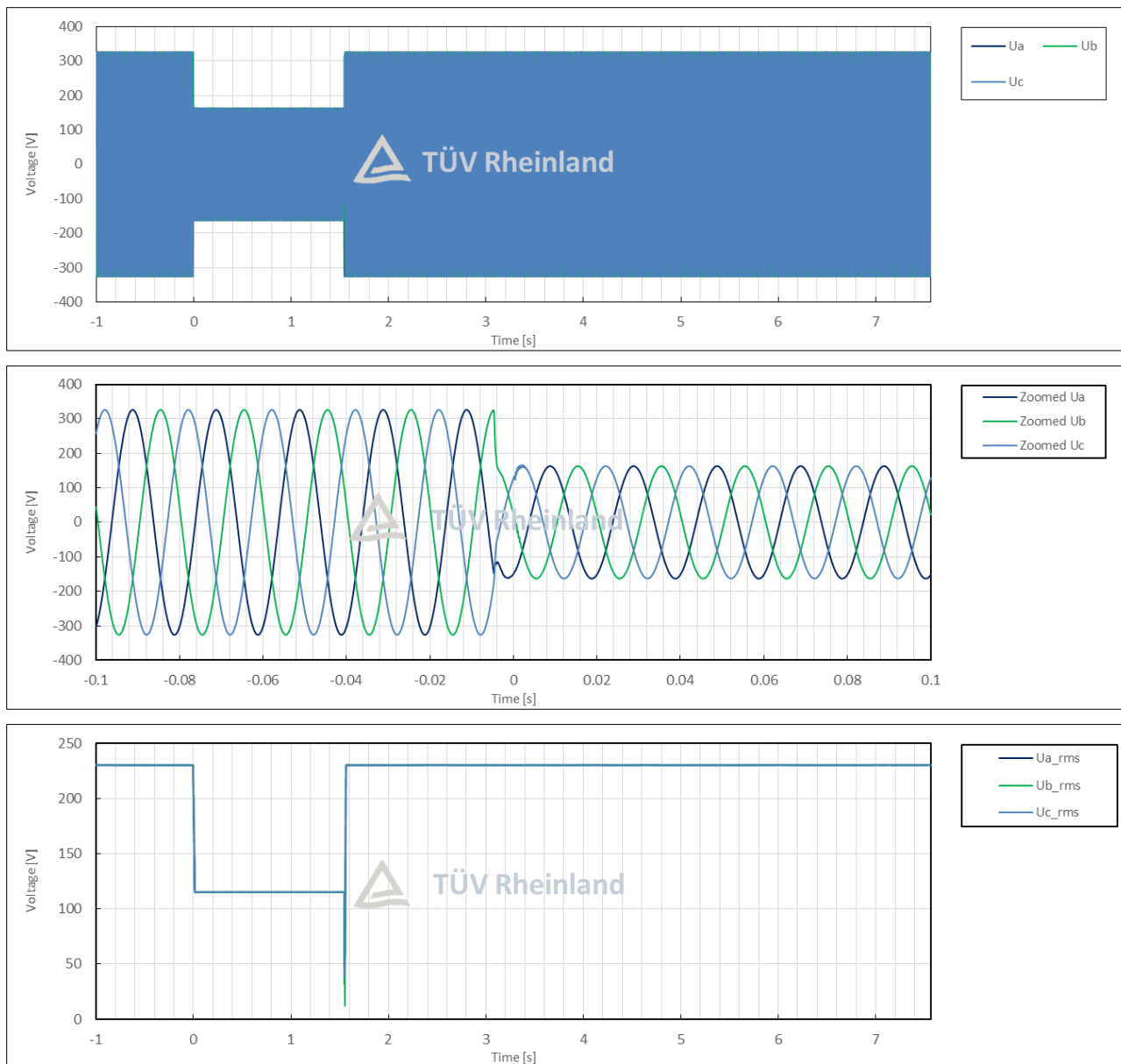
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.2
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:42:21
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1565
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1565
	8	Fault duration in empty load test	Total	--	ms	1565
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.50
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.52
	13	Active power	Total	t1-10s to t1	p.u.	0.20
	14		Pos.			0.20
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos φ	--	t1-10s to t1	--	0.387
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03

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	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.03
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.20
	29		Pos.			0.20
	39	Active power rising time	Pos.	--	s	0.132
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.41
	32		Pos.			-0.41
	33	Reactive power rising time	Pos.	--	s	9.261
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

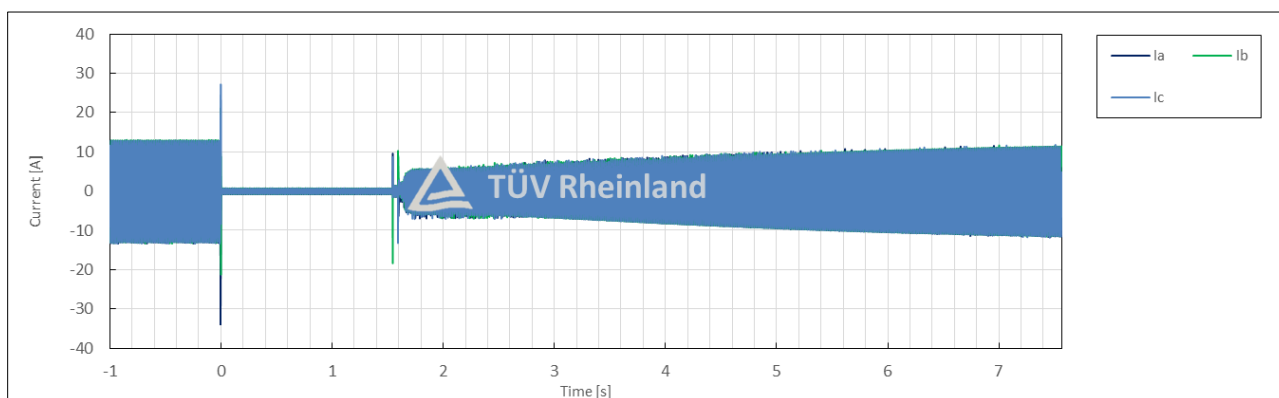
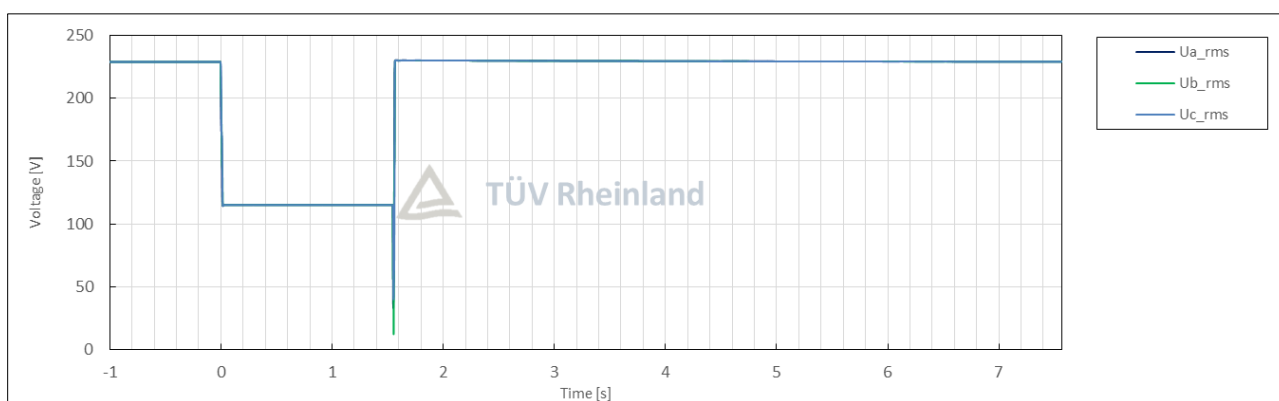
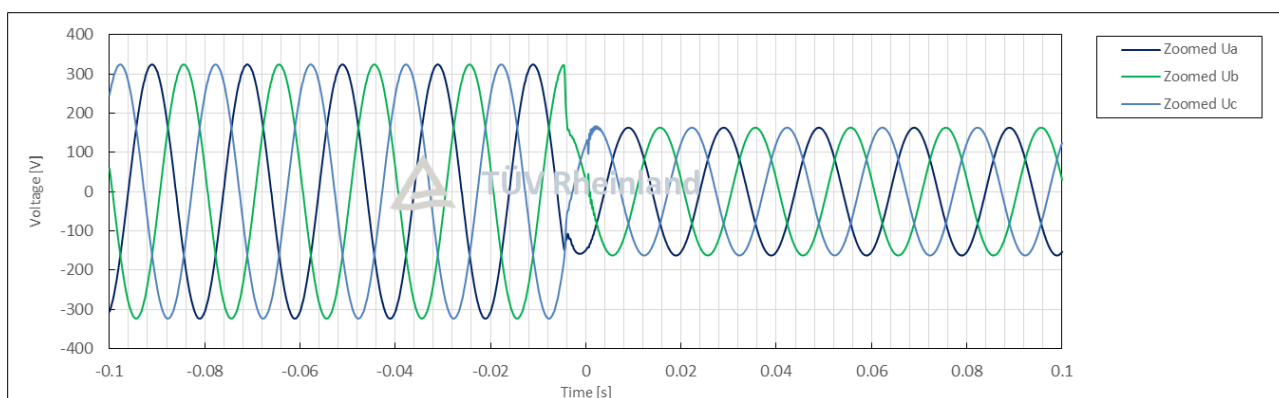
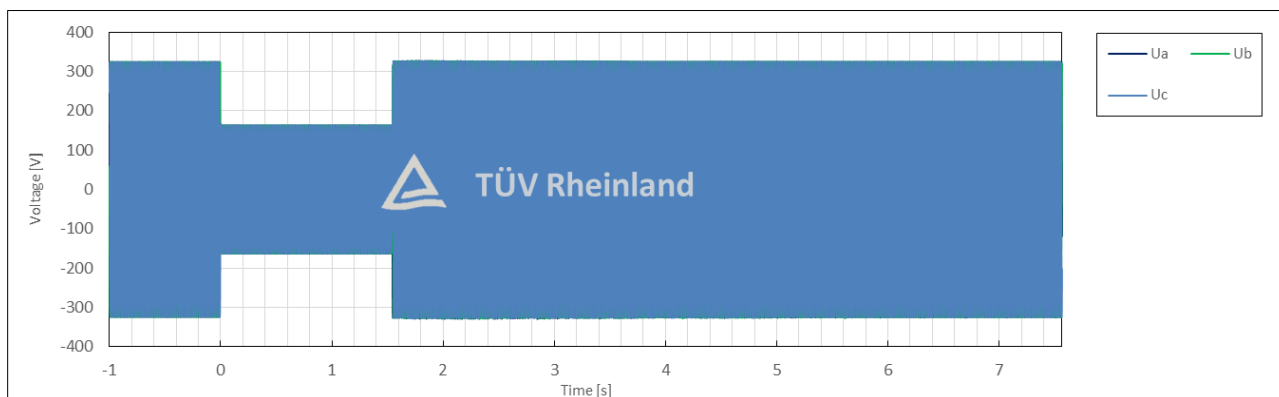
Test No. 2.2 idle test



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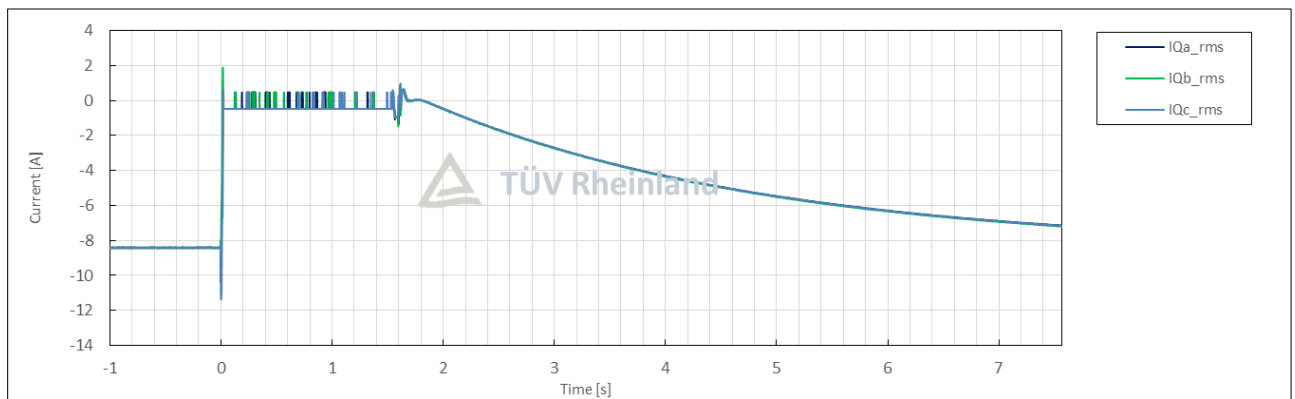
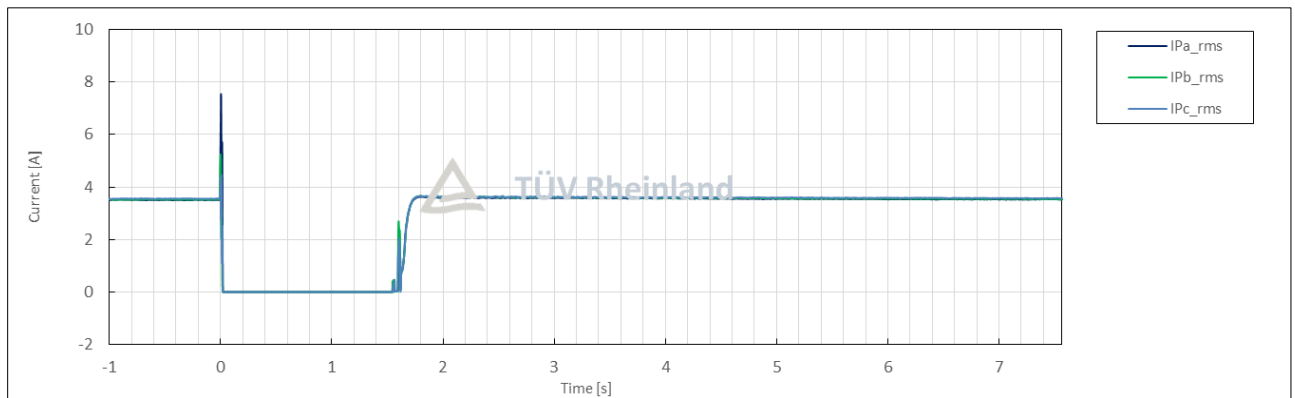
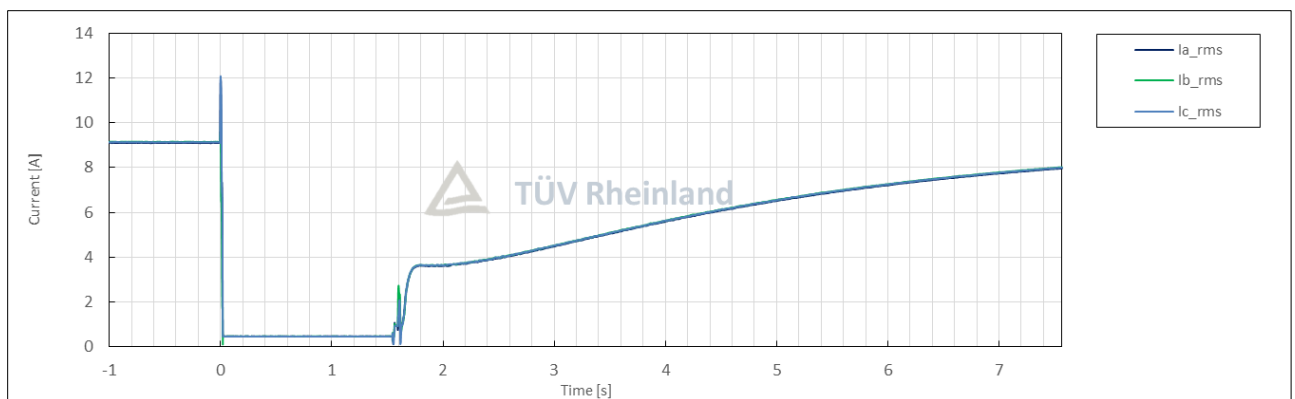
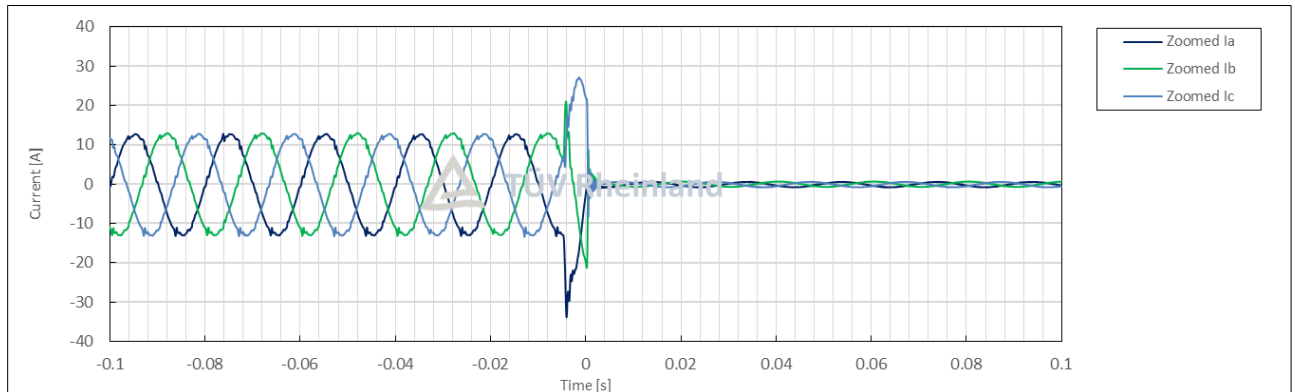
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Test No. 2.2 with PGU



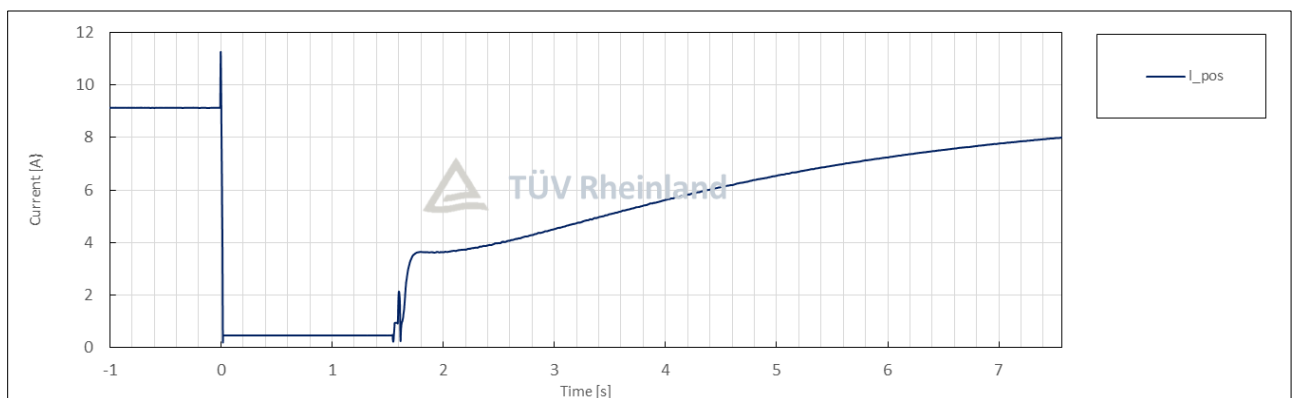
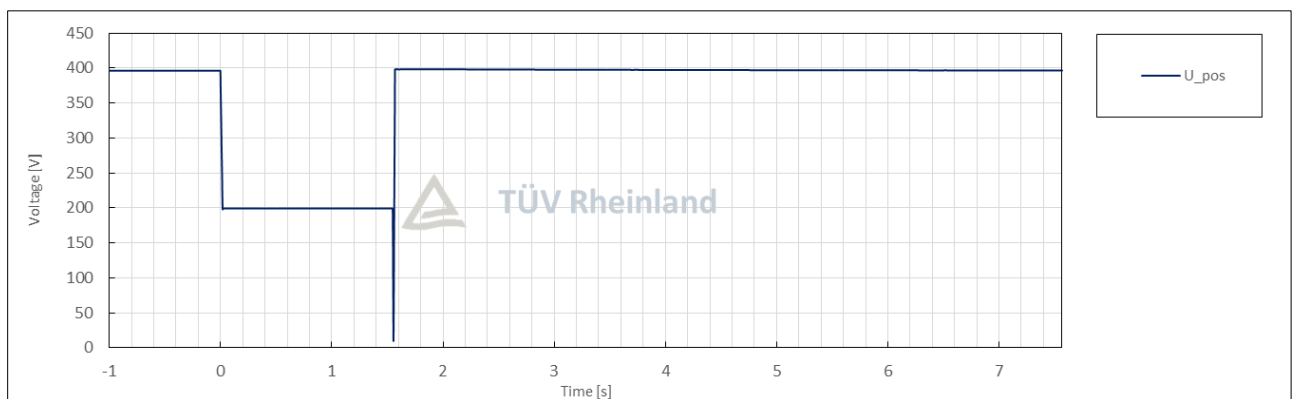
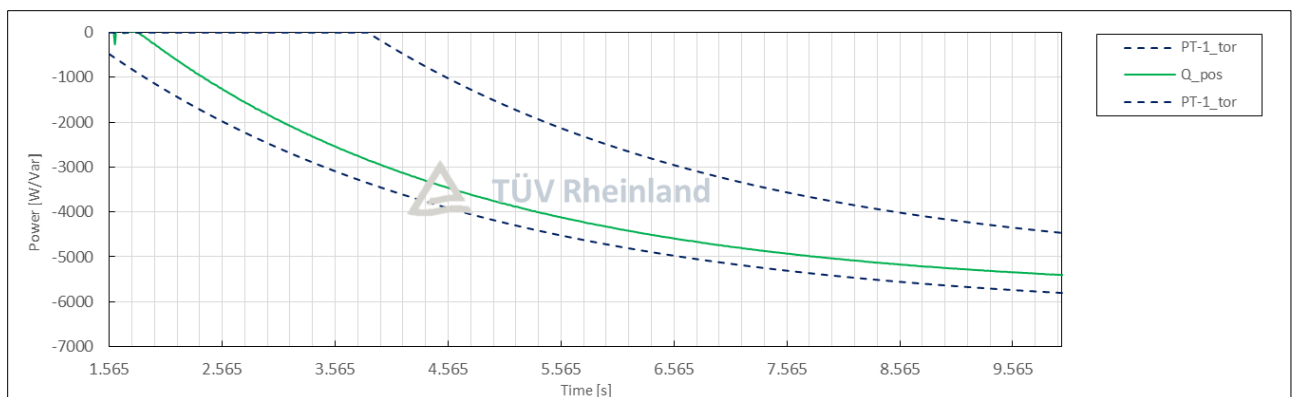
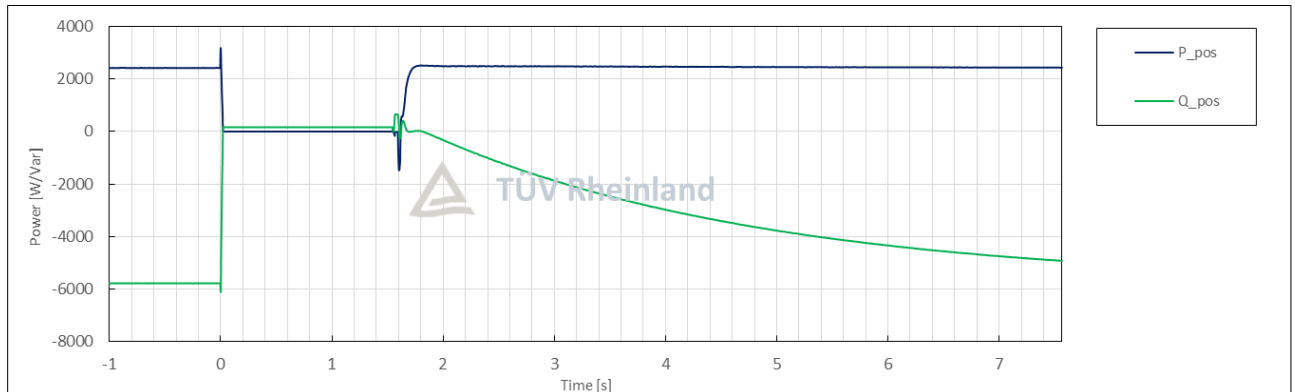
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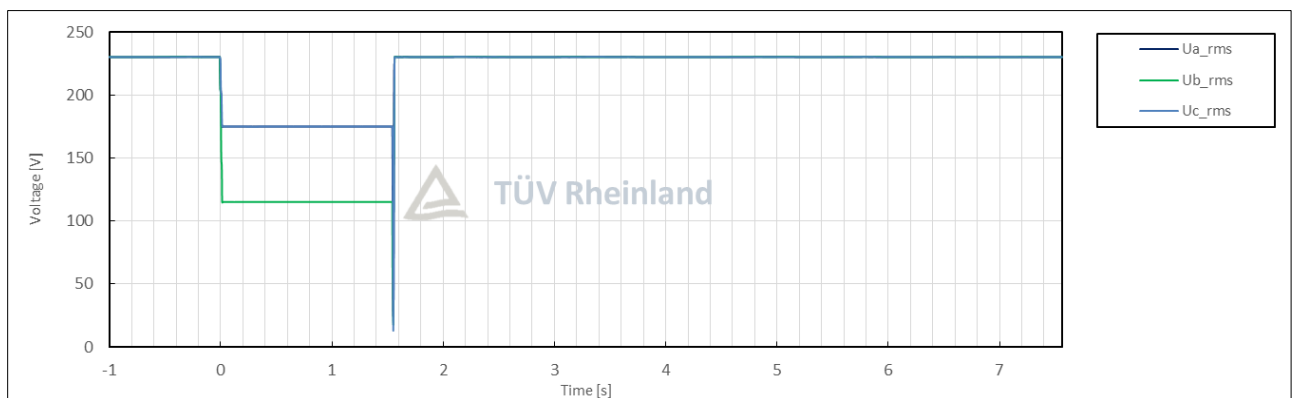
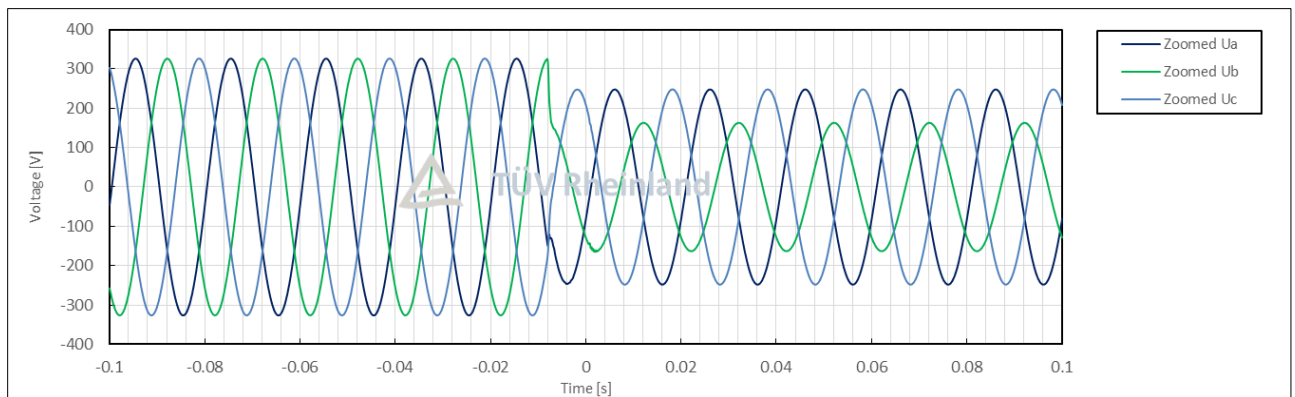
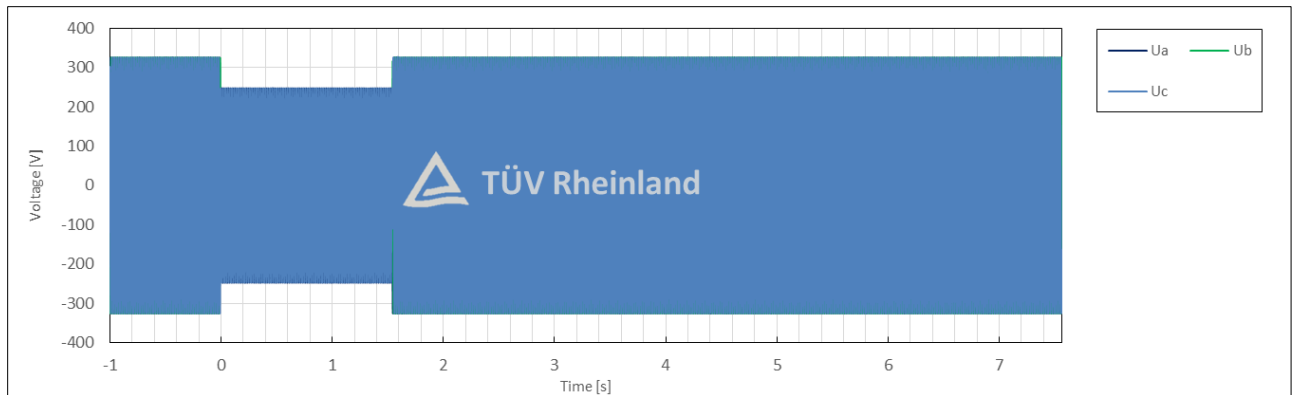
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.3
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:42:56
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1562
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1562
	8	Fault duration in empty load test	Total	--	ms	1562
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.66
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.02
	13	Active power	Total	t1-10s to t1	p.u.	0.90
	14		Pos.			0.90
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos ϕ	--	t1-10s to t1	--	0.880
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.04

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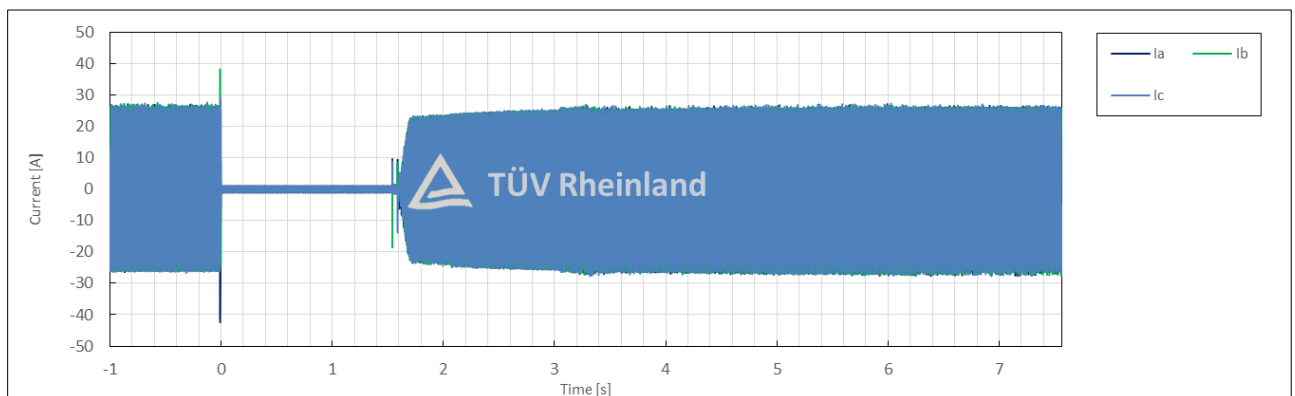
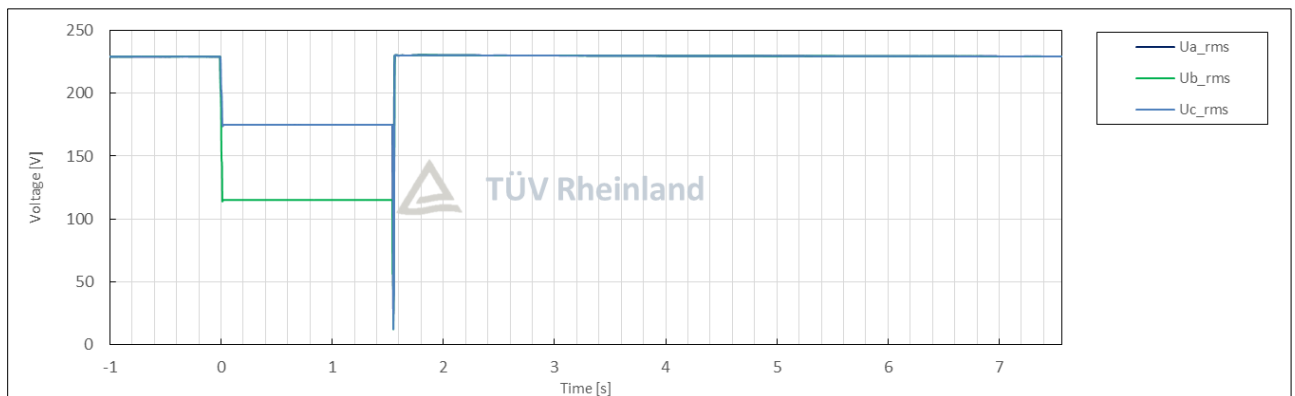
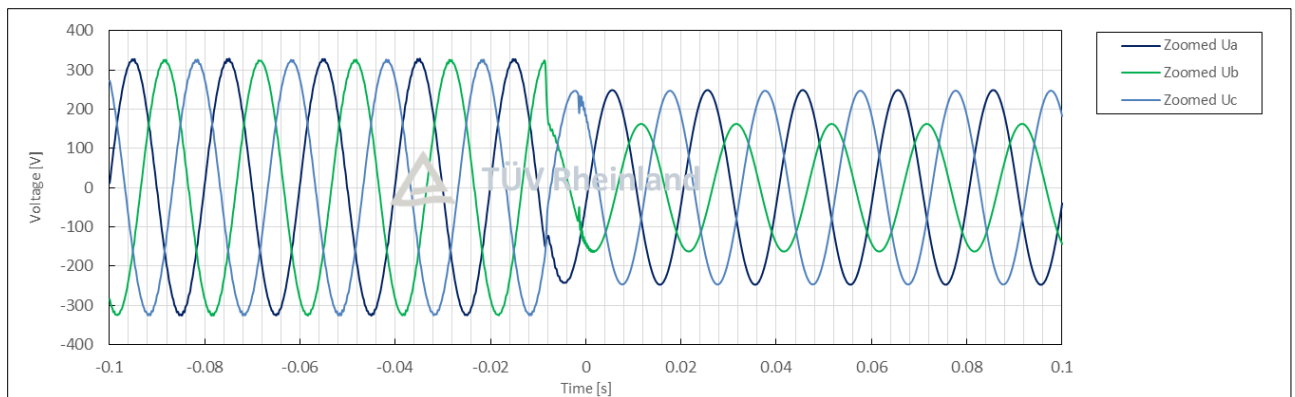
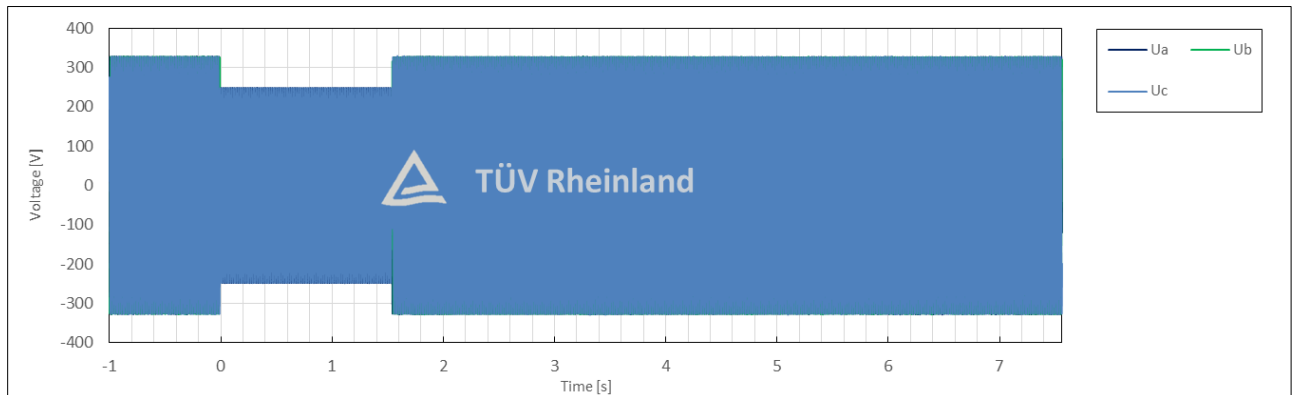
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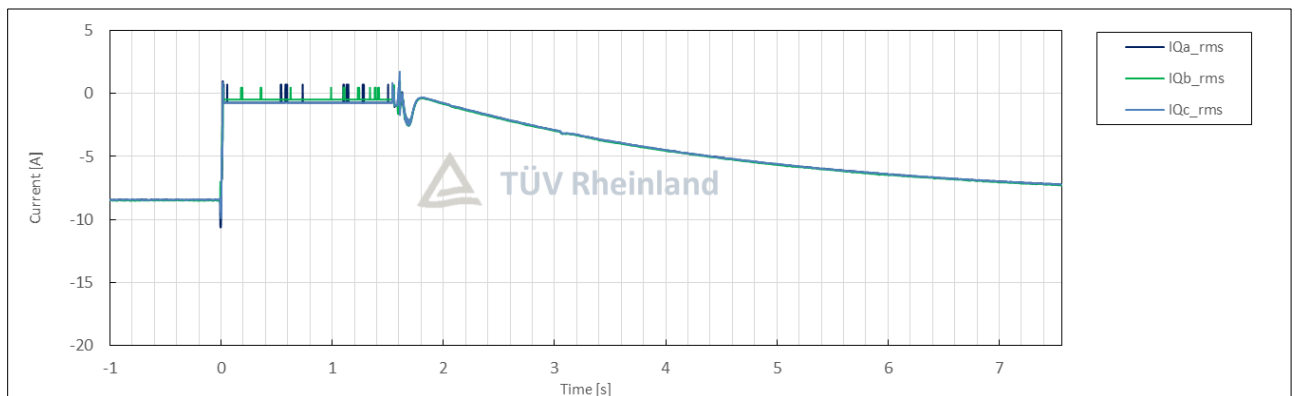
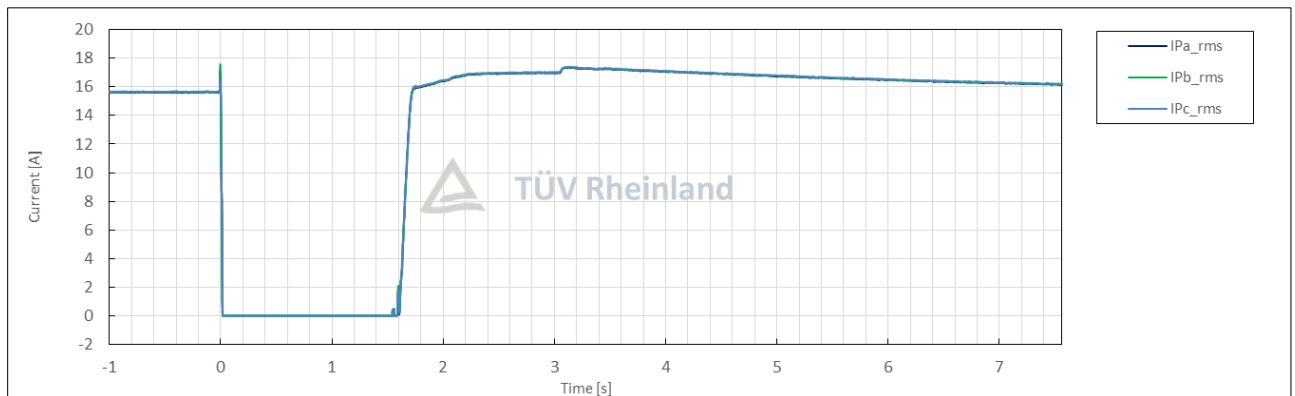
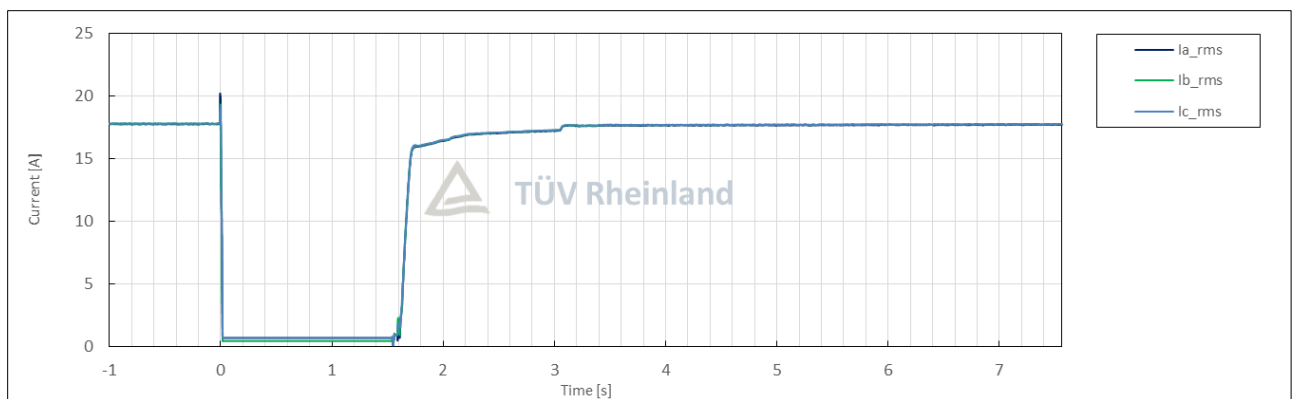
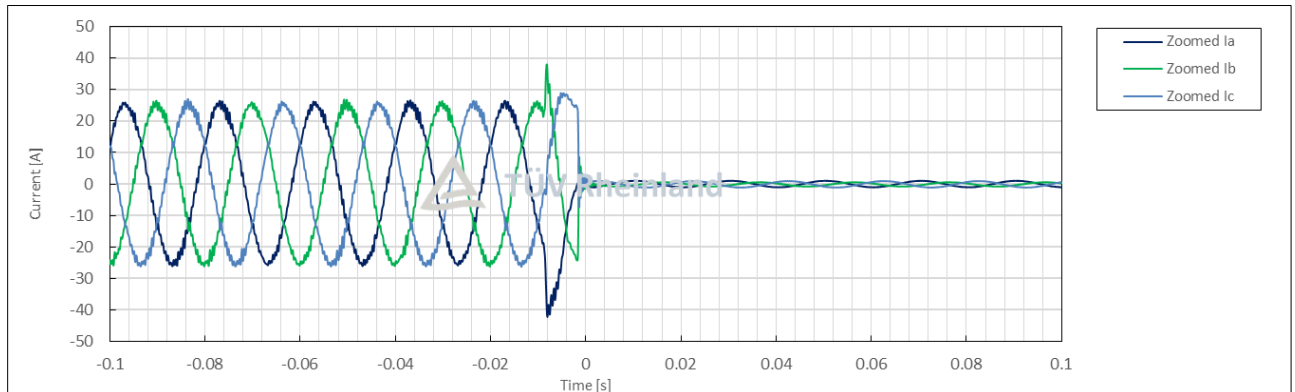
	20		Phase 2			0.03
	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.03
	24		Phase 3			0.04
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.93
	29		Pos.			0.93
	39	Active power rising time	Pos.	--	s	0.137
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.41
	32		Pos.			-0.41
	33	Reactive power rising time	Pos.	--	s	9.04
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

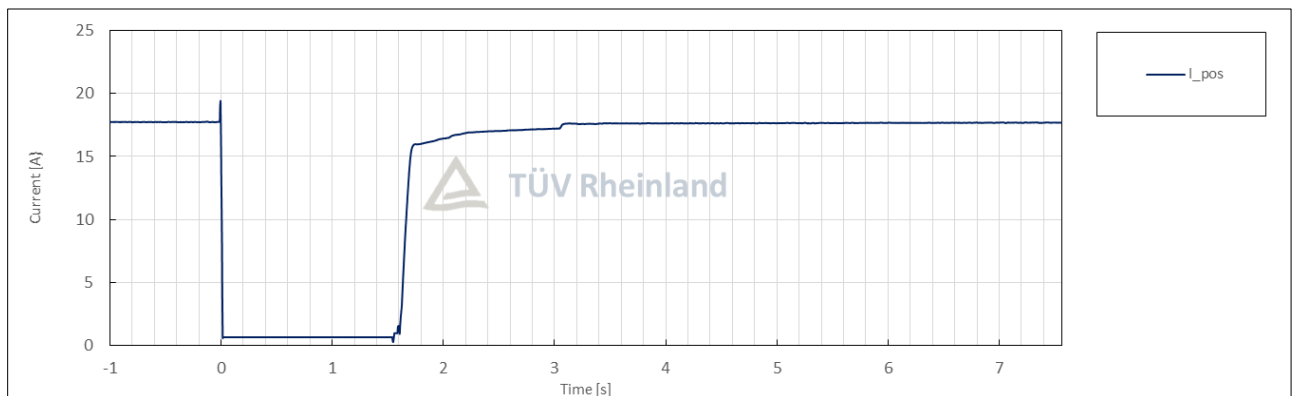
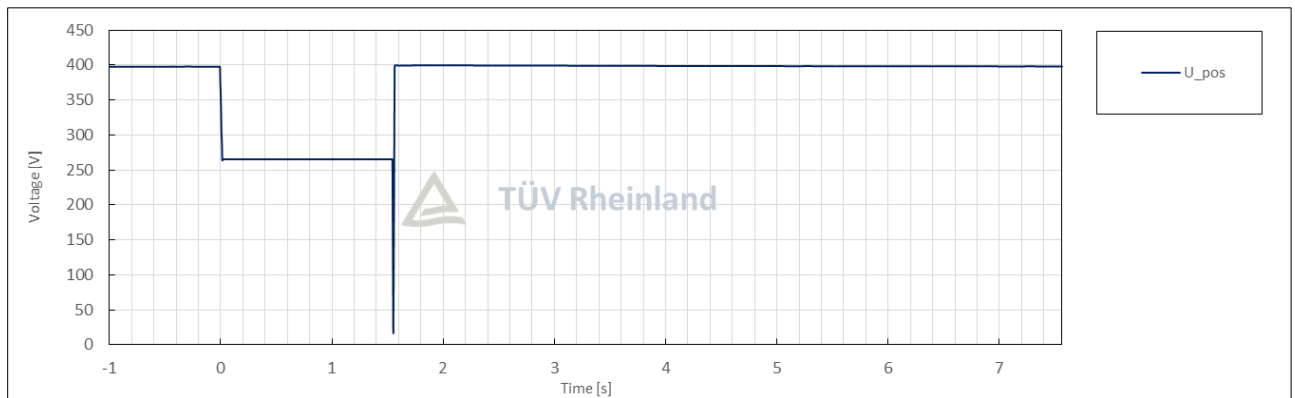
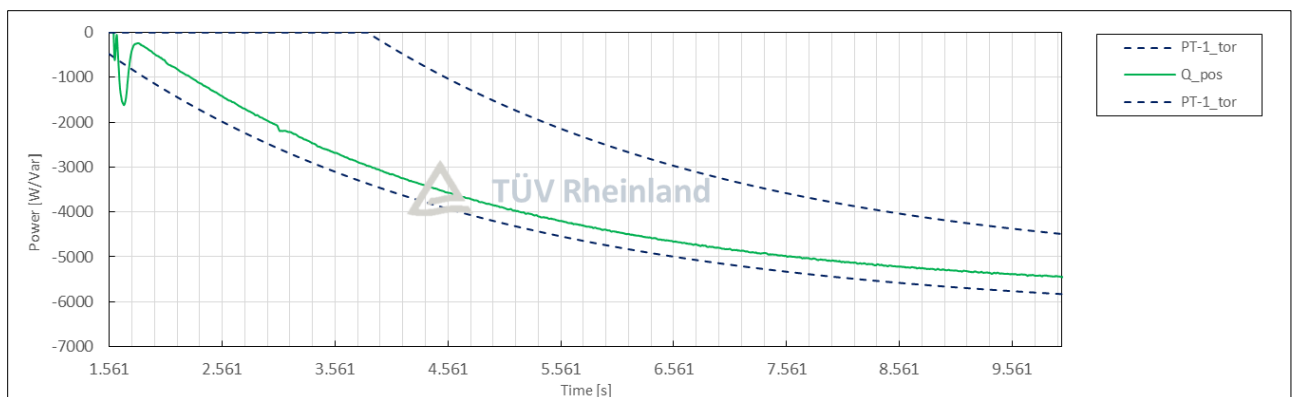
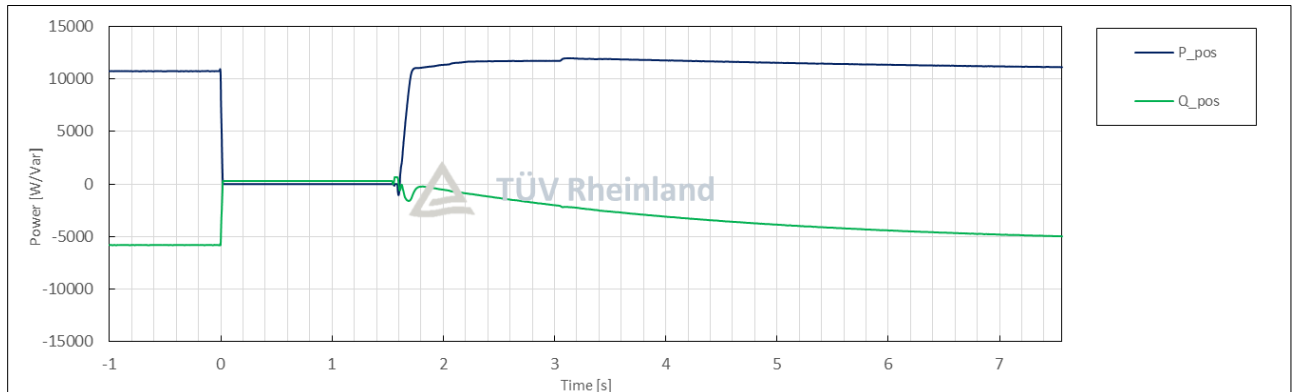
Test No. 2.3 idle test



Test No. 2.3 with PGU







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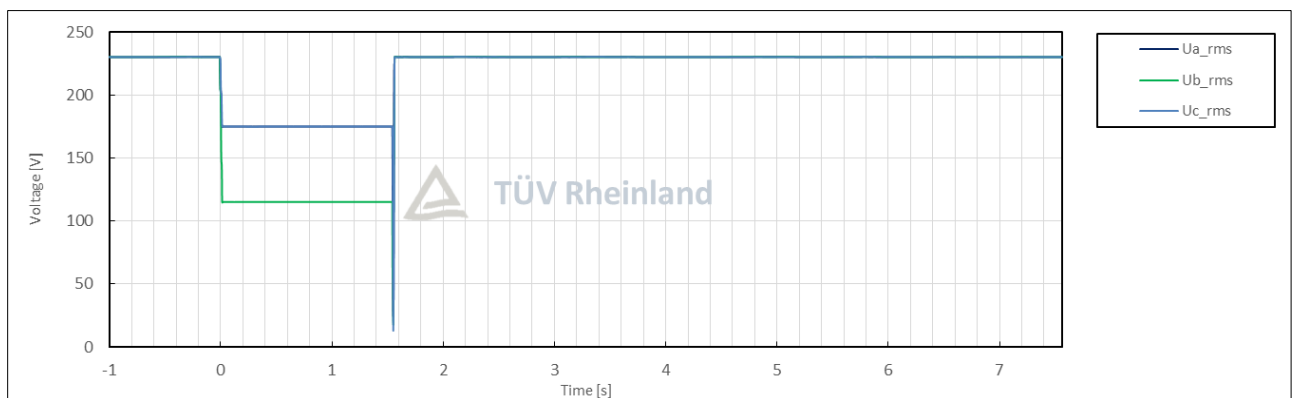
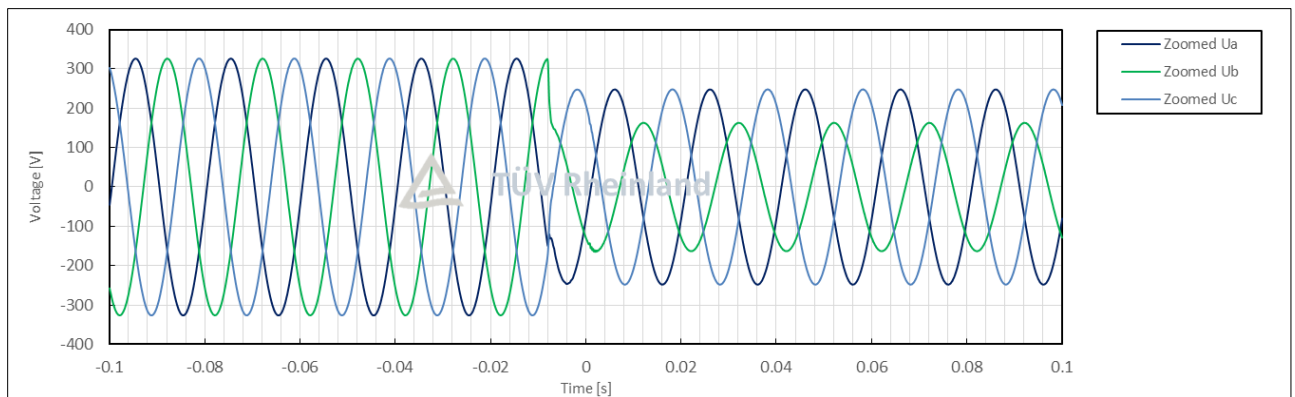
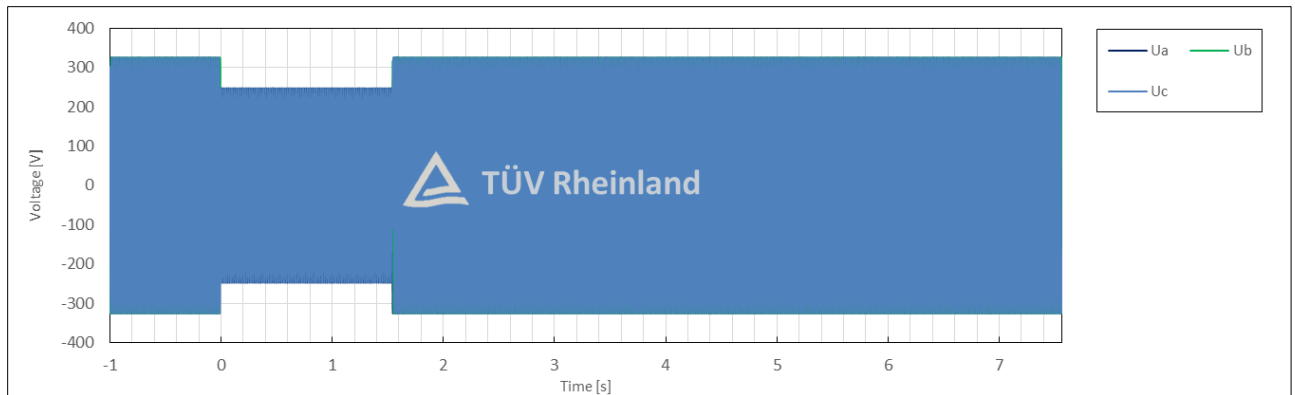
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	2.4
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:44:06
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1562
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1562
	8	Fault duration in empty load test	Total	--	ms	1562
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.66
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.52
	13	Active power	Total	t1-10s to t1	p.u.	0.20
	14		Pos.			0.20
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos φ	--	t1-10s to t1	--	0.387
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.03

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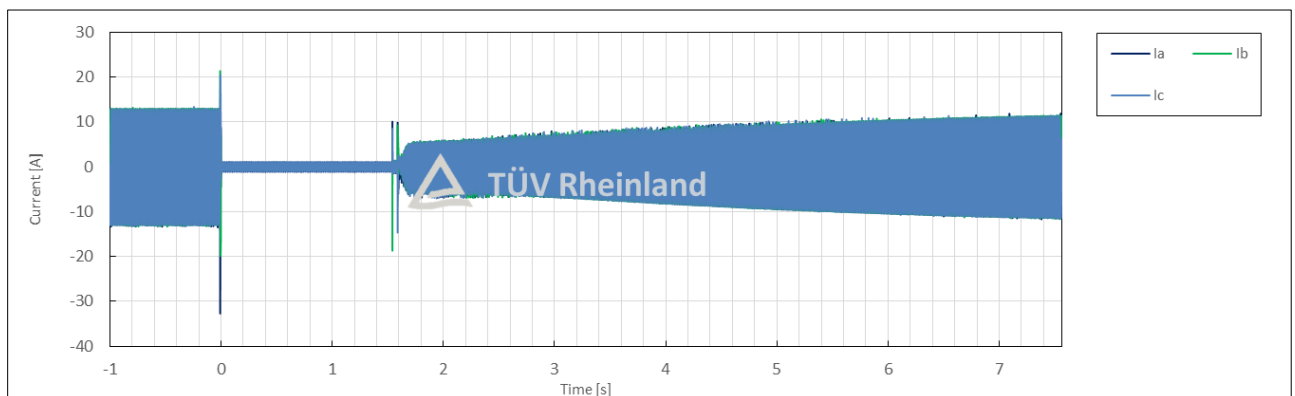
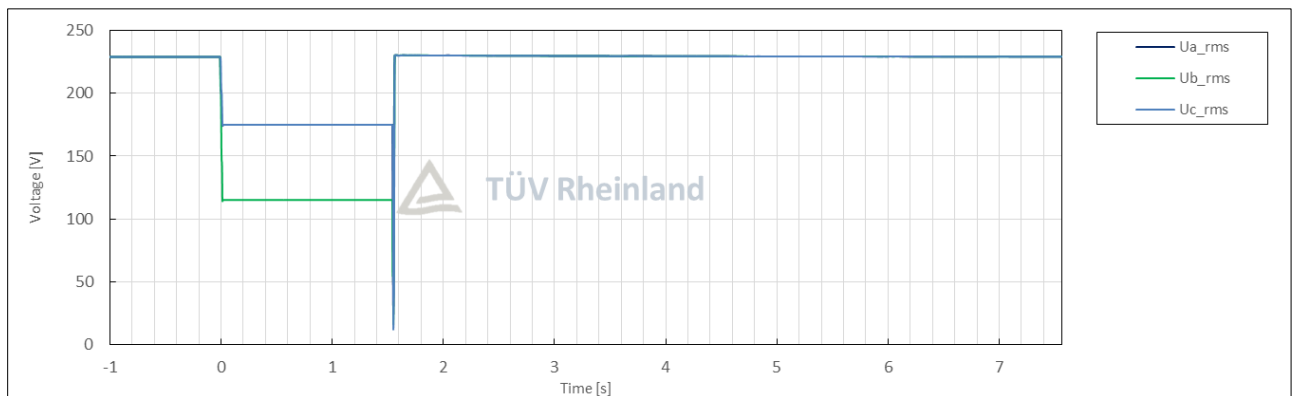
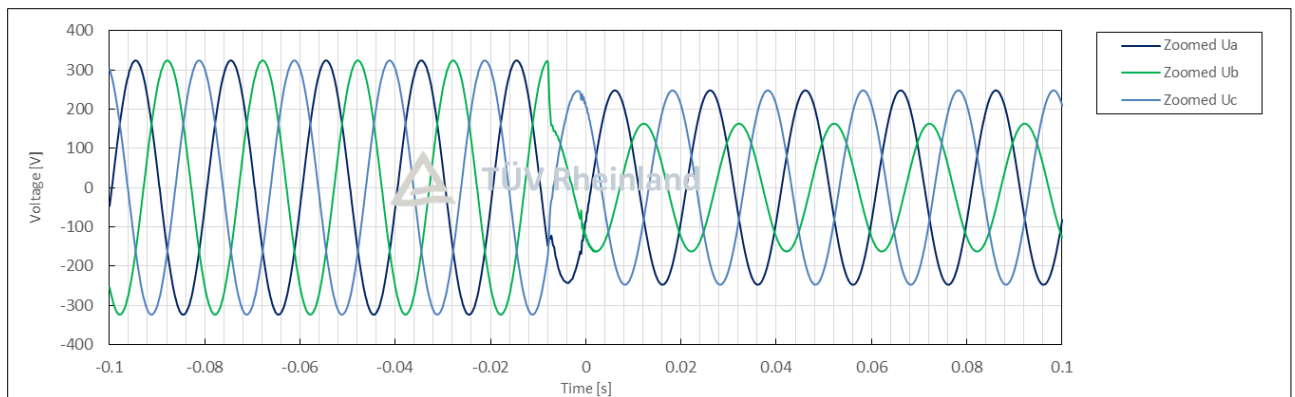
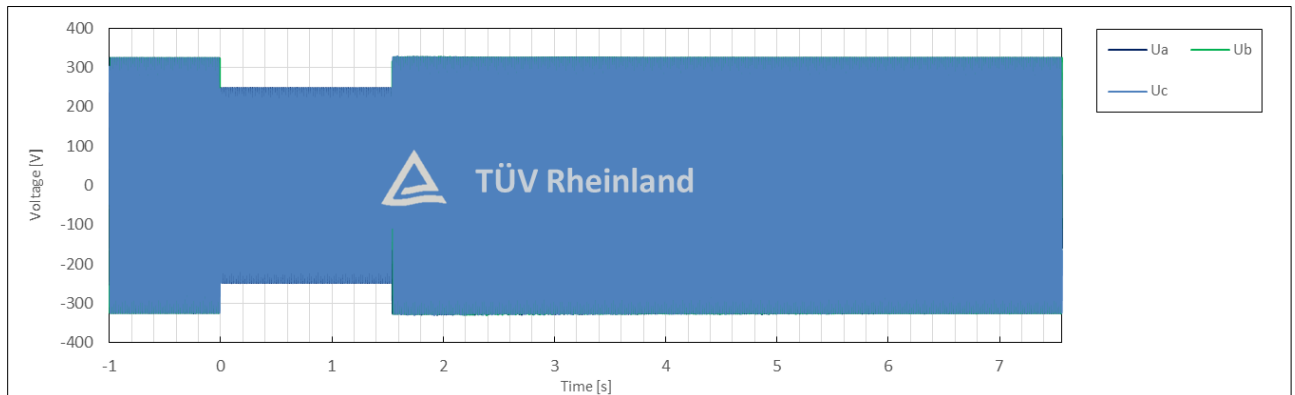
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	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.03
	24		Phase 3			0.04
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.20
	29		Pos.			0.20
	39	Active power rising time	Pos.	--	s	0.132
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.41
	32		Pos.			-0.41
	33	Reactive power rising time	Pos.	--	s	9.227
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

Test No. 2.4 idle test

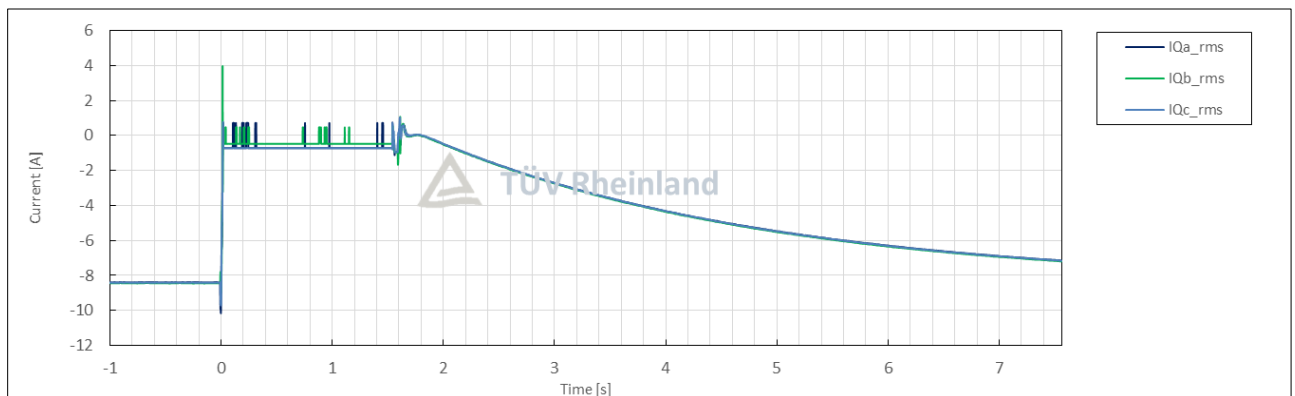
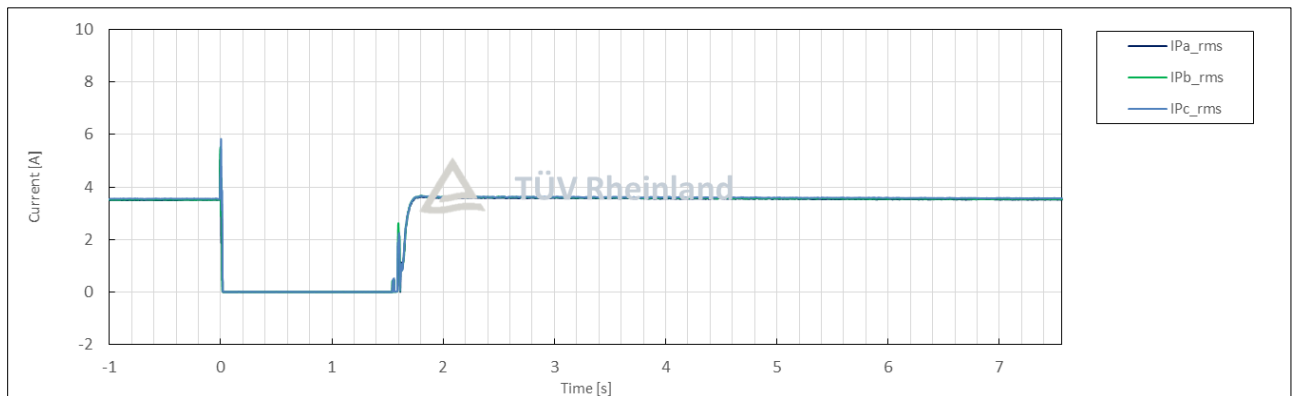
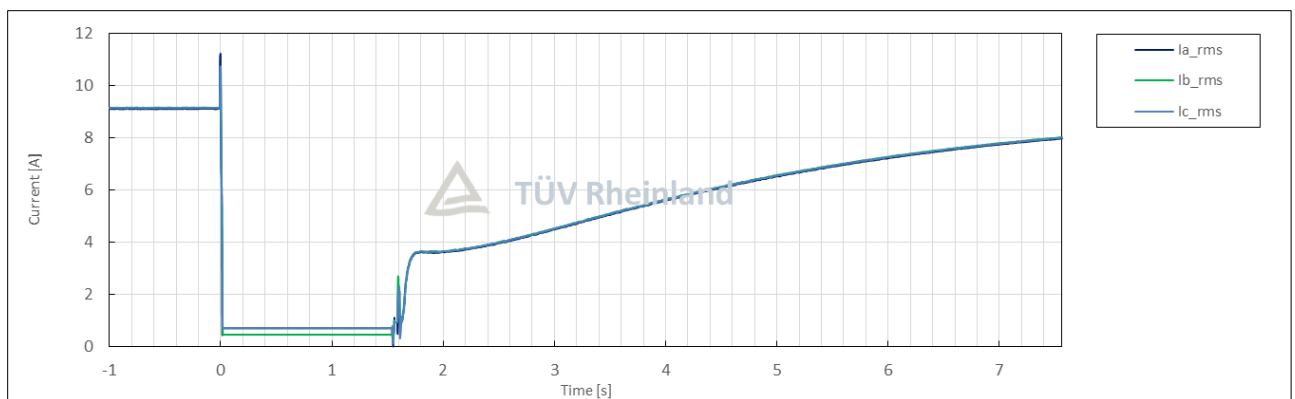
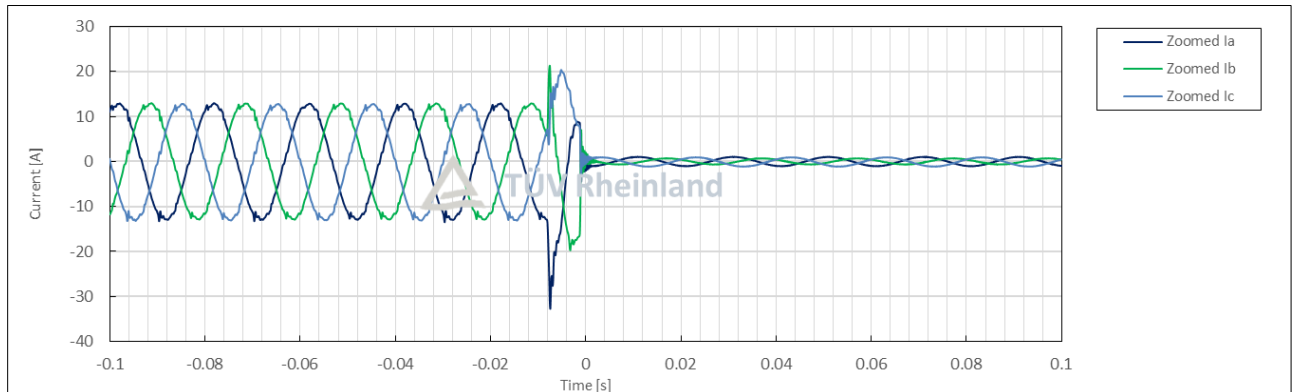


Test No. 2.4 with PGU



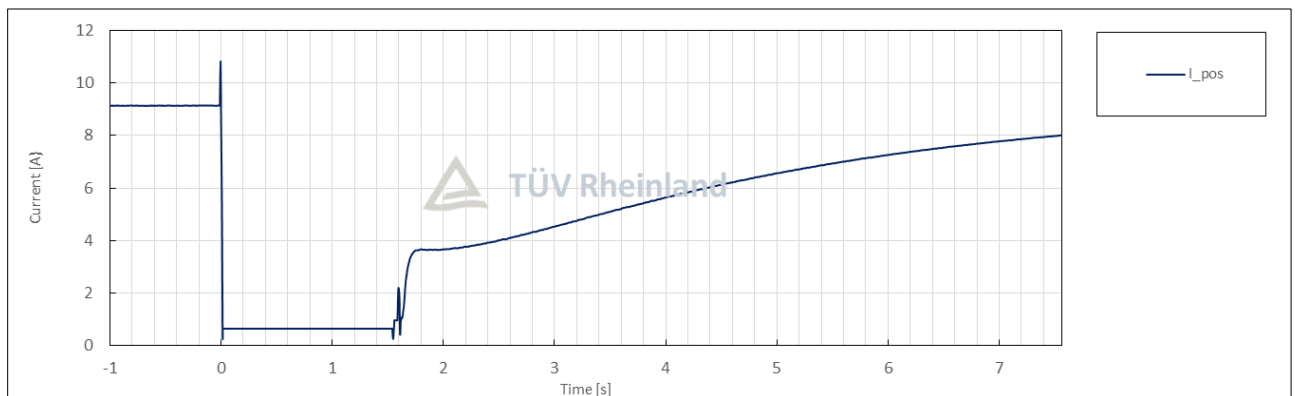
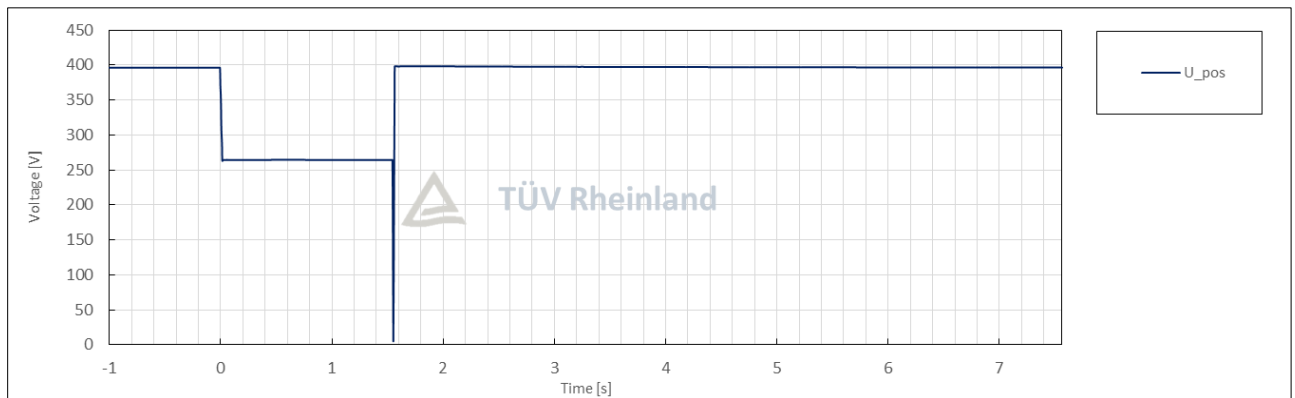
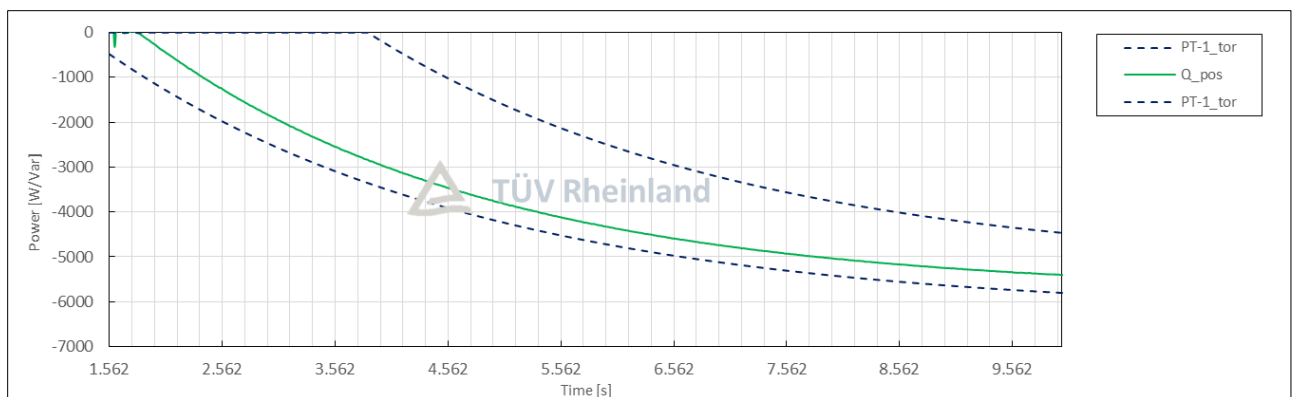
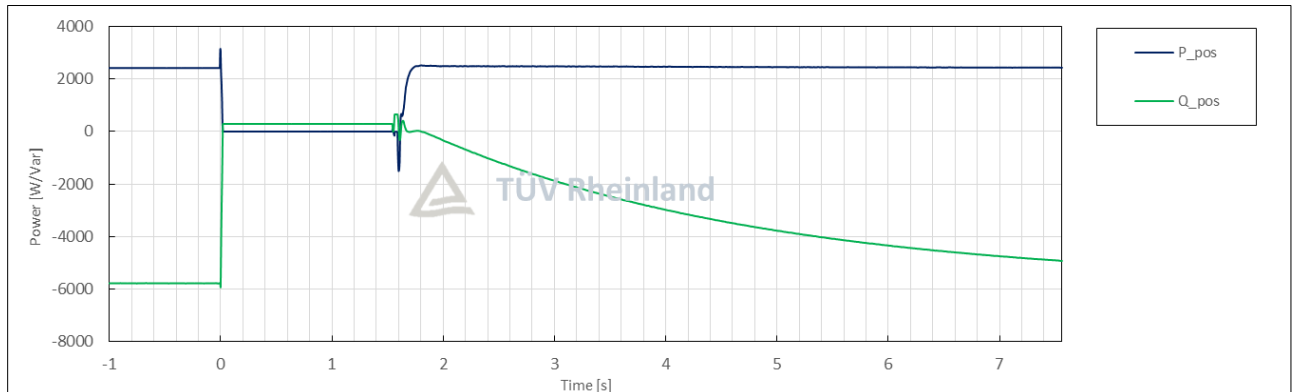
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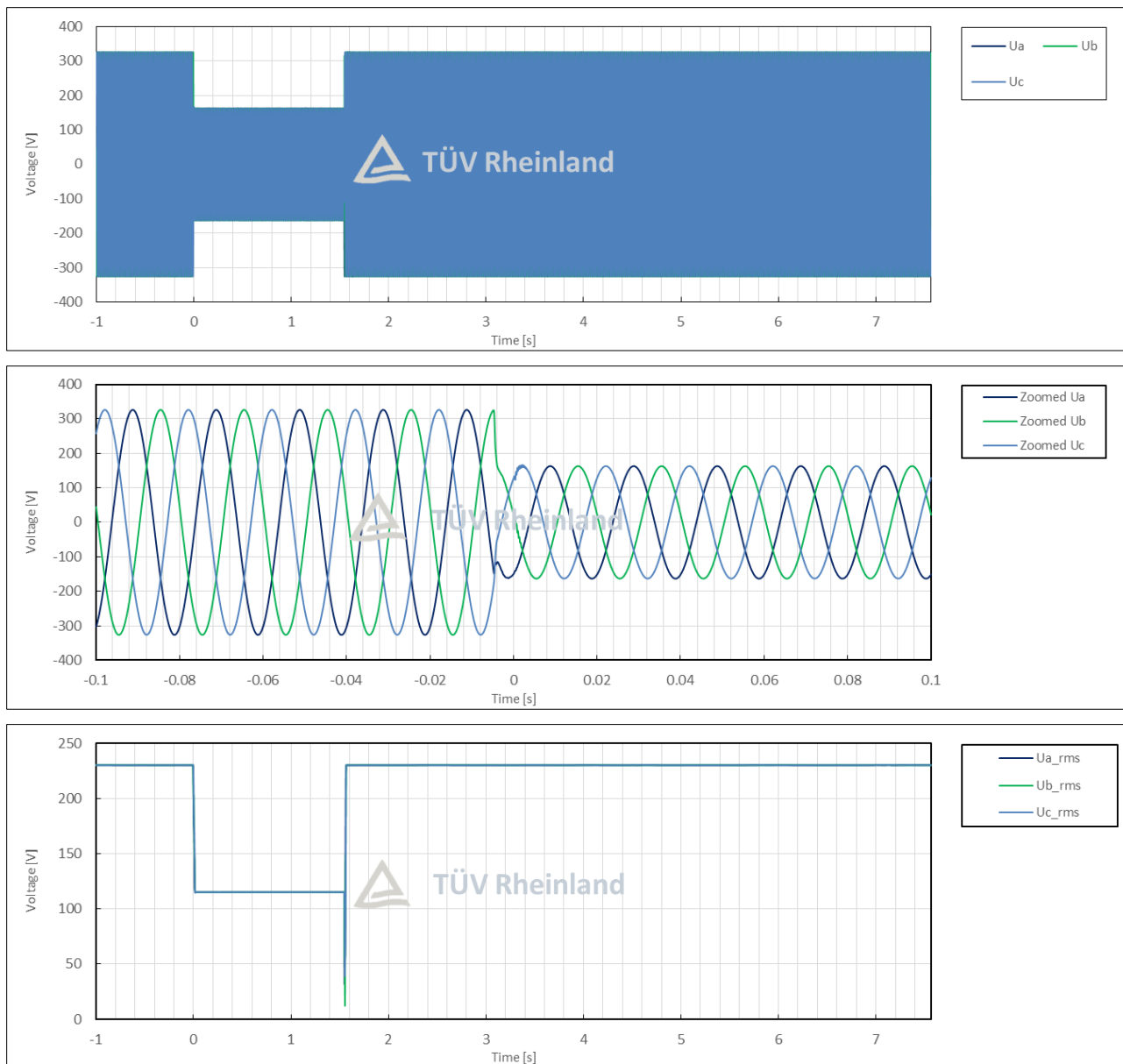
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.1
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:45:12
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1565
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1565
	8	Fault duration in empty load test	Total	--	ms	1565
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.50
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.01
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.03
	13	Active power	Total	t1-10s to t1	p.u.	0.92
	14		Pos.			0.92
	15	Reactive power	Total	t1-10s to t1	p.u.	0.48
	16		Pos.			0.48
	17	Cos φ	--	t1-10s to t1	--	0.887
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03

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	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.03
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.01
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.95
	29		Pos.			0.95
	39	Active power rising time	Pos.	--	s	0.145
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.41
	32		Pos.			0.41
	33	Reactive power rising time	Pos.	--	s	9.099
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

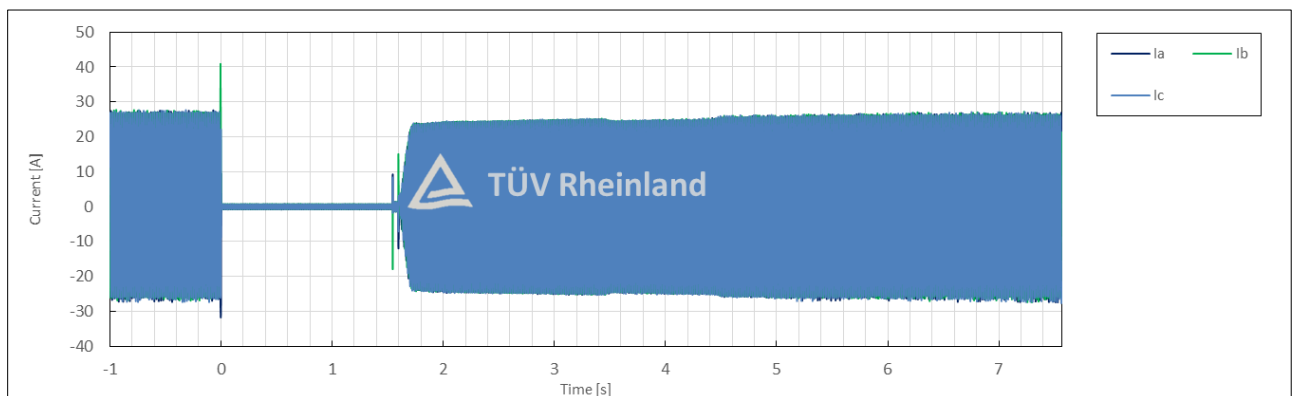
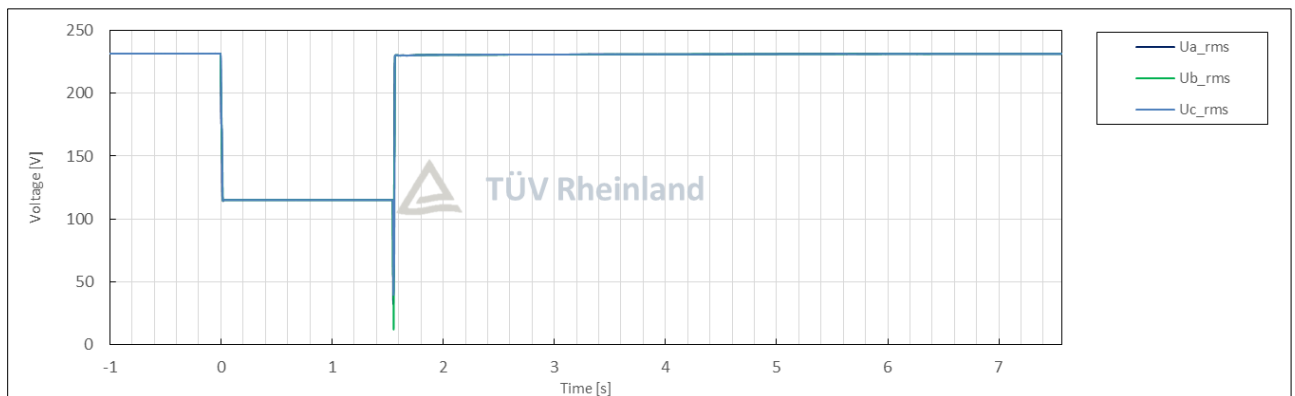
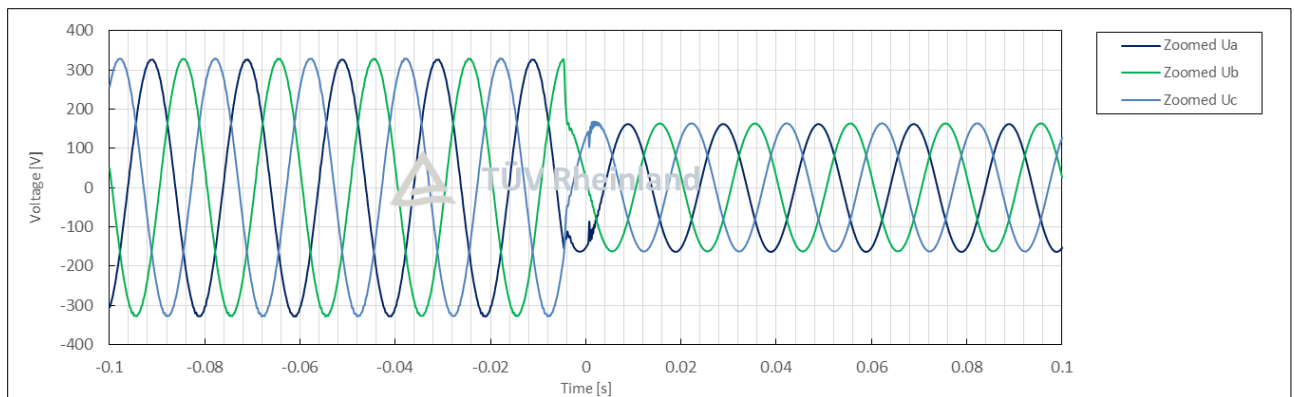
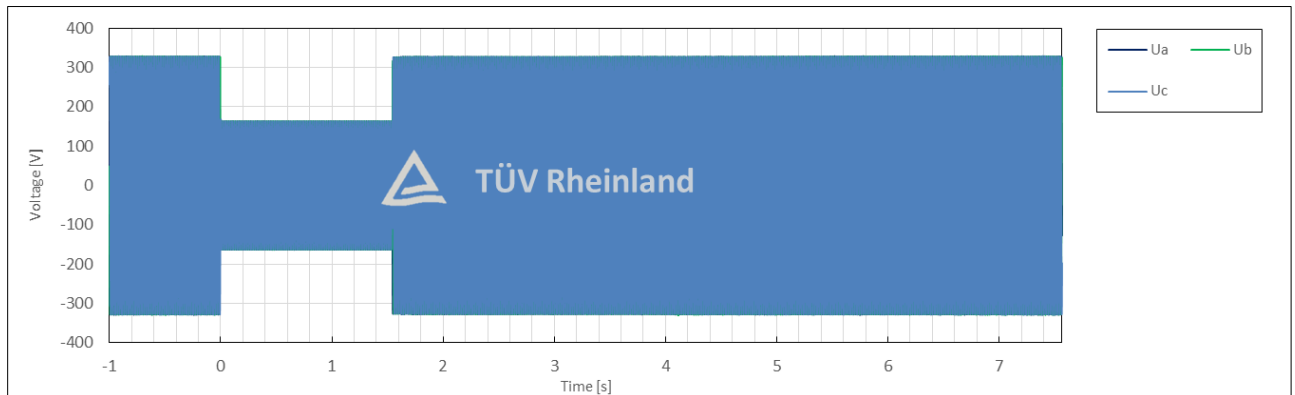
Test No. 3.1 idle test



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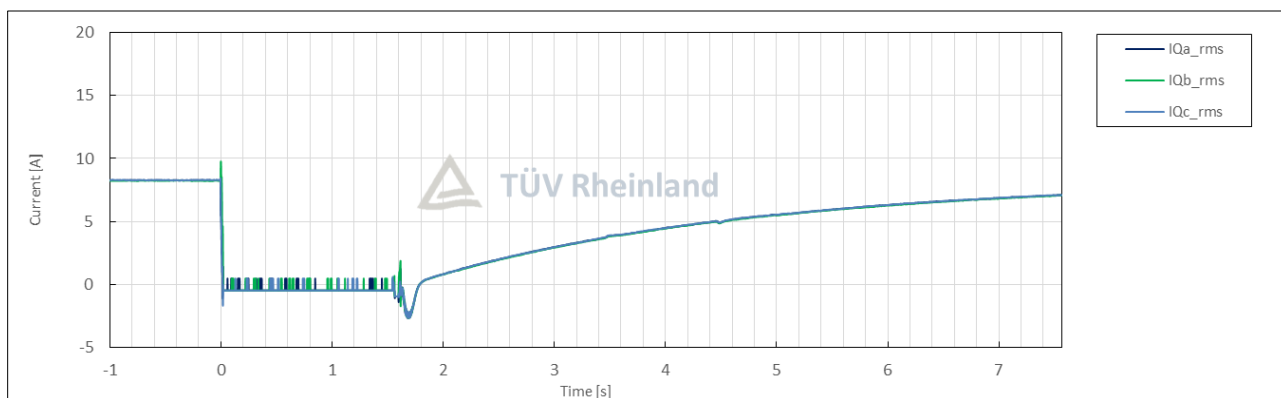
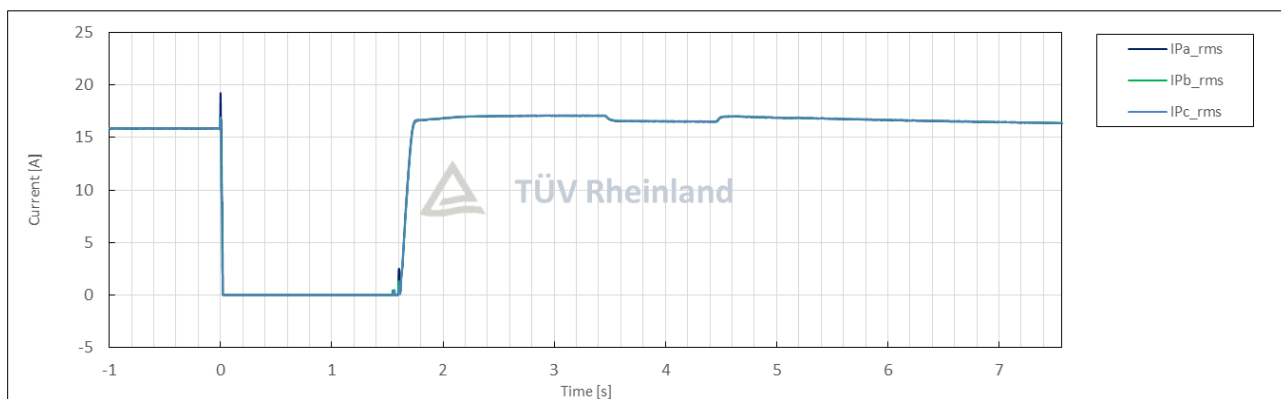
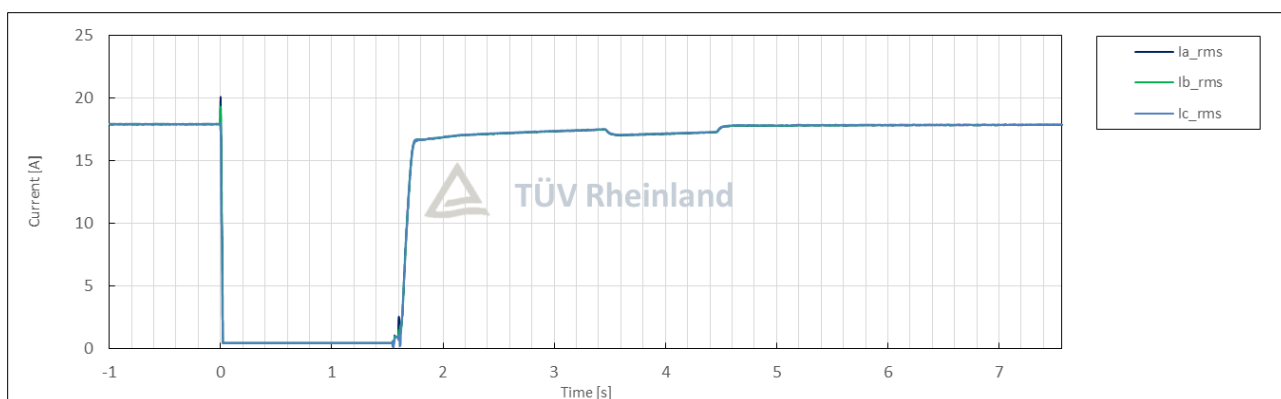
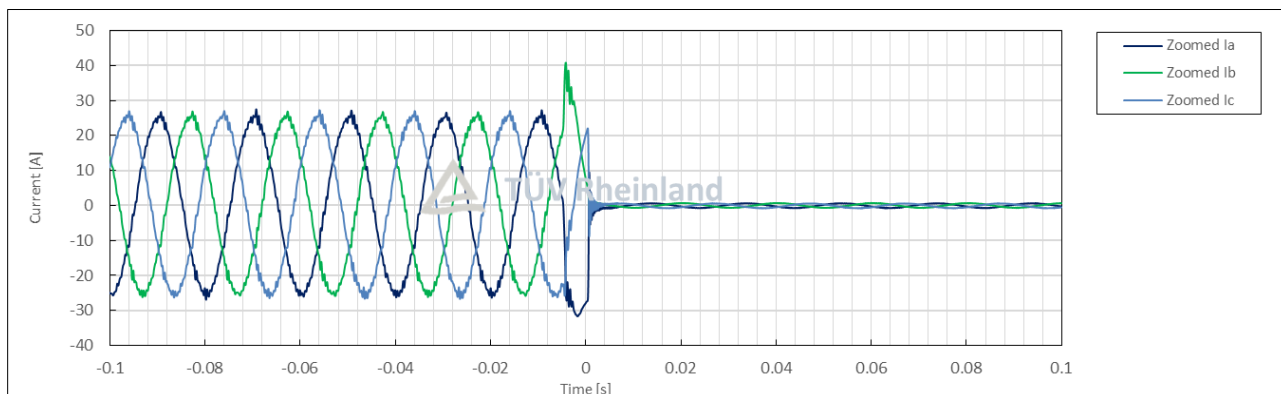
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Test No. 3.1 with PGU



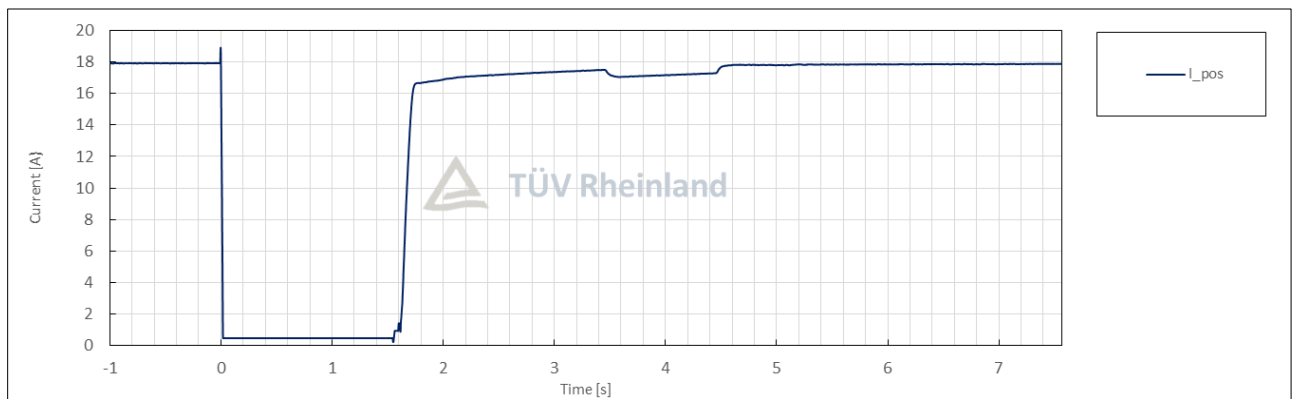
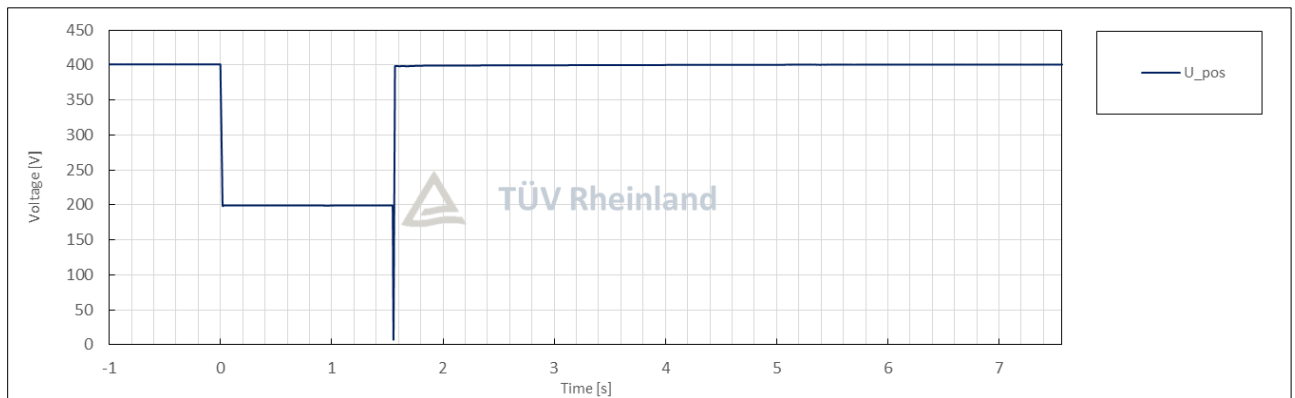
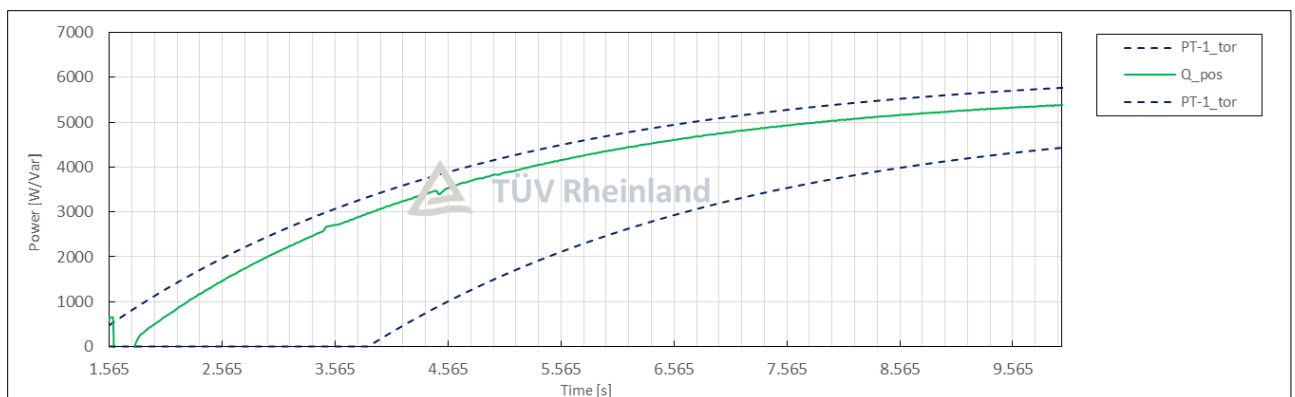
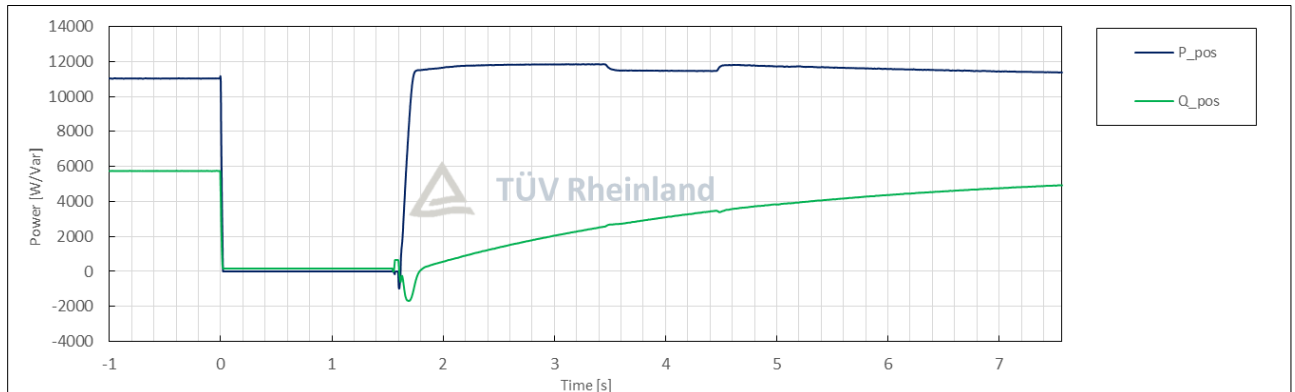
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Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.2
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:45:48
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1565
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1565
	8	Fault duration in empty load test	Total	--	ms	1565
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.50
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.01
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.52
	13	Active power	Total	t1-10s to t1	p.u.	0.20
	14		Pos.			0.20
	15	Reactive power	Total	t1-10s to t1	p.u.	0.48
	16		Pos.			0.48
	17	Cos φ	--	t1-10s to t1	--	0.386
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03

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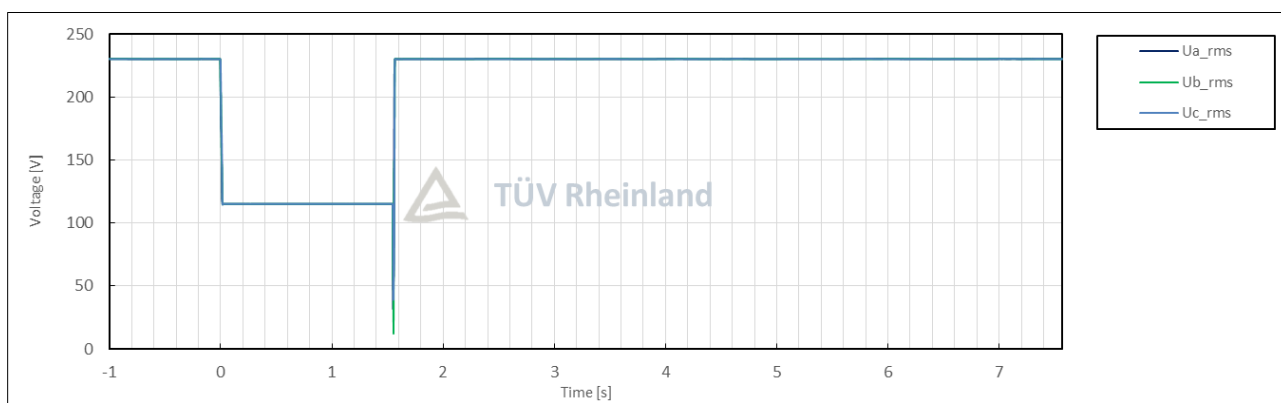
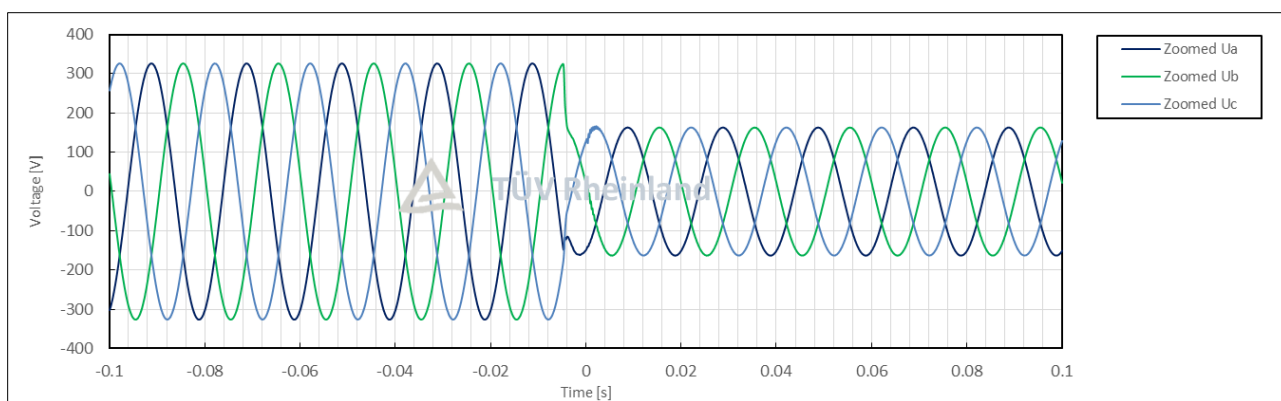
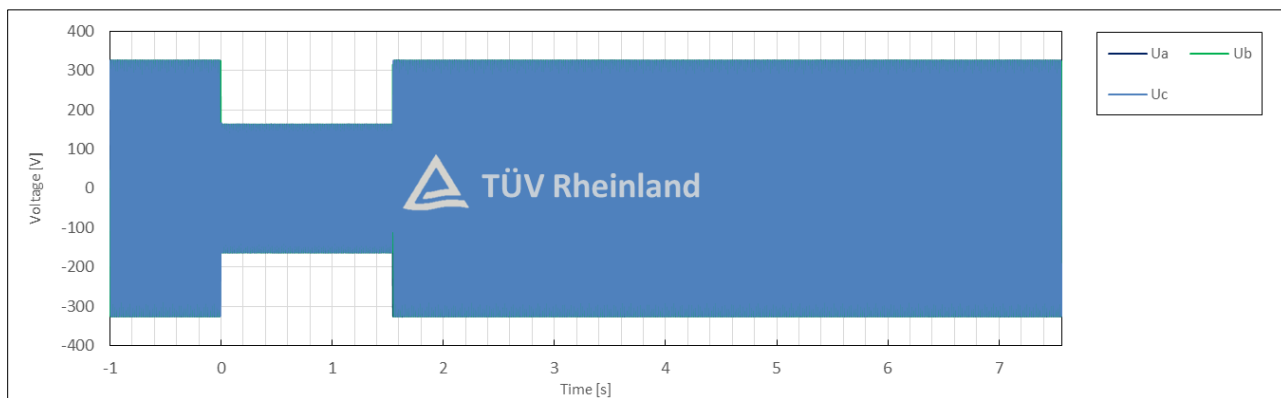
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	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.03
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.01
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.20
	29		Pos.			0.20
	39	Active power rising time	Pos.	--	s	0.159
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.41
	32		Pos.			0.41
	33	Reactive power rising time	Pos.	--	s	8.977
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

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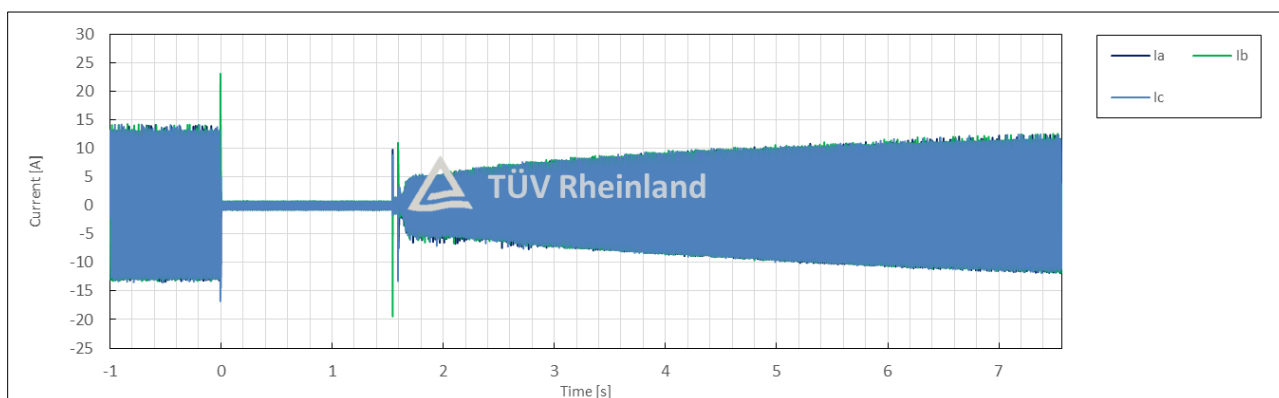
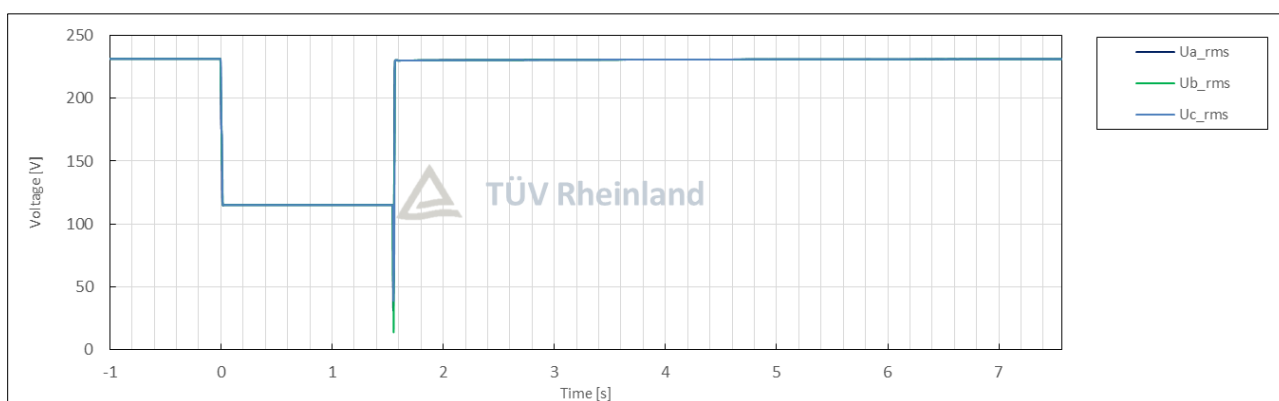
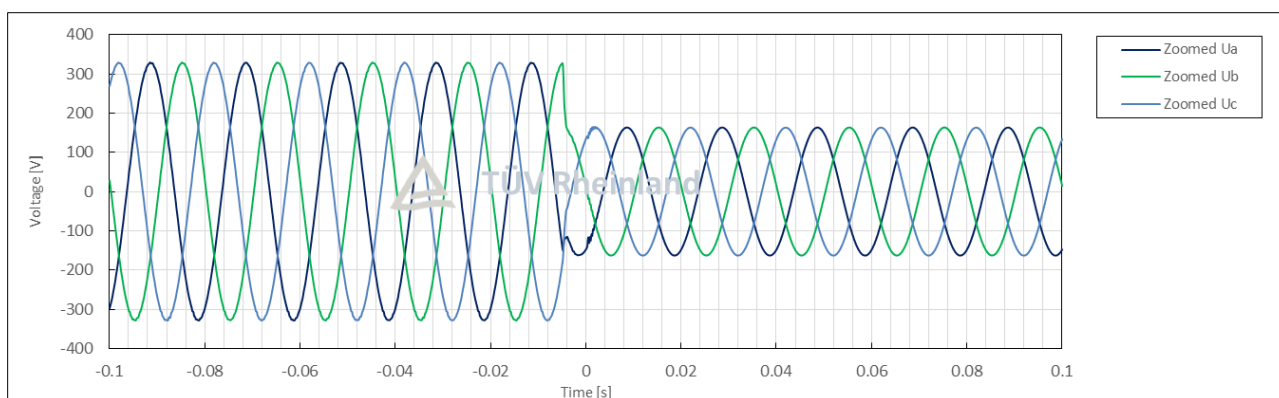
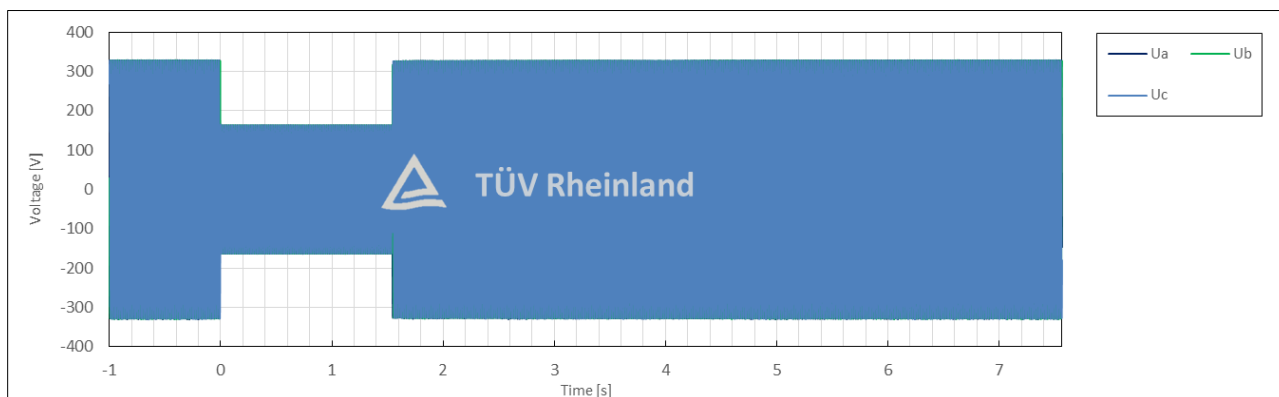
Test No. 3.2 idle test



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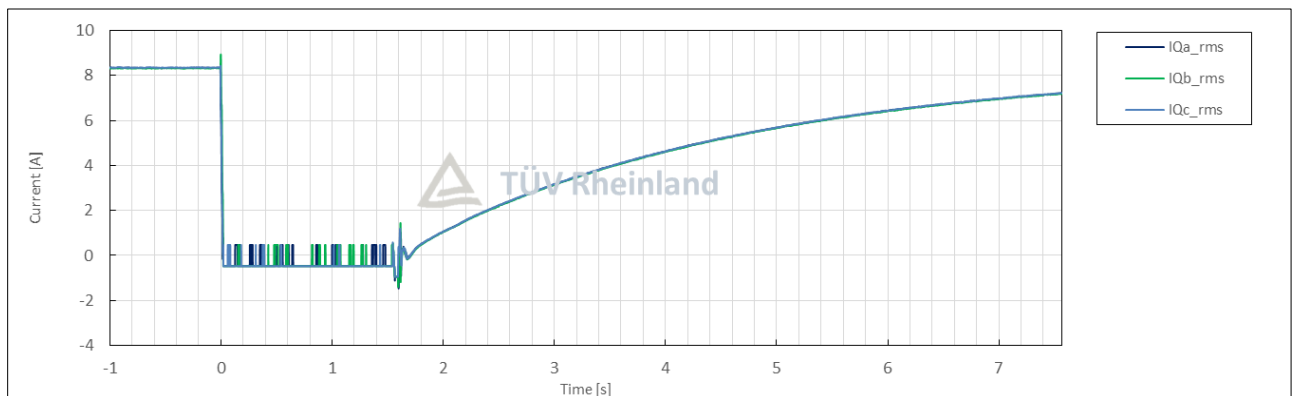
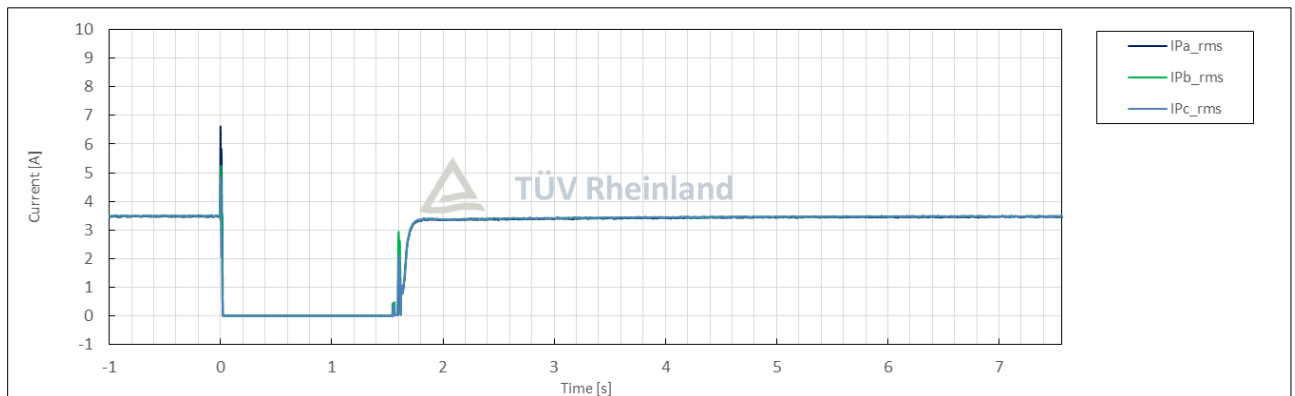
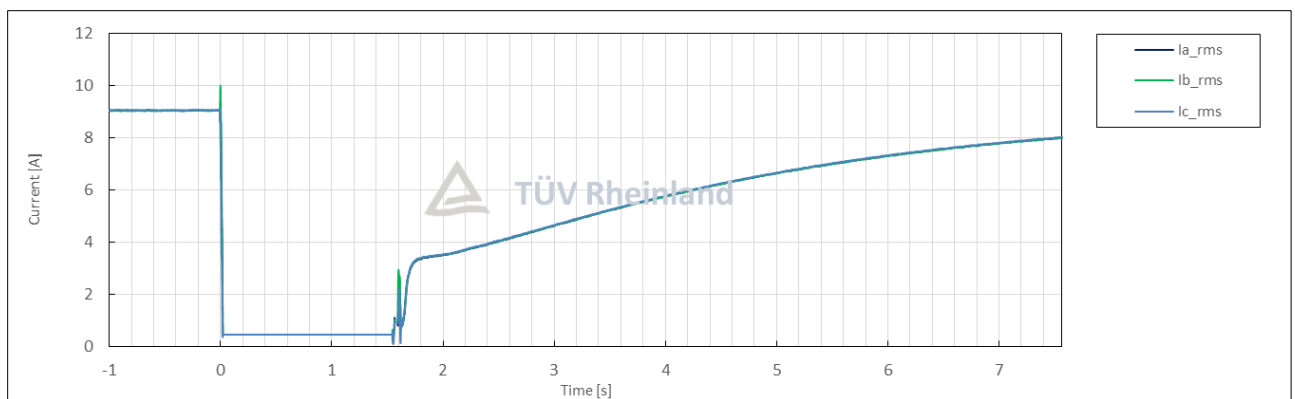
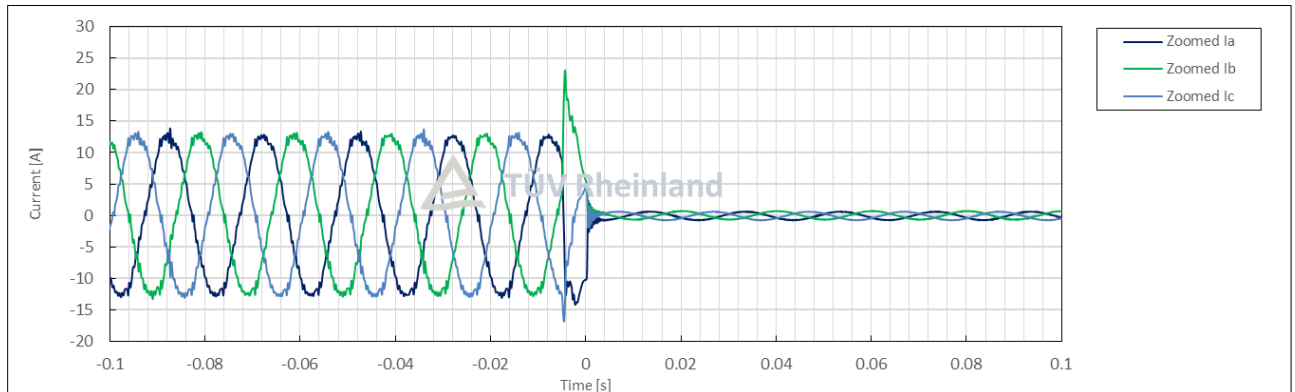
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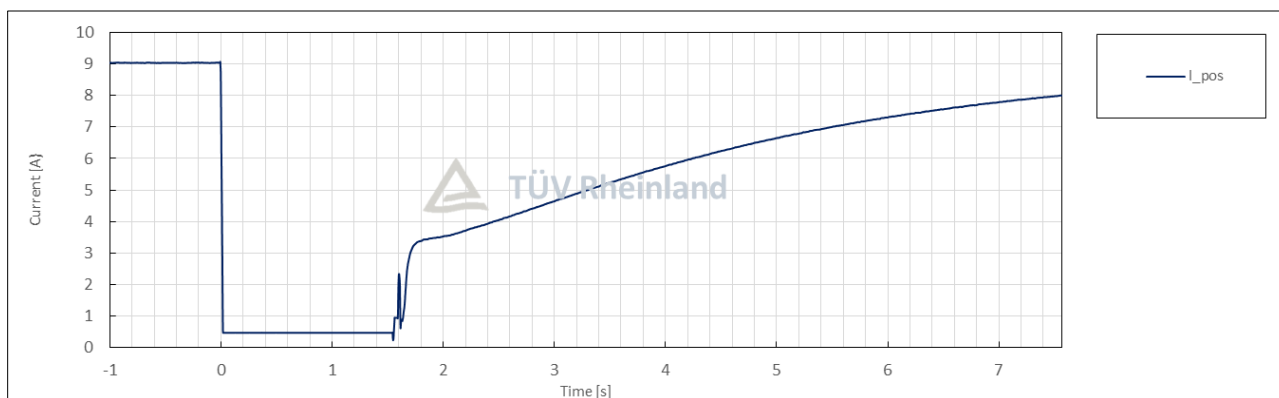
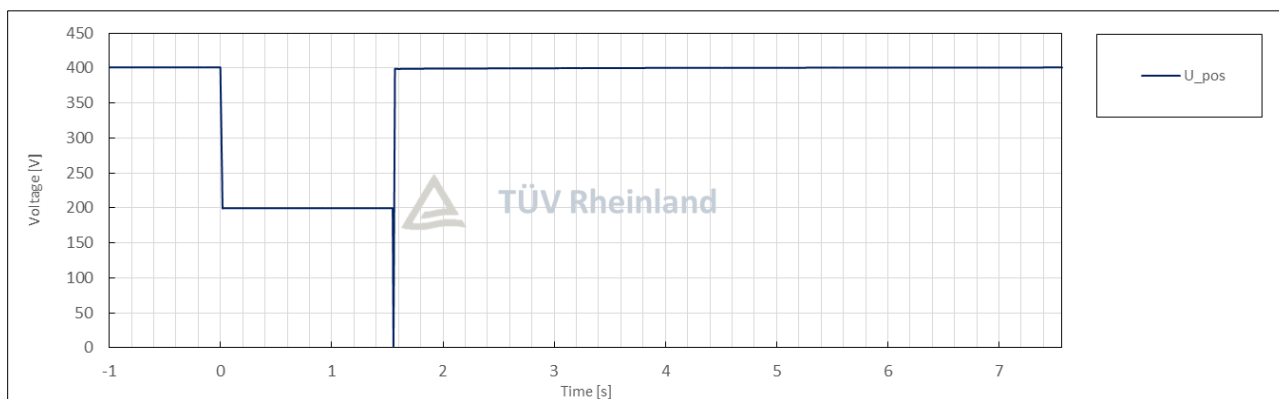
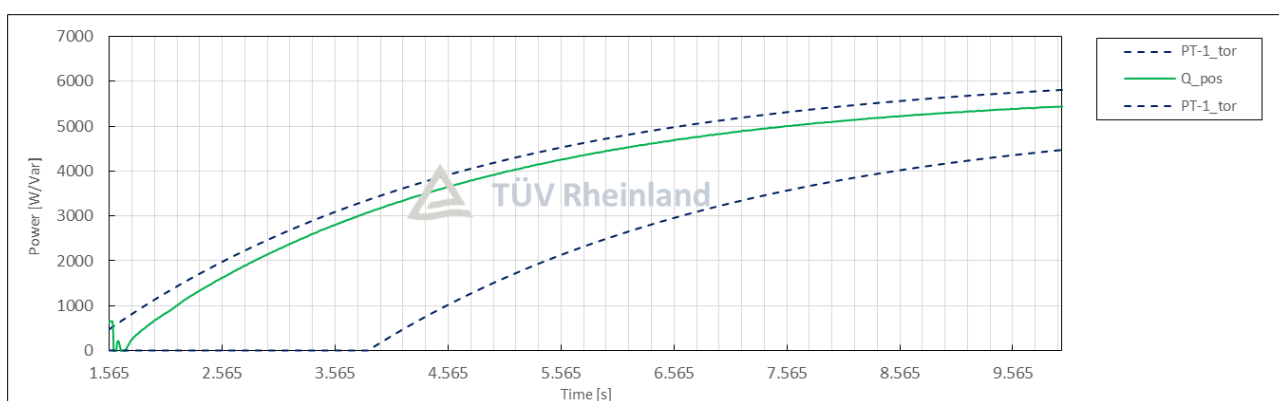
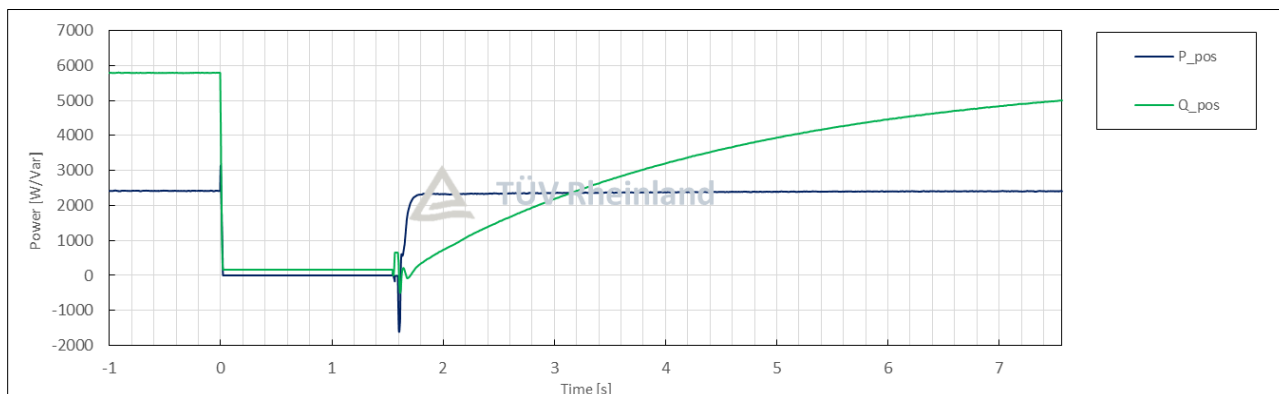
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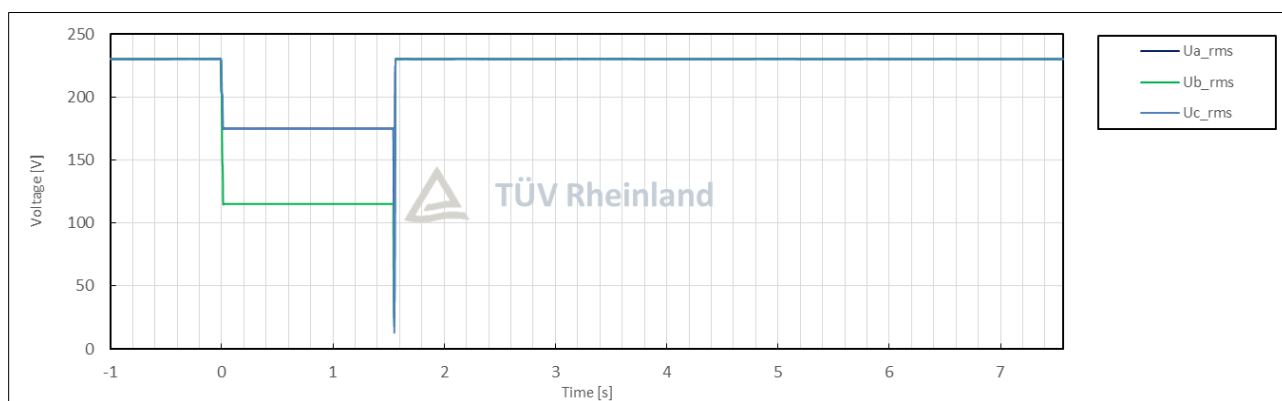
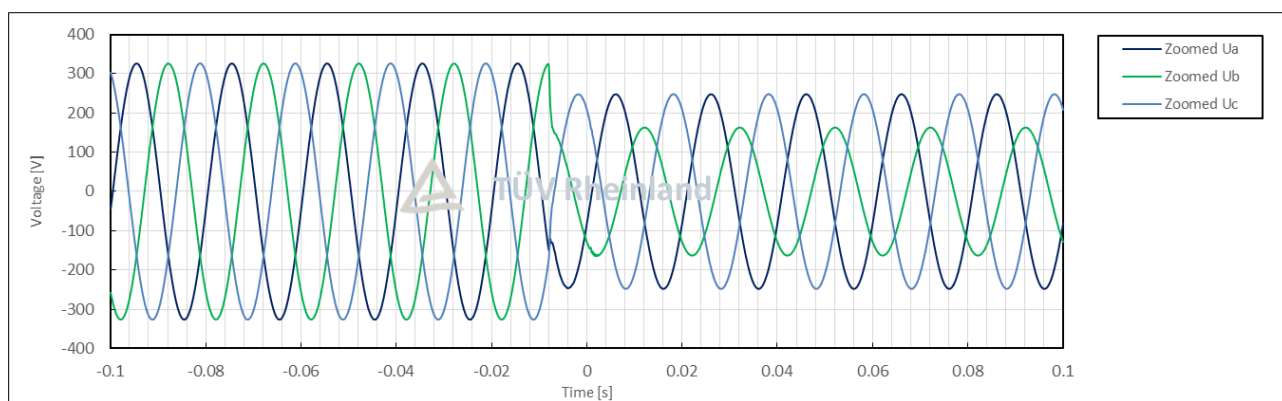
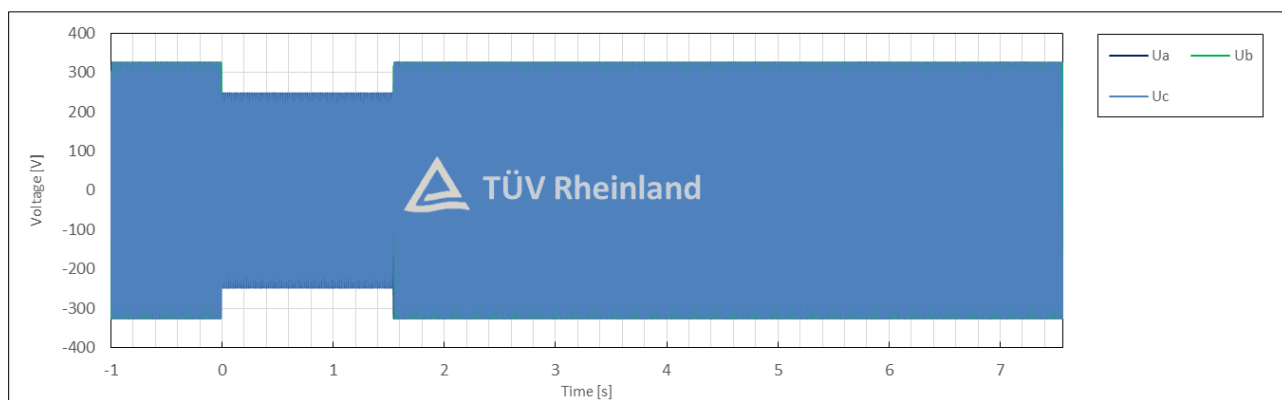
5.8	TABLE: Verification of dynamic network supporting (FVRT)					P/F
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.3
	1	Date	--	--	dd.mm.yyyy	05.10.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	21:46:22
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1562
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1562
	8	Fault duration in empty load test	Total	--	ms	1562
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.66
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.01
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.03
	13	Active power	Total	t1-10s to t1	p.u.	0.92
	14		Pos.			0.92
	15	Reactive power	Total	t1-10s to t1	p.u.	0.48
	16		Pos.			0.48
	17	Cos φ	--	t1-10s to t1	--	0.887
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.04

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	20		Phase 2			0.03
	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.03
	24		Phase 3			0.04
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.01
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.95
	29		Pos.			0.95
	39	Active power rising time	Pos.	--	s	0.15
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.41
	32		Pos.			0.41
	33	Reactive power rising time	Pos.	--	s	9.075
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

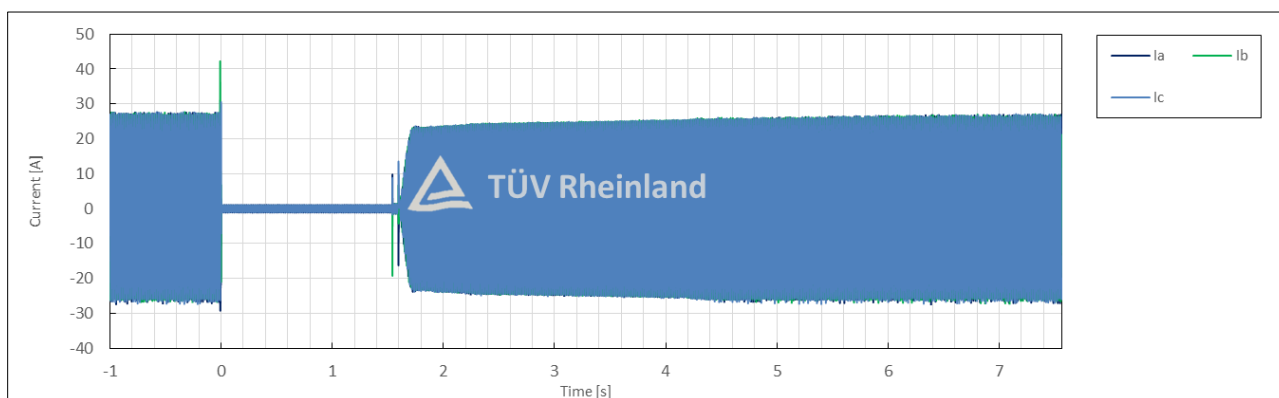
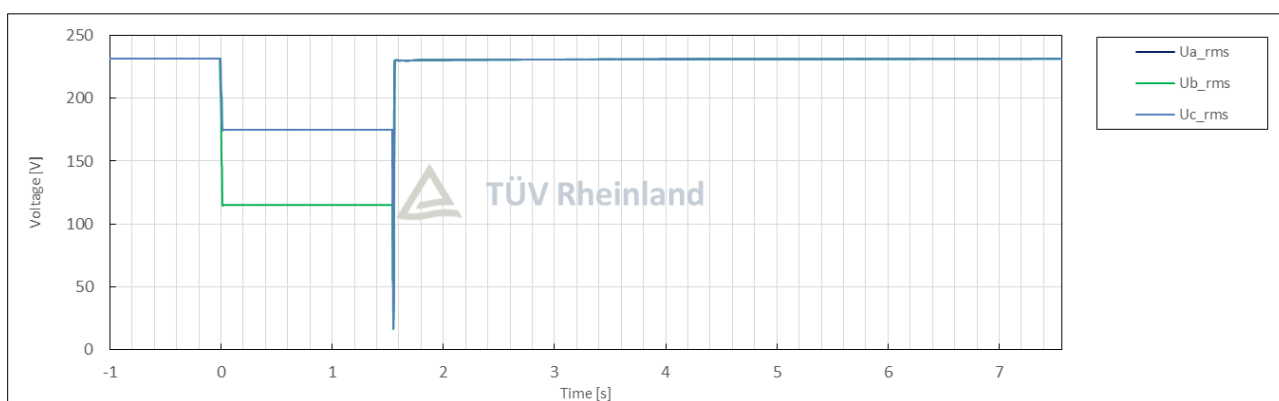
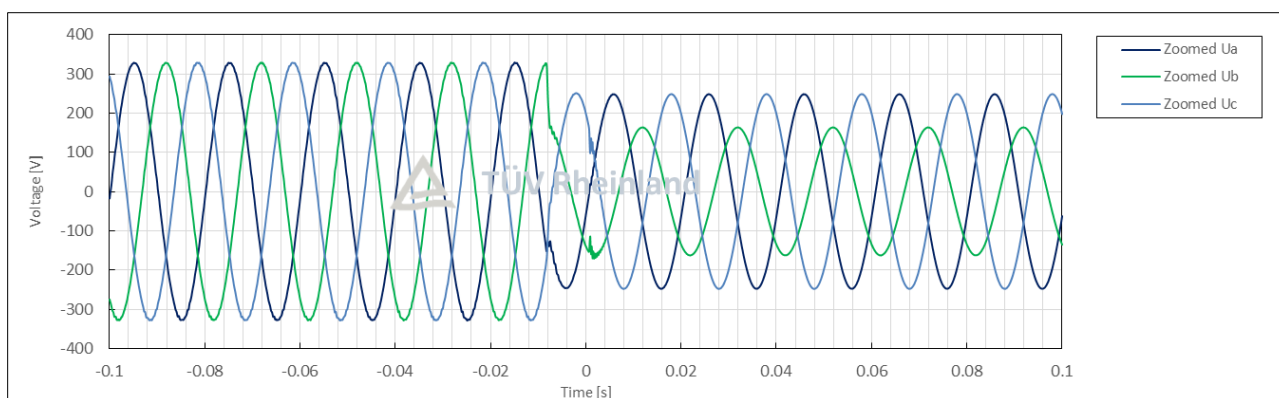
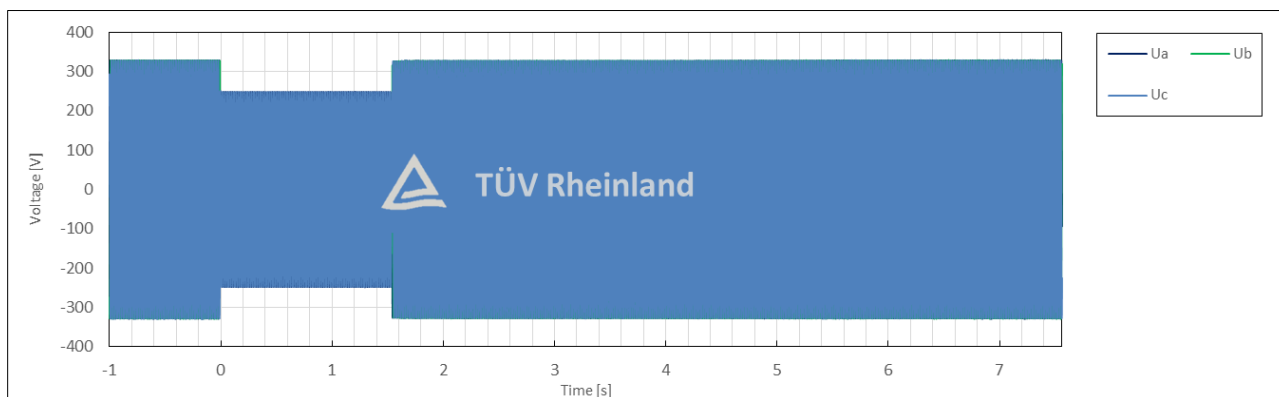
Test No. 3.3 idle test



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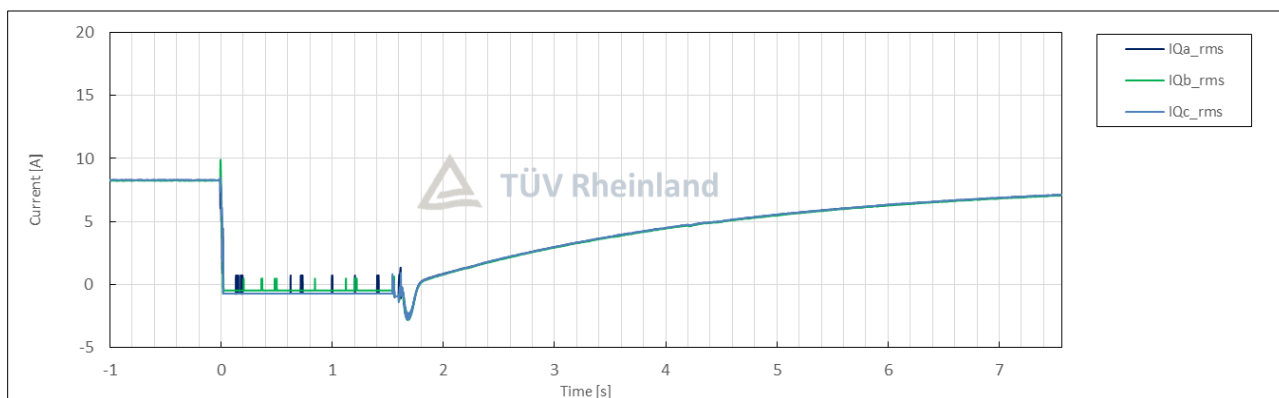
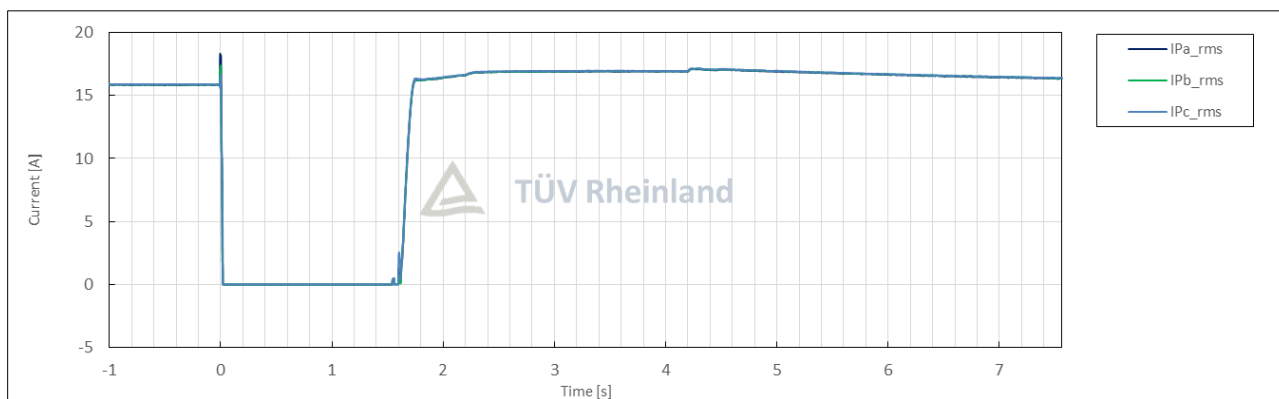
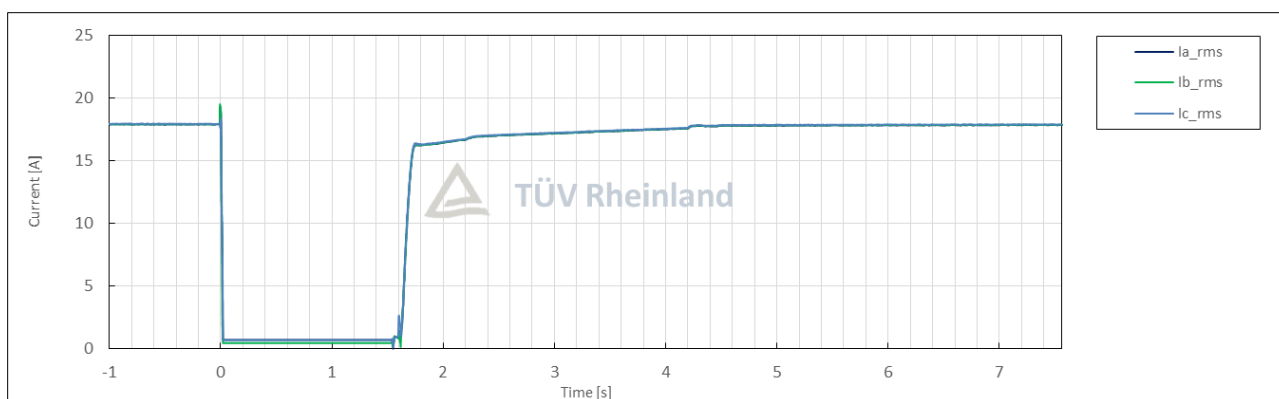
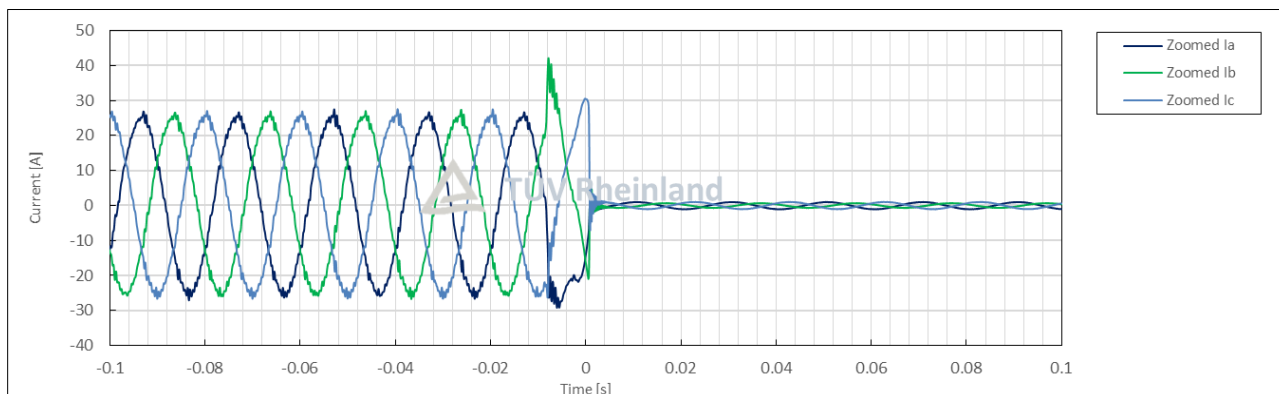
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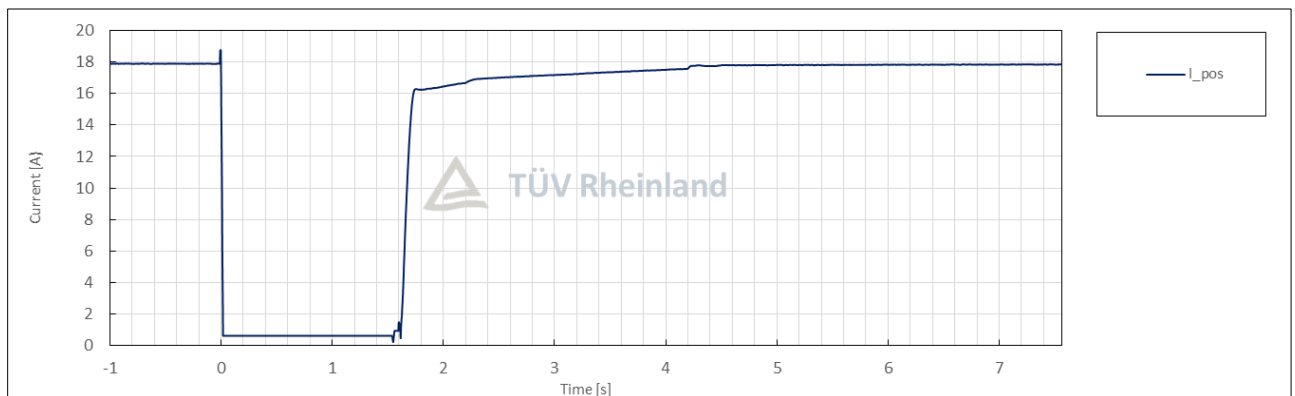
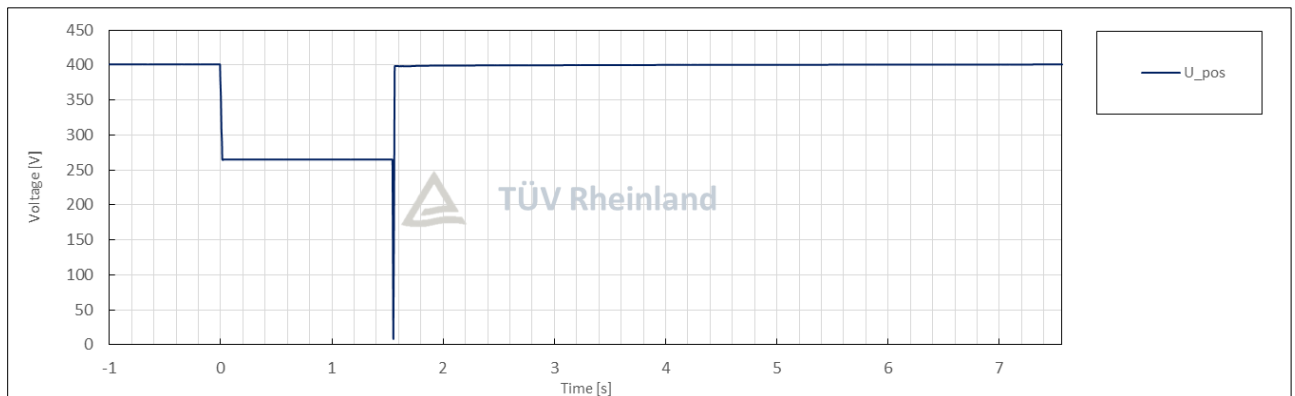
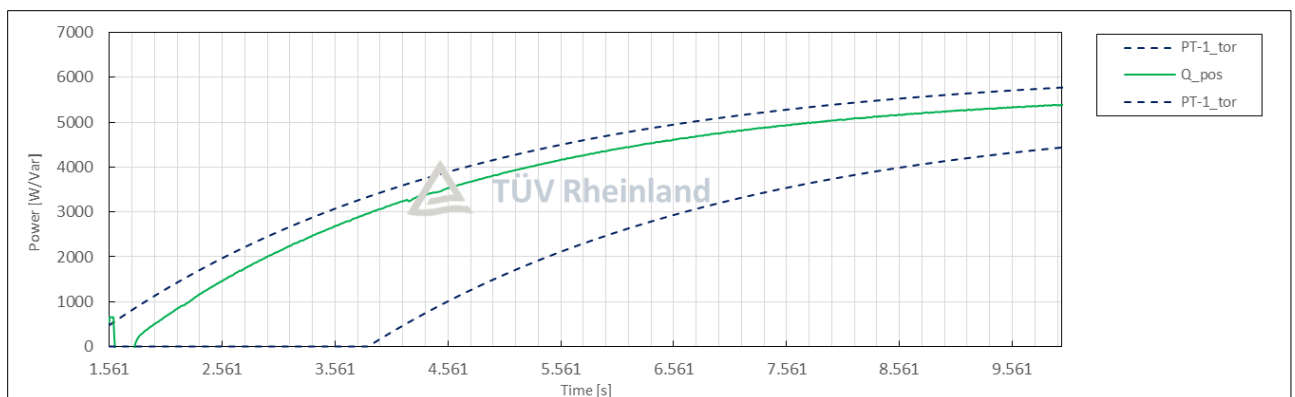
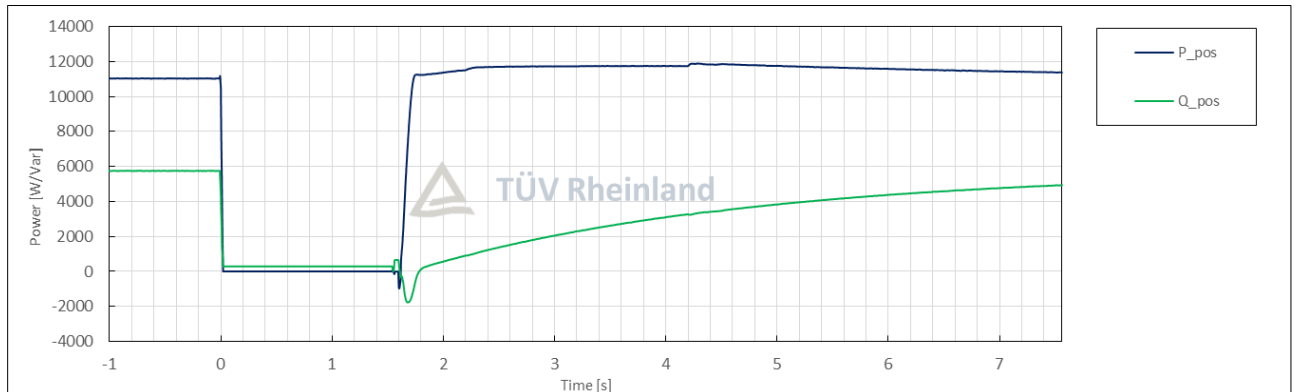
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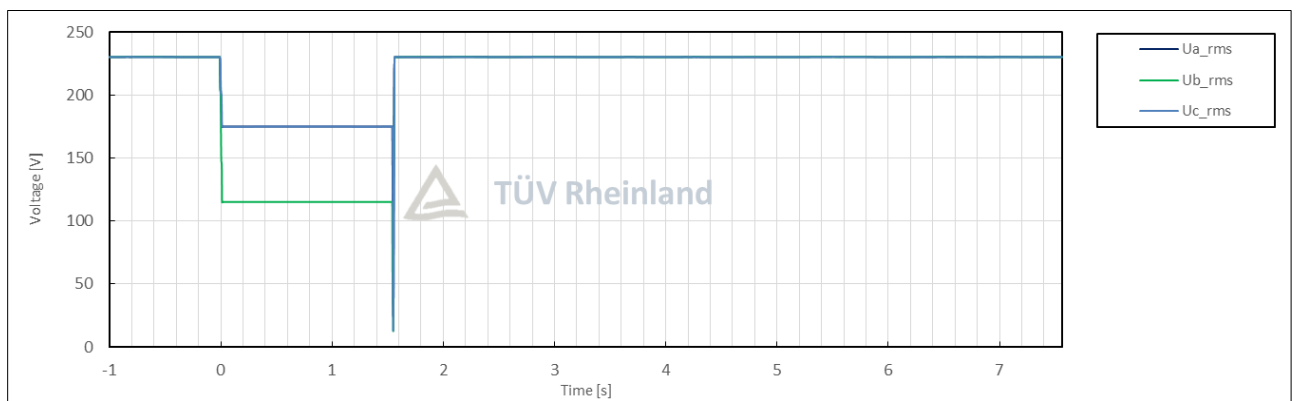
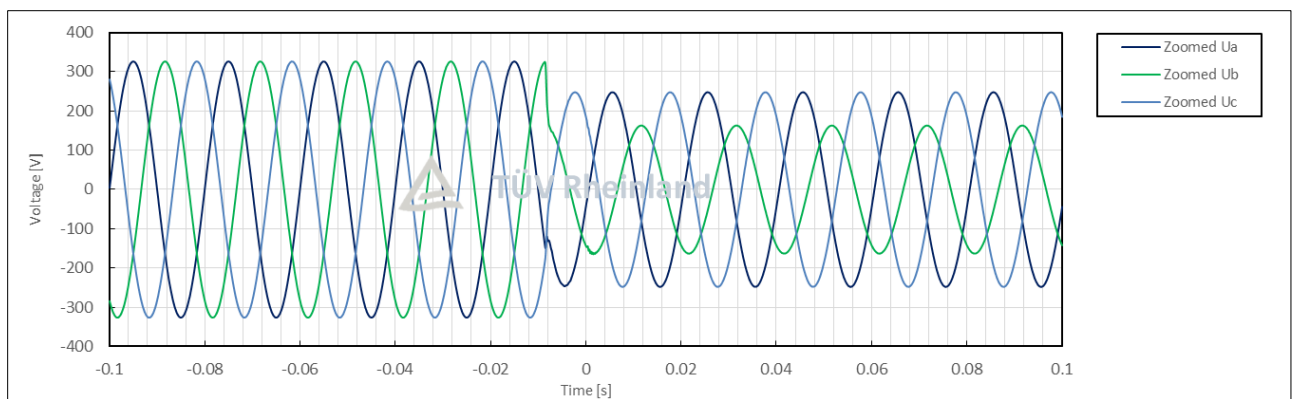
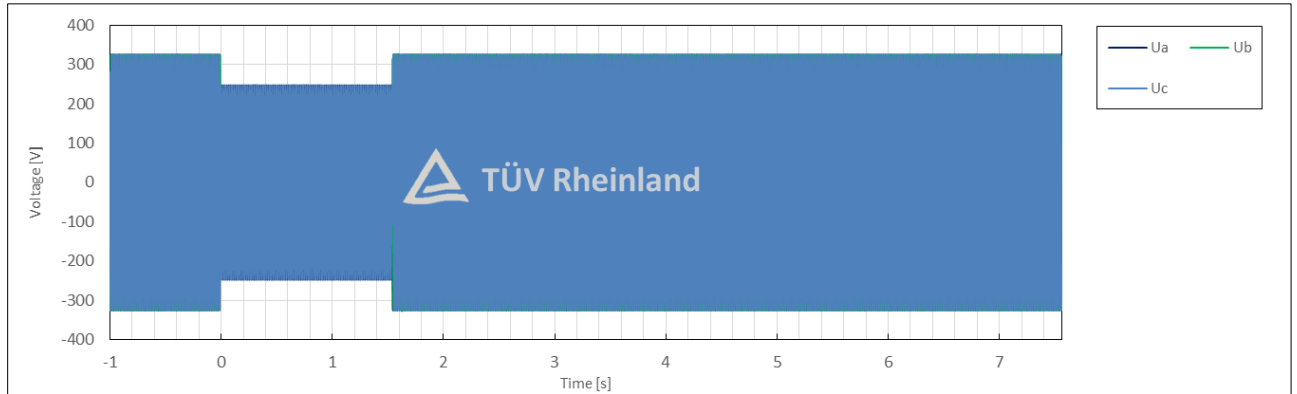
Condition						Measurement
	No.	Parameter	Phase ref.	Time ref.	unit	
General Info.	0	Test number	--	--	--	3.4
	1	Date	--	--	dd.mm.yyyy	17.4.2023
	2	Time (start of test)	--	--	hh:mm:ss.f	23:21:19
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1561
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1561
	8	Fault duration in empty load test	Total	--	ms	1561
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.50
	10		Pos.		p.u.	0.66
Before dip <t1	11	Voltage	Line to neutral	t1-100s to t1	p.u.	1.00
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.53
	13	Active power	Total	t1-10s to t1	p.u.	0.20
	14		Pos.			0.20
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos φ	--	t1-10s to t1	--	0.390
During dip t1 to t2	18	Voltage	Line to neutral	t1+100ms to t2-20ms	p.u.	0.50
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.03

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	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.03
	24		Phase 3			0.04
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.00
	26		Pos.			0.00
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.21
	29		Pos.			0.21
	39	Active power rising time	Pos.	--	s	0.192
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.41
	32		Pos.			-0.41
	33	Reactive power rising time	Pos.	--	s	9.311
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

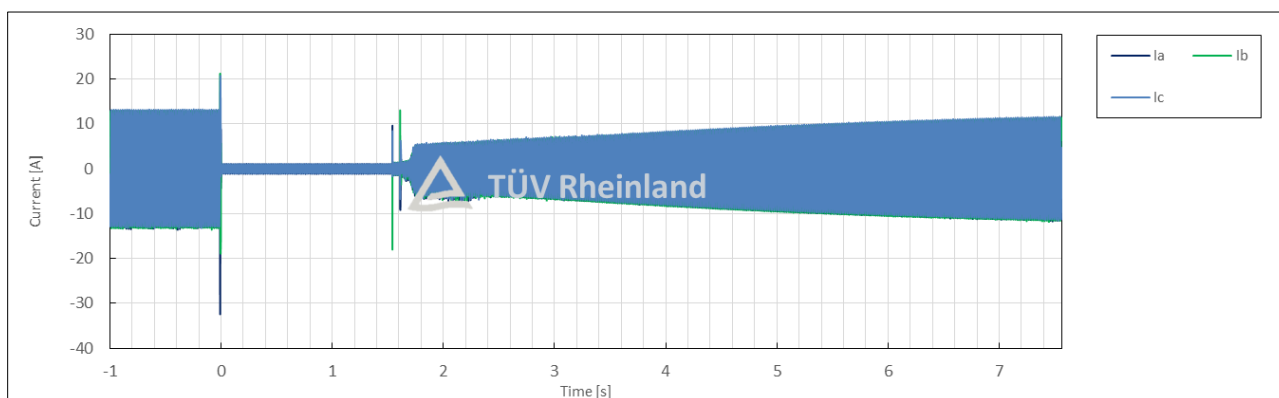
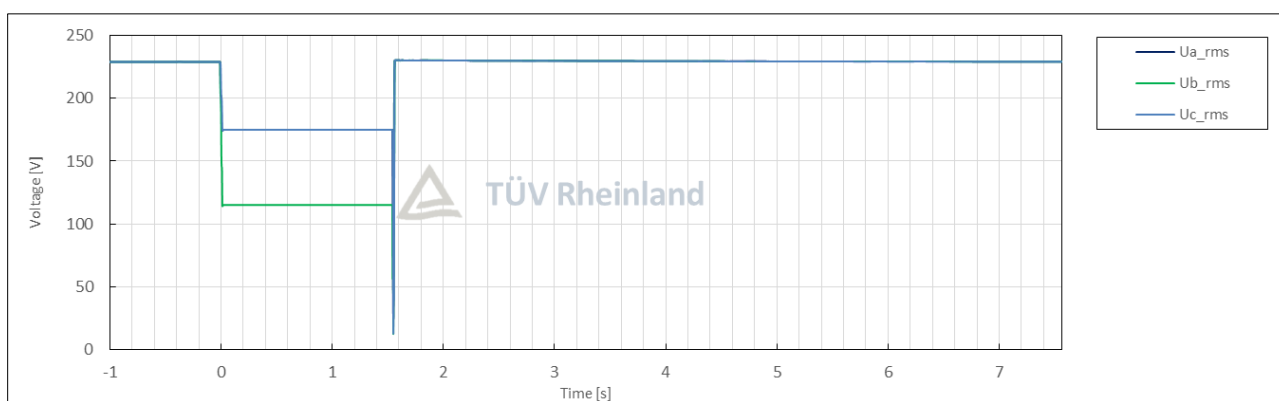
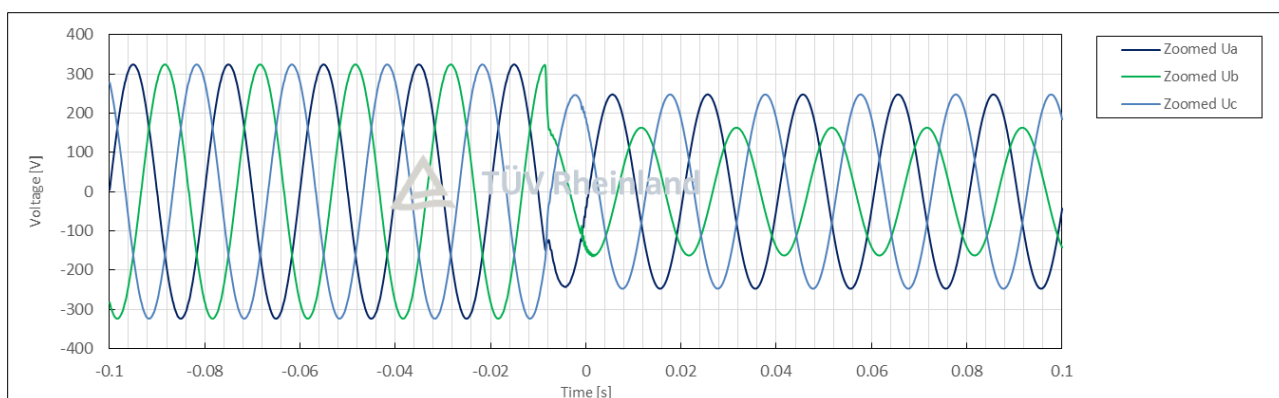
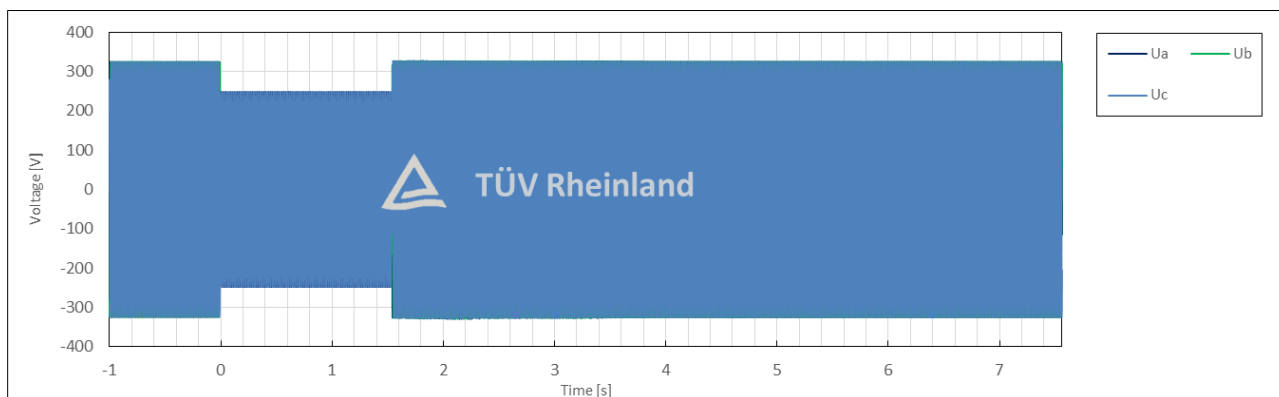
Test No. 3.4 idle test



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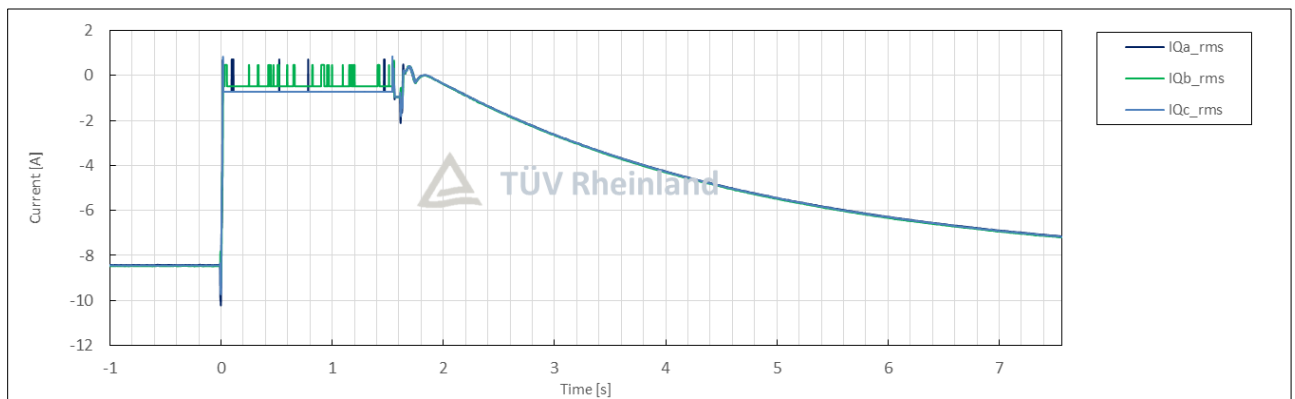
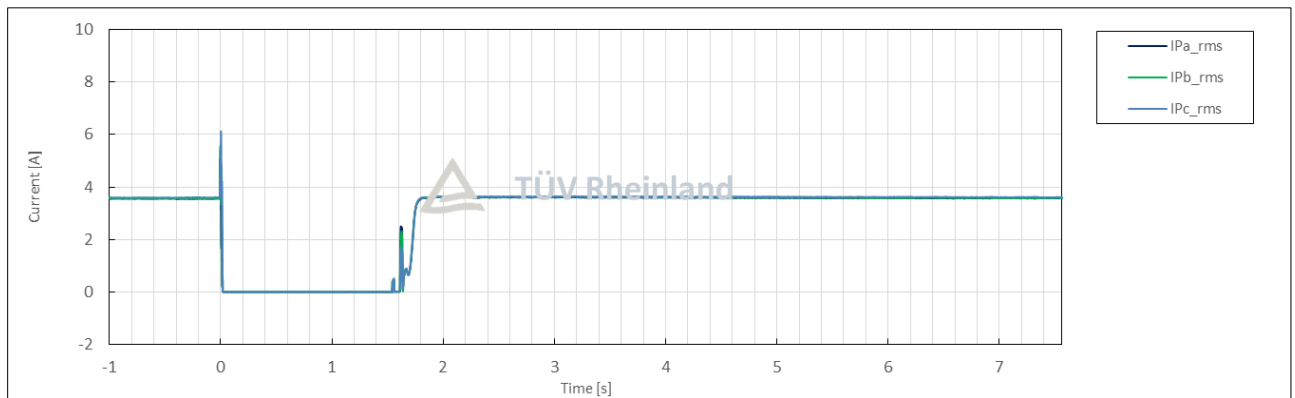
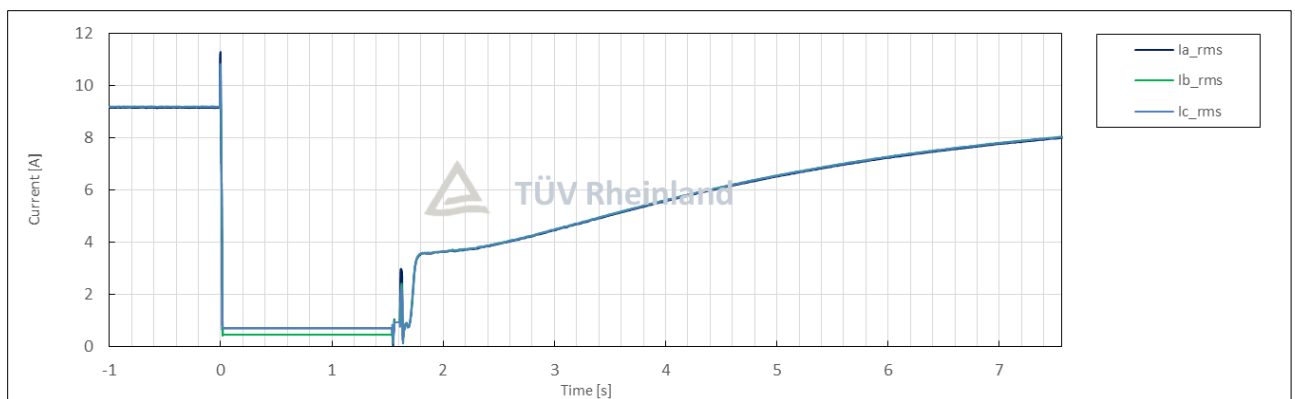
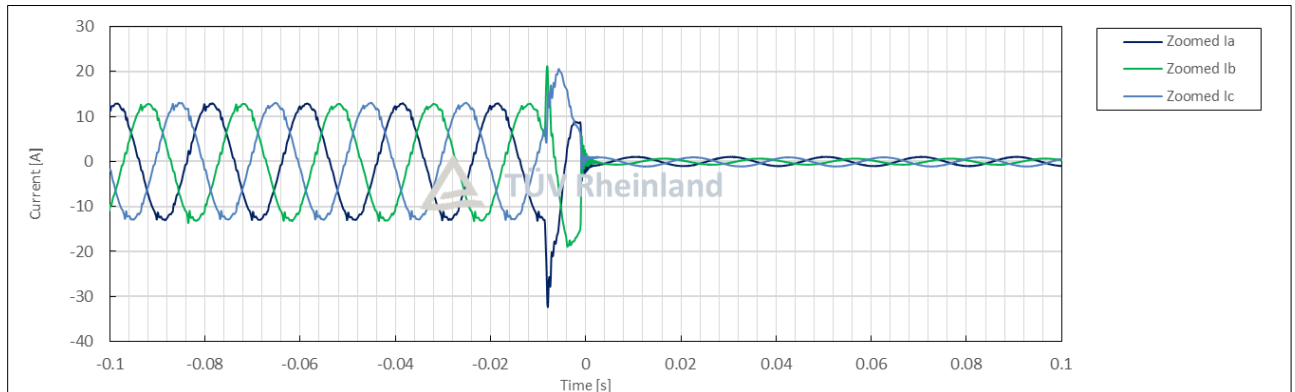
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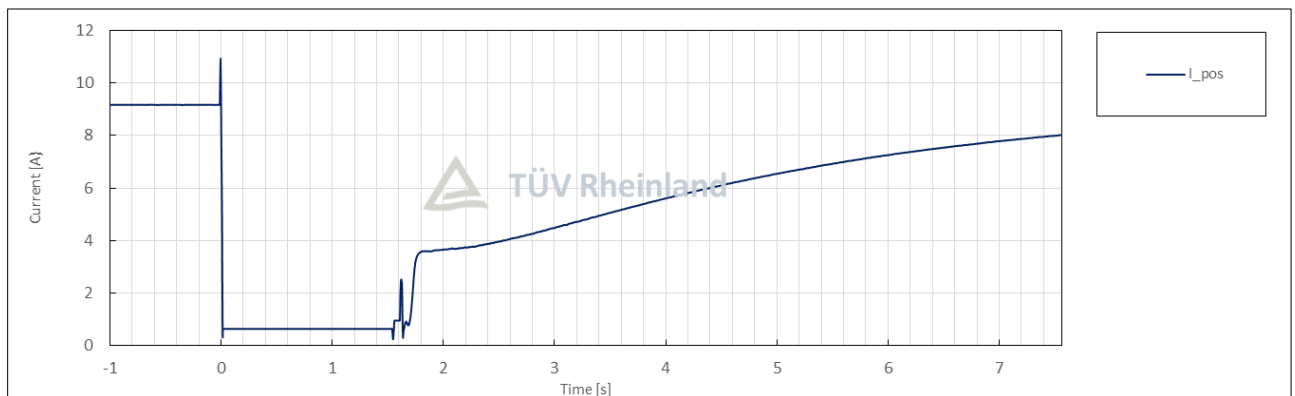
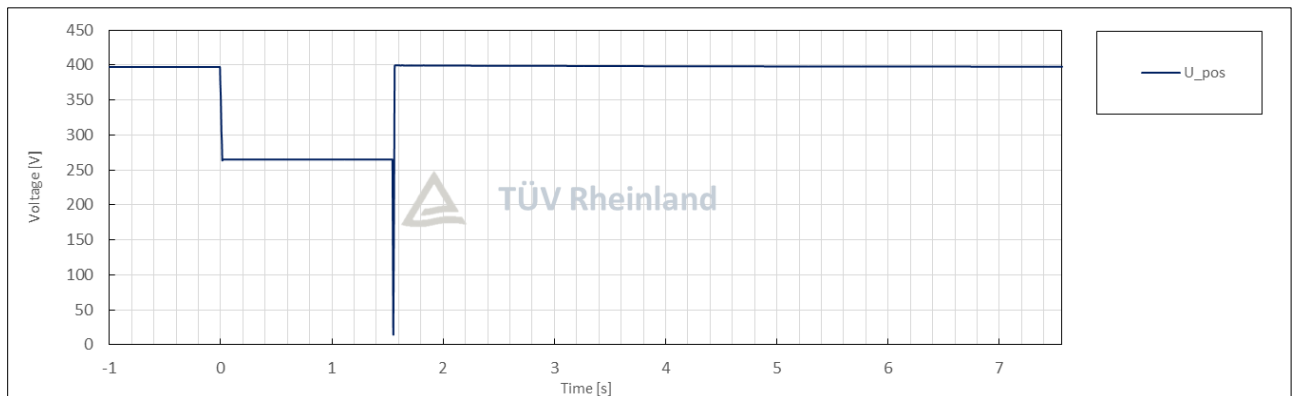
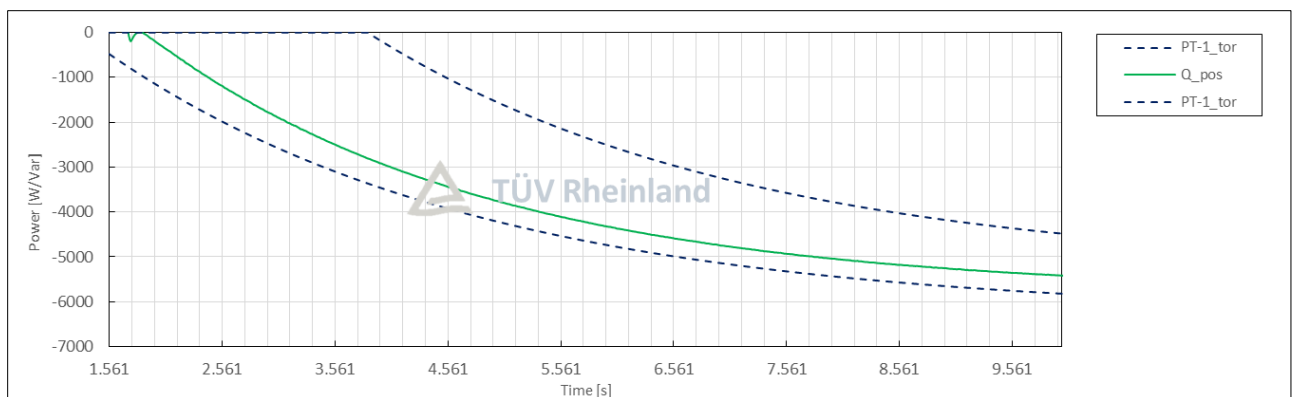
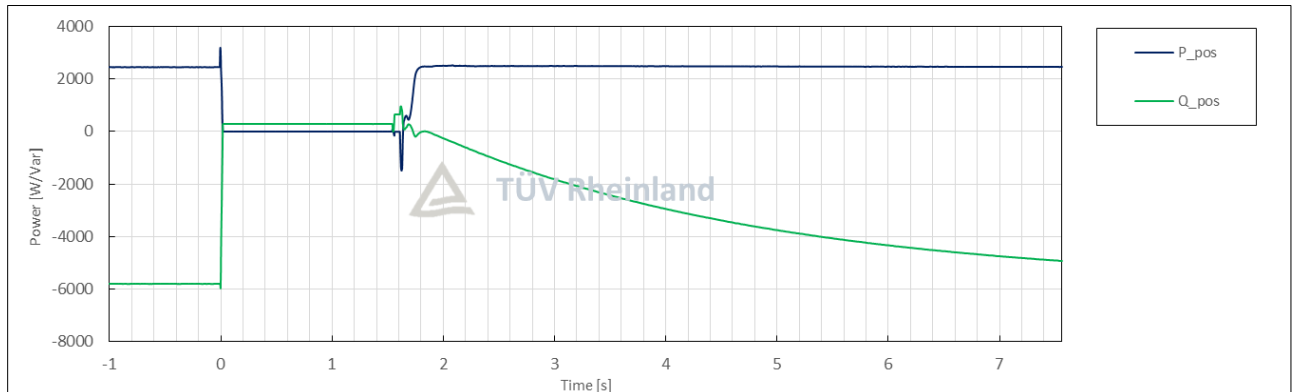
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Test condition:

Test	Voltage dip/swell U/Un [p.u.]	VRT fault type	Fault duration (t2-t1) [ms]	Pmax/Pn [p.u.]	Q/Pmax [p.u.]	Test No.
1	0.15 or 0.05 ¹⁾	A	≥200 or ≥250 ¹⁾	0.98 to 1.02	0 to ± 0.1	1.1
				0.1 to 0.5		1.2
		D		0.98 to 1.02		1.3
				0.1 to 0.5		1.4
2	0.3	A	≥480 or ≥1110 ¹⁾	0.98 to 1.02	0 to ± 0.1	2.1
				0.1 to 0.5		2.2
		D		0.98 to 1.02		2.3
				0.1 to 0.5		2.4
3	0.7	A	≥1230 or ≥2500 ¹⁾	0.98 to 1.02	0 to ± 0.1	3.1
				0.1 to 0.5		3.2
		D		0.98 to 1.02		3.3
				0.1 to 0.5		3.4
4	1.2....1.25	A	≥100	0.98 to 1.02	0 to ± 0.1	4.1
				0.1 to 0.5		4.2
		D		0.98 to 1.02		4.3
				0.1 to 0.5		4.4
5	1.15...1.20	A	≥5000	0.98 to 1.02	0 to ± 0.1	5.1
				0.1 to 0.5		5.2
		D		0.98 to 1.02		5.3
				0.1 to 0.5		5.4
6	1.10...1.15	A	≥60000	0.98 to 1.02	0 to ± 0.1	6.1
				0.1 to 0.5		6.2
		D		0.98 to 1.02		6.3
				0.1 to 0.5		6.4

Note(s): ¹⁾ most stringent

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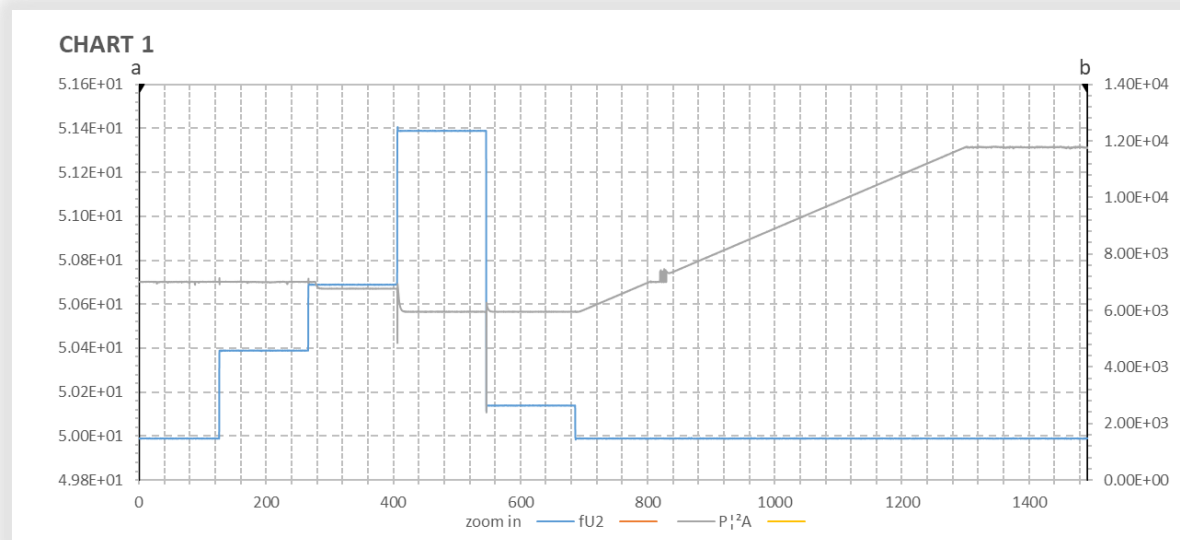
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4.6.1	TABLE: Active power output of PGU by over-frequency (LFSM-O)							P
Available P limit to reach the minimum value during the over-frequency transient								
Parameter	Test No. 2 (For other generating unit)							
Test Conditions	Measurements					Target value	Δ	Limitation
f [Hz]	P/Pn	f [Hz]	Trise [s]	Tsettling [s]	Tv [s]	P/Pn	Δ P/Pn	Δ P/Pn
a) 50	58.44	50.00	--	--	--	60%	-1.56	± 10%
b) 50.4	58.41	50.40	--	--	--	60%	-1.59	
c) 50.7	56.46	50.70	0.4	0.2	0.1	58%	-1.54	
d) 51.4	49.65	51.40	0.5	0.2	0.1	51%	-1.35	
e) 50.15	49.65	50.15	--	--	--	51%	-1.35	
f) 50	98.2	50.00	--	--	--	51% to 100%	-1.8	
Test Conditions f [Hz]	Measurement				Limitation			
	Power Gradient				Power Gradient			
e) 50.15 to f) 50	4.8%				≤ 10% Pn /min			

Note(s):

P(f) curve setting for test: f1: 50.5Hz; fstop: 50.1Hz (Activated); Droop: 12% (16.67%Pref / Hz)

Digram:



4.7.2.2		TABLE: Capabilities (P&Q range, Fixed cosφ)							P	
Test no.1:										
Test Conditions		Measurements					Target value	Δ	Δ Limit	
U/Un	cosφ	P/Pn [%]	Q/Pn [%]	S/Sn [%]	I/In [%]	U/Un [%]	Q/Pn [%]	$\Delta \frac{Q}{Pn}$ [%]	$\Delta \frac{Q}{Pn}$ [%]	
85%	1	-0.02	3.29	3.29	0.04	85.0	--	--	--	
90%		90.0	-3.18	90.0	100.0	90.0	--	--		
95%		95.0	-1.12	95.0	100.0	95.0	--	--		
100%		97.5	-3.49	97.5	97.8	100.0	--	--		
105%		97.5	-3.50	97.5	92.6	105.0	--	--		
110%		97.5	-1.24	97.5	88.6	110.0	--	--		
85%	≤ 0.9 (max. under-excited)	75.9	-36.3	88.3	100.6	85.0	--	--	--	
90%		81.5	-40.1	90.8	100.7	90.1	--	--		
95%		86.0	-42.3	95.8	100.7	95.2	-41.4	0.9	≤ 5	
100%		90.4	-44.5	100.8	100.6	100.0	-43.6	0.9		
105%		90.4	-44.5	100.8	95.8	105.0	-43.6	0.9		
110%		90.4	-44.5	100.8	91.5	110.0	-43.6	0.9		
85%	≤ 0.9 (max. over-excited)	76.1	36.8	87.4	99.1	85.0	37.1	-0.3	$\geq - 5$	
90%		80.8	38.9	89.7	99.4	90.2	39.2	-0.3		
95%		85.2	41.0	94.6	99.4	95.1	41.4	-0.4		
100%		89.7	43.2	99.5	99.3	100.0	43.6	-0.4		
105%		89.7	43.2	99.5	94.6	105.0	43.6	-0.4		
110%		89.7	43.2	99.5	94.6	110.0	--	--	--	
Note(s): The limitation capacity of reactive power shall be met to Figure 13 or better.										

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Test no.2:								
Test Conditions		Measurements					Δ	Limit
P/Pn	cos φ	P/Pn	Q/Pn	S/Pn	U/Un	I/In	$\Delta Q/Pn$	$\Delta Q/Pn$
0-10%	1	4.97%	-0.75%	5.41%	100.01%	5.41%	-0.75%	$\leq \pm 10\%$
10%		9.99%	-0.70%	10.19%	100.02%	10.19%	-0.70%	$\leq \pm 5\%$
20%		20.01%	-0.72%	20.11%	100.04%	20.10%	-0.72%	
30%		29.37%	-0.78%	29.45%	100.05%	29.43%	-0.78%	
40%		40.00%	-1.56%	40.06%	100.07%	40.04%	-1.56%	
50%		49.98%	-0.88%	50.04%	100.09%	50.00%	-0.88%	
60%		59.99%	-0.95%	60.04%	100.11%	59.98%	-0.95%	
70%		69.98%	-1.99%	70.04%	100.12%	69.96%	-1.99%	
80%		79.97%	-3.03%	80.03%	100.15%	79.91%	-3.03%	
90%		89.97%	-3.29%	90.03%	100.17%	89.88%	-3.29%	
100%		97.49%	-3.57%	97.56%	100.18%	97.39%	-3.57%	
0-10%	≤ 0.9 (max. under- excited)	5.03%	-3.21%	5.97%	100.01%	5.97%	-1.03%	$\leq \pm 10\%$
10%		10.05%	-5.32%	11.37%	100.02%	11.37%	0.48%	$\leq \pm 5\%$
20%		20.10%	-10.04%	22.47%	100.04%	22.46%	0.44%	
30%		30.13%	-14.84%	33.59%	100.05%	33.58%	0.31%	
40%		40.17%	-19.78%	44.78%	100.07%	44.75%	0.41%	
50%		50.21%	-24.69%	55.95%	100.09%	55.91%	0.47%	
60%		60.25%	-29.58%	67.12%	100.11%	67.06%	0.52%	
70%		70.31%	-34.58%	78.35%	100.12%	78.26%	0.68%	
80%		80.22%	-38.59%	89.03%	100.15%	88.90%	0.11%	
90%		90.43%	-44.46%	100.77%	100.17%	100.61%	0.86%	
Smax		90.42%	-44.48%	100.77%	100.16%	100.62%	0.88%	
0-10%	≤ 0.9 (max. over- excited)	4.94%	3.19%	5.88%	100.01%	5.88%	1.01%	$\leq \pm 10\%$
10%		9.97%	5.12%	11.21%	100.02%	11.21%	-0.28%	$\leq \pm 5\%$
20%		19.93%	9.81%	22.21%	100.04%	22.21%	-0.13%	
30%		29.89%	14.54%	33.24%	100.06%	33.22%	-0.01%	
40%		39.83%	19.28%	44.25%	100.07%	44.22%	-0.09%	
50%		49.78%	24.03%	55.28%	100.09%	55.23%	-0.19%	
60%		59.74%	28.73%	66.29%	100.11%	66.23%	-0.33%	
70%		69.64%	33.09%	77.11%	100.13%	77.01%	-0.82%	
80%		79.67%	38.34%	88.42%	100.15%	88.30%	-0.41%	
90%		89.65%	43.14%	99.49%	100.17%	99.33%	-0.46%	
Smax		89.64%	43.15%	99.49%	100.16%	99.34%	-0.45%	

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4.7.2.3.3	TABLE: Voltage related control mode (Q(U))					P
Test procedure for accuracy						
Q(U) curve settings:	Set points	X1	X2	X3	X4	
	U/Un	93%	97%	103%	107%	
	Q/Pn*	43.6%	0	0	-43.6%	
Test Conditions		Measurements		Target vlaue	Δ	Δ Limits
U/Un	P/Pn	Q/Pn	U/Un	Q/Pn*	ΔQ/Pn	ΔQ/Pn
102%	< 20%	-0.07%	102.02%	0	-0.07%	≤ ±4.5%
105%	< 20%	-0.07%	105.02%	0	-0.07%	
105%	30%	-20.29%	105.05%	-21.80%	1.51%	
105%	50%	-21.14%	105.09%	-21.80%	0.66%	
105%	100%	-22.46%	105.17%	-21.80%	-0.66%	
108%	100%	-44.21%	108.16%	-43.60%	-0.61%	
108%	10%	-43.52%	108.01%	-43.60%	0.08%	
108%	< 5%	0.00%	108.00%	0	0.00%	
Test Conditions		Measurements		Target vlaue	Δ	Δ Limits
U/Un	P/Pn	Q/Pn	U/Un	Q/Pn*	ΔQ/Pn	ΔQ/Pn
98%	< 20%	-0.07%	98.01%	0	-0.07%	≤ ±4.5%
95%	< 20%	-0.07%	95.02%	0	-0.07%	
95%	30%	22.76%	95.06%	21.80%	0.96%	
95%	50%	22.36%	95.10%	21.80%	0.56%	
95%	100%	20.69%	95.19%	21.80%	-1.11%	
92%	100%	43.06%	92.17%	43.60%	-0.54%	
92%	10%	43.52%	92.02%	43.60%	-0.08%	
92%	< 5%	0.00%	92.00%	0	0.00%	

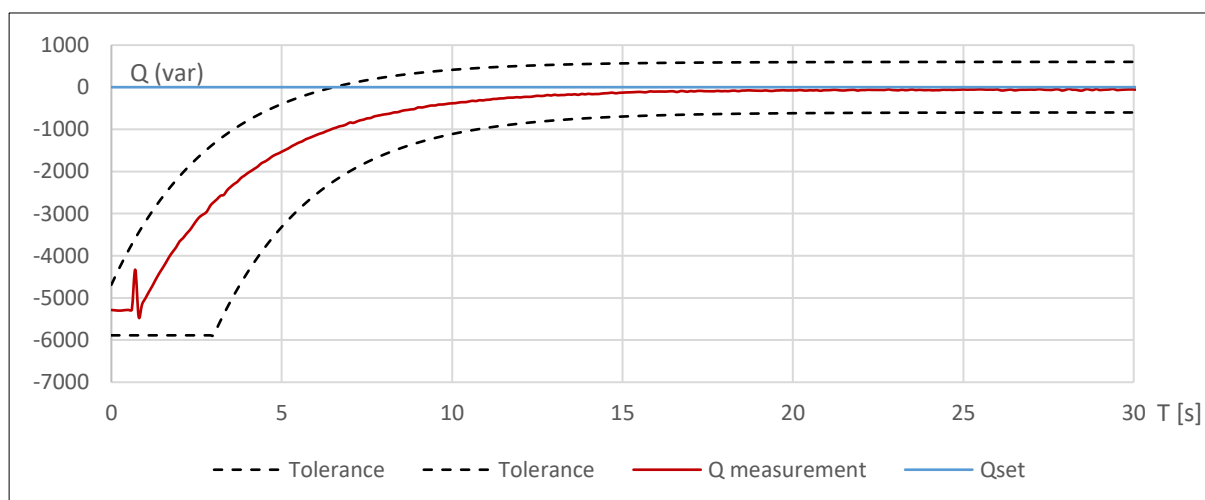
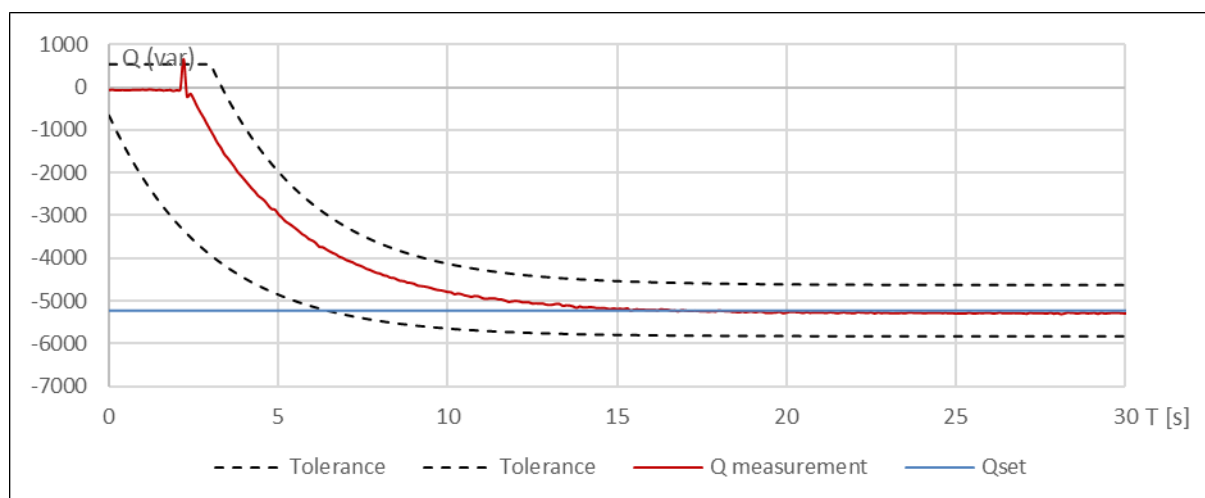
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Test procedure for Dynamic

Test Conditions	Measurements	
Un -> Un + $\Delta 8\% \text{Un}$	Response time T95%	9.5
Un -> Un - $\Delta 8\% \text{Un}$		9.1

Plotting P, PF, Q, Qstd, Qlim



Note(s):

P lock-in: 20%Pn; P lock-out: 5%Pn.

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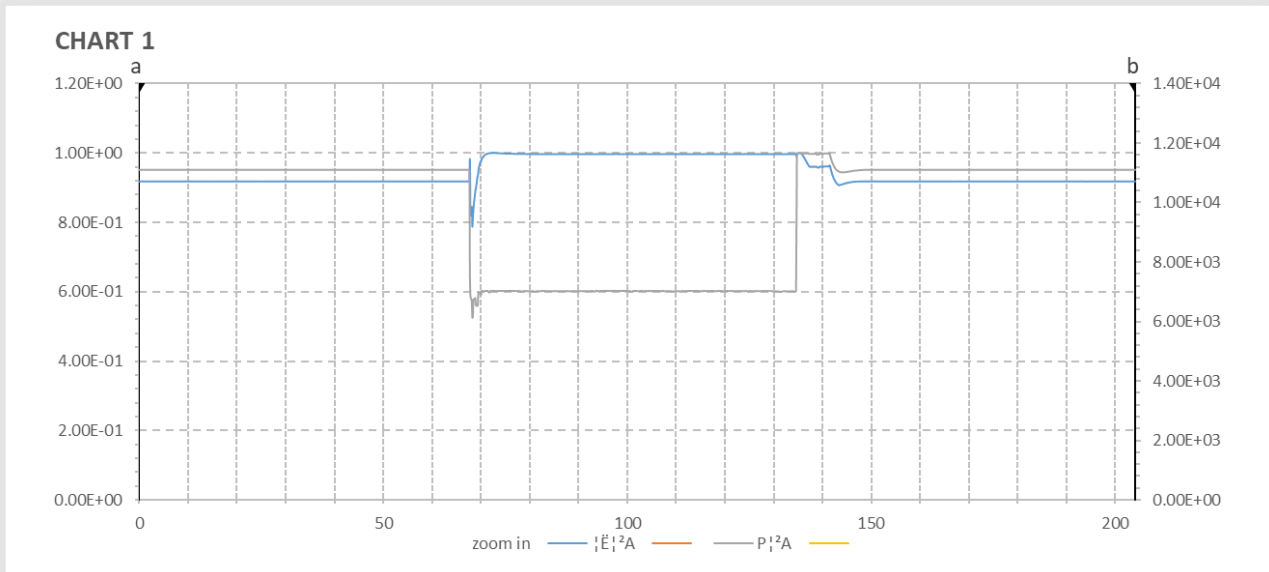
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4.7.2.3.4	TABLE: Power related control mode (cosφ(P))					P
Test procedure for accuracy						
cosφ (P) curve settings:	Set points	1	2	3	4	
	P/Pn	20%	40%	50%	100%	
	cosφ	0.9c	0.98c	0.98i	0.9i	
Test Conditions	Measurements			Target vlaue	Δ	Δ Limits
P / Pn	P / Pn	Q / Pn	cosφ	Q / Pn	Δ Q / Pn	Δ Q / Pn
10%	10.4%	6.49%	0.847	4.36%	2.13%	≤ ±5%
20%	21%	8.7%	0.924	8.72%	-0.02%	
30%	31.0%	10.22%	0.95	10.24%	-0.02%	
40%	41.3%	8.72%	0.978	7.96%	0.76%	
50%	51.1%	0.03%	0.991	0%	0.03%	
60%	61.2%	-11.72%	-0.982	-11.94%	0.22%	
70%	71.6%	-19.38%	-0.965	-19.60%	0.22%	
80%	81.8%	-27.83%	-0.947	-27.29%	-0.54%	
90%	92.7%	-37.82%	-0.926	-35.27%	-2.55%	
100%	93.3%	-38.47%	-0.925	--	--	

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Test procedure for Dynamic		
Test Conditions	Measurements	
100%Pn -> 50%Pn	Response time T95%	3.7s
50%Pn -> 100%Pn		8.4s

Diagram:



Note(s):

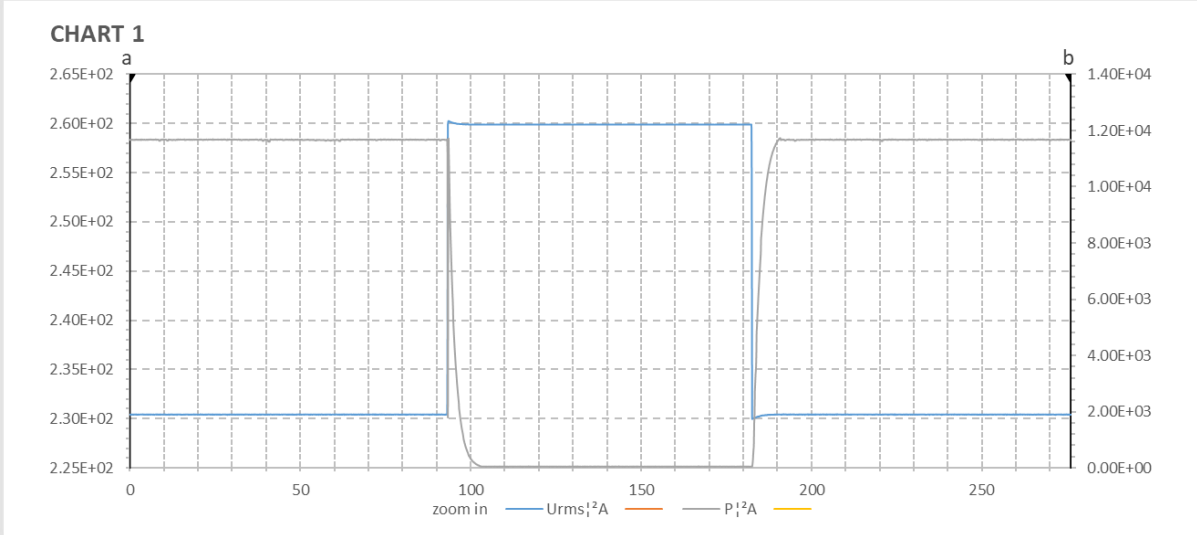
i: under-excited; c: over-excited

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4.7.3	TABLE: Voltage related active power reduction (P(U))					P
P(U) curve settings:	Set points	1		2		3
	U/Un	110%		111%		112%
	P/Pn	100%		50%		0%
Test procedure for accuracy						
Test Conditions		Measurements		Target vlaue	Δ	Δ Limits
U/Un	P/Pn	P/Pn	U/Un	P/Pn	ΔP/Pn	ΔP/Pn
100%	100%	97.39%	100.18%	100%	-2.61%	≤ ±10%
108%		97.42%	108.17%	100%	-2.58%	
109%		97.40%	109.16%	100%	-2.60%	
110%		97.45%	110.16%	100%	-2.55%	
111%		54.99%	111.09%	50%	4.99%	
112%		8.73%	112.01%	0%	8.73%	
113%		0.36%	113%	0%	0.36%	
112%		8.59%	112.01%	0%	8.59%	
111%		54.52%	111.09%	50%	4.52%	
110%		97.51%	110.17%	100%	-2.49%	
109%		97.44%	109.17%	100%	-2.56%	
108%		97.45%	108.17%	100%	-2.55%	
Test procedure for Dynamic						
Test Conditions		Measurements				
100%Un -> 113%Un		Response time T95%		3.9		
113%Un -> 100%Un				3.7		

Diagram:



Note(s):

4.9.3	Table: Requirements on voltage and frequency protection	P
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All thresholds must be adjustable									
Voltage values									
Threshold	(27<)	tmin (27<)	(27<<)	tmin (27<<)	59>	tmax (59>)	59>>	tmax (59.S1)	59 10 min-mean
Range	0.2-1.0 U _n	0.1- 100s	0.2-1.0 U _n	0.1-5s	1.0-1.2 U _n	0.1- 100s	1.0-1.3 U _n	0.1-5s	1.0-1.15 U _n
Adjustable in Step	0.01 U _n	0.1s	0.01 U _n	0.05s	0.01 U _n	0.1s	0.01 U _n	0.05s	0.01 U _n
Frequency values									
Threshold	81<	tmin (81<)	81<<	tmin (81<<)	81>	tmax (81>)	81>>	tmax (81>>)	
Range	47.0- 50.0Hz	0.1- 100s	47.0- 50.0Hz	0.1-5s	50.0- 52.0Hz	0.1- 100s	50.0- 52.0Hz	0.1-5s	
Steps	0.1 Hz	0.1s	0.1 Hz	0.05s	0.1 Hz	0.1s	0.1 Hz	0.05s	
Note 1:	External SPI stays in operation conditions for 5s after disconnecting the mains voltage								
Note 2:	The frequency protection shall function correctly in the input voltage range between 20% U _n and 120% U _n and shall be inhibited for input voltages of less than 20% U _n . Under 20% U _n the frequency protection is inhibited. Disconnection may only happen based on undervoltage protection.								

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4.9.3.2, 4.9.3.3	TABLE: Under/over voltage protection (OV/UV)				P
Condition	Setting	Measurement			Limitation
		Trip value [V]			
		L1	L2	L3	
U>>	125%Un	286.3	286.2	286.0	± 1% of U _n
		287.0	286.2	286.0	
		287.5	286.2	286.0	
U<	85%Un	195.0	195.5	195.4	
		195.0	195.5	195.4	
		195.5	195.5	195.4	
U<<	40%Un	92.0	92.0	91.5	
		92.0	92.0	91.5	
		91.9	92.0	91.5	
Condition	Setting [ms]	Measurement			Limitation
		Trip time			
		L1	L2	L3	
U>>	100	110	110	110	100-200
		188	110	110	
		188	110	110	
U<	3000	3020	3020	3020	3000-3100
		3000	3020	3020	
		3010	--	--	
U<<	1500	1510	1511	1510	1500-1600
		1511	1511	1511	
		1510	1510	1510	
Note(s):					

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4.9.3.5, 4.9.3.6	TABLE: Under/over frequency protection (OF/UF)		P
Condition	Setting	Measurement	Limitation
		Trip value [Hz]	
F>>	52Hz	52.0	± 0.1% of f _n
		52.0	
		52.0	
F>	51.5Hz	51.5	
		51.5	
		51.5	
F<	47.5Hz	47.4	
		47.4	
		47.4	
F<<	47Hz	47.0	
		47.0	
		47.0	
Condition	Setting [ms]	Measurement	Limitation
		Trip time	
F>>	100	172	100-200
		174	
		173	
F>	5000	5074	5000-5100
		5074	
		5072	
F<	5000	5256	5000-5100
		5256	
		5250	
F<<	100	160	100-200
		160	
		161	
Note(s):			

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4.10	TABLE: Connection and starting to generate electrical power (Connection and reconnection)			P	
Condition	Measurement		Limitation		
	Delay time [s]	Power Gradient [per mimute]	Delay time	Power Gradient	
Connection:					
U>	74.4	--	60s	--	
U<	74.4	--			
f>	74.2	--			
f<	74.4	--			
Reconnection:					
U>	74.2	8.04%	60s	≤10%Pn/minutes	
U<	74.3	8.02%			
f>	74.4	8.01%			
f<	74	8.09%			
Note(s):					

PHOTO DOCUMENTATION

CN230HHW 001

for

Hybrid Inverter

HI-3P5K-H-Y1, HI-3P6K-H-Y1, HI-3P8K-H-Y1,
HI-3P10K-H-Y1, HI-3P12K-H-Y1

Yi Energy Technology (Zhejiang) Co., Ltd.



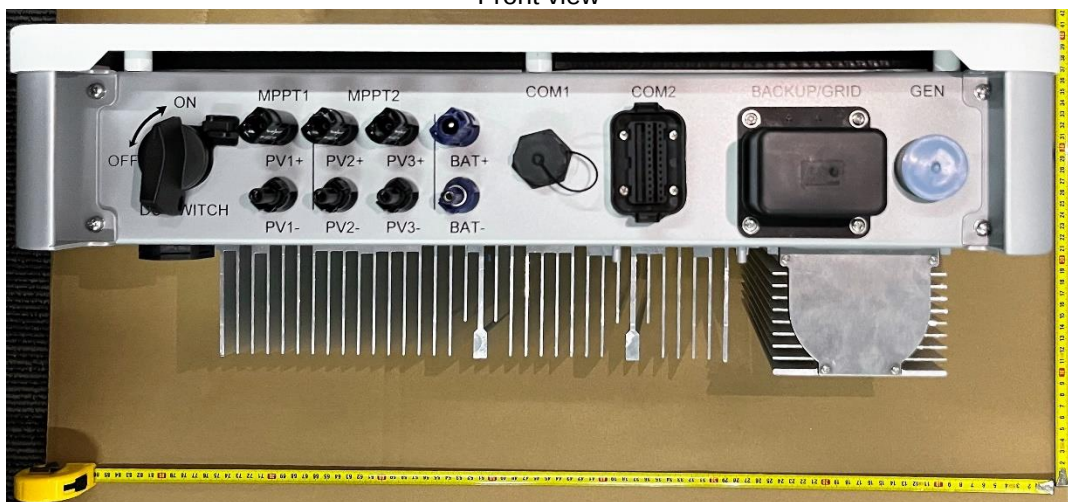
This documentation consists of 9 pages (excluding this cover page)

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Model: see cover page



Front view



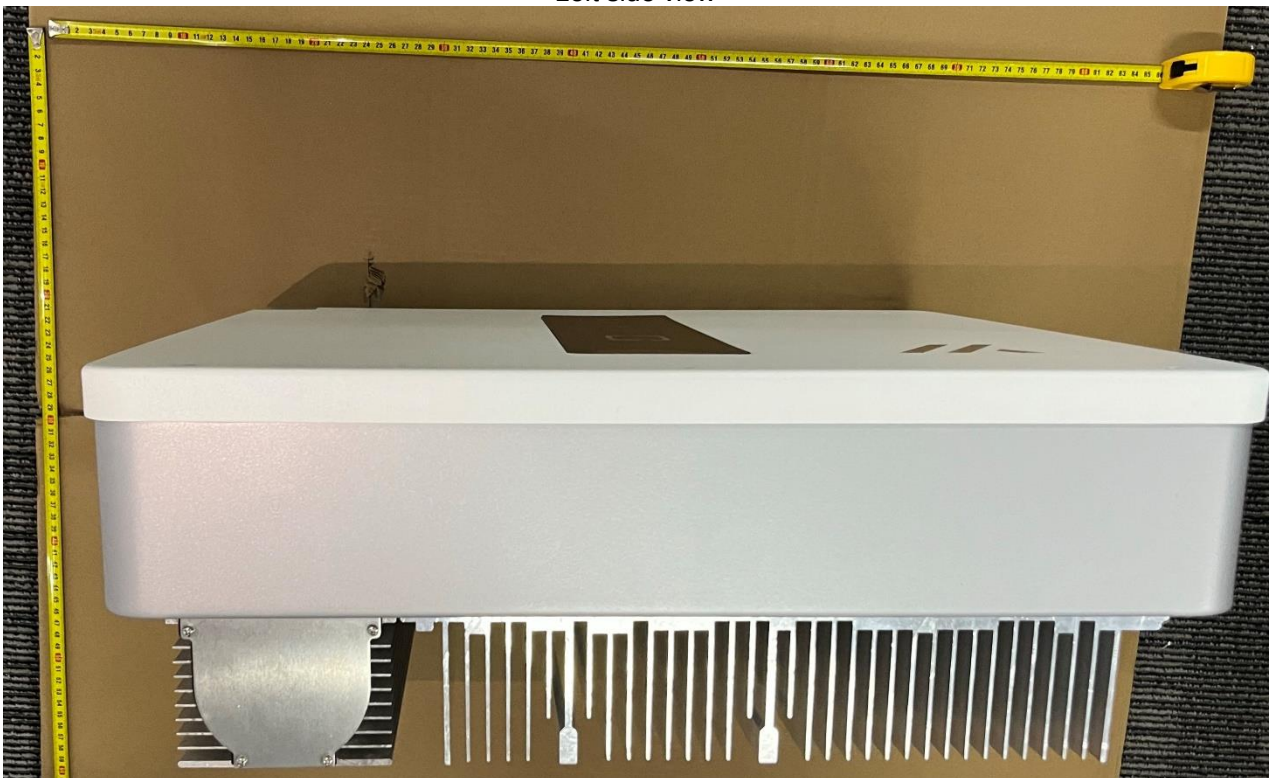
Bottom view

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Left side view



Top side view

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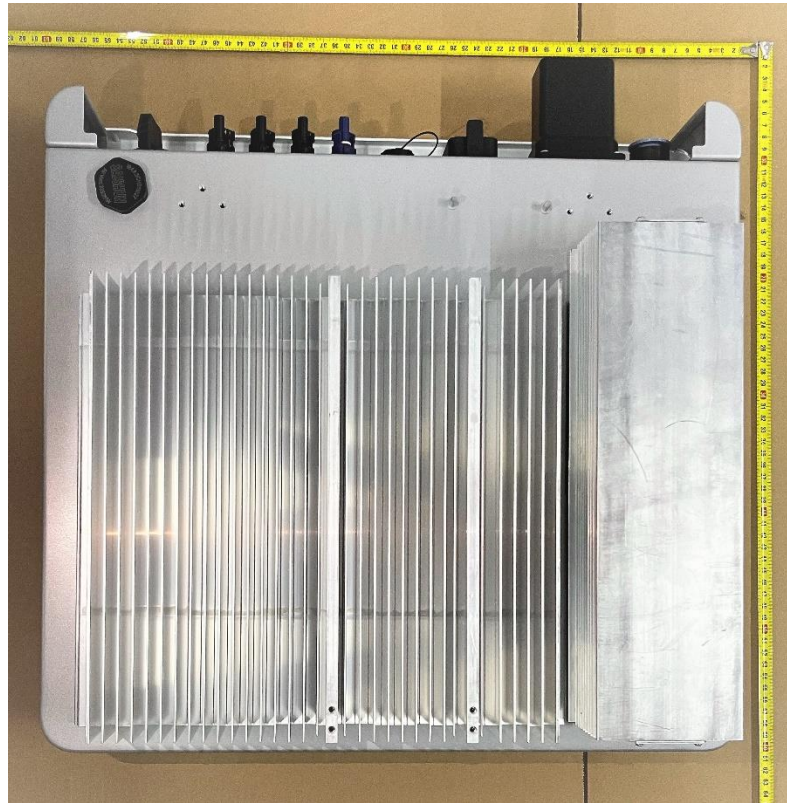
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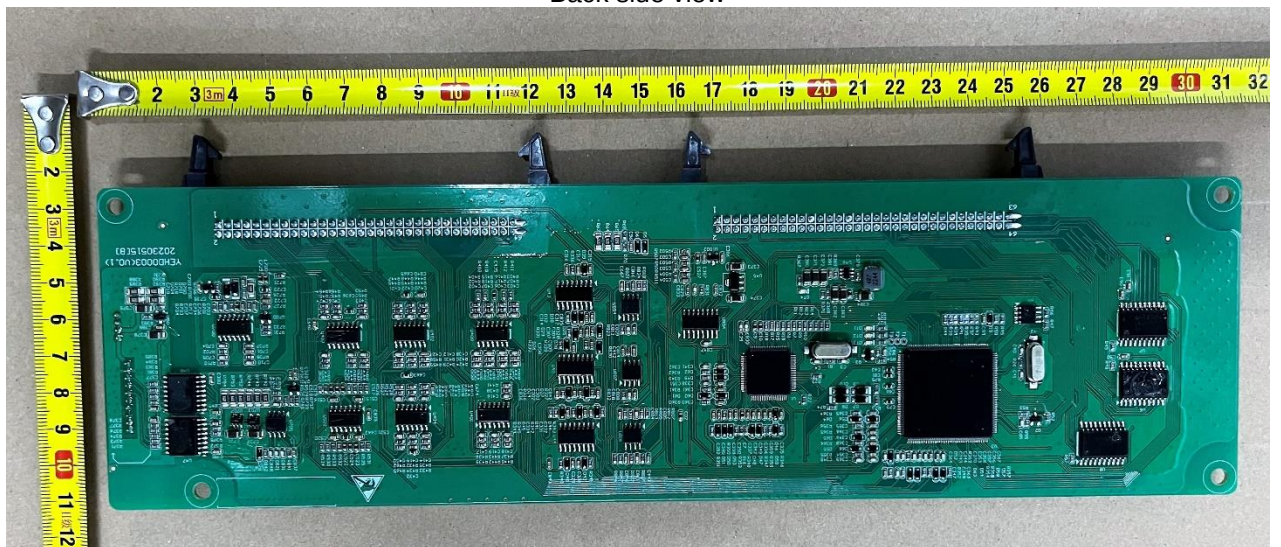
Right side view

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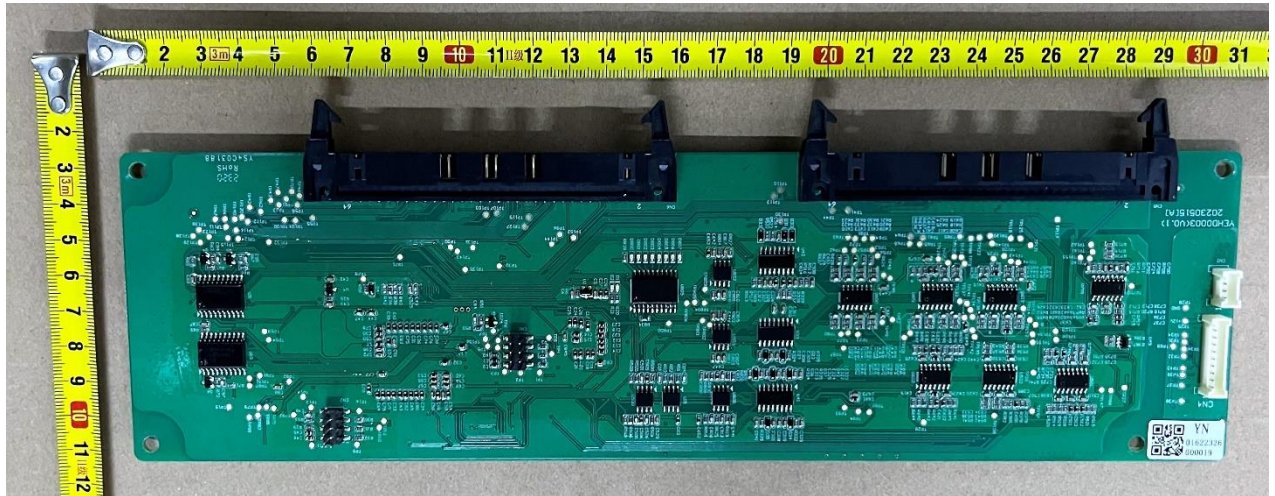
Back side view



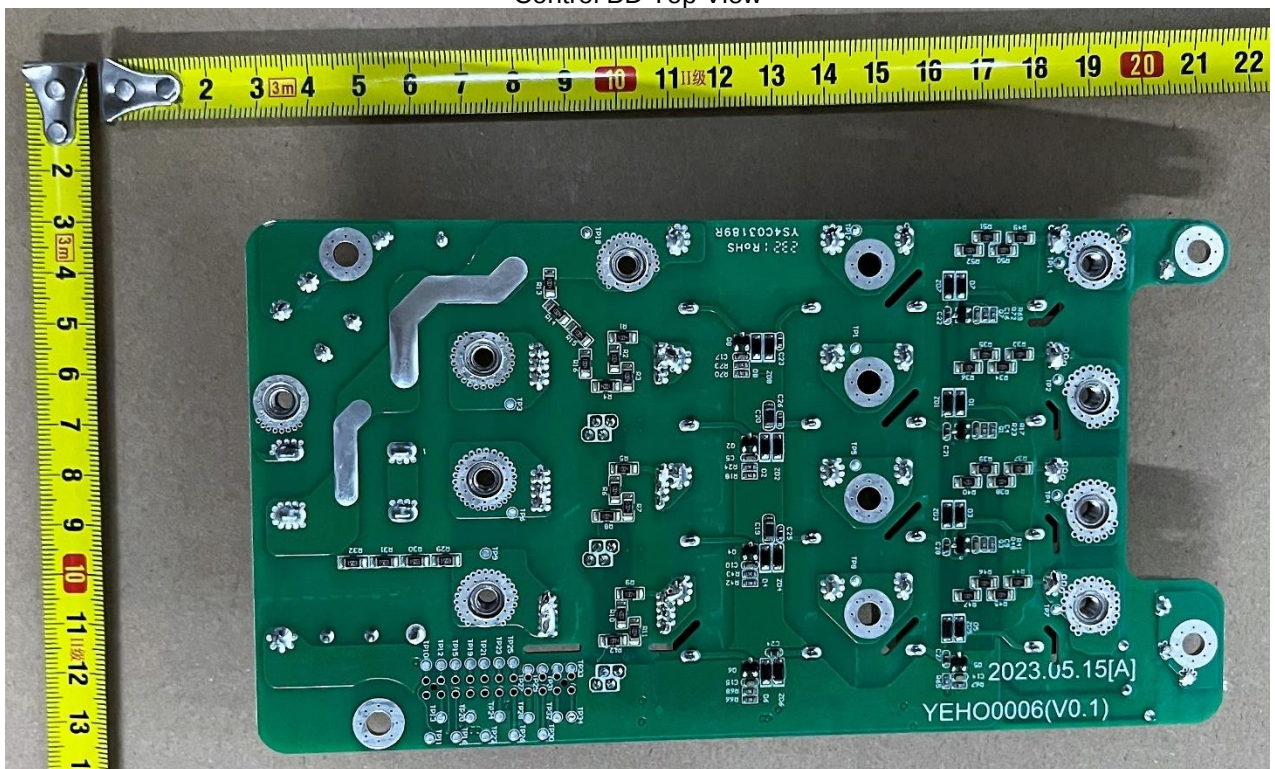
Control BD Bottom View

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Model: see cover page



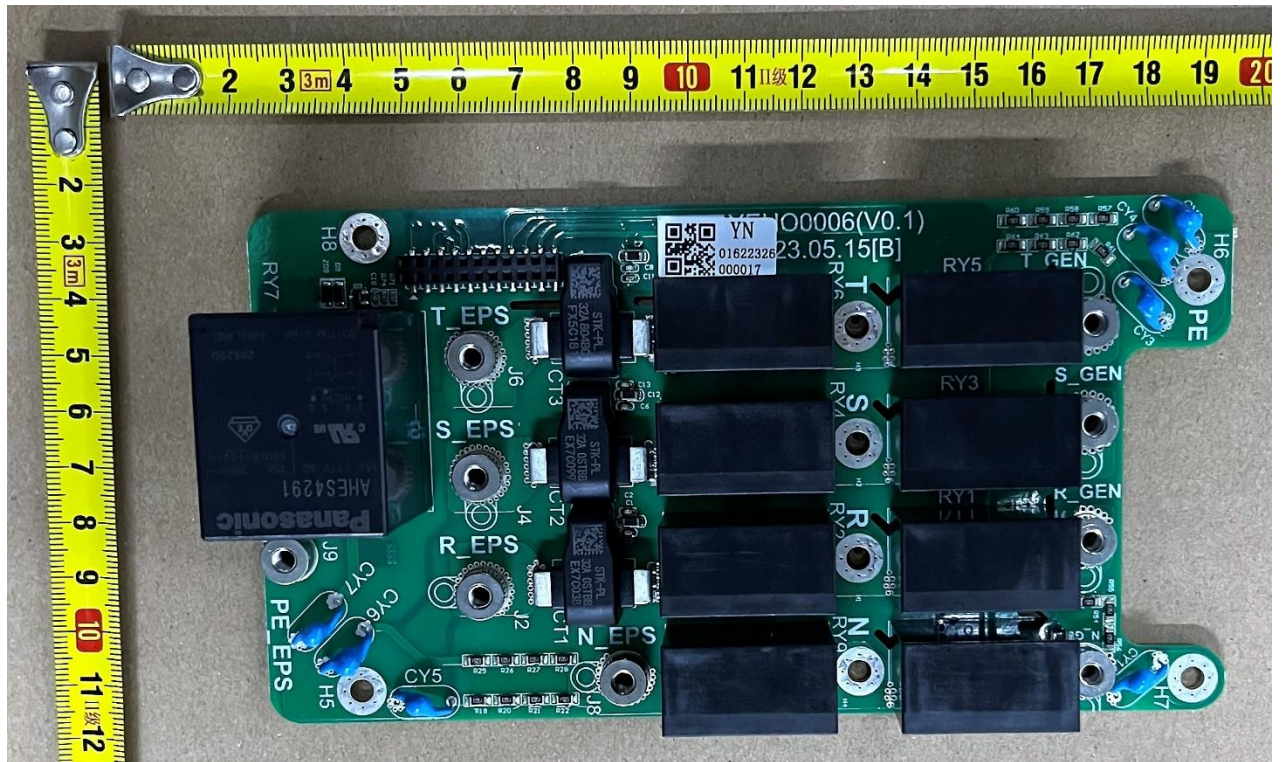
Control BD Top View



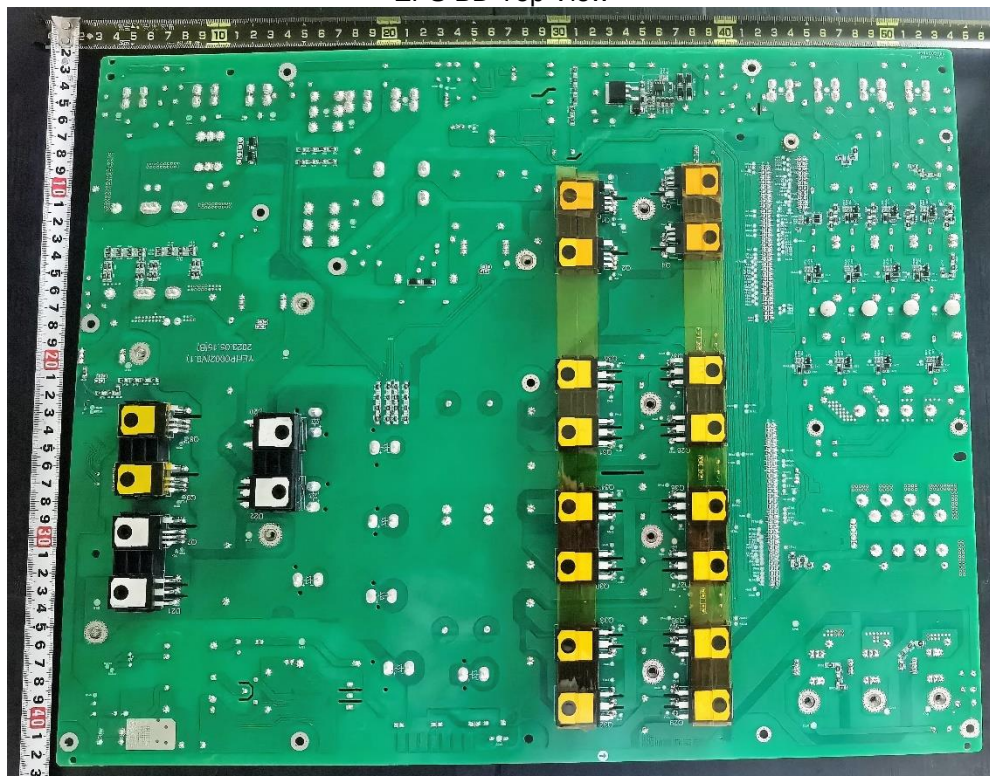
EPS BD Bottom View

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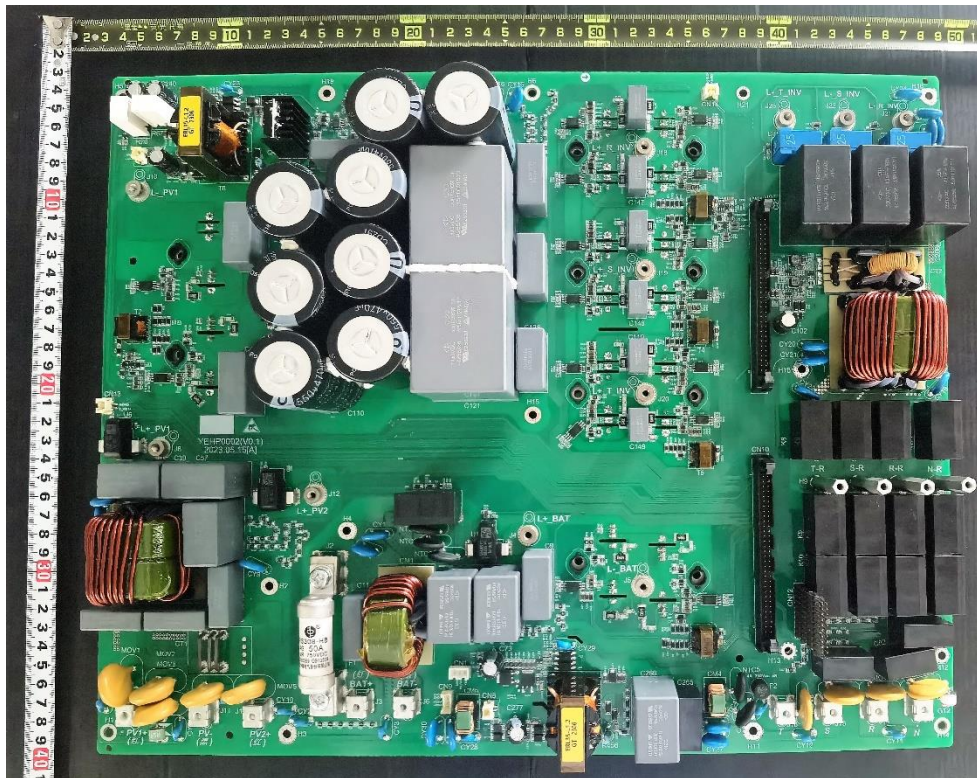
EPS BD Top View



Power BD Bottom View

Report Number: CN230HHW 001

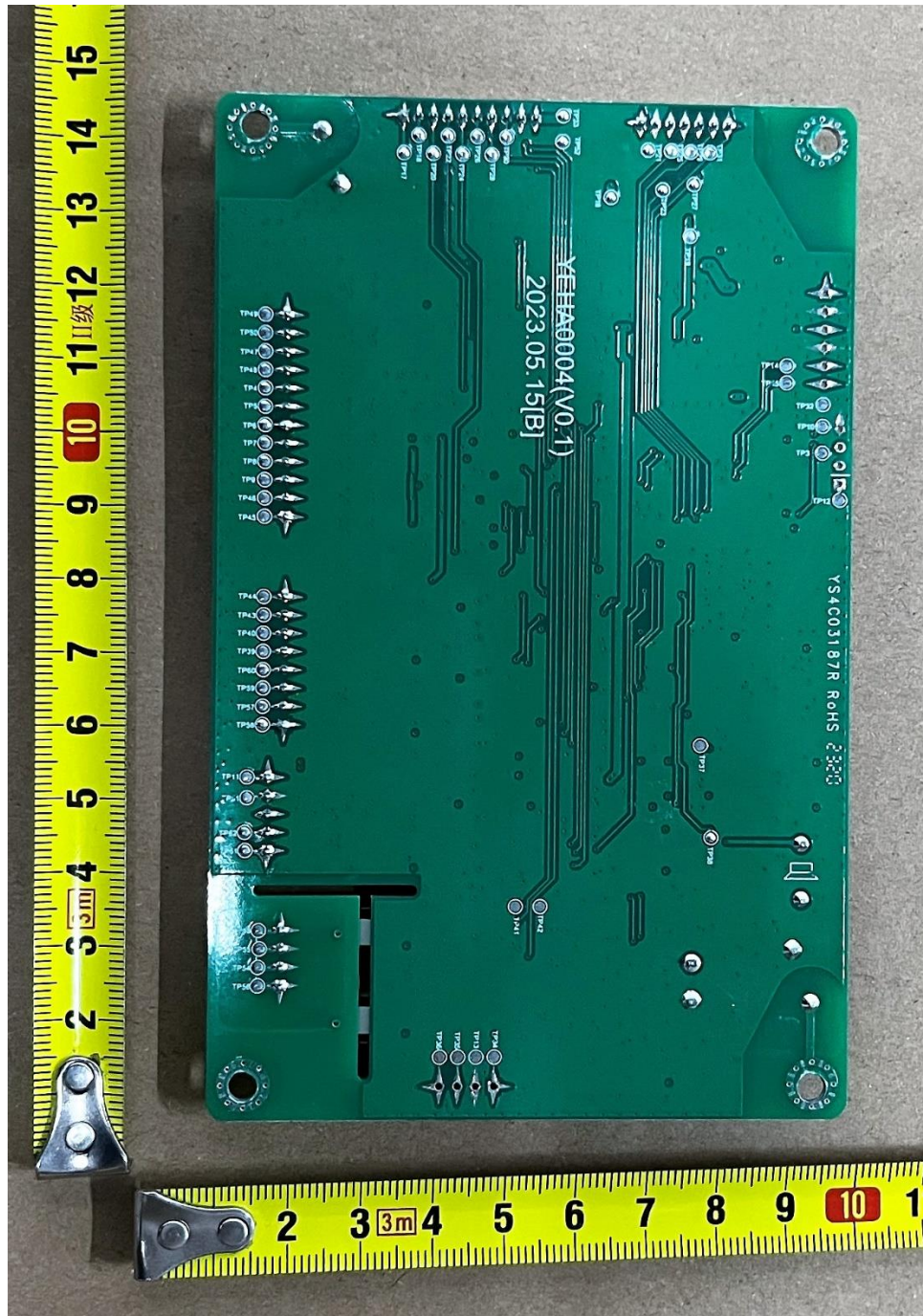
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Power BD Top View

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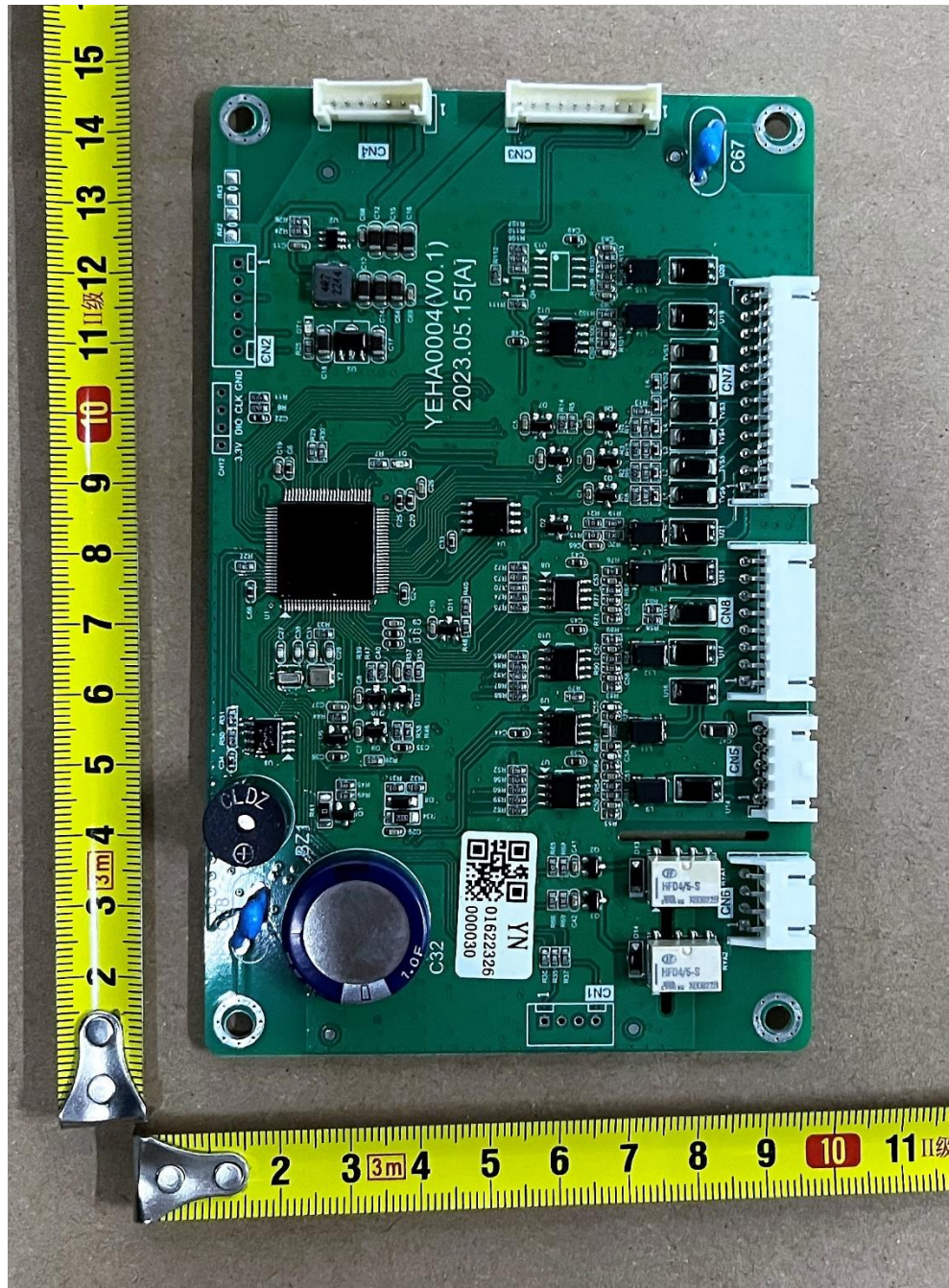
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System BD Bottom View

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Model: see cover page



System BD Top View