Prüfbericht-Nr.: *Test Report No.*:	**50350516 001**	**Auftrags-Nr.:** *Order No.*:	266130669
Kunden-Referenz-Nr.: *Client Reference No.*:	417691	**Auftragsdatum:** *Order date*:	12.12.2018
Auftraggeber: *Client*:	Sungrow Power Supply Co., Ltd., No.1699 Xiyou Rd.,New & High, Technology Industrial Development Zone, Hefei 230088, P. R. China		
Prüfgegenstand: *Test item*:	Grid-Connected PV Inverter		
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	SG33CX, SG40CX, SG50CX		
Auftrags-Inhalt: *Order content*:	AK certificate		
Prüfgrundlage: *Test specification*:	VDE-AR-N 4105/11.18 *Erzeugungsanlagen am Niederspannungsnetz – Technische Mindestanforderungen für Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz* *Generators connected to the low-voltage distribution network – Technical requirements for the connection to and parallel operation with low-voltage distribution networks*		

Wareneingangsdatum: *Date of receipt*:	09.12.2019
Prüfmuster-Nr.: *Test sample No.*:	N/A
Prüfzeitraum: *Testing period*:	09.12.2019 - 30.03.2020
Ort der Prüfung: *Place of testing*:	Sungrow Power Supply Co., Ltd.
Prüflaboratorium: *Testing laboratory*:	TUV Rheinland (Shanghai) Co., Ltd.
Prüfergebnis*: *Test result**:	Pass

geprüft von / *tested by*:			**kontrolliert von /** *reviewed by*:		
06.04.2020	Tobias Yang / PE		06.04.2020	Yin Yue / TC	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*: Test procedure complied with E DIN VDE V 0124-100/09.19, see report 50350516 001 attachment 1 for detail.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Prüfbericht-Nr.: 50350516 001
Test Report No.: 50350516 001

Liste der verwendeten Prüfmittel
List of used test equipment

Prüfmittel *Test equipment*	**Prüfmittel-Nr. / ID-Nr.** *Equipment No. / ID-No.*	**Nächste Kalibrierung** *Next calibration*
See test report 50350516 001 Attachment 1		

Produktbeschreibung
Product description

1	**Produktdetails** *Product details*	See test report 50350516 001 Attachment 1
2	**Maße / Gewicht** *Dimensions / Weight*	Same as above.
3	**Bedienelemente** *Operating elements*	Same as above.
4	**Ausstattung / Zubehör** *Equipment / Accessories*	Same as above.
5	**Verwendete Materialien** *Used materials*	Same as above.
6	**Sonstiges** *Other*	Same as above.

Absatz *Clause*	Anforderungen - Prüfungen *Requirements - Tests*	Messergebnisse - Bemerkungen *Measuring results - Remarks*	Bewertung *Evaluation*
1	**Anwendungsbereich** ***Scope*** Details zur Ausgestaltung der messtechnischen Nachweise und zur Dokumentation der Messergebnisse sind in E DIN VDE-V 0124-100 (VDE V 0124-100):2019-09 beschrieben. Details on the design of the measuring certificates and the documentation of the measurement results are described in E DIN VDE-V 0124-100 (VDE V 0124-100):2019-09.		

ANLAGE zum Prüfbericht-Nr.: 50350516 001
APPENDIX to Test Report No.: 50350516 001

ZUSATZ-DOKUMENTATION
ADDITIONAL DOCUMENTATION

1. E DIN VDE V 0124-100/09.19 Report 50350516 001 attachment 1 (233 pages)
2. Photo documentations (11 pages)

Prüfbericht-Nr.: *Test Report No.*:	50350516 001 Attachment 1	**Auftrags-Nr.:** *Order No.*:	See test report 50350516 001	Seite 1 von 233 *Page 1 of 233*
Kunden-Referenz-Nr.: *Client Reference No.*:	See test report 50350516 001	**Auftragsdatum:** *Order date*:	See test report 50350516 001	
Auftraggeber: *Client*:	See test report 50350516 001			
Prüfgegenstand: *Test item*:	See test report 50350516 001			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	See test report 50350516 001			
Auftrags-Inhalt: *Order content*:	AK certificate			
Prüfgrundlage: *Test specification*:	E DIN VDE V 0124-100/09.19 *Netzintegration von Erzeugungsanlagen –Niederspannung –Prüfanforderungen an Erzeugungseinheiten vorgesehen zum Anschluss und Parallelbetrieb am Niederspannungsnetz* *Grid integration of generator plants – Low-voltage – Test requirements for generator units to be connected to and operated in parallel with low-voltage distribution networks*			

Wareneingangsdatum: *Date of receipt*:	09.12.2019
Prüfmuster-Nr.: *Test sample No.*:	N/A
Prüfzeitraum: *Testing period*:	09.12.2019 - 30.03.2020
Ort der Prüfung: *Place of testing*:	Sungrow Power Supply Co., Ltd.
Prüflaboratorium: *Testing laboratory*:	TÜV Rheinland (Shanghai) Co., Ltd.
Prüfergebnis*: *Test result**:	Pass

geprüft von / *tested by*:			**kontrolliert von /** *reviewed by*:		
See test report 50350516 001			See test report 50350516 001		
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*:

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*:	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Prüfbericht-Nr.: 50350516 001 Attachment 1
Test Report No.: 50350516 001 Attachment 1

Liste der verwendeten Prüfmittel
List of used test equipment

Prüfmittel *Test equipment*	**Prüfmittel-Nr. / ID-Nr.** *Equipment No. / ID-No.*	**Nächste Kalibrierung** *Next calibration*
PV simulation source	602001150702159	16.09.2020
AC programmable source	618603800175	16.09.2020
Power analyzer	91U213254	09.12.2020
Power analyzer	07100392-CHN	11.11.2020
Current transducer	1160570037	06.08.2020
Current transducer	1160570033	06.08.2020
Current transducer	1160570036	06.08.2020
Current transducer	1160570034	06.08.2020
Current transducer	A621	17.07.2020
Voltage transducer	C022429	22.05.2020
Oscilloscope	C029069	07.07.2020
RLC load	93H001827	19.12.2020

Produktbeschreibung
Product description

1	**Produktdetails** *Product details*	See product description and model list in appendix for deail.
2	**Maße / Gewicht** *Dimensions / Weight*	Same as above.
3	**Bedienelemente** *Operating elements*	Same as above.
4	**Ausstattung / Zubehör** *Equipment / Accessories*	Same as above.
5	**Verwendete Materialien** *Used materials*	Same as above.
6	**Sonstiges** *Other*	N/A

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*

1	**Anwendungsbereich** ***Scope***		
	Diese DIN-VDE-Vornorm dient dem Nachweis der elektrischen Eigenschaften von Erzeugungseinheiten (EZE) nach der VDE-AR N 4105:2018-11 und gegebenenfalls anderen Netzanschlussbedingungen. *This DIN VDE preliminary standard serves to verify the electrical properties of power generation units (PGU) in accordance with VDE-AR N 4105:2018-11 and, if applicable, other grid connection conditions.*		
2	**Normative Verweise** ***Normative References***		
3	**Begriffe und Abkürzungen** ***Terms and abbreviations***		
4	**Anforderungen an die Messgeräte und den Prüfstand** ***Requirements for the measuring instruments and the test bench***		
	In diesem Abschnitt werden allgemeine Anforderungen an Messungen und Messequipment definiert. Abweichende, testspezifische Anforderungen sind den einzelnen Abschnitten des jeweiligen Tests zu entnehmen. *This section defines general requirements for measurements and measurement equipment. Deviating, test-specific requirements can be found in the individual sections of each test.*		P ☒ F ☐ N/A ☐ N/T ☐
5	**Prüfungen** ***Tests***		
5.1	**Allgemeines** ***General information***		
	Bei Vollumrichterbasierten EZE und hinreichend realistischer Nachbildung der elektrischen Energiequelle dürfen die Messungen auch lediglich am Umrichter und den relevanten Komponenten durchgeführt werden. *In the case of full converter-based PGU and sufficiently realistic simulation of the electrical energy source, the measurements may only be carried out on the converter and the relevant components.*		
5.2	**Nachweis zulässiger Netzrückwirkungen** ***Verification of permissible network pertubations***		
	Dieser Abschnitt dient dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 5.4. Diese verweist bzgl. der Netzrückwirkungen auf die VDE-AR-N 4100:2019-04, 5.4. *This section serves as proof of the requirements of VDE AR N 4105:2018-11, 5.4, which refers to VDE-AR-N 4100:2019-04, 5.4 with regard to network perturbations.*		
5.2.1	**Allgemeines** ***General information***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*

	Netzrückwirkungen im Sinne dieses Dokumentes nach VDE-AR-N 4100:2019-04, 5.4 sind: – schnelle Spannungsänderungen; – Flicker; – Oberschwingungen, Zwischenharmonische und Supraharmonische (Höhere Frequenzen von 2 bis 9 kHz); – Kommutierungseinbrüche; – Einspeisung von Gleichströmen. *Network perturbations within the meaning of this document according to VDE-AR-N 4100:2019-04, 5.4:* *- Fast voltage changes;* *- Flicker;* *- Harmonics, interharmonics and supraharmonics (higher frequencies from 2 to 9 kHz);* *- Commutation dips;* *- Feed-in of direct currents.*		
5.2.2	**Schnelle Spannungsänderungen** ***Rapid voltage changes***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE-AR-N 4100:2019-04. *These tests serve as proof of the requirements of VDE-AR-N 4100:2019-04.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.2.3	**Flicker** ***Flicker***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE-AR-N 4100:2019-04. *These tests serve as proof of the requirements of VDE-AR-N 4100:2019-04.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.2.4	**Oberschwingungen und Zwischenharmonische** ***Harmonics and interharmonics***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4100:2019-04. Ziel der Prüfung ist es, die Ströme der Oberschwingungen, der Zwischenharmonischen und der Supraharmonischen (zwischen 2 kHz und 9 kHz) zu bestimmen. *These tests serve as proof of the requirements of VDE AR N 4100:2019-04.* *The aim of the test is to determine the currents of the harmonics, the interharmonics and the supraharmonics (between 2 kHz and 9 kHz).*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.2.5	**Kommutierungseinbrüche** ***Communication notches***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Diese Prüfung dient der Ermittlung der Kommutierungsströme, die zur projektspezifischen Ermittlung und Beurteilung der Kommutierungsspannungseinbrüche nach VDE-AR-N 4100:2019-04, 5.4.4.4 unter Berücksichtigung der Kurzschlussleistung am Verknüpfungspunkt erforderlich ist. Diese Prüfung ist nur für netzgeführte Umrichter erforderlich. *This test serves to determine the commutation currents required for the project-specific determination and assessment of the commutation voltage dips according to VDE-AR-N 4100:2019-04, 5.4.4.4 under consideration of the short-circuit power at the connection point.* *This test is only required for line-commutated inverters.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.2.6	**Einspeisung von Gleichströmen** ***Feed-in of direct currents***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4100:2019-04. Ziel der Prüfung ist es nachzuweisen, dass keine unzulässigen Gleichstromanteile in das Niederspannungsnetz eingespeist werden. Diese Prüfung ist nur für Umrichter erforderlich. *These tests serve as proof of the requirements of VDE AR N 4100:2019-04.* *The aim of the test is to prove that no inadmissible direct current components are fed into the low-voltage network.* *This test is only required for inverters.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.3	**Nachweis des Symmetrieverhaltens von Umrichtern** ***Verification of the symmetry behaviour of inverters***		
5.3.1	**Allgemeines** ***General information***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4100:2019-04, 5.5. Diese Prüfungen gelten nicht für rotierende Generatoren, die direkt an das Verteilnetz angeschlossen sind. *These tests serve as proof of the requirements of VDE AR N 4100:2019-04, 5.5.* *These tests do not apply to rotating generators connected directly to the distribution network.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4	**Nachweis des Verhaltens der Erzeugungseinheit am Netz** ***Proof of the behaviour of the power generation unit on the grid***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
5.4.1	**Allgemeines** ***General information***		
	Diese Prüfungen dienen dem Nachweis des einstellbaren Blindleistungsbereiches nach Anforderungen der VDE-AR-N 4105:2018-11(Kap. 5.7.2.2), sowie zur Ermittlung der Werte für SEmax und PEmax. Die RoCoF Anforderungen aus der VDE-AR-N 4105:2018-11, 5.7.1 sind nicht Teil der Einheitenzertifizierung. *These tests serve to verify the adjustable reactive power range in accordance with the requirements of VDE-AR-N 4105:2018-11 (Section 5.7.2.2) and to determine the values for SEmax and PEmax.* *The RoCoF requirements from VDE-AR-N 4105:2018-11, 5.7.1 are not part of the unit certification.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.2	**Messung des Wirk- und Blindleistungsbereiches** ***Measurement of active and reactive power range***		
	Diese Prüfungen dienen dem Nachweis des einstellbaren Blindleistungsbereiches nach Anforderungen der VDE-AR-N 4105:2018-11(Kap. 5.7.2.2), sowie zur Ermittlung der Werte für SEmax und PEmax. Die RoCoF Anforderungen aus der VDE-AR-N 4105:2018-11, 5.7.1 sind nicht Teil der Einheitenzertifizierung. *These tests serve to verify the adjustable reactive power range in accordance with the requirements of VDE-AR-N 4105:2018-11 (Section 5.7.2.2) and to determine the values for SEmax and PEmax.* *The RoCoF requirements from VDE-AR-N 4105:2018-11, 5.7.1 are not part of the unit certification.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.3	**Wirkleistungsreduktion durch Sollwertvorgabe** ***Active power reduction by setpoint input***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Für EZE, welche nach VDE-AR-N 4105:2018-11, 5.7.4.2.1 am Einspeisemanagement/Netzsicherheits-management teilnehmen müssen, sowie EZE, welche laut Herstellerangaben am Einspeise-management/Netzsicherheitsmanagement teilnehmen können, gelten nachstehende Prüfungen. Die Messungen sind, wenn technisch möglich, bei einer Vorgabe des Verschiebungsfaktors von 1 durch-zuführen. *The following tests apply to PGU, which according to VDE-AR-N 4105:2018-11, 5.7.4.2.1 must participate in feed-in management/grid safety management, and EZE, which according to the manufacturer's specifications can participate in feed-in management/grid safety management.* *If technically possible, the measurements must be carried out with a default shift factor of 1.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.4	**Wirkleistungseinspeisung von EZE bei Überfrequenz** ***Active power input from PGU at overfrequency***		
	Die Prüfung dient dem Nachweis der Wirkleistungsreduktion der EZE bei Überfrequenz nach VDE-AR-N 4105:2018-11 5.7.4.3. sowie dem Nachweis des Wirkleistungsgradienten nach Wiederzuschalten nach VDE-AR-N 4105:2018-11, 8.3.1. Falls einstellbar, ist die Prüfung zur Vergleichbarkeit mit einer cos(φ) Vorgabe von 1 durchzuführen. *The test serves to prove the active power reduction of the PGU at overfrequency according to VDE-AR-N 4105:2018-11 5.7.4.3. as well as to prove the efficiency gradient after reconnection according to VDE-AR-N 4105:2018-11, 8.3.1. If adjustable, the test shall be carried out with a cos(φ) specification of 1 for comparability.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.5	**Wirkleistungseinspeisung von Speichern bei Überfrequenz** ***Active power input from energy storage systems at overfrequency***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Die Prüfung dient dem Nachweis der Wirkleistungsreduktion des Speichers bei Überfrequenz nach VDE-AR-N 4105:2018-115.7.4.3, sowie dem Nachweis des Wirkleistungsgradienten nach Wiederzuschalten nach VDE-AR-N 4105:2018-11, 8.3.1. Falls einstellbar, ist die Prüfung zur Vergleichbarkeit mit einer cos(φ) Vorgabe von 1 durchzuführen *The test serves to verify the active power reduction of the storage in the event of overfrequency in accordance with VDE-AR-N 4105:2018-115.7.4.3, as well as the verification of the efficiency gradient after reconnection in accordance with VDE-AR-N 4105:2018-11, 8.3.1. If adjustable, the test shall be carried out with a cos(φ) specification of 1 for comparability.*		P ☐ F ☐ N/A ☒ N/T ☐
5.4.6	**Wirkleistungseinspeisung für EZE bei Unterfrequenz** ***Active power supply for PGU at low frequency***		
	Die Prüfung dient dem Nachweis der Wirkleistungserhöhung der EZE bei Unterfrequenz nach VDE-AR-N 4105:2018-11 5.7.4.3 sowie dem Nachweis des Wirkleistungsgradienten nach Wiederzuschalten nach VDE-AR-N 4105:2018-11, 8.3.1. Falls einstellbar, ist die Prüfung zur Vergleichbarkeit mit einer cos(φ) Vorgabe von 1 durchzuführen. *The test serves to verify the increase in active power of the PGU at underfrequency according to VDE-AR-N 4105:2018-11 5.7.4.3 as well as the verification of the efficiency gradient after reconnection according to VDE-AR-N 4105:2018-11, 8.3.1. If adjustable, the test shall be carried out for comparability with a cos(φ) specification of 1.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.7	**Wirkleistungseinspeisung von Speichern bei Unterfrequenz** ***Active power input from energy storage systems at underfrequency***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Die Prüfung dient dem Nachweis der Wirkleistungserhöhung des Speichers bei Unterfrequenz nach VDE-AR-N 4105:2018-11 5.7.4.3. sowie dem Nachweis des Wirkleistungsgradienten nach Wiederzuschalten nach VDE-AR-N 4105:2018-11, 8.3.1. Falls einstellbar, ist die Prüfung zur Vergleichbarkeit mit einer cos(φ) Vorgabe von 1 durchzuführen. Die Prüfungen sind unter Verwendung einer Schnittstelle zur Wirkleistungsreduzierung durchzuführen, die geringer priorisiert ist als die Wirkleistungseinspeisung bei Unterfrequenz (Details sind in Abschnitt 8.1 der VDE-AR-N 4105:2018-11 gegeben). Ist eine solche Schnittstelle nicht vorhanden, ist dies zu dokumentieren und die Prüfung entfällt. *The purpose of the test is to verify the increase in active power of the energy storage system at underfrequency in accordance with VDE-AR-N 4105:2018-11 5.7.4.3. and to verify the efficiency gradient after reconnection in accordance with VDE-AR-N 4105:2018-11, 8.3.1. If adjustable, the test shall be performed for comparability with a cos(φ) specification of 1.* *The tests shall be performed using an interface for active power reduction which has a lower priority than the active power input at low frequency (details are given in Section 8.1 of VDE-AR-N 4105:2018-11). If such an interface is not available, this shall be documented and the test shall be omitted.*		P ☐ F ☐ N/A ☒ N/T ☐
5.4.8	**Statische Spannunshaltung / Blindleistungsbereitstellung** ***Static voltage holding / reactive power supply***		
	Die Prüfung dient dem Nachweis der Blindleistungsfahrweise nach VDE-AR-N 4105:2018-11, 5.7.2 der EZE im Normalbetrieb. Alle Prüfungen sind bei den jeweils angegebenen Spannungen durchzuführen. Wenn Prüfstandmessungen nicht möglich sind, ist eine technisch begründete Erklärung des Herstellers vorzulegen. Bei Anlagen, die über Wechselrichter an das Netz angeschlossen werden, darf der Wechselrichter alleine geprüft werden. *The test serves as proof of reactive power operation according to VDE-AR-N 4105:2018-11, 5.7.2 of the PGU in normal operation.* *All tests must be carried out at the specified voltages. If test bench measurements are not possible, a technically justified declaration by the manufacturer shall be submitted. For systems which are connected to the grid via inverters, the inverter may be tested alone.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
5.4.8.1	**Prüfungen der Blindleistungs/Verschiebungsfaktor Einstellgenauigkeit** ***Reactive power/displacement factor tests setting accuracy***		
	Die Messungen sind bei 0,9 Un, Un und 1,1 Un mit einer Toleranz von ± 2 % Un durchzuführen. Die Einschränkungen der spannungsabhängigen Blindleistungsstellbereiche laut VDE-AR-N 4105:2018-11, Bild 2 – 4, sind zu berücksichtigen. *Measurements shall be made at 0,9 Un, Un and 1,1 Un with a tolerance of ± 2 % Un.* *The restrictions of the voltage-dependent reactive power control ranges according to VDE-AR-N 4105:2018-11, Figs. 2 - 4, must be taken into account.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.8.2	**Prüfung der Verschiebungsfaktor-/Wirkleistungskennlinie cos (P)** ***Testing the displacement factor/effective power characteristic curve cos (P)***		
	Dieser Abschnitt dient der Überprüfung der in VDE-AR-N 4105:2018-11, 5.7.2.4 b) dargestellten Standardkennlinie für cos (P). Die Blindleistungsregelung für dieses Kennlinienverfahren ist hinsichtlich stationärer Genauigkeit und Dynamik zu beurteilen. *This section serves to check the standard characteristic curve for cos (P) shown in VDE-AR-N 4105:2018-11, 5.7.2.4 b).* *The reactive power control for this characteristic curve method shall be evaluated with regard to steady-state accuracy and dynamics.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.4.8.3	**Prüfung der Blindleistungs-Spannungskennlinie Q(U)** ***Testing the reactive power voltage characteristic Q(U)***		
	Die Überprüfung der Q(U)-Regelung nach VDE-AR-N 4105:2018-05, 5.7.2.4 ist in zwei Teilprüfungen geteilt, sodass einerseits die Genauigkeit und andererseits die Dynamik der Q(U)-Regelung geprüft wird. *The verification of the Q(U) control according to VDE-AR-N 4105:2018-05, 5.7.2.4 is divided into two partial tests, so that on the one hand the accuracy and on the other hand the dynamics of the Q(U) control are checked.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5	**Nachweise des NA-Schutzes** ***Proof of NS-protection***		
5.5.1	**Allgemeines** ***General information***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, Abschnitt 6. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, Section 6.*		P ☒ F ☐ N/A ☐ N/T ☐
5.5.2	**NA-Schutz** ***NS-protection***		
	Die Prüfung auf Fehlererkennung mit nachfolgender Abschaltung erfolgt durch Fehlersimulation, gegebenenfalls mit zusätzlichen Fehlertests (siehe VDE AR N 4105:2018-11, 6.1) Für EZE, welche die Anforderungen nach DIN EN 62109 (VDE 0126-14) nachweislich erfüllen, müssen die Prüfungen nicht durchgeführt werden. Der Nachweis in Form eines Prüfberichts eines akkreditierten Prüflabors oder eines Komponentenzertifikates ist vorzulegen. *The check for fault detection with subsequent switch-off is carried out by fault simulation, if necessary with additional fault tests (see VDE AR N 4105:2018-11, 6.1).* *For PGU, which demonstrably meet the requirements of DIN EN 62109 (VDE 0126-14), the tests do not have to be carried out. Evidence in the form of a test report from an accredited test laboratory or a component certificate must be submitted.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.3	**Zentraler NA-Schutz** ***Central NS-protection***		
	Die folgenden Prüfungen sind der Reihe nacheinander durchzuführen: – Die Hilfsspannung des NA-Schutzes wird abgeschaltet. – Die Prüfeinrichtung am NA-Schutz wird betätigt. *The following tests shall be carried out one after the other:* *- The auxiliary voltage of the NS-protection is switched off.* *- The test device on the NS-protection is actuated.*	In case central NS-protection is required, tests shall be implemented on individual NS protection device.	P ☐ F ☐ N/A ☒ N/T ☐
5.5.4	**Integrierter NA-Schutz** ***Integrated NS-protection***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Die Prüfung des integrierten NA-Schutzes erfolgt im Kapitel 5.5.7 und im Zusammenhang mit der Prüfung der Gesamtwirkungskette NA-Schutz – Kuppelschalter. *The integrated NS-protection is tested in chapter 5.5.7 and in connection with the testing of the overall chain of action of the NS-protection - coupling switch.*	See appendix for detail. Although	P ☒ F ☐ N/A ☐ N/T ☐
5.5.5	**Dokumentation** ***Documentation***		
	Es ist mindestens festzuhalten: – Die durchgeführte Fehlersimulation und/oder Fehlertests sowie das Ergebnis – Die Art des NA-Schutzes (zentral oder integriert) – Ob das Signal für die unverzögerte Auslösung erzeugt wurde - Anforderung an die Schnittstelle der EZE bzw. Kuppelschalter sind zu definieren *It shall at least be recorded:* *- The error simulation and/or error tests carried out and the result* *- The type of NS-protection (central or integrated)* *- Whether the signal for instantaneous tripping was generated* *- Requirements for the interface of the PGU or coupling switch must be defined.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.6	**Kuppelschalter** ***Interface switch***		
5.5.6.1	**Allgemeines** ***General information***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 6.4 *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 6.4*		P ☒ F ☐ N/A ☐ N/T ☐
5.5.6.2	**Zentraler Kuppelschalter** ***Central interface switch***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Zur Auslegung eines zentralen Kuppelschalters sind einige Angaben der EZE notwendig. Die Dokumentation des Herstellers der EZE muss daher folgende Angaben enthalten: – maximaler Anfangs-Kurzschlusswechselstrom; – – maximale Vorsicherung; – Schaltplan/ Anschlussplan (EZE, NA-Schutz, Kuppelschalter) beinhaltet die erforderlichen Ansteuer- und Rückmeldesignale. *Some information from PGU is required for the design of a central dome switch. The documentation of the PGU manufacturer must therefore contain the following information:* *- maximum initial short-circuit alternating current;* - *- maximum back-up fuse;* *- Circuit diagram/ connection diagram (PGU, NS-protection, coupling switch) contains the required control and feedback signals.*	In case central NS-protection is required, tests shall be implemented on individual NS protection device. Related information of inverter includes initial short circuit current , fuse and connection diagram have been provided in the user manual.	P ☐ F ☐ N/A ☒ N/T ☐
5.5.6.3	**Integrierter Kuppelschalter** ***Integrated interface switch***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Bei der Kombination von integriertem Kuppelschalter und integriertem NA-Schutz ist die gesamte Wirkungskette zu überprüfen. Die EZE muss dabei mit dem Netz verbunden sein. Folgende Wirkungsweisen sind zulässig: a) Verwendung eines Kuppelschalters, bei dem im eingeschalteten Zustand ständig eine Steuerspannung anliegen muss und der selbsttätig abschaltet, wenn diese Spannung nicht anliegt. Die betriebsmäßige Ein- und Ausschaltvorgänge sind zu überwachen. b) Eine mindestens einmal tägliche Ein- und Ausschaltung des Kuppelschalters durch den NA-Schutz und Überwachung der ordnungsgemäßen Funktion des Kuppelschalters c) Verwendung des integrierten Kuppelschalters und des integrierten NA-Schutzes bei PV- und Batterieumrichtern nach DIN EN 62109 *When combining an integrated bus tie breaker and integrated NS-protection, the entire efficiency chain must be checked. The PGU must be connected to the mains. The following modes of action are permissible:* *a) Use of a interface switch with which a control voltage must always be present when switched on and which switches off automatically when this voltage is not present. The operational switch-on and switch-off procedures must be monitored.* *b) The interface switch must be switched on and off at least once a day by the NS-protection and the proper functioning of the coupling switch must be monitored.* *c) Use of the integrated interface switch and the integrated NS-protection for PV and battery converters according to DIN EN 62109*	See appendix for detail. Although internal switch integrated in inverter, but central device may be required in final installation.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.7	**Schutzeinrichtungen und Schutzeinstellungen** ***Protective devices and settings***		
5.5.7.1	**Allgemeines** ***General information***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 6.5.1. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 6.5.1.*		P ☒ F ☐ N/A ☐ N/T ☐
5.5.7.2	**Spannungsüberwachung und Frequenzüberwachung NA-Schutz** ***Voltage monitoring and frequency monitoring NS-protection***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Prüfung des: - Spannungssteigerungsschutzes U>>, U> - Spannungsrückgangsschutzes U<<, U< - Frequenzsteigerungsschutzes f> - Frequenzrückgangsschutzes f< *Checking the:* *- Voltage increase protection U>>, U>* *- Voltage drop protection U<<, U<<* *- Frequency increase protection f>* *- Frequency drop protection f<<*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.8	**Meldungen des NA-Schutzes** ***Messages of the NS-protection***		
5.5.8.1	**Prüfung** ***Test***		
	Es ist durch Sichtprüfung festzustellen, dass die letzten 5 datierten Fehlermeldungen am NA Schutz ablesbar sind. Es ist zu prüfen, dass eine Unterbrechung der Versorgungsspannung 3 s nicht zum Verlust der Fehlermel¬dungen führt. Es ist nachzuprüfen, dass bei einem integrierten NA-Schutz die Einstellwerte der Schutzfunktion und die Fehlermeldungen über eine Datenschnittstelle auszu¬lesen sind, sofern diese nicht direkt ablesbar sind. *It must be determined by visual inspection that the last 5 dated error messages can be read on the NS-protection.* *It must be checked that an interruption of the supply voltage for 3 s does not lead to the loss of the error messages.* *It must be checked that, with integrated NS-protection, the setting values of the protective function and the error messages can be read out via a data interface if these cannot be read off directly.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.8.2	**Dokumentation** ***Documentation***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Es ist mindestens festzuhalten: – die letzten 5 datierten Fehlermeldungen; – die Fehlermeldungen nach der Unterbrechung der Versorgungsspannung. Es ist anzugeben, ob die Werte direkt oder mithilfe einer Datenschnittstelle auslesebar sind. Sofern vorhanden, ist der Typ der Datenschnittstelle anzugeben. *It shall at least be recorded:* *- the last 5 dated error messages;* *- the error messages after the interruption of the supply voltage.* *Indicate whether the values can be read out directly or via a data interface.* *If available, indicate the type of data interface.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.9	**Bauliche Merkmale des NA-Schutzes** ***Structural characteristics of NS-protection***		
5.5.9.1	**Allgemeines** ***General information***		
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 6.5.2. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 6.5.2.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.9.2	**Prüfung** ***Tests***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Es ist zu prüfen, ob der NA-Schutz mit einem Schutz vor unbefugtem Zugriff versehen ist, z.B.: – NA-Schutz plombierbar: durch Sichtprüfung, oder – NA-Schutz passwortgeschützt: Prüfung, auf Basis der Herstellerangaben, oder – andere geeignete Maßnahme. Es ist zu prüfen, ob U> und die Zeitverzögerungen für U< und U<< einstellbar sind. Es ist zu prüfen, ob alle anderen Schutzfunktionen, die in VDE-AR-N 4105:2018-11, Abschnitt 6.5 beschrieben sind, entweder fest oder durch einen zusätzlichen, separaten Schutz vor unbefugtem Zugriff geschützt sind. *It must be checked whether the NS-protection is provided with protection against unauthorised access, e.g.:* *- NS-protection can be sealed: by visual inspection, or* *- NS-protection password-protected: Testing, based on the manufacturer's specifications, or* *- other appropriate measure.* *Check whether U> and the time delays for U< and U<< can be set. Check whether all other protection functions described in VDE-AR-N 4105:2018-11, section 6.5 are either fixed or protected against unauthorised access by an additional, separate protection.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.9.3	**Dokumentation** ***Documentation***		
	Es ist mindestens festzuhalten: – die Art und Form des Schutzes – Einstellbarkeit U> und die Zeitverzögerungen für U< und U<< – Ob alle anderen Schutzfunktionen entweder fest oder durch einen zusätzlichen, separaten Schutz vor unbefugtem Zugriff geschützt sind. *It shall at least be recorded:* *- the nature and form of the protection* *- adjustability U> and the time delays for U< and U<<* *- Whether all other protective functions are either fixed or protected against unauthorized access by an additional, separate protection.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.10	**Inselnetzerkennung** ***Island network detection***		
5.5.10.1	**Allgemeines** ***General information***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 6.5.3. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 6.5.3.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.10.2	**Passives Verfahren** ***Passive procedure***		
	Das passive Verfahren wird durch den Spannungssteigerungs- und den Spannungsrückgangsschutz des NA-Schutzes realisiert. Anm.: Nur bei EZE ohne Umrichter oder bei einphasigen Erzeugungseinheiten mit Umrichter. Die dreiphasige Spannungsüberwachung ist auch bei einer baulichen Integration mehrerer einphasiger EZE, die in unterschiedliche Außenleiter einspeisen zulässig, solange die Ströme dieser EZE unabhängig voneinander geregelt werden, so dass sich beliebige Phasenlagen einstellen können. *The passive process is realized by the voltage increase and voltage decrease protection of the NS-protection.* *Note: Only for PGU without inverter or for single-phase generation units with inverter. Three-phase voltage monitoring is also permissible in the case of structural integration of several single-phase PGUs which feed into different phase conductors, as long as the currents of these PGUs are controlled independently of each other so that any phase positions can be set.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.5.10.3	**Aktives Verfahren** ***Active process***		
	Das aktive Verfahren wird geprüft nach DIN EN 62116 (VDE 0126-2) ANMERKUNG Die Prüfung von Geräten, die nicht am Netzsimulator geprüft werden können, ist in Beratung. Es ist mindestens festzuhalten: – Das Verfahren der Inselnetzerkennung The active process is tested according to DIN EN 62116 (VDE 0126-2). NOTE The testing of devices that cannot be tested on the network simulator is being advised. *It shall at least be recorded:* *- The procedure of island network recognition*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*

5.6	**Zuschaltbedingungen und Synchronisierung** ***Switching conditions and synchronization***
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 8.3. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 8.3.*
5.6.1	**Allgemeines** ***General information***

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Die Zuschaltung und die Synchronisierung werden durch mindestens eine geeignete Einrichtung ausgeführt bzw. überwacht. Diese Einrichtung kann in der Steuerung der EZE, im integrierten NA-Schutz oder im zentralen NA-Schutz realisiert sein und ist nach VDE-AR-N 4105:2018-11, 8.3 einzustellen und wie nachstehend zu prüfen: a) Der Hersteller hat dem Prüflaboratorium eine Dokumentation vorzulegen, welche Funktionen in welcher Komponente realisiert sind. b) Bei nicht zugeschalteter EZE wird die Prüfung durch die Veränderung der eingestellten Nennfrequenz und Nennspannung in der Steuerung durchgeführt. Alternativ dürfen auch andere Verfahren wie Netzsimulator oder ein Prüfstandtest für den Nachweis ver-wendet werden. Nach Auslösen des NA-Schutzes ist zu prüfen, dass sich die Anlage nur innerhalb der Toleranzbänder ((85 % Un <= U <= 110 % Un) und (47,5 Hz <= fist <= 50,1 Hz)) und nach Verbleiben von Spannung und Frequenz innerhalb der Toleranzbänder frühestens nach 60 s zuschalten lässt. ANMERKUNG 1 Bei dem nachstehenden Ablauf sind die Messtoleranzen des NA-Schutzes berücksichtigt. ANMERKUNG 2 Der maximale Gradient der Wirkleistung bei Wiederzuschaltung wird in den Kapiteln 5.4.4 bis 5.4.7 überprüft *The connection and synchronisation shall be carried out or monitored by at least one suitable device. This device can be implemented in the PGU control, in the integrated NS-protection or in the central NS-protection and must be set in accordance with VDE-AR-N 4105:2018-11, 8.3 and tested as described below:* *a) The manufacturer shall provide the testing laboratory with documentation of which functions are implemented in which component.* *b) If PGU is not switched on, the test is performed by changing the set nominal frequency and nominal voltage in the controller.* *Alternatively, other methods such as a mains simulator or a test bench test may also be used for verification.* *After triggering the NS-protection, it must be checked that the system can only be switched on within the tolerance bands ((85 % Un <= U <= 110 % Un) and (47.5 Hz <= f <= 50.1 Hz)) and after voltage and frequency have remained within the tolerance bands, at the earliest after 60 s. The system must not be switched on before the end of the test period.* *NOTE 1 The following procedure takes the measurement tolerances of the NS-protection into account.* *NOTE 2 The maximum gradient of the active power on reconnection is checked in chapters 5.4.4 to 5.4.7.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*

5.7	**Nachweis der PAV,E-Überwachung** ***Proof of PAV,E monitoring***		
5.7.1	**Allgemeines** ***General information***		
	Die Prüfung dient dem Nachweis der Anforderungen der VDE-AR-N 4105:2018-11, 5.5.2. Die PAV,E-Überwachung kann, muss aber nicht in der EZE integriert sein. Wird die PAV,E-Überwachung nicht als Einheit gebaut, sondern auf mehrere Geräte verteilt, ist die gesamte Wirkungskette analog zur Prüfung des NA-Schutzes inklusive der kommunikativen Kopplung zu prüfen. *The test serves to verify the requirements of VDE-AR-N 4105:2018-11, 5.5.2. The PAV,E monitoring can, but does not have to, be integrated into the PGU. If the PAV,E monitoring is not built as a unit but distributed over several devices, the entire chain of effects must be tested analogously to the testing of the NA protection including the communicative coupling.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
5.8	**Nachweis der dynamischen Netzstützung** ***Proof of dynamic network support***		
5.8.1	**Allgemeines** ***General information***		

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Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Diese Prüfungen dienen dem Nachweis der Anforderungen der VDE AR N 4105:2018-11, 5.7.3. Ziel dieser Prüfungen ist es, festzustellen, ob der Prüfling in der Lage ist, Spannungseinbrüche und Spannungsüberhöhungen unbeschadet zu durchfahren und sich entsprechend VDE-AR-N 4105:2018-11,5.7.3 zu verhalten. Der Prüfling kann eine Erzeugungseinheit (EZE) oder ein Speichersystem sein. Zum Prüfling zählen dabei: • Das Steuerungssystem und die Hilfsaggregate inklusive der in der EZE verbauten Eigenversorgung • Der Generator (Typ1 oder Asynchrongenerator) bzw. der Umrichter (Typ2 oder Speicher) Folgende EZE sind von der Prüfung ausgenommen: • Stirlinggeneratoren und Brennstoffzellen, die prinzipbedingt keine dynamische Netzstützung erbringen können; • Synchron- und Asynchrongeneratoren, die direkt oder über Umrichter gekoppelt sind, mit PrE<= 50 kW; Anmerkung: Die Hausgerätenorm DIN EN 60335 (VDE 0700) (alle Teile) fordert bei KWK-Anlagen eine Abschaltung der Brennstoffzufuhr bei Unter- und Überspannung. Das Durchfahren von mehreren aufeinander folgenden Netzfehlern ist nicht Gegenstand der Prüfung. Die im Folgenden aufgeführten Tests können aber für eine beliebige Folge von Netzfehlern mit fester oder variabler Pausenzeit wiederholt werden, um das Durchfahren von Mehrfach-Netzfehlern zu prüfen. *These tests serve as proof of the requirements of VDE AR N 4105:2018-11, 5.7.3.* *The aim of these tests is to determine whether the test object is able to pass through voltage dips and voltage increases without damage and to behave in accordance with VDE-AR-N 4105:2018-11,5.7.3. The test object can be a power generation unit (PGU) or a storage system.* *The test item is considered to be one:* *- The control system and the auxiliary units, including the self-supply installed in the PGU.* *- The generator (type 1 or asynchronous generator) or the inverter (type 2 or accumulator)* *The following PGU are excluded from the examination:* *- Stirling generators and fuel cells which, due to their principle, cannot provide dynamic grid support;* *- Synchronous and asynchronous generators which are coupled directly or via converters, with PrE<= 50 kW;* *Note: The household appliance standard DIN EN 60335 (VDE 0700) (all parts) requires a switch-off of the fuel supply in CHP plants in the event of undervoltage or overvoltage.* *The passing through of several successive network faults is not the subject of the test. The tests listed below can, however, be repeated for any sequence of mains faults with fixed or variable pause times in order to test the passing through of multiple mains faults.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
5.8.2	**Verfahren** ***Procedure***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Der Prüfling wird an ein Netz mit nachgeschalteter Prüfeinrichtung (oder einen Netzsimulator mit nachgeschalteter Netznachbildung) angeschlossen. Diese Prüfeinrichtung muss in der Lage sein, den/die entsprechende/n Spannungseinbruche/-überhöhungen, auf der Prüflingsseite nachbilden können. Alle Anforderungen an die Prüfeinrichtungen sind im Anhang A aufgeführt.Die korrekte Parametrierung der Prüfeinrichtung, um die jeweiligen Spannungseinbrüche/-überhöhungen entsprechend Tabelle 17 und Tabelle 18 zu erhalten, ist für jeden Test durch einen Leerlaufversuch zu kontrollieren (jeweils separat symmetrisch, unsymmetrisch). Der jeweils einzustellende Wert ist für Spannungseinbrüche die jeweilig resultierende, kleinste Leiter-Neutralleiter-Spannung. Für Spannungsüberhöhungen ist der einzustellende Wert die jeweilig resultierende, auf den Nennwert bezogene, größte Leiter-Neutralleiter-Spannung. Die Tests sind dabei jeweils bei einer Spannung im Bereich von Un ± 5 % Un zu starten.Bezugspunkt für die dynamische Netzstützung der EZE oder des Speichersystems sind die netzseitigen Anschlussklemmen des Prüflings. Es ist bei Volllast (PrE ± 2 % PrE) sowie im Teillastbereich von 0,2 PrEbis 0,6 PrEzu testen. Referenzwert ist die gemessene Wirkleistung als 10-s-Mittelwert unmittelbar vor dem/der Spannungseinbruch/-überhöhung. Alle Tests 1 bis 6 aus Tabelle 17 bzw. die Tests 1 bis 7 aus Tabelle 18 müssen sowohl symmetrisch (Fehlerbild A) wie auch unsymmetrisch (gemäß Fehlerbild D) durchgeführt werden (nach Bollen, siehe Anhang). *The test object is connected to a network with downstream test equipment (or a network simulator with downstream network simulation). This test device shall be capable of simulating the corresponding voltage dip/surges as on the test item side. All requirements for the test equipment are listed in Annex A.For each test, the correct parameterization of the test equipment in order to obtain the respective voltage dips / increases in accordance with Table 17 and Table 18 shall be checked by a no-load test (each separately symmetrical, asymmetrical). For voltage dips, the value to be set in each case is the resulting smallest conductor-neutral conductor voltage. For voltage increases, the value to be set is the respective resulting largest conductor-neutral conductor voltage related to the nominal value. The tests must be started with a voltage in the range of Un ± 5 % Un.The reference point for the dynamic network support of the PGU or the storage system are the network-side terminals of the test item. It must be tested at full load (PrE ± 2 % PrE) and in the partial load range from 0.2 PrE to 0.6 PrE. The reference value is the measured active power as an average of 10 s immediately before the voltage dip/exaggeration. All tests 1 to 6 from Table 17 or tests 1 to 7 from Table 18 must be performed both symmetrically (error pattern A) and asymmetrically (according to error pattern D) (according to Bollen, see*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
5.9	**Prüfung von Hilfsaggregaten** ***Testing of auxiliary aggregates***		
5.9.1	**Allgemeines** ***General information***		
	Hilfsaggregate, die nicht bei den FRT-Tests gemäß Abschnitt 5.8 mitgetestet wurden, können nach dem hier beschriebenen Verfahren überprüft werden. *Auxiliary power units not included in the FRT tests according to section 5.8 can be tested according to the procedure described here.*		P ☐ F ☐ N/A ☒ N/T ☐
6	**Hinweise zum Zertifizierungsverfahrens** ***Notes on the certification procedure***		
6.1	**Allgemeines** ***General information***		
	Die allgemein übliche Form der Nachweisführung ist die Vorlage von Zertifikaten beim Netzbetreiber. Wenn Zertifikate erstellt werden, dann werden diese nach dem Zertifizierungsprogramm FGW TR8:2019-02 erstellt. Die Bewertung der Messergebnisse erfolgt nach den Bewertungskriterien der VDE V 0124-100. *The generally accepted form of verification is the submission of certificates to the grid operator. When certificates are issued, they are issued in accordance with the certification program FGW TR8:2019-02. The evaluation of the measurement results is carried out according to the evaluation criteria of VDE V 0124-100.*		P ☒ F ☐ N/A ☐ N/T ☐
6.2	**Übertragbarkeit von Messungen** ***Transferability of measurements***		

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Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Vermessungsergebnisse können zwischen Erzeugungseinheiten/ Komponenten übertragen werden, wenn sichergestellt werden kann, dass die eingesetzte Software zur Steuerung/ Regelung der Erzeugungseinheit/ Komponente identisch beziehungsweise gleichwertig ist und die Hardware technisch gleichwertig ist. Dieses ist durch die Zertifizierungsstelle mit Hilfe der Hersteller Dokumentation zu prüfen. Der Hersteller hat ebenfalls eine Abschätzung bzgl. möglicher Unterschiede abzugeben. Der Übertragbarkeitsbereich wird nach den Regeln der VDE-AR-N 4110:2018-11 Kapitel 11.2.1 bestimmt. Ergebnisse der Vermessung einer Erzeugungseinheit können in Summe oder in Teilen auf andere Erzeugungseinheiten übertragen werden, wenn 1) die Ausführung und die für die elektrischen Eigenschaften maßgebende Regelungstechnik einschließlich der eingesetzten Software in diesen Erzeugungseinheiten technisch gleichwertig sind und 2) die Ergebnisse für die kleinste und größte Leistungsvariante unter Berücksichtigung von 1) vorliegen oder alternativ die Nennleistung der zu zertifizierenden Erzeugungseinheit zwischen dem 1/√10-fachen und √10-fachen (bei Typ-1-Anlagen) bzw. zwischen dem 1/√10-fachen und 2-fachen (bei Typ-2-Anlagen) der Nennleistung der vermessenen Erzeugungseinheit liegt. *Measurement results can be transferred between generation units/components if it can be ensured that the software used to control the generation unit/component is identical or equivalent and that the hardware is technically equivalent. This must be checked by the certification body with the help of the manufacturer's documentation. The manufacturer shall also provide an estimate of possible differences.* *The range of transferability is determined in accordance with the regulations of VDE-AR-N 4110:2018-11 Chapter 11.2.1. Results of the measurement of a generation unit can be transferred in sum or in parts to other generation units, if* *1) the design and the control technology relevant for the electrical properties, including the software used, are technically equivalent in these generation units, and* *2) the results for the smallest and largest power variant are available taking into account 1) or alternatively the nominal power of the generation unit to be certified is between 1/√10 and √10 times (for type 1 plants) or between 1/√10 and 2 times (for type 2 plants) the nominal power of the measured generation unit.*	Unless otherwise specified, all tests were implemented on model to SG50CX represent other family models.	P ☒ F ☐ N/A ☐ N/T ☐

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Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*

6.3	**Alternative Form des FRT-Nachweises** ***Alternative form of FRT detection***

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	Standardmäßig ist der Nachweis durch Messungen zu erbringen. Eine alternative Form der Nachweisführung ist von der TAR nicht vorgesehen und auch nicht notwendig, da die fraglichen Leistungen stets direkt getestet werden können. Falls dies in begründeten Fällen dennoch nicht möglich ist, so kann der FRT-Nachweis für Typ 1 EZE alternativ per rechnerischer Simulation mit einem Synchronmaschinenmodell durchgeführt werden. Dies erfolgt unter direkter Bezugnahme auf die Festlegungen der 4110 und erfordert mindestens die folgenden Schritte: 1) Erstellung eines Anlagenzertifikates „C“ nach FGW TR8:2019-02 inklusive einem vorläufigen Simulationsmodell nach FGW TR 4:2019-02. 2) Inbetriebsetzung und Vermessung nach der EZA nach FGW TR 3:2018-09. 3) Erstellung einer erweiterten Konformitätserklärung einschließlich der Optimierung des erstellten Simulationsmodells nach FGW TR 4:2019-02. 4) Vorläufiger Betrieb der EZA unter Monitoring mit Störschreibern. Melde- und Nachbesserungspflicht bei Netzereignissen (mindestens 5 Jahre Überwachung durch die Zertifizierungsstelle). Die Hilfsaggregate der EZE sind separat auf Unter- und Überspannung zu prüfen. Die Prüfung der Hilfsaggregate ist nach Kapitel 5.9 durchzuführen. *By default, proof shall be provided by measurements. An alternative form of verification is not provided for by the TAR and is also not necessary, since the services in question can always be tested directly. If this is still not possible in justified cases, the FRT verification for type 1 PGU can alternatively be carried out by mathematical simulation with a synchronous machine model. This is done with direct reference to the specifications of the 4110 and requires at least the following steps:* *1) Creation of a plant certificate "C" according to FGW TR8:2019-02 including a preliminary simulation model according to FGW TR 4:2019-02.* *2) Commissioning and surveying after development cooperation according to FGW TR 3:2018-09.* *3) Preparation of an extended declaration of conformity including the optimisation of the simulation model according to FGW TR 4:2019-02.* *4) Provisional operation of the development cooperation under monitoring with fault recorders. Obligation to report and rectify grid events (at least 5 years monitoring by the certification body).* *The auxiliary units of the PGU must be tested separately for undervoltage and overvoltage. The auxiliary power units shall be tested in accordance with Chapter 5.9.*		P ☐ F ☐ N/A ☒ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
A	**Anhang A** ***Annex A***		
A.1	**Anhang FRT (normativ)** ***Annex FRT (normative)***		
A.1.1	**Anforderungen an den Prüfstand für FRT Tests** ***Requirements for the test bench for FRT tests***		
	The generated voltage dips and voltage increases shall meet the following requirements: *- The effective mains impedance from the PGU point of view (with voltage divider principle: with connected longitudinal impedance) must meet the following criteria:* *- The short-circuit power at the PGU before and after the fault must be between 10x Sn and 30x Sn.* *- R/X 0,3 - 3 (for the impedances used in the test equipment)* *- The test equipment and, if necessary, the mains simulator must be able to conduct the maximum current of the test object both in the generator and in the motor area. The energy consumption must be designed for the occurring surge short-circuit current iP (according to IEC 60909). iP of the test types is very different. are standard values:* *- for inverter-coupled systems approx. 2.2 Ir,* *- for directly coupled asynchronous or synchronous machines approx. 7 Ir.* *- For symmetrical and asymmetrical voltage dips and voltage increases, the error form A and D as shown in Fig. 8 with the phase positions of the voltages as shown in Table 21 must be observed, taking into account the switching group effect. The diagrams show conductor-neutral conductor voltages.* *Note: In the case of a medium-voltage side, two-pole fault without ground contact (conductor-conductor voltages: fault pattern D) upstream of a Dy transformer, fault pattern D results on the undervoltage side of the transformer when the conductor-neutral conductor voltages are considered.* *- The edge steepness of the voltage must correspond to that of a circuit-breaker when a fault occurs and when a fault is declared.* *A change in the instantaneous voltage from 90 % to 10 % of the pre-fault voltage should take place within a period of max. 4 ms for UVRT.* *- The requirements for the waveform of the test voltage are to be tested within the scope of the idle tests. The test voltage must lie within the tolerances shown in Fig. 9 for voltage dip tests or in Fig. 10 for overvoltage tests.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
A.2	**Beispiele möglicher Prüfstände für UVRT (informativ)** ***Examples of possible test benches for UVRT (informative)***		
A.2.1	**Netzsimulator** ***Network simulator***		
	Netzsimulatoren setzten sich im Wesentlichen aus einer niederohmigen Spannungsquelle sowie einer Netznachbildung zusammen, mit der dem Prüfling geeignete Impedanzen präsentiert werden können. Im Gegensatz zu Prüfeinrichtungen mit Kurzschlusszweig muss hier der Netzsimulator die zwei- und dreiphasigen Fehler nachbilden. Zum Betrieb des Prüflings wird darüber hinaus entweder eine rotierende Antriebseinheit oder eine DC- oder AC-Quelle benötigt, die die entsprechende (mechanische oder elektrische) Leistung zur Durchführung der unterschiedlichen Tests bereitstellt. Die Antriebseinheit oder Quelle muss eine Regelung aufweisen, mit der die für die Tests notwendigen stationären und dynamischen Betriebsbedingungen nachgebildet werden können. *Network simulators essentially consist of a low impedance voltage source and a network simulation with which suitable impedances can be presented to the test item. In contrast to test equipment with a short-circuit branch, the network simulator has to simulate the two-phase and three-phase faults. In addition, either a rotating drive unit or a DC or AC source is required to operate the test item, which provides the appropriate (mechanical or electrical) power to perform the various tests. The drive unit or source must have a controller that can replicate the steady-state and dynamic operating conditions required for the tests.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
A.2.2	**Kurzschlusssimulator** ***Short-circuit simulator***		
	Ein Kurzschlusssimulator nach dem Spannungsteilerprinzip verfügt über Vor- und Kurzschlussdrossel. Die Kurzschlussdrossel wird durch den Schalter aktiviert. Dieser Schalter kann ein mechanischer Leistungsschalter oder ein elektronischer Schalter sein, wenn die Schalteigenschaften mit einem Mittelspannungsleistungsschalter vergleichbar sind. *A short-circuit simulator based on the voltage divider principle has a pre-circuit and short-circuit choke. The short-circuit choke is activated by the switch. This switch can be a mechanical circuit breaker or an electronic switch if the switching characteristics are comparable to a medium-voltage circuit breaker.*		P ☐ F ☐ N/A ☒ N/T ☐

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
A.3	**Beispiele möglicher Prüfstände OVRT (informativ)** ***Examples of possible test benches OVRT (informative)***		
A.3.1	**Liste von Prüfeinrichtungen** ***List of test facilities***		
	• Netzsimulator (Umrichtersystem) • Transformatorbasierte Prüfeinrichtungen (Auto- oder Bypass-Transformatorsystem) • kondensatorbasierte Prüfeinrichtung. *- Mains simulator (inverter system)* *- Transformer-based test equipment (auto- or bypass transformer system)* *- capacitor-based testing device.*	See appendix for detail.	P ☒ F ☐ N/A ☐ N/T ☐
A.3.2	**Transformatorbasierte Prüfeinrichtung** ***Transformer based test apparatus***		
	Transformatorbasierte Prüfeinrichtungen haben einen Transformator mit geeignet abgestuften Abgriffen als Basis. Durch den Wechsel auf eine andere Kombination der Abgriffe werden die Fehlerform sowie die Einbruchstiefe bestimmt. Die Einbruchsdauer wird durch eine Schalteinheit festgelegt, die zwischen den verschiedenen Abgriffen umschaltet und einen kontinuierlichen Stromfluss nach Anhang A.1.1 des Prüflings gewährleistet. *Transformer-based test facilities have a transformer with suitably graded taps as a base. By switching to a different combination of the taps, the type of fault and the burglary depth are determined. The burglary duration is determined by a switching unit which switches between the different taps and ensures a continuous current flow according to Appendix A.1.1 of the test item.*		P ☐ F ☐ N/A ☒ N/T ☐
A.3.3	**Kondensatorbasierte Prüfeinrichtung** ***Capacitor-based testing device***		

Absatz	Anforderungen-Prüfungen	Messergebnisse-Bemerkungen	Bewertung
Clause	*Requirements-Tests*	*Measuring results-Remarks*	*Evaluation*
	The example below shows a capacitor-based test setup for an overvoltage ride-through. By connecting a capacitor to a coil, a series resonant circuit can be formed which generates an overvoltage. In this way, overvoltage situations in networks (e.g. load shedding, Ferranti effect) can be realistically simulated. *As already described above for the undervoltage ride-through, the effect of the test sequence for the upstream network is limited by the resistor XSR.* *The XSR resistor should be variable and selected so that the overvoltage generated for the test does not create an undesirable situation in the upstream network and at the same time does not significantly influence the transient response of the PGU.* *A bypass for XSR (LS1) can be switched before and after the voltage rise triggered by actuating LS2.The overvoltage is triggered by connecting the resistor of CL and Rd via switch LS2.* *The values of XSR, CL and Rd should be selected so that the voltage specified for the test is generated when the test item is not connected. The values of XSR, CL and Rd as used in the test shall be specified in the test apparatus description, together with the no-load short-circuit ratio of mains and test apparatus.* *Switches LS1 and LS2 shall be used to control the duration of the voltage rise. These may, for example, be mechanical switches. If other switching devices are used, the behaviour of mechanical switches with respect to closing time and opening time is regarded as a reference to be observed.*		P ☐ F ☐ N/A ☒ N/T ☐

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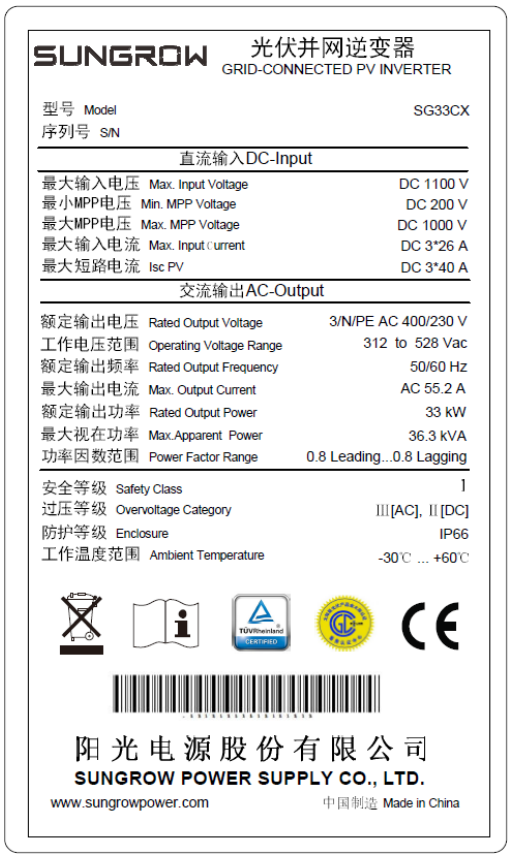
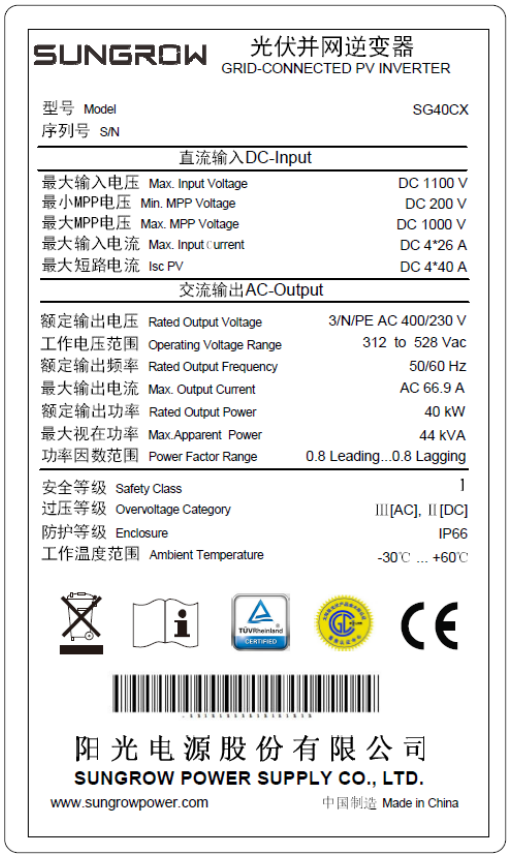
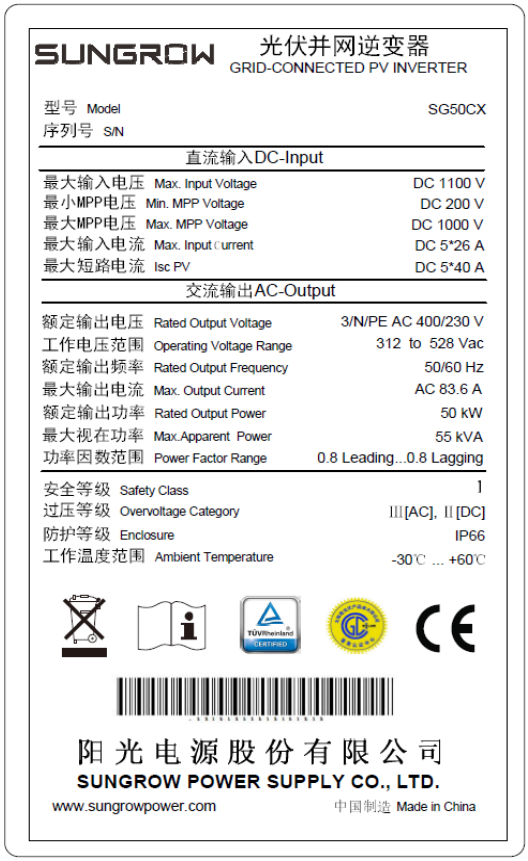
ZUSATZ-DOKUMENTATION
ADDITIONAL DOCUMENTATION

See following pages.

Copy of marking plate:



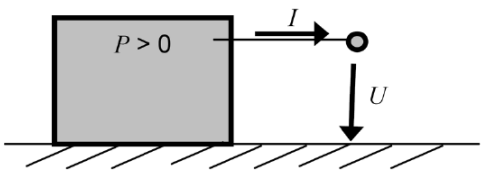




Possible test case verdicts:	
- test case does not apply to the test object ..... :	N/A
- test object was not evaluated for the requirement .... :	N/E
- test object does meet the requirement ..... :	Pass (P)
- test object does not meet the requirement ..... :	Fail (F)
Testing:	
Date of receipt of test items ..... :	09.12.2019
Date(s) of performance of tests ..... :	09.12.2019 - 30.03.2020

General remarks:

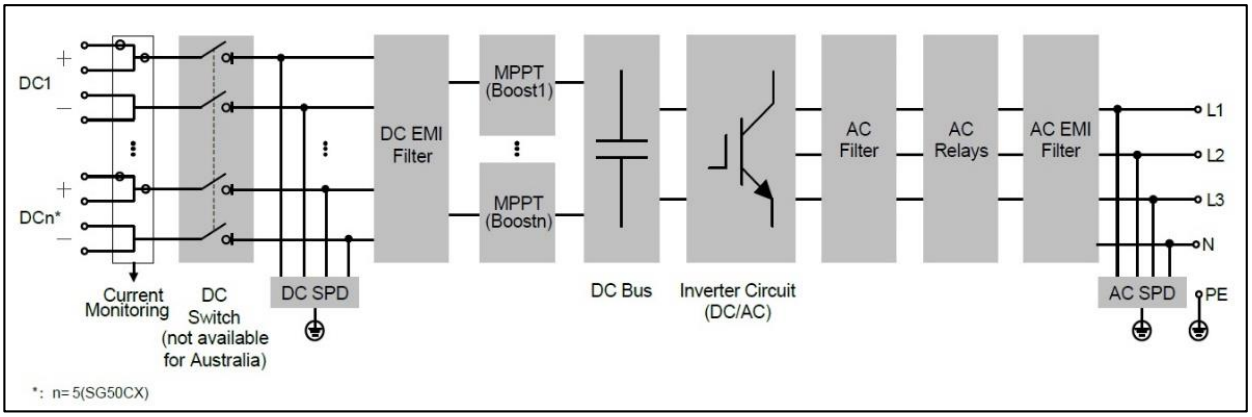
"(see Attachment #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.
The tests results presented in this report relate only to the object tested.
This report shall not be reproduced except in full without the written approval of 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:



General product information:

Brief description:

The PCE under test (EUT) is Grid-connected PV Inverter which utilizes the advanced power electronics conversion components such as MOSFET, IGBT, IPM to convert the variable DC power generated from the photovoltaic (PV) arrays to the stable utility AC power which can be fed into the commercial electrical grid. The PCE series under test is three-phase grid-connected PV inverter for solar power generation with the rating of 33kW-50kW.



Block diagram

Interface relays disconnect the equipment from utility in case any one of following faults occurred:

1. PV array insulation resistance fault
2. Residual current fault
3. Over & under grid voltage
4. Over & under grid frequecny
5. Islanding operation
6. Over DC injection current

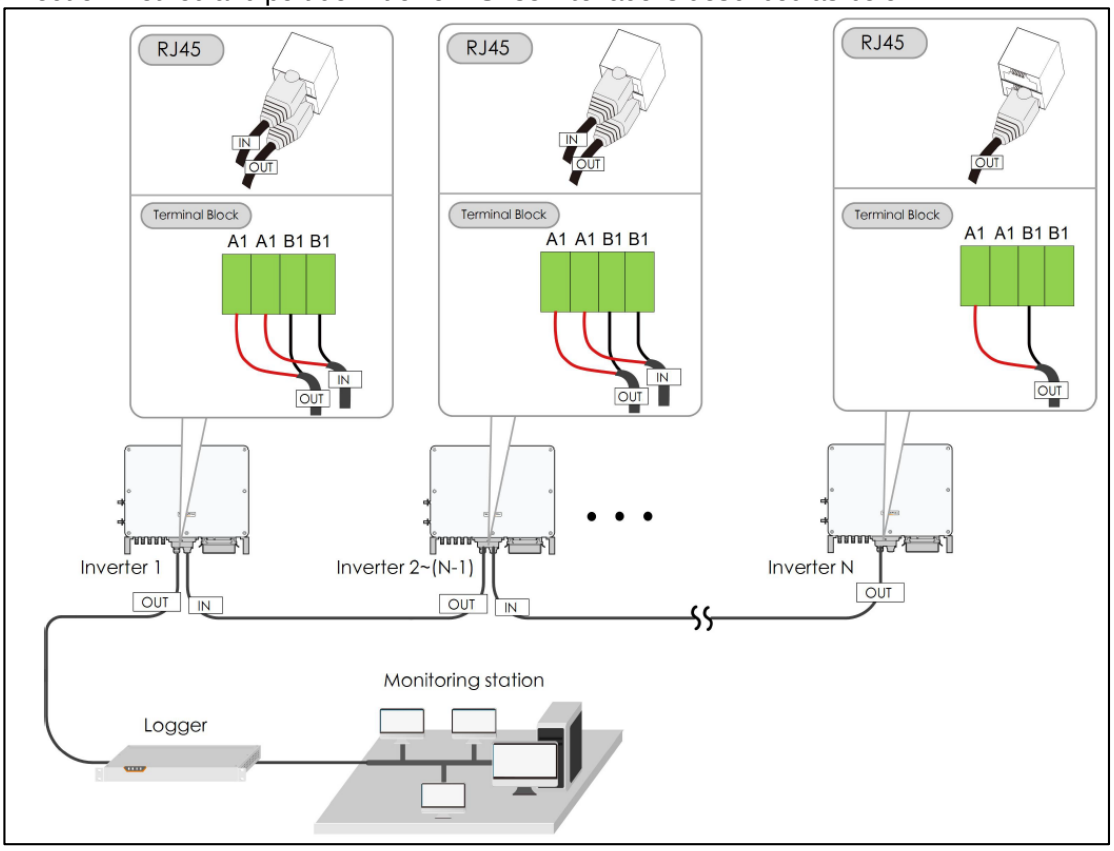
The protection device makes up of two in series, communicative coupled AC relays so that the equipment could be effectively separated from utitlity even any one of relays short circuited or works abnormally. **However, the external protection device shall be also installed additionally acc. to the requirements of VDE-AR-N 4105.**

The controlling section is also redundant built, one master DSP, and one slave DSP. The master DSP carries out the main calculation and driving instructions. Slave DSP is responsible for the redundant relay independently. In case any one of two chips breaks down or runs a wrong program, which result to the loss of protection funciton, the another chip could indicate the fault and disconnect the equipment immediately

Remote control:

The product provides RS485 interface for remote control. The logger collect the commands sent by network operator, and transfer the signal to RS485 interface.

The connection method and port definition of RS485 interface is described as below:



Model Difference:

The models SG33CX, SG40CX, SG50CX are identical in hardware and software, except for MPPT numbers, electrical ratings, model name, components numbers and specifications. Detail information are as follows:

Items	SG33CX	SG40CX	SG50CX
Number of input	6	8	10
Number of independent MPPT	3	4	5
Numer of string detector	3	4	5
DC switch	6 poles	4 poles	6 poles + 4 poles
DC common mode inductor	L1: CA01-10292/1.0mH	L1: CA01-11264/0.95mH; L2: CA01-11264/0.95mH	L1: CA01-10292/1.0mH L2: CA01-11264/0.95mH
Number of boost current detector	3	4	5
Boost module	NXH240B120H3Q1PG	DF150R12W1H3F_B11	NXH240B120H3Q1PG; DF150R12W1H3F_B11

Boost inductor	MA095005/750uH	MA095006/750uH x 2	MA095005/750uH; MA095006/750uH
Inverter Module	FS3L100R07W3S5_B11	10-PF07NIA100S505-P927F53T x 3	F3L200R07W2S5_B11 x 3
Inverter Inductor	BP085007/400uH	BP100A08/280uH	BP110B14/220uH
Bus Cap.(Film type)	6 pcs	7 pcs	8 pcs
Bus Cap.(E-Cap)	8 pcs	10 pcs	12 pcs
AC current detector	5V/50A	5V/75A	5V/100A
AC filter capacitor	380V/8uF+350V/3.3uF	380V/8uF x 2	380V/8uF x 2
AC common mode inductor	55A/0.36mH	84A/0.44mH	84A/0.44mH
Small inductor of L	55A/10uH	84A/10uH	84A/10uH
Number of external fans	2	3	3

Unless otherwise specified, all tests were conducted on model SG50CX to represent other family models.

$P_{AV,E}$ monitoring device:

$P_{AV,E}$ monitoring function is realized by smart meter and current transducer in the test. The power at the power connection point was sampled and feed back to inverter through UMG604 and EMG610.

The product was tested on:
Firmware version: MDSP_AGATE-S_V11_V01_A

Test condition:
Temperature: 25°C
Relative humidity: 70%

Model list:

MODELS LIST		SG33CX	SG40CX	SG50CX
PV INPUT	$V_{MAX\ PV}$ [Vdc]	1100		
	$I_{SC\ PV}$ [A]	3*40	4*40	5*40
	MPP Voltage Range V_{MPP} [Vdc]	200 - 1000		
	Max. Input Current I_{MAX} [A]	3*26	4*26	5*26
AC OUTPUT	Rated Output Voltage Ur [Vac]	3/N/PE 400		
	Rated Output Frequency F_{NETZ} [Hz]	50		
	Rated Output Power P_E [W]	33000	40000	50000
	Max. Output Power P_{Emax} [W]	36300	44000	55000
	Max. Apparent power S_{Emax} [VA]	36300	44000	55000
	Max. Output Current Imax [A]	55.2	66.9	83.6
	Power Factor cosφ [λ]	[$0.8_{under\text{-}excited}$…$0.8_{over\text{-}excited}$]		
ROTECTION SETTINGS	Firmware version	MDSP_AGATE-S_V11_V01_A		
	Voltage threshold value [U/Un]	$U_{MIN\ stage\ 1}$: 0.80, $U_{MIN\ stage\ 2}$: 0.45 $U_{MAX\ stage\ 1}$: 1.10, $U_{MAX\ stage\ 2}$: 1.25		
	The accuracy of voltage measurement [U/Un]	±0.01		
	Voltage trip time [ms]	$U_{MIN\ stage\ 1}$: <3100 (T_{LIMIT}: <3100), $U_{MIN\ stage\ 2}$: <400 (T_{LIMIT}: <400), $U_{MAX\ stage\ 1}$: <200 (T_{LIMIT}: <200), $U_{MAX\ stage\ 2}$: <200 (T_{LIMIT}: <200)		
	Frequency threshold value [Hz]	F_{MIN}: 47.5, F_{MAX}: 51.5		
	The accuracy of frequency measurement [f/fn]	±0.005		
	Frequency trip time [ms]	F_{MIN}: <200 (T_{LIMIT}: 200), F_{MAX}: <200 (T_{LIMIT}: 200)		
	Active anti-islanding trip time [s]	<9.0 (T_{LIMIT}: 9.0)		
	Reconnection Voltage [U/Un]	U_{MIN}: 0.85 , U_{MAX}: 1.10		
	Reconnection Frequency [Hz]	F_{MIN}: 47.5, F_{MAX}: 50.10		
	Reconnection Time [s]	60 (T_{LIMIT} ≥ 60)		

Throughout the test report following abbreviations may be used:

General	P_{Emax}	Highest measured active power of generator, as 10min average value, equal to $P_{Emax600}$. Determination of $P_{Emax600}$ see table 5.7.2.2 for detail.
General	S_{Emax}	Highest measured apparant power of generator, as 10 min average value, equal to $S_{Emax600}$. Determination of $S_{Emax600}$ see table 5.7.2.2 for detail.
General	EUT	Equipment under test
General	PGU	Power generator unit
General	PGS	Power generator system
General	ESS	Energy storage system
Table 5.7.2.2	$P_{Emax*)}$	Possible maximum active power as 10min average value under the corresponded test condition. *) might represent a) to c).
Table 5.7.2.2	$S_{Emax*)}$	Possible maximum active power as 10min average value under the corresponded test condition. *) might represent a) to c).
Table 5.7.2.2	$P_{Emax600}$	$P_{Emax600}=max(P_{Emax600a)}, P_{Emax600b)}, P_{Emax600c)})$
Table 5.7.2.2	$S_{Emax600}$	$S_{Emax600}=max(S_{Emax600a)}, S_{Emax600b)}, S_{Emax600c)})$
Table 6.4	o-c	Open-circuited
Table 6.4	s-c	Short-circuited
Table 6.4	SD	Shut down
Table 6.4	RO	Recovered to Operate after removing the single fault
Table 6.4	DG	Disconnection to grid
Table 6.4	NCD	No components damaged
Table 6.4	NH	No Hazards
Table 6.4	FID	Fault indication

Summary of tests:	
Clause	Test items
☒ **5.2**	**Verification of network reaction**
☒ 5.2.2	Rapid voltage change
☒ 5.2.3	Flicker
☒ 5.2.4	Harmonics and Inter-harmonics
☒ 5.2.5	Commutation notches
☒ 5.2.6	DC current feeding to network
☒ **5.3**	**Verification of symmetry character of inverter**
☒ 5.3.2.1	Calculation of asymmetry of three-phase inverter
☐ 5.3.2.2.1	Loss of individual inverter
☐ 5.3.2.2.2	Power reduction of individual inverter
☐ 5.3.2.3	Symmetry operation with a symmetry device
☒ **5.4**	**Verification of character of PGU in network**
☒ 5.4.2	Measurement of active- and reactive power range
☒ 5.4.3	Active power reduction through setting command
☒ 5.4.3.2	Measure of accuracy
☒ 5.4.3.3	Measure of power gradient
☐ 5.4.3.4	Measure of interface priority
☒ 5.4.4	Active power of PGU by over frequency
☐ 5.4.5	Active power of ESS by over frequency
☒ 5.4.6	Active power of PGU by under frequency
☐ 5.4.7	Active power of ESS by under frequency
☒ 5.4.8	Static voltage maintance / reactive power provision
☒ 5.4.8.1	Tests of reactive power / displacement factor accuracy
☒ 5.4.8.2	Tests of displacement factor- / active power character line $\cos_{\varphi}$ (P)
☒ 5.4.8.3	Tests of reactive power-voltage character line Q(U)
☒ 5.4.8.3.1	Tests of accuracy of Q(U) control
☒ 5.4.8.3.2	Tests of dynamic of Q(U) control
☒ **5.5**	**Verification of NS protection**
☐ 5.5.3	Central NS protection
☒ 5.5.4	Integrated NS protection
☐ 5.5.6.2	Central interface switch
☒ 5.5.6.3	Integrated interface switch
☒ 5.5.7	Protection devices and settings
☒ 5.5.8	Indication of NS protection
☒ 5.5.9	Constructional features of NS protection

☒ 5.5.10	Islanding detection
☒ **5.6**	**Connection conditions and synchronization**
☒ **5.7**	**Verification of $P_{AV,E}$ monitoring**
☒ **5.8**	**Verification of dynamic network supporting**

5.2.2	TABLE: Rapid voltage change		P
Test voltage: 3/N/PE 400V, 50Hz			
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159			
Switching actions	U r.m.s [V]	I r.m.s [A]	Ki
Marking operation without default (to primary energy carrier)	230.1	7.1	0.10
Worst case at switch over of generator sections	N/A	N/A	N/A
Marking operation at reference conditions(of primary energy carrier)	230.1	74.2	1.02
Breaking operation at nominal power	230.2	72.4	1.00
Worst case value of all switching operations Ki max	1. 02		

5.2.3	TABLE: Flicker		P
☒ PGU and ESS with nominal current ≤75A (Per DIN EN 61000-3-3 / DIN EN 61000-3-11)			
Test voltage: 3/N/PE 400V, 50Hz			
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159			
☐ Zref : Z_A = 0.24+0.15j, Z_N = 0.16+0.10j		☒ Ztest : Z_A = 0.15+0.15j, Z_N = 0.10+0.10j	
Test No.	Power [%]	Pst	CΨk
1	100	0.28	0.67
2	100	0.28	0.67
3	100	0.28	0.67
4	100	0.28	0.67
5	100	0.28	0.67
6	100	0.28	0.67
7	100	0.28	0.67
8	100	0.28	0.67
9	100	0.28	0.67
10	100	0.28	0.67
11	100	0.28	0.67
12	100	0.28	0.67
Plt	0.28	CΨk max	0. 67
Remark: The worst value of three phases shall be determined.			

5.2.4	TABLE: Harmonics and inter-harmonics											P
Rated voltage: 3/N/PE 400V, 50Hz												
Harmonics												
Active power P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100	Limit
Harmonic number	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]
2	0.00	0.07	0.07	0.06	0.06	0.06	0.08	0.08	0.08	0.10	0.13	8.0
3	0.01	0.07	0.05	0.05	0.03	0.05	0.10	0.11	0.14	0.19	0.26	--
4	0.00	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	4.0
5	0.00	1.15	0.73	0.51	0.65	0.77	0.53	0.45	0.40	0.37	0.36	10.7
6	0.00	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	2.7
7	0.00	0.47	0.59	0.45	0.39	0.35	0.44	0.33	0.25	0.18	0.14	7.2
8	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	2.0
9	0.00	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	--
10	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.6
11	0.00	0.26	0.19	0.04	0.07	0.14	0.23	0.18	0.15	0.12	0.12	3.1
12	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.3
13	0.00	0.03	0.28	0.11	0.03	0.07	0.18	0.15	0.12	0.08	0.08	13.0
14	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	--
15	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	--
16	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--
17	0.00	0.18	0.12	0.13	0.09	0.04	0.10	0.11	0.10	0.07	0.05	--
18	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	--
19	0.00	0.14	0.09	0.10	0.09	0.06	0.07	0.09	0.09	0.07	0.05	--
20	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
21	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	--
23	0.00	0.10	0.11	0.03	0.07	0.07	0.03	0.05	0.06	0.05	0.05	--
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
25	0.00	0.07	0.07	0.04	0.05	0.06	0.02	0.04	0.05	0.05	0.04	--
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	--
27	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--
28	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	--
29	0.00	0.05	0.02	0.06	0.02	0.05	0.01	0.03	0.04	0.04	0.04	--
30	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	--
31	0.00	0.08	0.04	0.05	0.02	0.04	0.02	0.03	0.04	0.04	0.04	--
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
33	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--
34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
35	0.00	0.02	0.05	0.02	0.03	0.02	0.03	0.02	0.04	0.04	0.04	--
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
37	0.00	0.03	0.03	0.01	0.04	0.02	0.03	0.02	0.03	0.03	0.03	--
38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
39	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	--
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--

Intern-harmonics											
Active power P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
Frequency [Hz]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]
75	0.01	0.08	0.08	0.08	0.08	0.09	0.10	0.11	0.13	0.12	0.13
125	0.00	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
175	0.00	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
225	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
275	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
325	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
375	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
425	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
475	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
525	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
575	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
625	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
675	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
725	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
775	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
825	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
875	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
925	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
975	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
1025	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
1075	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
1275	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
1375	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1425	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01
1475	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
1525	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
1575	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
1625	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
1725	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1775	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
1825	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1875	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01
1925	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Higher frequencies											
Active power P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Frequency [kHz]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]	I[%]
2.1	0.00	0.04	0.04	0.03	0.04	0.02	0.05	0.02	0.04	0.05	0.05
2.3	0.01	0.02	0.02	0.03	0.02	0.03	0.04	0.02	0.03	0.04	0.04
2.5	0.01	0.02	0.02	0.03	0.02	0.03	0.04	0.03	0.03	0.04	0.04
2.7	0.00	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.07	0.08
2.9	0.00	0.03	0.03	0.04	0.03	0.02	0.04	0.06	0.06	0.07	0.08
3.1	0.00	0.02	0.03	0.04	0.04	0.03	0.05	0.04	0.04	0.05	0.05
3.3	0.01	0.03	0.04	0.03	0.03	0.04	0.07	0.06	0.06	0.05	0.05
3.5	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
3.7	0.04	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
3.9	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
4.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.3	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.5	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
4.7	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.9	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5.1	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.02
5.3	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02
5.5	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5.7	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5.9	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
6.1	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
6.3	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02
6.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6.7	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
6.9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
7.1	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
7.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
7.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
7.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remark: The worst case of three phases has been choosed.											

5.2.5	TABLE: Commutation notches		P
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159			
Test condition	Commutation notches current [A]		
Between 25% P_{Emax} and 35% P_{Emax}	0	0	0
Between 65% P_{Emax} and 75% P_{Emax}	0	0	0
> 90 P_{Emax}	0	0	0
Remark: No commutation notches currents were observed in test.			

5.2.6	TABLE: DC current feeding		P
Test voltage: 3/N/PE 400V, 50Hz			
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159			
S/S_{Emax}	30% - 40%		
Measurement			Limitation
Phase A	Phase B	Phase C	
0.37%	0.13%	0.42%	0.5% or 20mA
S/S_{Emax}	60% - 70%		
Measurement [%]			Limitation
Phase A	Phase B	Phase C	
0.37%	0.13%	0.45%	0.5% or 20mA
S/S_{Emax}	> 95%		
Measurement [%]			Limitation
Phase A	Phase B	Phase C	
0.38%	0.15%	0.39%	0.5% or 20mA
Remark: The max. absolute value of measurements shall be taken.			

5.3.2.1	TABLE: Asymmetry calculation for three-phase inverter						P
☒ Three-phase inverter							
Test voltage: 3/N/PE 400V, 50Hz							
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159							
No.	Test condition		Power asymmetry [VA]				
	cos ϕ	P/P_{Emax}	I	II	III	IV	VI
1	1.00	100%	109.8	110.2	108.7	110.3	108.9
2	1.00	50%	54.7	54.9	52.2	54.3	55.6
3	max. under-excited	100%	115.3	115.5	116.8	116.8	116.5
4		50%	68.9	68.5	69.1	69.0	69.2
5	max. over-excited	100%	118.2	116.9	117.5	117.4	115.9
6		50%	68.3	69.7	69.5	70.3	70.4
Max. Power Asymmetry [VA]			118.2		Limitation [VA]		2750

5.4.2	TABLE: Measurement of active- and reactive power ranges	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

No.	Test condition		Measurement						
	Cos_φ	U / Un	U [V]	I [A]	$P_{Emax600}$*) [W]	$S_{emax600}$*) [VA]	Q [Var]	Cos_φ	Limit Cos_φ
a1	1.00	90%	207.5	81.2	50537.6	50556.3	1331.7	1.000	--
a2		95%	219.0	81.1	53245.7	53253.7	910.0	1.000	--
a3		100%	230.5	79.4	54884.8	54893.9	974.1	1.000	--
a4		105%	242.0	75.7	54948.7	54959.6	1066.3	1.000	--
a5		109%	251.2	72.8	54850.9	54862.1	1072.2	1.000	--
b1	max. under-excited	90%	207.4	81.4	40393.6	50618.5	-30505.6	0.798	--
b2		95%	218.9	80.9	42458.6	53139.7	-31954.6	0.799	≤0.90
b3		100%	230.4	80.4	44454.3	55567.9	-33340.7	0.800	≤0.90
b4		105%	241.9	76.6	44400.0	55569.4	-33415.6	0.799	≤0.90
B5		109%	251.1	73.8	44456.9	55571.1	-33342.7	0.800	≤0.90
c1	max. over-excited	90%	207.5	81.4	40329.0	50664.6	30667.1	0.796	≤0.90
c2		95%	219.0	80.8	42212.1	53097	32209.1	0.795	≤0.90
c3		100%	230.5	80.5	44246.7	55656.2	33761.6	0.795	≤0.90
c4		105%	242.0	76.7	44282.6	55701.4	33789.0	0.795	≤0.90
C5		109%	251.2	74.0	44364.8	55734.7	33736.0	0.796	≤0.90

$P_{Emax600}$ [W]	54948.7
$S_{Emax600}$ [VA]	55734.7

Remark:.

5.4.3	TABLE: Active power reduction by setting command	P

Test voltage: 3/N/PE 400V, 50Hz

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

Nominal active power P_{Emax} [W]	55000

Setting P/ P_{Emax}	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
P [W]	54908	49748	44237	38704	33177	27681	22137	16607	11072	5556
Δ P/ P_{Emax}	-0.2%	0.5%	0.4%	0.4%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%
Limitation Δ P/ P_{Emax}	± 5%									

PGU disconnect from network ?	☐ Yes ☒ No

Power gradient (100%P_{Emax} ->5%P_{Emax}) [%P_n/s]:	0.65%Pn/s
Power gradient (5%P_{Emax} ->100%P_{Emax}) [%P_n/s]:	0.65%Pn/s
Limitation of gradient [%Pn/s]	0.33%Pn/s – 0.66%Pn/s

Multiple security management interface provided by PGU ?	☐ Yes ☒ No

5.4.4	TABLE: Active power feeding of PGU at over frequency	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

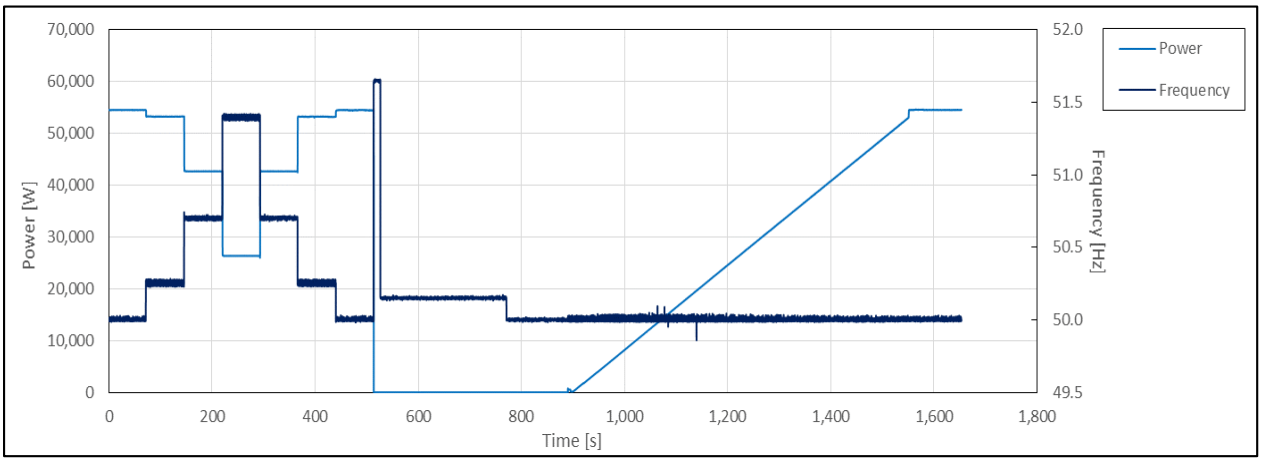
Test No. 1:

Power output:	100% P_{Emax}
Starting frequency:	50.2Hz
Droop:	5% (40%Pref / Hz)

No.	Frequency [Hz]	DC available power [W]	Power output [W]	Target power [P/ P_{Emax}]	Deviation ΔP/ P_{Emax}	Rise time $T_{rise\_90\%}$ [s]	Settling time T_{set} [s]	Response delay Tv [s]
Limitation		--	--	--	< ± 10%	< 2	< 20	< 2
a)	50.00	56817.0	54544.3	100%	-0.8%	--	--	--
b)	50.25	56817.0	53267.7	98%	-1.1%	0.70	0.70	0
c)	50.70	56817.0	42696.2	80%	-2.4%	0.40	0.40	0
d)	51.40	56817.0	26361.2	52%	-4.1%	0.50	0.50	0
e)	50.70	56817.0	42700.8	80%	-2.4%	0.50	0.50	0
f)	50.25	56817.0	53250.3	98%	-1.2%	0.50	0.50	0
g)	50.00	56817.0	54516.6	100%	-0.9%	0.80	0.80	0

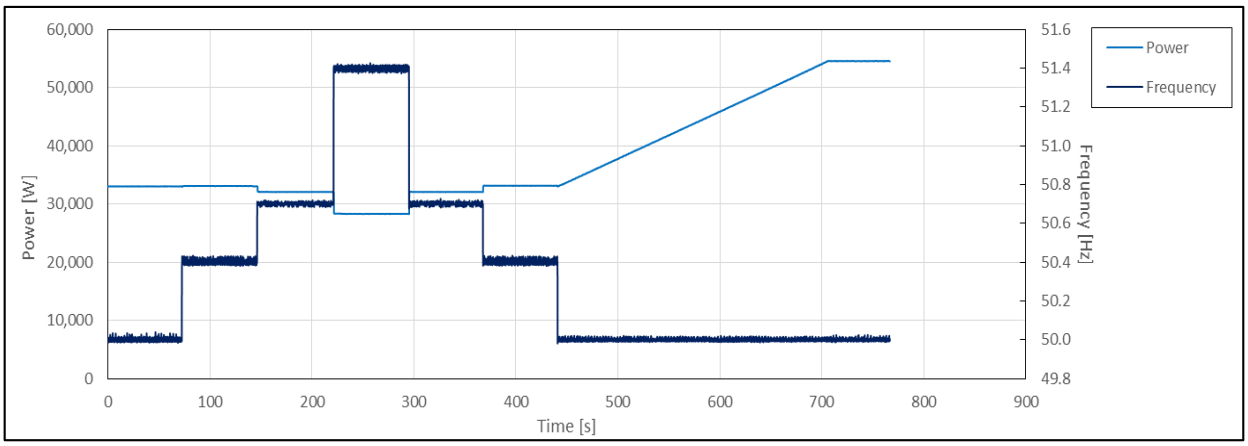
h)	51.65	Disconnection Time[ms]: 96.2, Limitation[ms]: 200
i)	50.15	Reconnection : ☐ Yes/ ☒ No, Limitation: No reconnection is allowed.
j)	50.00	Maximal Rising Gradient [W/min]: _4924.5__, Limitation [W/min]: __5500___

f(t), P(t) Diagram



Test No. 2:								
Power output:			60% P_{Emax}					
Starting frequency:			50.5Hz					
Droop:			12% (16.67%Pref / Hz)					
No.	Frequency [Hz]	DC available power [W]	Power output [W]	Target power [P/ P_{Emax}]	Deviation $\Delta P/ P_{Emax}$	Rise time $T_{rise\_90\%}$ [s]	Settling time T_{set} [s]	Response delay Tv [s]
Limitation		--	--	--	< ± 10%	< 2	< 20	< 2
a)	50.00	34412.5	33036.0	60%	0.07%	--	--	--
b)	50.40	34412.5	33100.5	60%	0.18%	--	--	--
c)	50.70	57291.7	32075.3	58%	0.07%	0.60	0.60	0
Set the primary available power or release the power limit to 100%P_{Emax}								
d)	51.40	57291.7	28307.1	51%	0.47%	0.40	0.40	0
e)	50.70	57291.7	32075.2	58%	0.32%	0.40	0.40	0
f)	50.40	57291.7	33144.5	60%	0.26%	0.30	0.30	0
g)	50.00	Maximal Rising Gradient [W/min]: _4875.9__, Limitation [W/min]: __5500__						

f(t), P(t) Diagram



5.4.6	TABLE: Active power feeding of PGU at under frequency	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

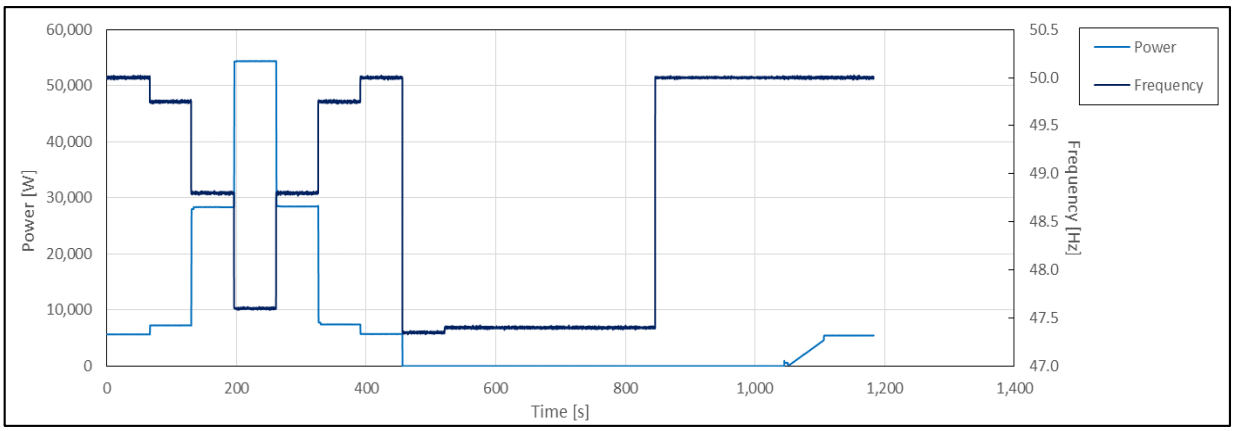
Test No. 1:

Power output:	10% P_{Emax}

No.	Frequency [Hz]	DC available power [W]	Power output [W]	Target power [P/ P_{Emax}]	Deviation $\Delta P/ P_{Emax}$	Rise time $T_{rise\_90\%}$ [s]	Settling time T_{set} [s]	Response delay Tv [s]
Limitation		--	--	--	< ± 10%	< 2	< 20	< 2
a)	50.00	57291.7	5650.4	10%	0.27%	--	--	--
b)	49.75	57291.7	7253.9	12%	1.19%	0.4	0.4	0
c)	48.80	57291.7	28353.1	50%	1.55%	0.60	0.60	0
d)	47.60	57291.7	54374.0	98%	0.86%	0.70	0.70	0
e)	48.80	57291.7	28468.9	50%	1.76%	0.80	0.80	0
f)	49.75	57291.7	7442.7	12%	1.53%	0.60	0.70	0
g)	50.00	57291.7	5714.9	10%	0.39%	0.30	0.30	0

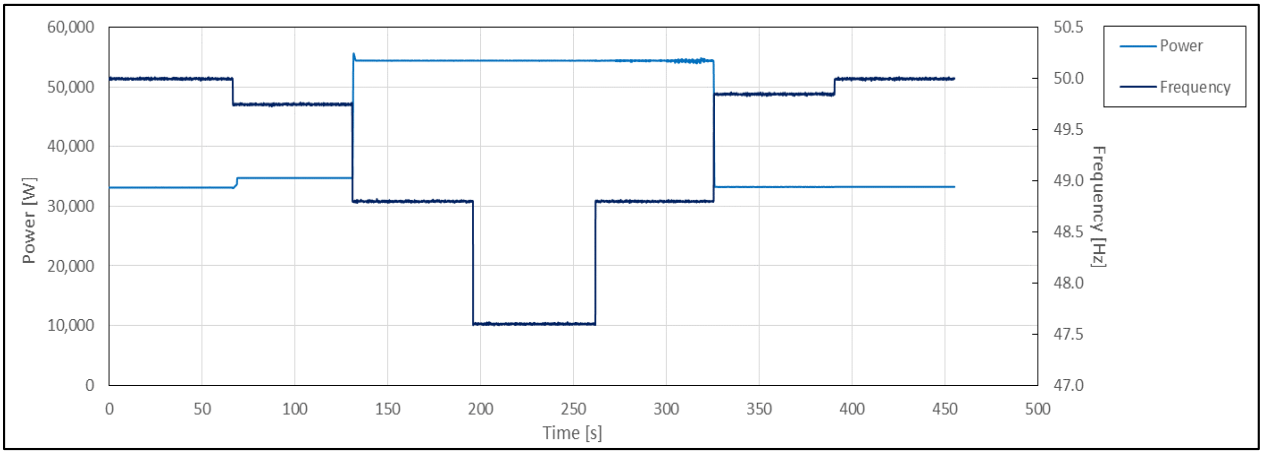
h)	47.35	Disconnection Time[ms]: 77.8, Limitation[ms]: 200
i)	47.40	Reconnection : ☐ Yes/ ☒ No, Limitation: No reconnection is allowed.
j)	50.00	Maximal Rising Gradient [W/min]: _3331.6__, Limitation [W/min]: __5500___

f(t), P(t) Diagram



Test No. 2:								
Power output:			60% P_{Emax}					
No.	Frequency [Hz]	DC available power [W]	Power output [W]	Target power [P/ P_{Emax}]	Deviation $\Delta P/ P_{Emax}$	Rise time $T_{rise\_90\%}$ [s]	Settling time T_{set} [s]	Response delay Tv [s]
Limitation		--	--	--	< ± 10%	< 2	< 20	< 2
a)	50.00	57291.7	33236.6	60%	0.43%	--	--	--
b)	49.75	57291.7	34821.4	62%	1.31%	--	--	--
c)	48.80	57291.7	54422.5	100%	-1.05%	0.60	0.60	0
d)	47.60	57291.7	54424.6	100%	-1.05%	--	--	--
e)	48.80	57291.7	54419.6	100%	-1.06%	--	--	--
f)	49.85	57291.7	33326.9	60%	0.59%	0.40	0.40	0
g)	50.00	57291.7	33350.9	60%	0.64%	--	--	--

f(t), P(t) Diagram



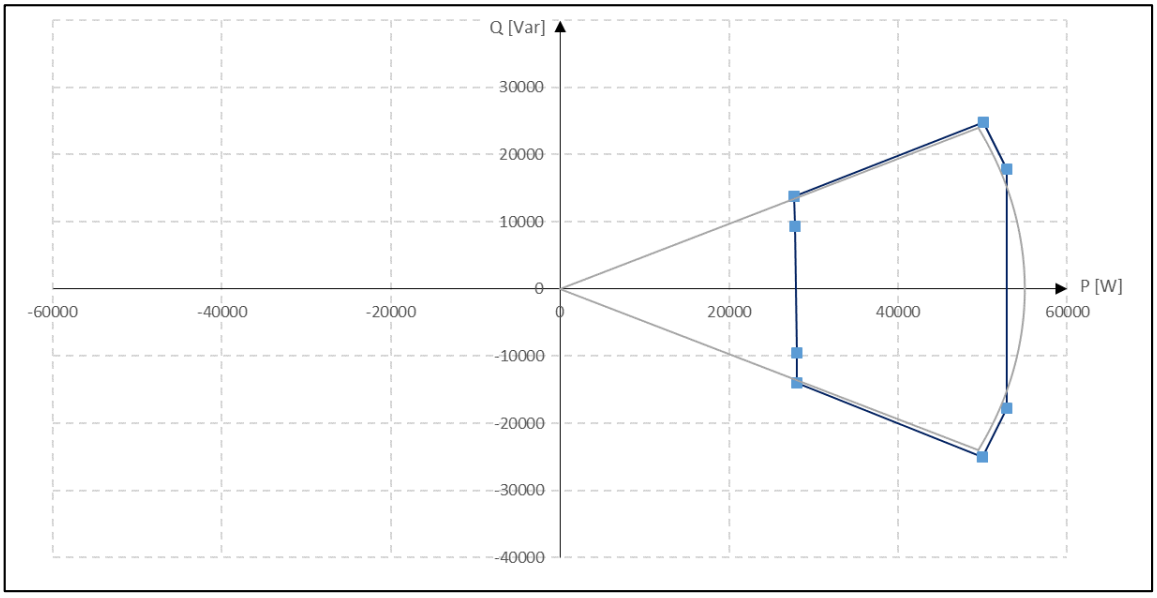
5.4.8.1	TABLE: Reactive power / displacement factor setting accuracy	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

Min. Cos_{φ} setting step: ±0.01

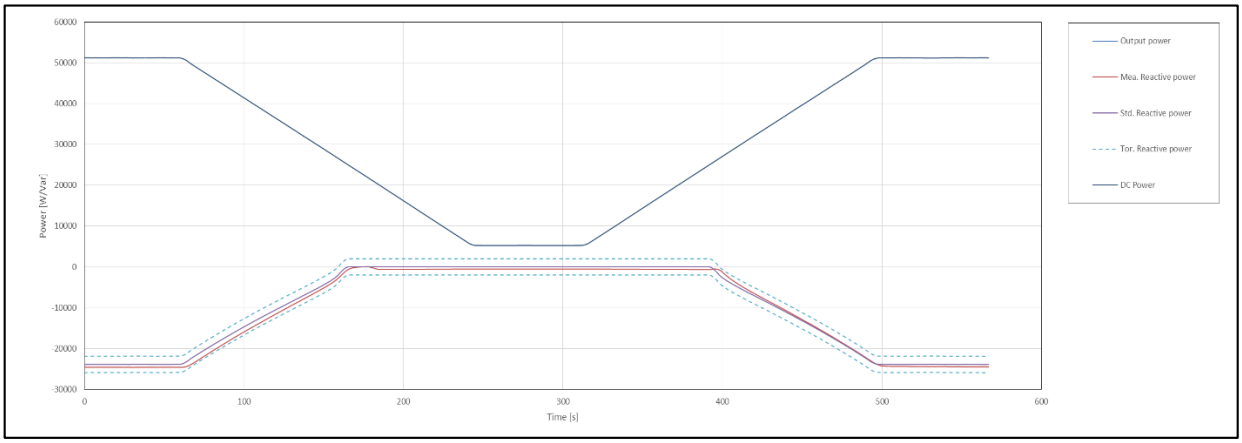
No.	Test condition		Measurement					
	Cos_{φ}	Power	U [V]	P [kW]	Q [kVar]	cos ϕ	$\Delta Q / P_{Emax}$	Limit $\Delta Q / P_{Emax}$
☒ ∑SEmax > 4.6kVA								
c)	0.90 under-excited	50%P_{Emax}	230.3	28020.9	-14027.9	0.894	-0.83%	≤ ±4%
		S_{Emax}	230.4	49936.9	-24940.2	0.895	-1.37%	≤ ±4%
	0.95 under-excited	50%P_{Emax}	230.4	28000.0	-9544.8	0.947	-0.62%	≤ ±4%
		S_{Emax}	230.4	52842.2	-17779.7	0.948	-0.75%	≤ ±4%
d)	0.90 over-excited	50%P_{emax}	230.4	27699.1	13773.2	0.895	0.65%	≤ ±4%
		S_{emax}	230.5	50061.5	24806.9	0.896	1.02%	≤ ±4%
	0.95 over-excited	50%P_{emax}	230.4	27762.1	9297.1	0.948	0.31%	≤ ±4%
		S_{emax}	230.5	52879.7	17790.0	0.948	0.74%	≤ ±4%

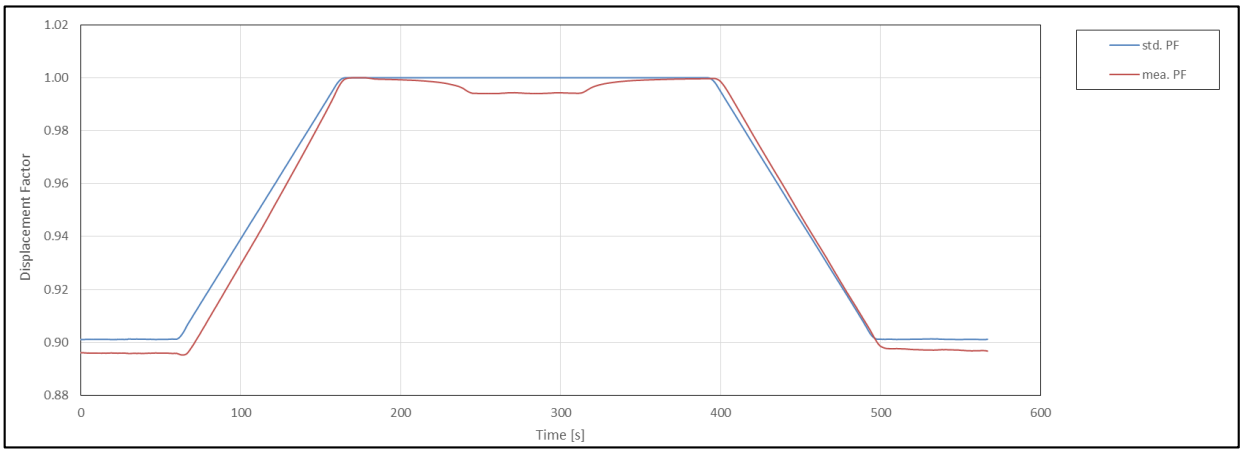
P-Q Diagram



5.4.8.2	TABLE: Displacement factor- / active power character line $Cos_{\varphi}(P)$	P
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159		
c) Test procedure for accuracy		
$P_{Primary}$ Setting: 100%Pn -> 10%Pn -> 100%Pn		
Limitation: $\Delta Q / P_{Emax} \leq \pm 4\%$	☒ Pass ☐ Failed	

P(t), Q(t), $Q_{set}(t)$, $Cos_{\varphi}(t)$, tolerance(t) Diagram





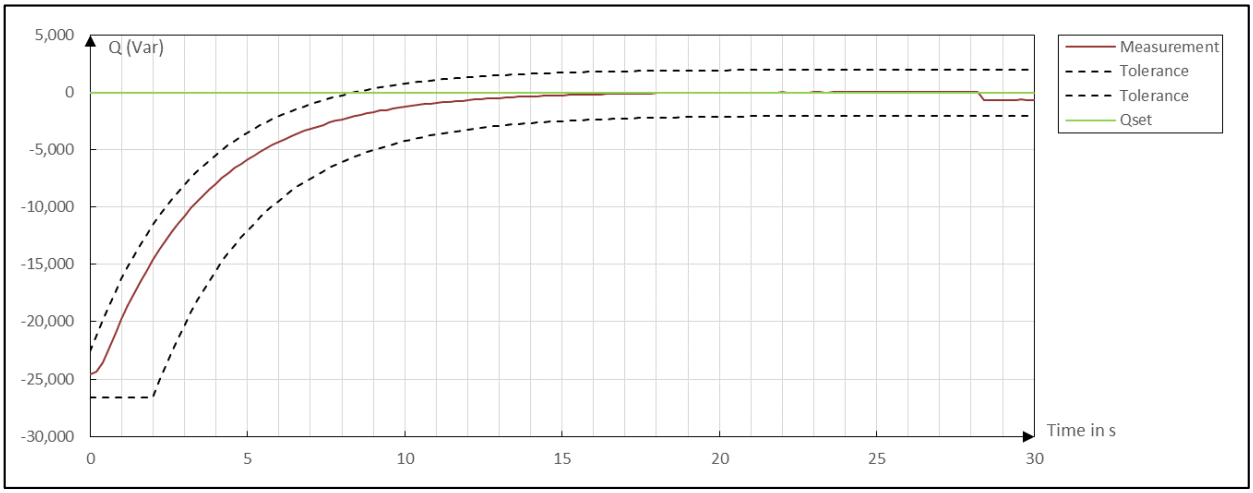
d) Test procedure for dynamic		
P/ P_n [%]	Duration [s]	Dynamic as PT1 character ?
100	60	--
40	60	☒ Pass ☐ Failed
100	60	--
75	60	☒ Pass ☐ Failed

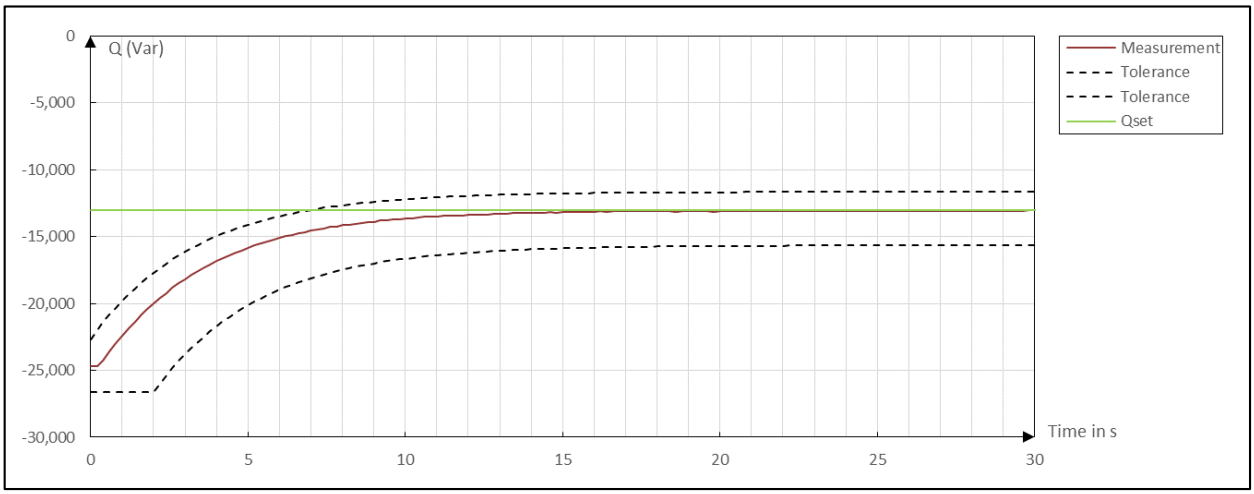
Remark:

PT1 upper boundary: $Q(t)= K(1-e^{(-t / Tau)}) + 0.04$, $K=\Delta Q_{set} / P_{Emax}$

PT1 lower boundary: $Q(t)= K(1-e^{(-(t-0.6Tau) / Tau)}) - 0.04$, $K=\Delta Q_{set} / P_{Emax}$

Q(t), Q_{set}(t) Diagram





5.4.8.3	TABLE: Reactive power-voltage character line Q(U)	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

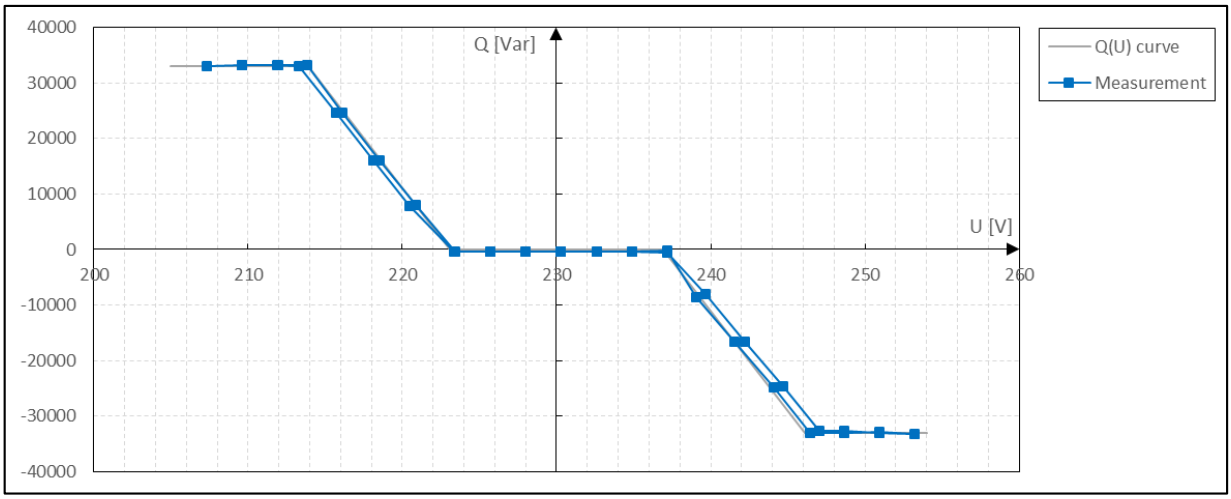
a) Test procedure for accuracy

Qmax= ± 33000

Voltage Setting U_{PGU}	Target Q_{PGU} [Var]	Measurement Q_{PGU} [Var]	Measurement U_{PGU} [V]	Δ Q_{PGU} [Var]
100%Un	0	-440.2	230.3	-440.2
99%Un	0	-432.5	228.0	-432.5
98%Un	0	-416.1	225.7	-416.1
97%Un	0	-404.1	223.4	-404.1
96%Un	8250	7873.5	220.5	-376.5
95%Un	16500	15956.4	218.1	-543.6
94%Un	24750	24692.6	215.7	-57.4
93%Un	33000	32994.3	213.3	-5.7
92%Un	33000	33234.3	211.9	234.3
91%Un	33000	33223.4	209.6	223.4
90%Un	33000	33102.8	207.3	102.8
91%Un	33000	33254.3	209.6	254.3
92%Un	33000	33217.6	211.9	217.6
93%Un	33000	33161.5	213.8	161.5
94%Un	24750	24547.6	216.1	-202.4
95%Un	16500	16102.1	218.5	-397.9
96%Un	8250	8011.2	220.9	-238.8
97%Un	0	-395.2	223.4	-395.2
98%Un	0	-415.8	225.7	-415.8
99%Un	0	-426.3	228.0	-426.3
100%Un	0	-443.9	230.3	-443.9
101%Un	0	-462.9	232.6	-462.9
102%Un	0	-467.5	234.9	-467.5
103%Un	0	-578.1	237.2	-578.1
104%Un	-8250	-7953.1	239.7	296.9
105%Un	-16500	-16565.4	242.2	-65.4
106%Un	-24750	-24699.8	244.7	50.2
107%Un	-33000	-32670.1	247.0	329.9
108%Un	-33000	-32576.6	248.7	423.4
109%Un	-33000	-33017.9	250.9	-17.9
110%Un	-33000	-33175.8	253.2	-175.8
109%Un	-33000	-32879.5	251.0	120.5
108%Un	-33000	-32956.9	248.7	43.1
107%Un	-33000	-33024.0	246.4	-24.0

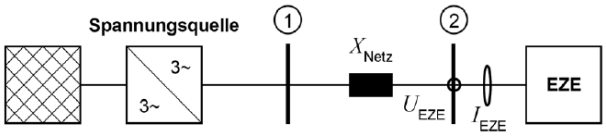
106%Un	-24750	-24774.5	244.1	-24.5
105%Un	-16500	-16552.8	241.6	-52.8
104%Un	-8250	-8618.5	239.1	-368.5
103%Un	0	-235.2	237.2	-235.2
102%Un	0	-390.3	234.9	-390.3
101%Un	0	-462.4	232.6	-462.4
100%Un	0	-452.9	230.3	-452.9
Limitation Δ Q	$Q_{PGU,tol} = \pm (0.01*U_{NY}*k_{QU}+0.04*P_{Emax})$, $k_{QU} = \lvert Q_{max} \rvert / (0.04*U_{NY})$			

Q(U) Diagram



b) Test procedure for Dynamic

X_{net} value: 0.11Ω, 3Tau=10s



Voltage Setting U_{PGU}	Target Q	Measurement Q_{PGU} [Var]	Measurement U_{PGU} [V]	Response time $T_{95\%}$ [s]	Dynamic as PT1
Reach to initial status, Q_{PGU} = 0					
Un + $\Delta U_{ind,Y}$	Inductive, 0.85Qmax	-28023	244.3	5.8	☒ Pass ☐ Failed
Return to initial status, stationary operation for 1min, Q_{PGU} = 0					
Un + $\Delta U_{ind,Y}$	Inductive, 0.85Qmax	-28037	244.3	5.8	☒ Pass ☐ Failed
Return to initial status, stationary operation for 1min, Q_{PGU} = 0					
Un + $\Delta U_{ind,Y}$	Inductive, 0.85Qmax	-28034	244.3	5.8	☒ Pass ☐ Failed
Return to initial status, stationary operation for 1min, Q_{PGU} = 0					
Un + $\Delta U_{Cap,Y}$	Capacitive, 0.85Qmax	26666	215.5	6.0	☒ Pass ☐ Failed
Return to initial status, stationary operation for 1min, Q_{PGU} = 0					
Un + $\Delta U_{Cap,Y}$	Capacitive, 0.85Qmax	26680	215.0	6.2	☒ Pass ☐ Failed
Return to initial status, stationary operation for 1min, Q_{PGU} = 0					
Un + $\Delta U_{Cap,Y}$	Capacitive, 0.85Qmax	26685	215.4	6.2	☒ Pass ☐ Failed

Remark:

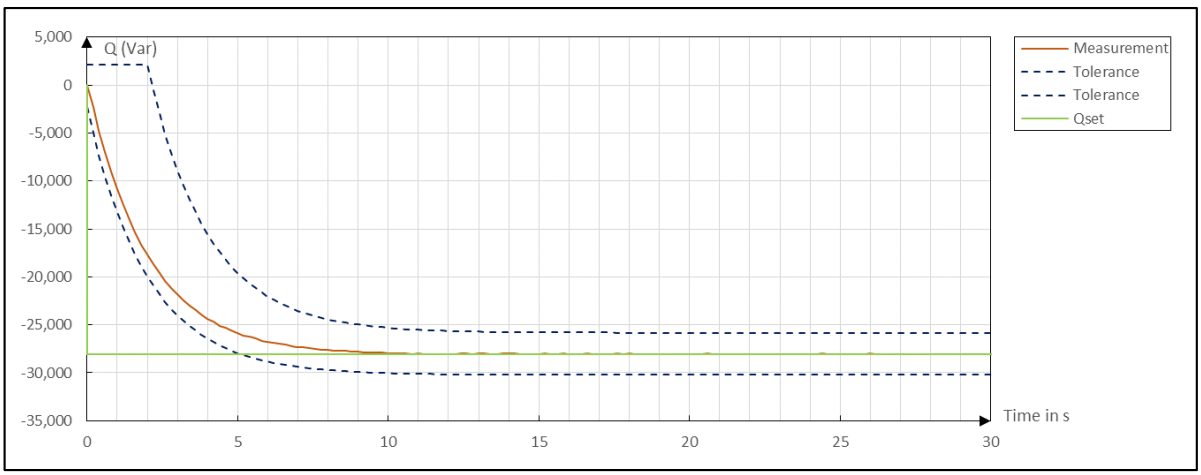
Xnet = 0.0218*3*U_{NY}^2 / (0.85*|Q_{max}|)

$\Delta U_{ind,Y}$ = 1.03*U_{NY} - U_{PGU} + (Xnet / (3*$U_{N,Y}$) + 1 / k_{QU}) * 0.85 * |Q_{max}|

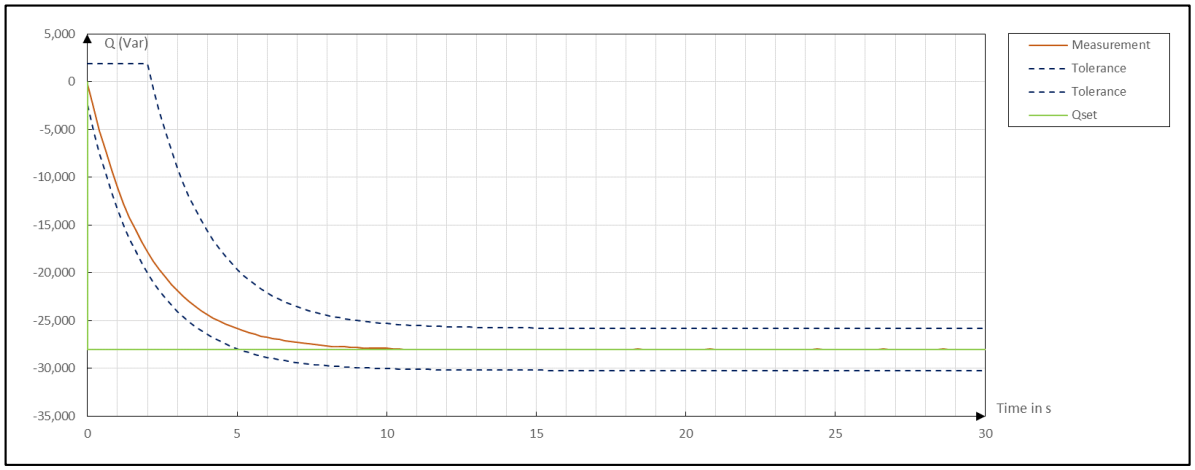
$\Delta U_{Cap,Y}$ = 0.97*U_{NY} - U_{PGU} - (Xnet / (3*$U_{N,Y}$) + 1 / k_{QU}) * 0.85 * |Q_{max}|

k_{QU} = |Q_{max}| / (0.04*U_{NY})

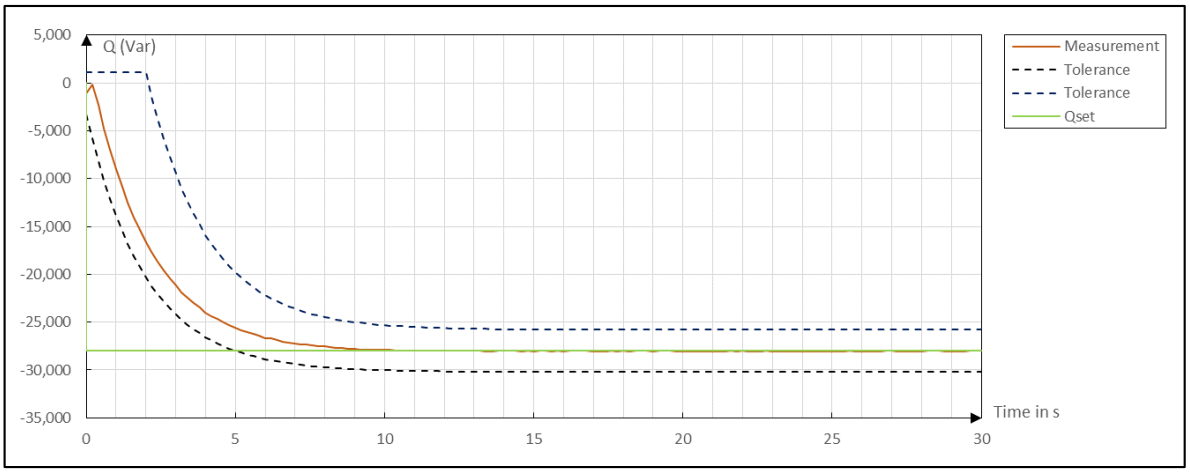
Q response at voltage Un + $\Delta U_{ind,Y}$



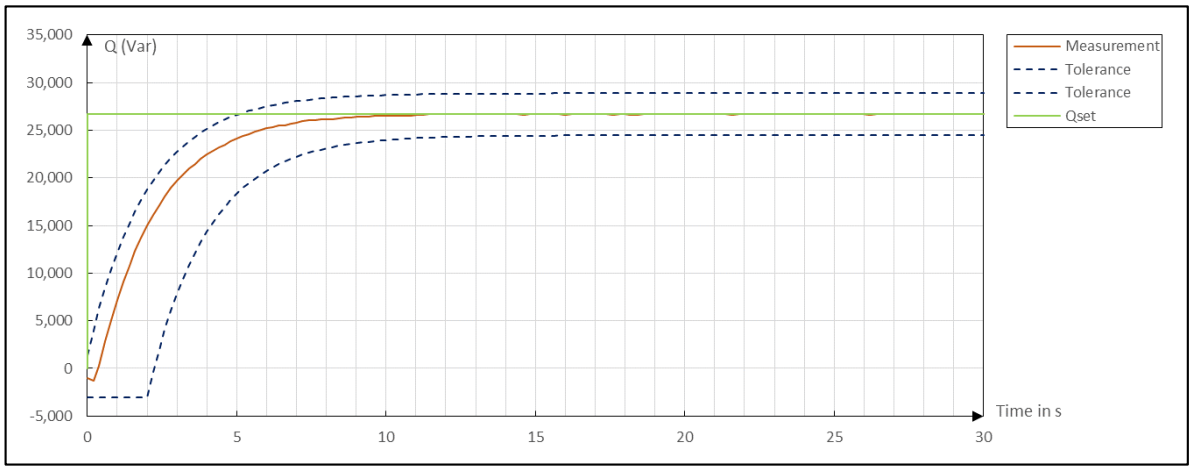
Q response at voltage Un + $\Delta U_{ind,Y}$



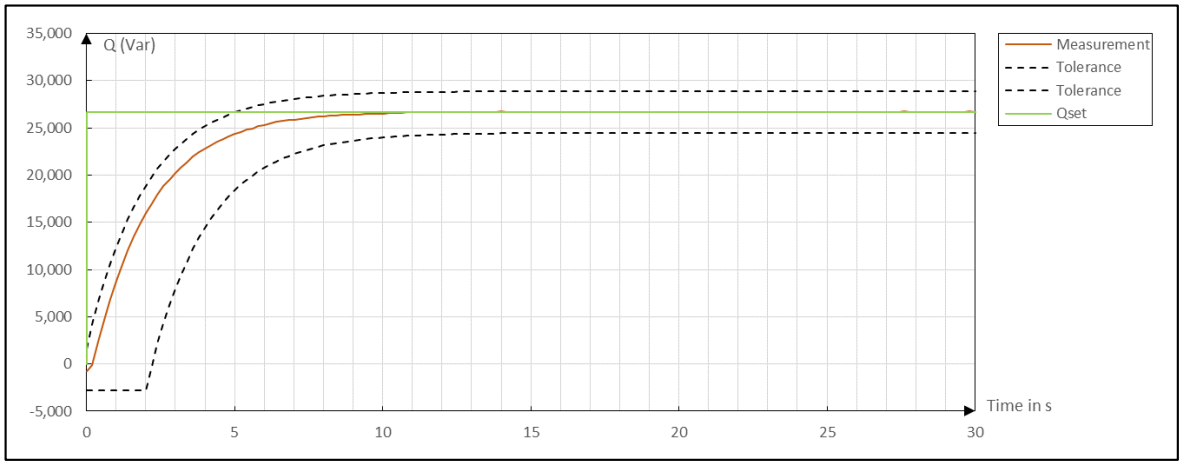
Q response at voltage Un + $\Delta U_{ind,Y}$



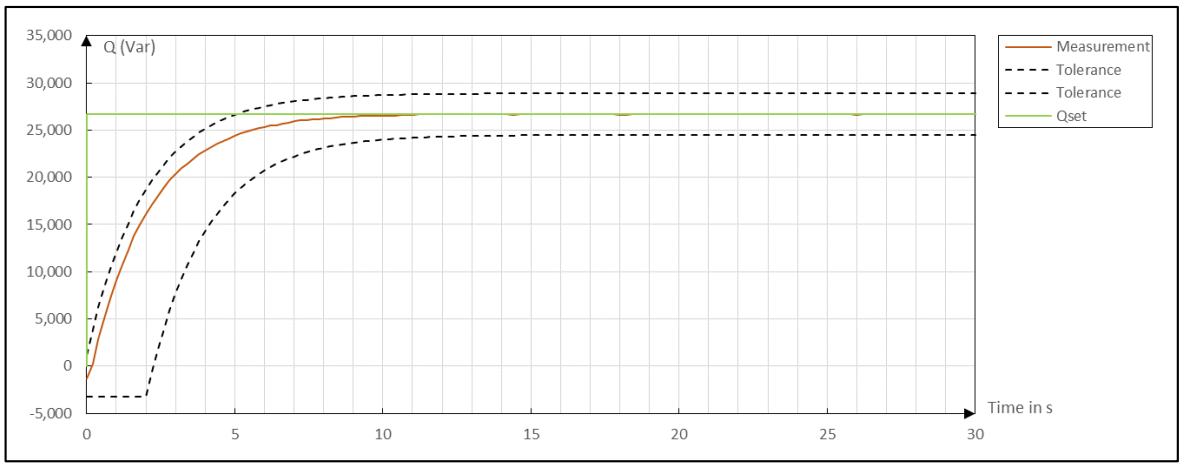
Q response at voltage Un + $\Delta U_{cap,Y}$



Q response at voltage Un + $\Delta U_{cap,Y}$



Q response at voltage Un + $\Delta U_{cap,Y}$



5.5.3, 5.5.4	TABLE: Interface switch (Functional safety)	P

☐ Central interface switch

Single fault type		A disconnection signal sent without delay ?
1.	Connection with a wrong equipment	☐ Pass ☐ Failed
2.	Connection interruption	☐ Pass ☐ Failed
3.	Connection incorrect establish	☐ Pass ☐ Failed
4.	Interruption of power supply of interface switch	☐ Pass ☐ Failed
5.	Trip the self-test of NS protection	☐ Pass ☐ Failed
Following information shall be stated in documentation of PGU:		
1.	The max. initial short-circuited current Ik":	☐ Pass ☐ Failed, _____A
2.	The max. fuse	☐ Pass ☐ Failed
3.	Connection plan includes necessary control signal	☐ Pass ☐ Failed

☒ Integrated interface switch

Although inverter under test integrates interface switch, but an external switch shall be installed in final system since the capacity over 30kVA.

☒ Complied with DIN EN 62109-1/-2

Switch manufacturer: Song Chuan / Xiamen Hongfa

Switch type: 511HP1-1AH-F-C / 515-1AH-F-C / HF172F-100/12-HF / HF167F-100/12-HF

The max. initial short-circuited current of PGU Ik": __83.6____A

EN 62109-1/-2 Cert No.: R50431160

No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
1.	INV voltage sampling R17	s-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "038", Device anomaly.
2.	INV voltage sampling R33	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "038", Device anomaly.
3.	Mains relay K15A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.
4.	Mains relay K17A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.
5.	Mains relay K19A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.
6.	Mains relay K16A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.
7.	Mains relay K18A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.

8.	Mains relay K20A	s-c before start	230Vac	2min	--	--	Inverter can't start, no hazard, fault indication: "038", Device anomaly.
9.	Mains relay driver R81	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "038", Device anomaly.
10.	ISO detection R286	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "039", Low system insulation resistance.
11.	Grid voltage sampling R263	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "010", Grid power outage.
12.	INV voltage sampling R269	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "038", Device anomaly.
13.	Grid voltage frequency sampling C199	s-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "013", Grid abnormal.
14.	Grid voltage sampling R59	s-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "017", Grid voltage unbalance.
15.	Grid voltage sampling R70	o-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "010", Grid power outage.
16.	Inverter IGBT driver C4	s-c	230Vac	2min	--	--	Inverter disconnect from grid, no hazard, fault indication: "038", Device anomaly.
17.	DSP power supply T1	12V s-c	230Vac	2min	--	--	Inverter shut down, no display, no hazard
18.	DSP power supply T1	7V s-c	230Vac	2min	--	--	Inverter shut down, no display, no hazard

5.5.7	TABLE: Protection device and settings	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

OV Stage 2 No.	Set value [ms]	Trip time [ms] L1-N	L2-N	L3-N	Limitation [ms]	Test condition
1	100	68.6	57.8	65.0	≤200	Mains voltage is jumped from Un to 1.28Un.

OV Stage 1 No.	Set value [ms]	Trip time [s]	Limitation [s]	Test condition
1	100	468	≤600	Operation under nominal voltage for 10min, then jumped from Un to 1.12Un.
2	100	No disconnect	No disconnect	Operation under nominal voltage for 10min, then jumped from Un to 1.08Un.
3	100	265	225 - 375	Operation under 1.06 voltage for 10min, then jumped from 1.06Un to 1.14Un.

UV Stage 2 No.	Set value [ms]	Trip time [ms] L1-N	L2-N	L3-N	Limitation [ms]	Test condition
1	300	No disconnect			No disconnect	Mains voltage is jumped from Un to 0.48Un and keep for 500ms.
2		281.1	287.1	290.1	≤400	Mains voltage is jumped from Un to 0.42Un and keep for 400ms.

UV Stage 1 No.	Set value [ms]	Trip time [ms] L1-N	L2-N	L3-N	Limitation [ms]	Test condition
1	3000	No disconnect			No disconnect	Mains voltage is jumped from Un to 0.83Un and keep for 60s.
2		2987	2987	2975	≤3100	Mains voltage is jumped from Un to 0.77Un.

OF No.	Set value [ms]	Trip time Measurement [ms]	Limitation [ms]	Remark
1	100	96.2	≤200	Mains frequency keep at 51.3Hz for 60s and then jumped to 51.7Hz
2		67.0		
3		66.0		

UF No.	Set value [ms]	Trip time Measurement [ms]	Limitation [ms]	Remark
1	100	75.6	≤200	Mains frequency keep at 47.7Hz for 60s and then jumped to 47.3Hz
2		77.8		
3		70.8		

5.5.8, 5.5.9	TABLE: Indication / protection of NS protection	P
1.	The last 5 fault indication can be read	☒ Pass ☐ Failed
	Fault 1:	“008”, Grid ovrefrequency
	Fault 2:	“008”, Grid ovrefrequency
	Fault 3:	“008”, Grid ovrefrequency
	Fault 4:	“008”, Grid ovrefrequency
	Fault 5:	“008”, Grid ovrefrequency
2.	Fault indication can be read after a supply interruption ≤ 3s	☒ Pass ☐ Failed
	Fault 1:	“008”, Grid ovrefrequency
	Fault 2:	“008”, Grid ovrefrequency
	Fault 3:	“008”, Grid ovrefrequency
	Fault 4:	“008”, Grid ovrefrequency
	Fault 5:	“008”, Grid ovrefrequency
3.	The protection settings can be read on PGU or data interface equipment	☒ Pass ☐ Failed
		Interface equipment: Cell phone
4.	The NS protection settings shall be protected.	☒ Pass ☐ Failed
		Protection type: Password
5.	If all protection settings are fixed	☒ Pass ☐ Failed

5.5.10	TABLE: Islanding detection (per IEC 62116: 2014)	P

Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159, 93H001827

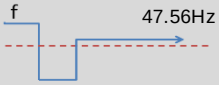
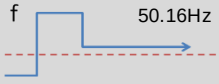
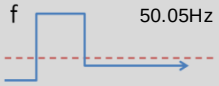
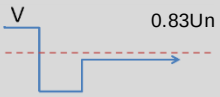
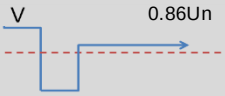
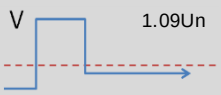
Power 100%

Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]
P_R: -10% Q_C: +10%	L1: 15.11	L1: 16.67	L1: 18.39	1.16	115.3	
	L2: 15.09	L2: 16.68	L2: 18.41	1.16		9000
	L3: 15.10	L3: 16.68	L3: 18.40	1.16		
P_R: -10% Q_C: +5%	L1: 15.10	L1: 16.69	L1: 17.52	1.13	153.3	
	L2: 15.10	L2: 16.67	L2: 17.51	1.13		9000
	L3: 15.08	L3: 16.68	L3: 17.51	1.13		
P_R: -10% Q_C: 0%	L1: 15.08	L1: 16.68	L1: 16.69	1.11	129.3	
	L2: 15.07	L2: 16.68	L2: 16.68	1.11		9000
	L3: 15.10	L3: 16.68	L3: 16.67	1.10		
P_R: -10% Q_C: -5%	L1: 15.10	L1: 16.68	L1: 15.91	1.08	95.3	
	L2: 15.08	L2: 16.68	L2: 15.89	1.08		9000
	L3: 15.08	L3: 16.69	L3: 15.88	1.08		
P_R: -10% Q_C: -10%	L1: 15.09	L1: 16.66	L1: 15.11	1.05	125.3	
	L2: 15.09	L2: 16.67	L2: 15.10	1.05		9000
	L3: 15.10	L3: 16.67	L3: 15.10	1.05		
P_R: -5% Q_C: +10%	L1: 15.88	L1: 16.68	L1: 18.40	1.10	97.3	
	L2: 15.90	L2: 16.68	L2: 18.39	1.10		9000
	L3: 15.89	L3: 16.69	L3: 18.38	1.10		
P_R: -5% Q_C: -10%	L1: 15.90	L1: 16.68	L1: 15.11	1.00	106.9	
	L2: 15.89	L2: 16.67	L2: 15.09	1.00		9000
	L3: 15.88	L3: 16.67	L3: 15.08	1.00		
P_R: 0% Q_C: +10%	L1: 16.69	L1: 16.69	L1: 18.37	1.05	130.3	
	L2: 16.68	L2: 16.68	L2: 18.38	1.05		9000
	L3: 16.68	L3: 16.67	L3: 18.39	1.05		
P_R: -5% Q_C: +5%	L1: 15.89	L1: 16.67	L1: 17.53	1.08	150.3	
	L2: 15.90	L2: 16.68	L2: 17.52	1.08		9000
	L3: 15.89	L3: 16.67	L3: 17.53	1.08		
P_R: -5% Q_C: 0%	L1: 15.88	L1: 16.70	L1: 16.68	1.05	115.3	
	L2: 15.88	L2: 16.69	L2: 16.67	1.05		9000
	L3: 15.90	L3: 16.71	L3: 16.69	1.05		
P_R: -5% Q_C: -5%	L1: 15.88	L1: 16.68	L1: 15.88	1.02	107.3	
	L2: 15.89	L2: 16.68	L2: 15.89	1.02		9000
	L3: 15.88	L3: 16.67	L3: 15.91	1.03		
P_R: 0% Q_C: +5%	L1: 16.67	L1: 16.69	L1: 17.56	1.03	137.3	
	L2: 16.69	L2: 16.69	L2: 17.53	1.02		9000

	L3: 16.68	L3: 16.67	L3: 17.53	1.02		
P_R: 0% Q_C: 0%	L1: 16.68	L1: 16.70	L1: 16.69	1.00	281.3	
	L2: 16.67	L2: 16.68	L2: 16.67	1.00		9000
	L3: 16.67	L3: 16.66	L3: 16.67	1.00		
P_R: 0% Q_C: -5%	L1: 16.69	L1: 16.67	L1: 15.88	0.97	135.9	
	L2: 16.68	L2: 16.70	L2: 15.88	0.98		9000
	L3: 16.67	L3: 16.69	L3: 15.89	0.98		
P_R: +5% Q_C: +5%	L1: 17.53	L1: 16.69	L1: 17.53	0.98	151.9	
	L2: 17.54	L2: 16.66	L2: 17.53	0.97		9000
	L3: 17.55	L3: 16.67	L3: 17.55	0.97		
P_R: +5% Q_C: 0%	L1: 17.52	L1: 16.69	L1: 16.69	0.95	163.9	
	L2: 17.53	L2: 16.67	L2: 16.68	0.95		9000
	L3: 17.53	L3: 16.70	L3: 16.68	0.95		
P_R: +5% Q_C: -5%	L1: 17.55	L1: 16.68	L1: 15.90	0.93	115.9	
	L2: 17.52	L2: 16.67	L2: 15.90	0.93		9000
	L3: 17.53	L3: 16.69	L3: 15.89	0.93		
P_R: 0% Q_C: -10%	L1: 16.67	L1: 16.70	L1: 15.12	0.95	98.9	
	L2: 16.67	L2: 16.69	L2: 15.10	0.95		9000
	L3: 16.68	L3: 16.69	L3: 15.09	0.95		
P_R: +5% Q_C: +10%	L1: 17.51	L1: 16.71	L1: 18.41	1.00	112.9	
	L2: 17.51	L2: 16.68	L2: 18.39	1.00		9000
	L3: 17.52	L3: 16.68	L3: 18.40	1.00		
P_R: +5% Q_C: -10%	L1: 17.53	L1: 16.71	L1: 15.11	0.91	102.9	
	L2: 17.54	L2: 16.71	L2: 15.09	0.91		9000
	L3: 17.54	L3: 16.69	L3: 15.11	0.91		
P_R: +10% Q_C: +10%	L1: 18.40	L1: 16.68	L1: 18.41	0.95	116.9	
	L2: 18.39	L2: 16.68	L2: 18.39	0.95		9000
	L3: 18.38	L3: 16.71	L3: 18.40	0.95		
P_R: +10% Q_C: +5%	L1: 18.39	L1: 16.69	L1: 17.54	0.93	158.9	
	L2: 18.39	L2: 16.70	L2: 17.55	0.93		9000
	L3: 18.38	L3: 16.68	L3: 17.53	0.93		
P_R: +10% Q_C: 0%	L1: 18.38	L1: 16.69	L1: 16.69	0.91	148.5	
	L2: 18.39	L2: 16.69	L2: 16.68	0.91		9000
	L3: 18.39	L3: 16.71	L3: 16.67	0.91		
P_R: +10% Q_C: -5%	L1: 18.41	L1: 16.66	L1: 15.89	0.88	120.9	
	L2: 18.40	L2: 16.67	L2: 15.90	0.88		9000
	L3: 18.40	L3: 16.68	L3: 15.88	0.88		
P_R: +10% Q_C: -10%	L1: 18.39	L1: 16.68	L1: 15.09	0.86	84.9	
	L2: 18.41	L2: 16.69	L2: 15.09	0.86		9000
	L3: 18.40	L3: 16.69	L3: 15.10	0.86		

Power 66%						
Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]
P_R: 0% Q_C: -5%	L1: 11.19	L1: 11.14	L1: 10.29	0.96	89.5	
	L2: 11.20	L2: 11.15	L2: 10.27	0.96		9000
	L3: 11.18	L3: 11.13	L3: 10.28	0.96		
P_R: 0% Q_C: -4%	L1: 11.13	L1: 11.16	L1: 10.50	0.97	108.5	
	L2: 11.14	L2: 11.18	L2: 10.51	0.97		9000
	L3: 11.13	L3: 11.19	L3: 10.51	0.97		
P_R: 0% Q_C: -3%	L1: 11.13	L1: 11.17	L1: 10.66	0.98	129.5	
	L2: 11.12	L2: 11.16	L2: 10.63	0.98		9000
	L3: 11.12	L3: 11.14	L3: 10.64	0.98		
P_R: 0% Q_C: -2%	L1: 11.14	L1: 11.18	L1: 10.83	0.99	166.5	
	L2: 11.13	L2: 11.19	L2: 10.81	0.99		9000
	L3: 11.13	L3: 11.19	L3: 10.80	0.99		
P_R: 0% Q_C: -1%	L1: 11.13	L1: 11.21	L1: 11.01	1.00	195.5	
	L2: 11.12	L2: 11.19	L2: 11.00	1.00		9000
	L3: 11.14	L3: 11.28	L3: 10.98	1.00		
P_R: 0% Q_C: 0%	L1: 11.10	L1: 11.21	L1: 11.18	1.01	314.5	
	L2: 11.20	L2: 11.17	L2: 11.13	1.00		9000
	L3: 11.10	L3: 11.19	L3: 11.17	1.01		
P_R: 0% Q_C: +1%	L1: 11.00	L1: 11.20	L1: 11.33	1.02	186.5	
	L2: 11.10	L2: 11.18	L2: 11.32	1.01		9000
	L3: 11.10	L3: 11.19	L3: 11.34	1.01		
P_R: 0% Q_C: +2%	L1: 11.09	L1: 11.18	L1: 11.52	1.02	170.5	
	L2: 11.12	L2: 11.19	L2: 11.53	1.02		9000
	L3: 11.13	L3: 11.20	L3: 11.52	1.02		
P_R: 0% Q_C: +3%	L1: 11.13	L1: 11.16	L1: 11.67	1.03	148.5	
	L2: 11.14	L2: 11.17	L2: 11.69	1.03		9000
	L3: 11.12	L3: 11.19	L3: 11.70	1.03		
P_R: 0% Q_C: +4%	L1: 11.11	L1: 11.17	L1: 11.85	1.04	128.5	
	L2: 11.11	L2: 11.19	L2: 11.86	1.04		9000
	L3: 11.12	L3: 11.16	L3: 11.88	1.04		
P_R: 0% Q_C: +5%	L1: 11.11	L1: 11.19	L1: 12.06	1.05	106.5	
	L2: 11.14	L2: 11.21	L2: 12.05	1.04		9000
	L3: 11.12	L3: 22.18	L3: 12.03	1.47		

Power 33%						
Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]
P_R: 0% Q_C: -5%	L1: 5.57	L1: 5.62	L1: 4.74	0.93	79.5	
	L2: 5.54	L2: 5.63	L2: 4.71	0.93		9000
	L3: 5.55	L3: 5.63	L3: 4.73	0.93		
P_R: 0% Q_C: -4%	L1: 5.56	L1: 5.59	L1: 4.92	0.94	87.5	
	L2: 5.54	L2: 5.58	L2: 4.90	0.94		9000
	L3: 5.55	L3: 5.58	L3: 4.91	0.94		
P_R: 0% Q_C: -3%	L1: 5.58	L1: 5.58	L1: 5.04	0.95	93.5	
	L2: 5.55	L2: 5.58	L2: 5.02	0.95		9000
	L3: 5.57	L3: 5.59	L3: 5.01	0.95		
P_R: 0% Q_C: -2%	L1: 5.57	L1: 5.58	L1: 5.22	0.97	104.5	
	L2: 5.58	L2: 5.61	L2: 5.20	0.97		9000
	L3: 5.58	L3: 5.60	L3: 5.20	0.97		
P_R: 0% Q_C: -1%	L1: 5.58	L1: 5.56	L1: 5.41	0.98	149.5	
	L2: 5.55	L2: 5.59	L2: 5.34	0.98		9000
	L3: 5.59	L3: 5.58	L3: 5.42	0.98		
P_R: 0% Q_C: 0%	L1: 5.54	L1: 5.58	L1: 5.58	1.01	247.5	
	L2: 5.50	L2: 5.59	L2: 5.55	1.01		9000
	L3: 5.53	L3: 5.56	L3: 5.63	1.01		
P_R: 0% Qc: +1%	L1: 5.57	L1: 5.64	L1: 5.86	1.03	190.5	
	L2: 5.51	L2: 5.58	L2: 5.78	1.03		9000
	L3: 5.54	L3: 5.67	L3: 5.79	1.03		
P_R: 0% Q_C: +2%	L1: 5.54	L1: 5.60	L1: 6.01	1.05	142.5	
	L2: 5.51	L2: 5.58	L2: 5.95	1.05		9000
	L3: 5.50	L3: 5.61	L3: 5.97	1.05		
P_R: 0% Q_C: +3%	L1: 5.57	L1: 5.65	L1: 6.20	1.06	119.5	
	L2: 5.53	L2: 5.62	L2: 6.13	1.06		9000
	L3: 5.55	L3: 5.63	L3: 6.15	1.06		
P_R: 0% Qc: +4%	L1: 5.57	L1: 5.63	L1: 6.36	1.07	100.5	
	L2: 5.53	L2: 5.58	L2: 6.31	1.07		9000
	L3: 5.57	L3: 5.61	L3: 6.34	1.07		
P_R: 0% Q_C: +5%	L1: 5.59	L1: 5.67	L1: 6.46	1.08	95.5	
	L2: 5.56	L2: 5.64	L2: 6.42	1.08		9000
	L3: 5.54	L3: 5.60	L3: 6.40	1.08		

5.6	TABLE: Connection conditions and synchronisation			P
Rated voltage: 3/N/PE 400V, 50Hz				
Voltage detection accuracy [V]	±1%Un		Frequency detection accuracy [Hz]	±0.05
Specified recover voltage range	0.85Un-1.1Un		Specified recover frequency range	47.5-50.1
Specified reconnect time [s]	60		Limitation [s]	≥ 60
Conditions				
Reconnect time [s]	No reconnection	197	No reconnection	201
Conditions				
Reconnect time [s]	No reconnection	198	No reconnection	202

5.7	TABLE: $P_{AV,E}$ monitoring	P

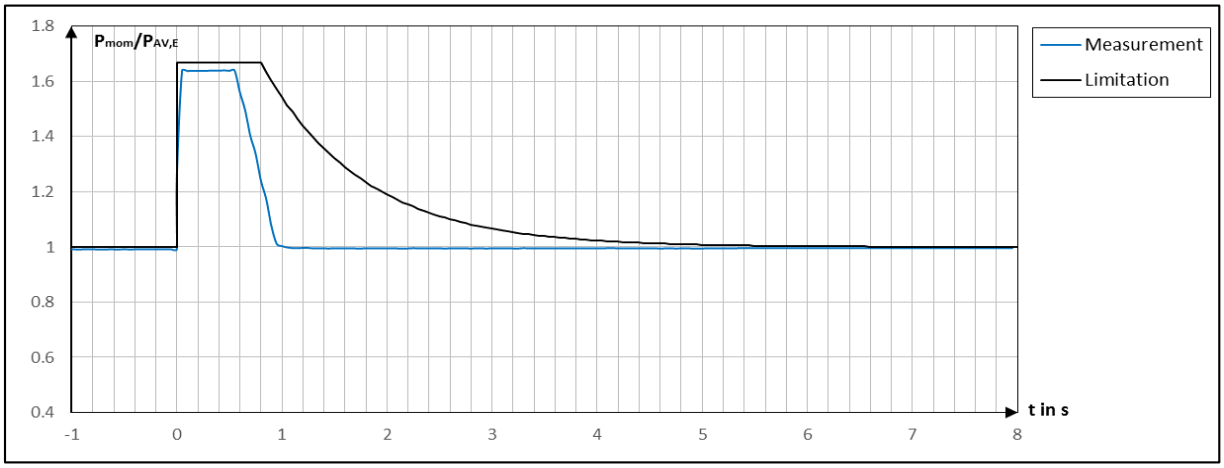
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

$P_{AV,E}$ setting: 60% Pn

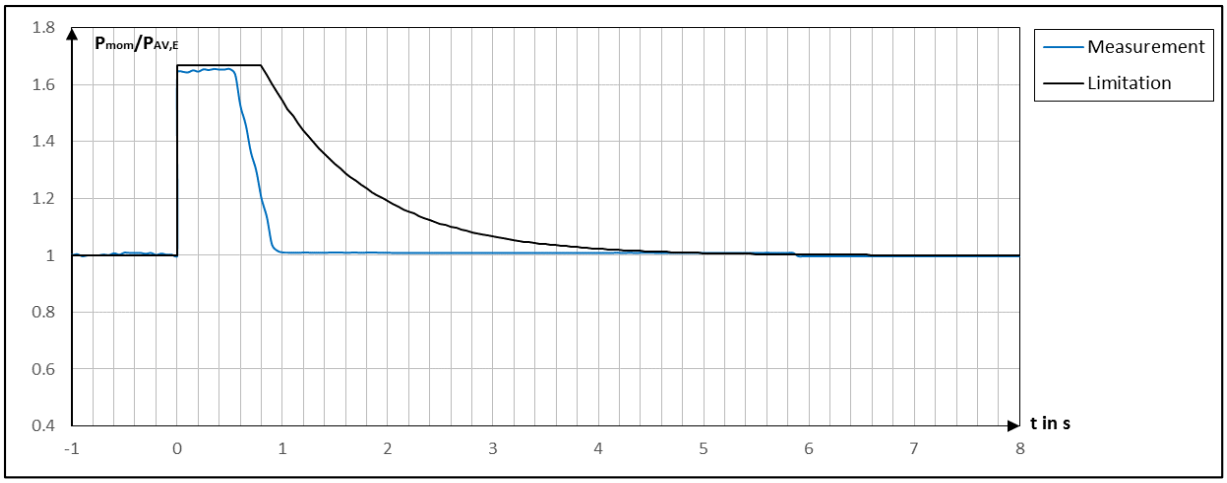
☒ Power limit method

Test method	Condition	Power complied with limit curve
☐ Jump of primary energy	Pdc: 60%Pn jump to 100%Pn	☐ Pass ☐ Failed
☒ Cut of load	Pac: 100%Pn, P_{load}: 40%Pn cut to 0	☒ Pass ☐ Failed

Power curve:



Test with external meter UMG604



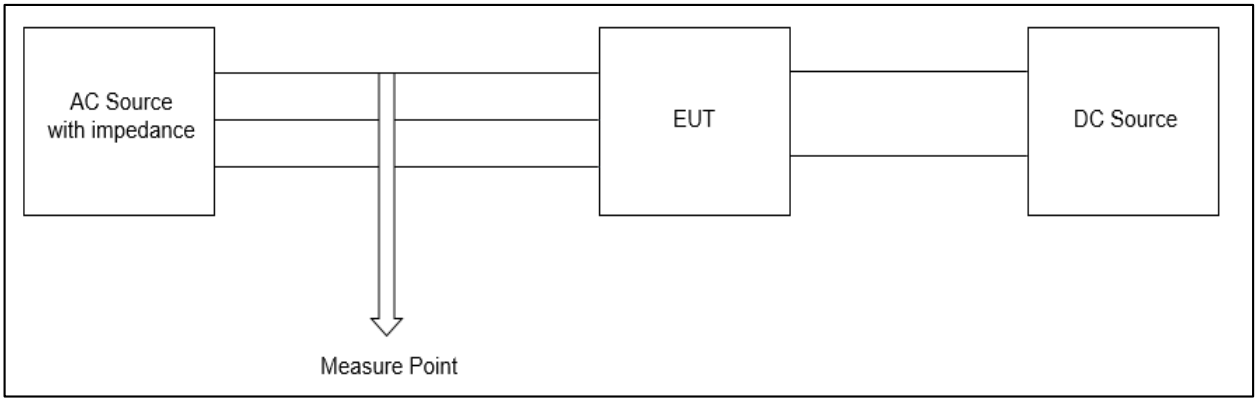
Test with external meter EMG610

5.8	Verification of dynamic network support					P
Test	Voltage depth U/Un [p.u.]	Fault type	Fault duration [ms]	Power P/Pn [p.u.]	Reactive power Q/Pn [p.u.]	Test No.
1	0.15…..0.25	A	For 0.15pu ≥ 150 For 0.25pu ≥ 500	1.0	0…±0.1	1.1
				0.2…0.6		1.2
		D1		1.0		1.3
				0.2…0.6		1.4
		D2		1.0		1.3 (2)
				0.2…0.6		1.4 (2)
2	0.50….0.60	A	For 0.5pu ≥1500 For 0.60pu ≥ 2000	1.0	Max. over-excited	2.1
				0.2…0.6		2.2
		D1		1.0		2.3
				0.2…0.6		2.4
3	0.50….0.60	A	For 0.5pu ≥1500 For 0.60pu ≥ 2000	1.0	Max. under-excited	3.1
				0.2…0.6		3.2
		D1		1.0		3.3
				0.2…0.6		3.4
4	0.85….0.90	A	≥ 60000	1.0	0…±0.1	4.1
				0.2…0.6		4.2
		D1		1.0		4.3
				0.2…0.6		4.4
5	1.2….1.25	A	≥ 100	1.0	0…±0.1	5.1
				0.2…0.6		5.2
		D1		1.0		5.3
				0.2…0.6		5.4
		D2		1.0		5.3 (2)
				0.2…0.6		5.4 (2)
6	1.15…1.20	A	≥ 5000	1.0	0…±0.1	6.1
				0.2…0.6		6.2
		D1		1.0		6.3
				0.2…0.6		6.4
7	1.10…1.15	A	≥ 60000	1.0	0…±0.1	7.1
				0.2…0.6		7.2
		D1		1.0		7.3
				0.2…0.6		7.4

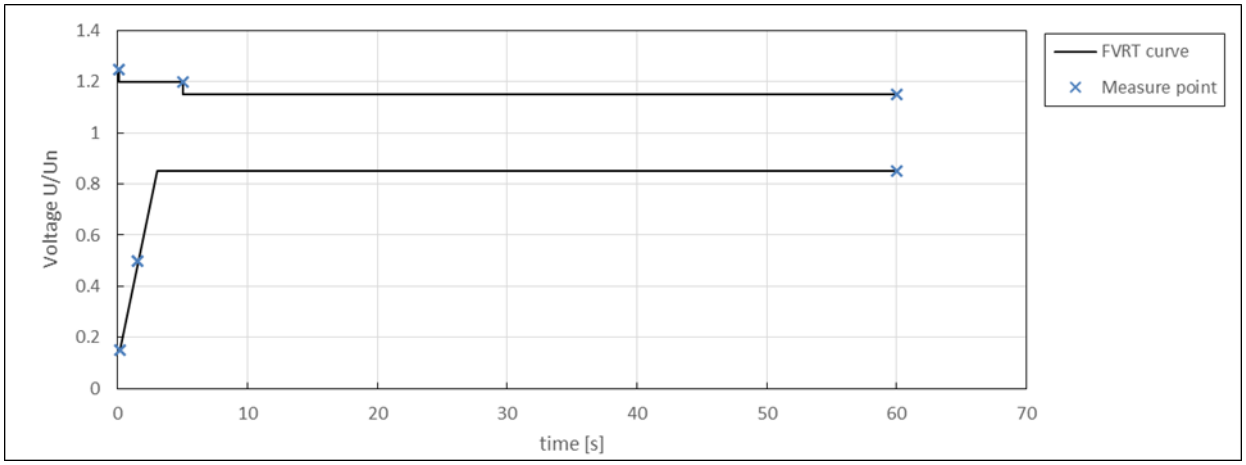
Equipment used: 91U213254, 1160570037, 1160570033, 1160570036, 1160570034, C029069, C022429, 04HH19727DV, 07100392-CHN, 618603800175, 602001150702159

Test bench diagram:

R_{netz}: 0.033Ohm, X_{netz}: 0.11Ohm (Internal imepdance in AC source)



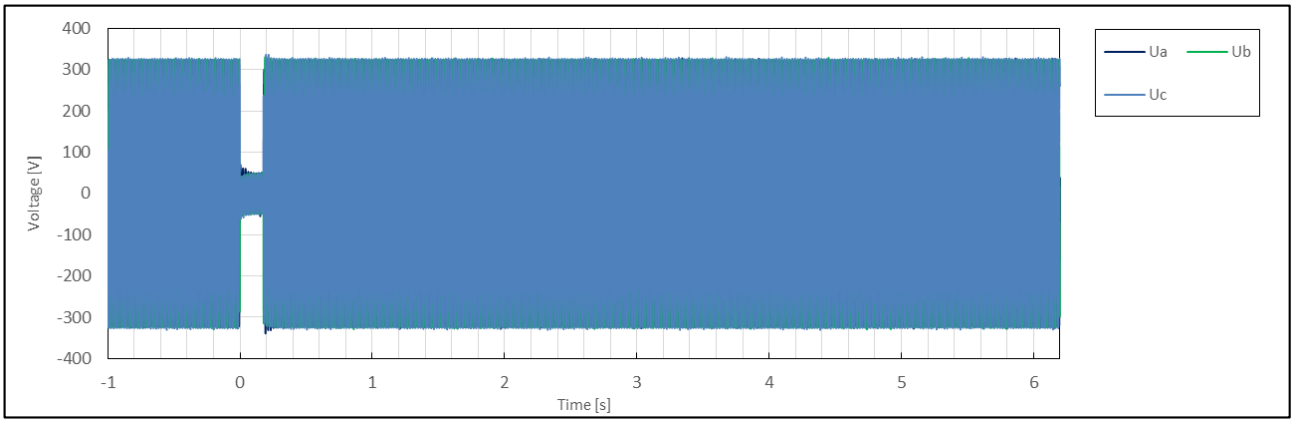
FRT curve settings:

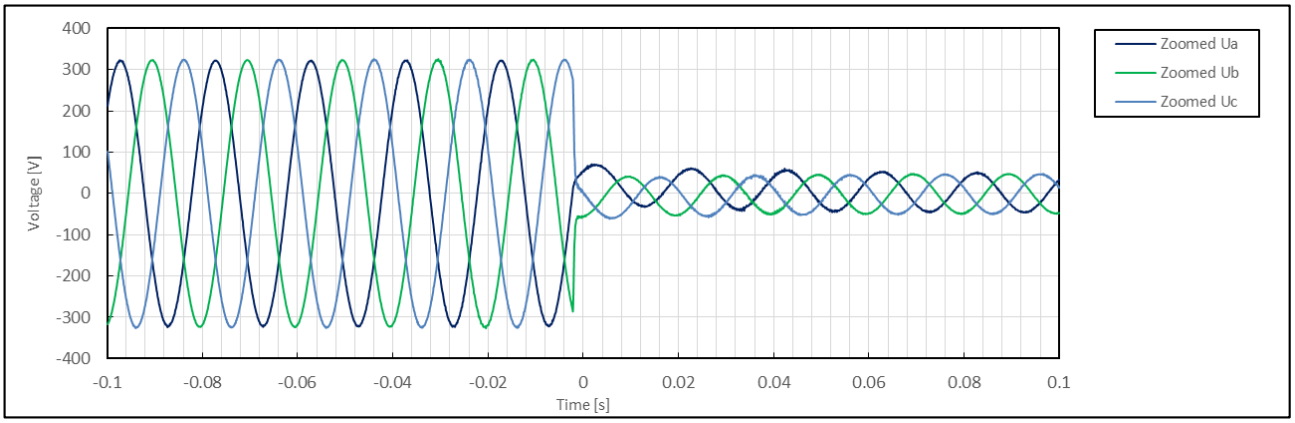


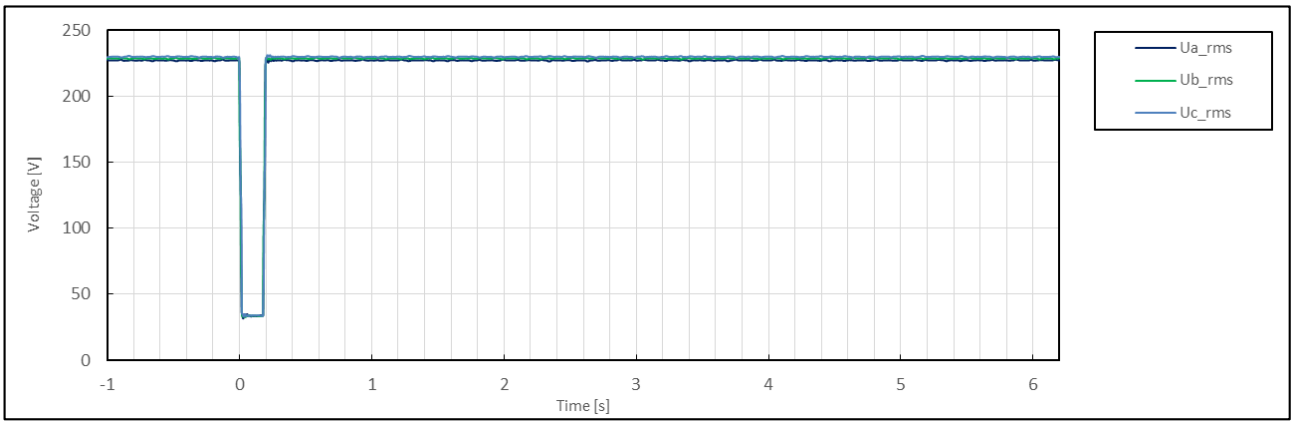
Fault Type	3-phase fault and 2-phase fault
Transformer Type	Dy5
Short-circuited power at generator terminal [kVA]	1500
Sk / Sn	30
R / X	0.3
NS protection settings	See table 5.5.7 for detail.
Any auxilliary power supply in fault ride through?	☐ Yes ☒ No
Terminal sequence	For D1: U-L1, V-L2, W-L3 For D2: U-L3, V-L1, W-L2

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.1
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:31:58
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		198
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	197
	8	Fault duration in empty load test	Total	--	ms	198
	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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.06
	20		Phase 2			0.06
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.01
	26		Pos.			0.01
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	1.00
	28	Active power	Pos.	t2+3s to t2+10s	p.u.	1.00
	29		Total			1.00
	39	Active power rising time	Pos.	--	s	0.124
	31	Reactive power	Pos.	t2+3s to t2+10s	p.u.	-0.02
	32		Total			-0.02
	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

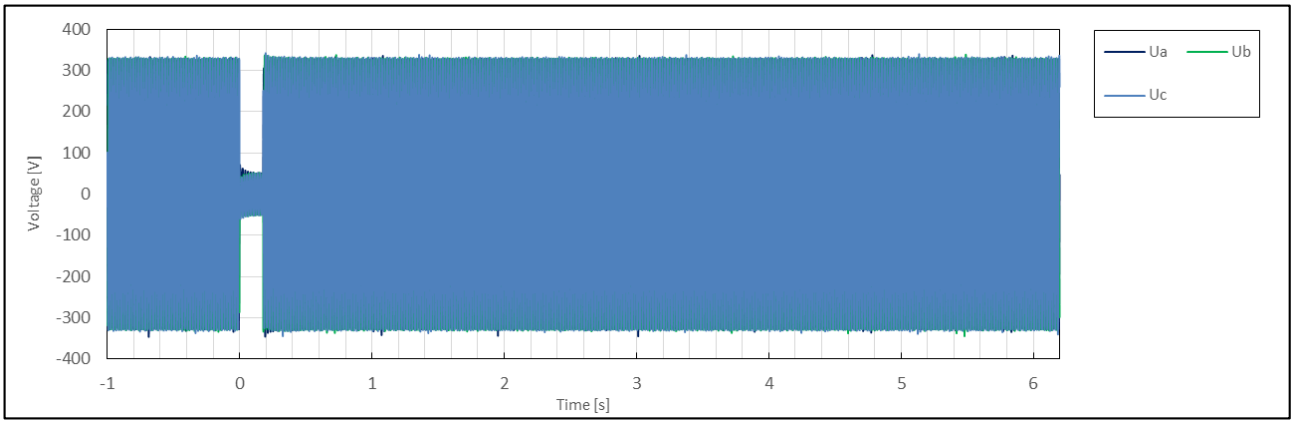
Test No. 1.1 idle test

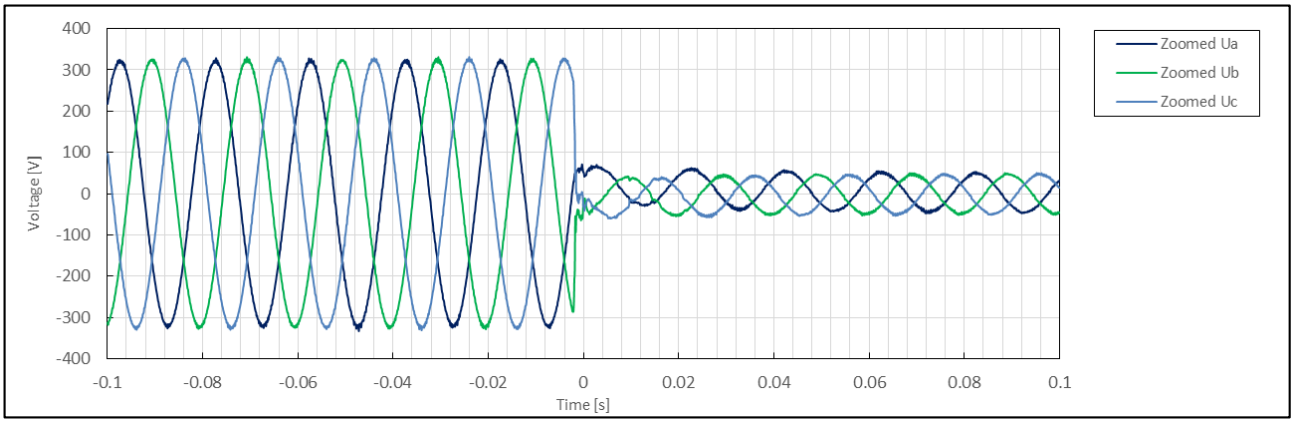


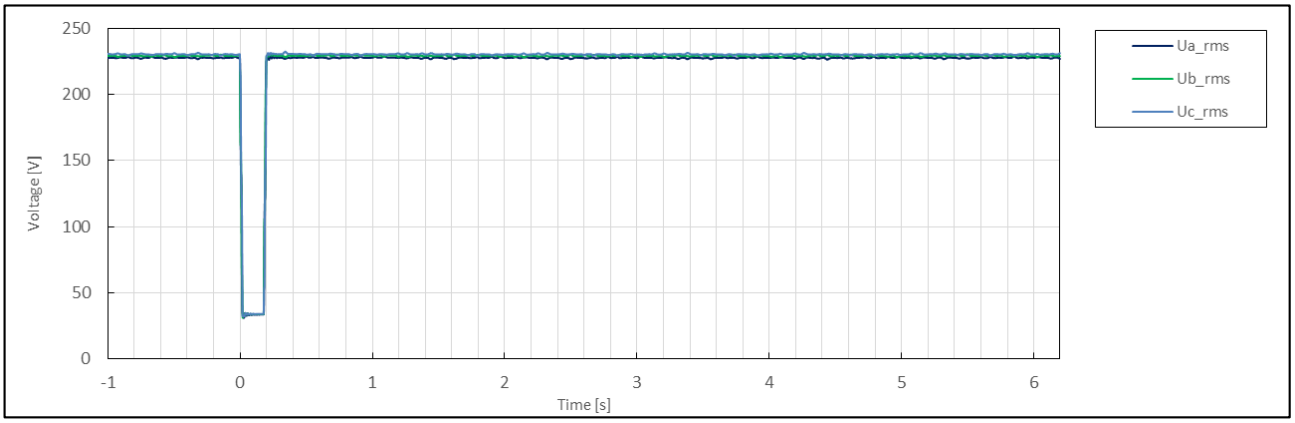


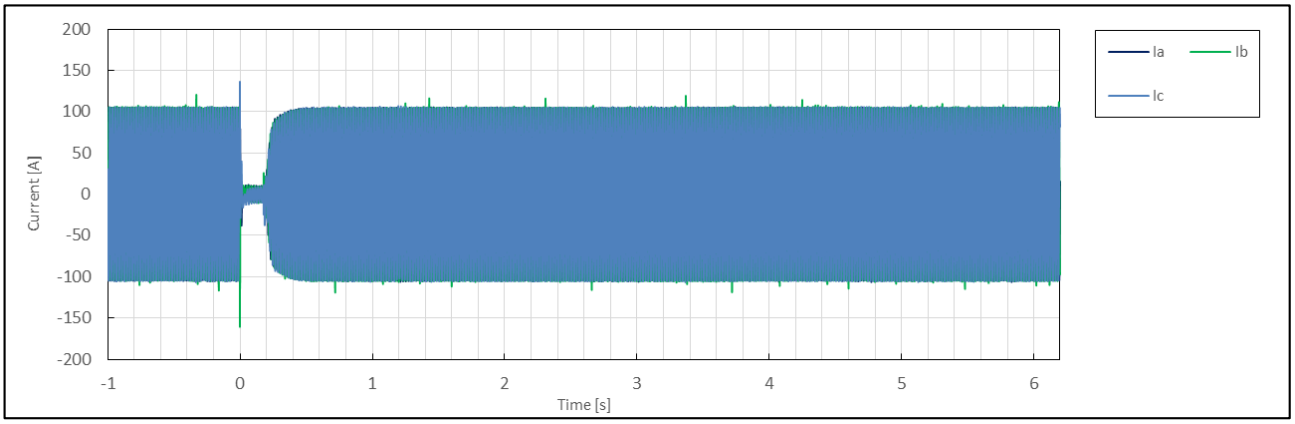


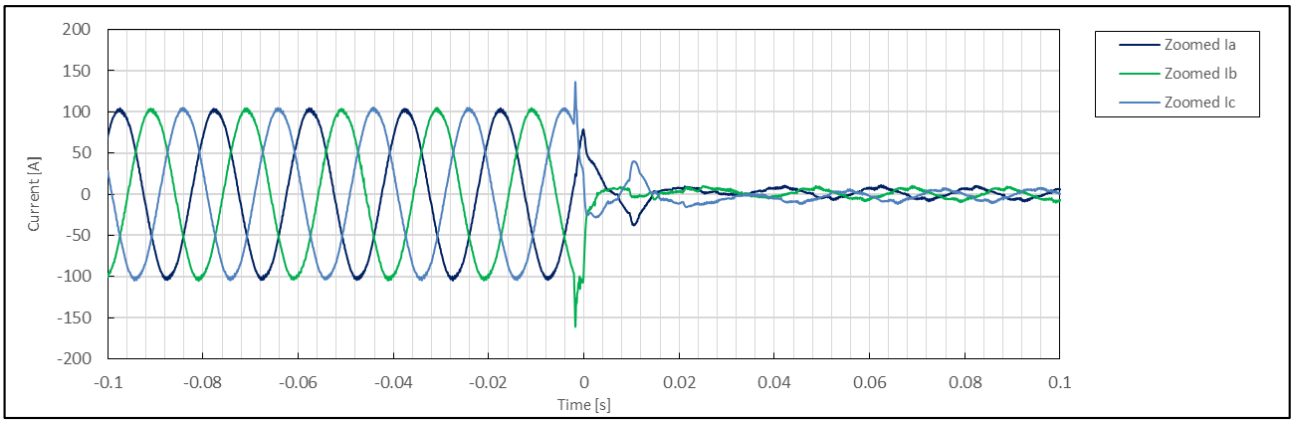
Test No. 1.1 with PGU

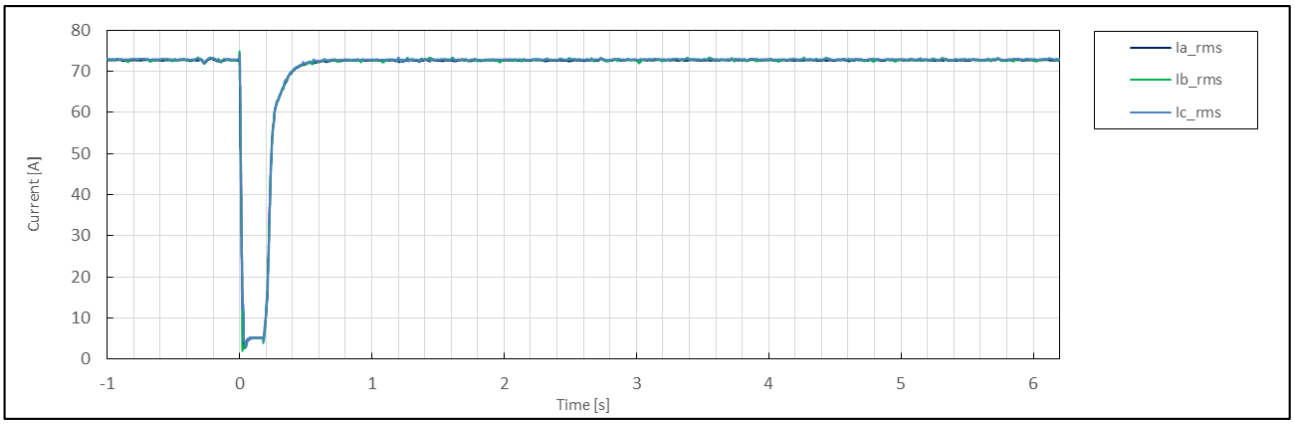


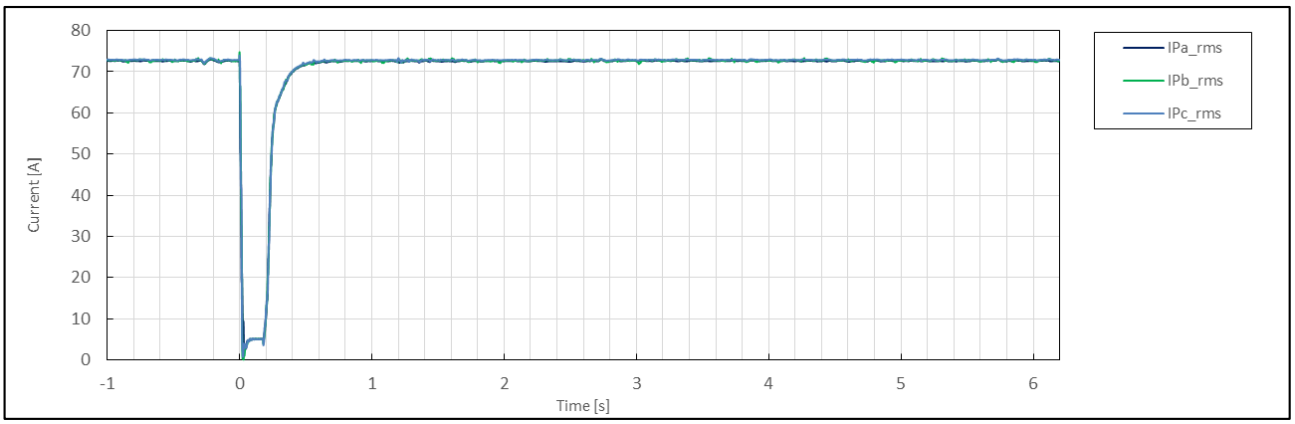


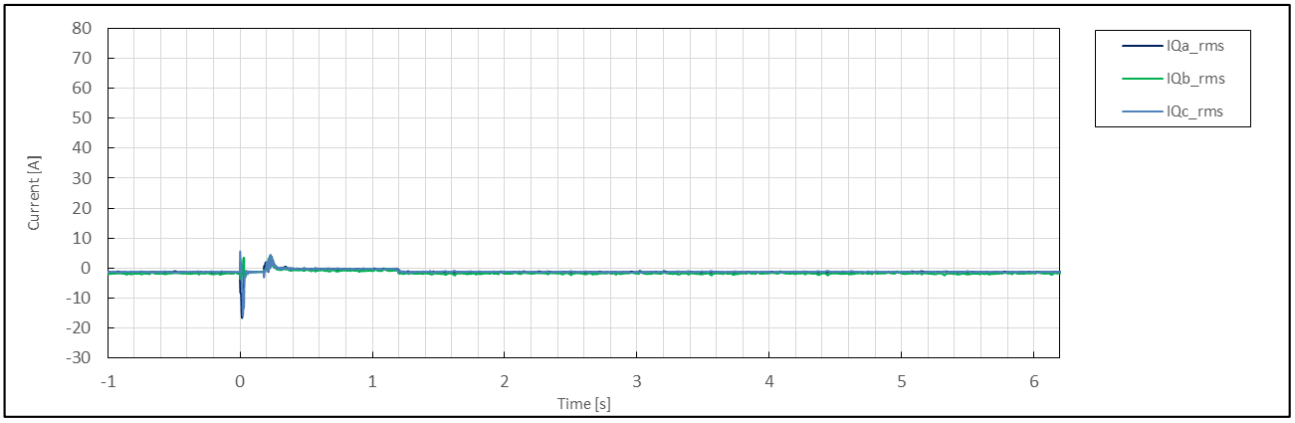


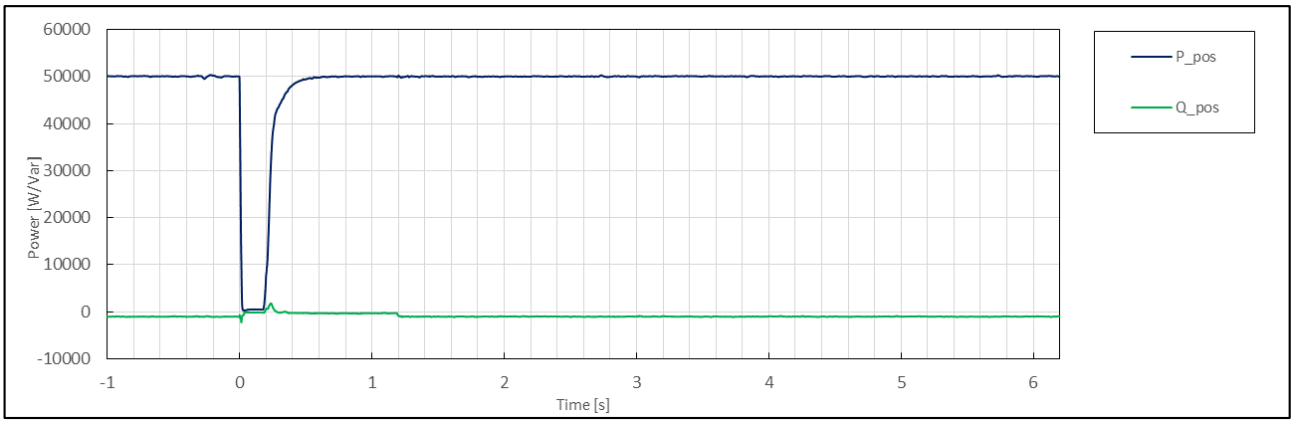


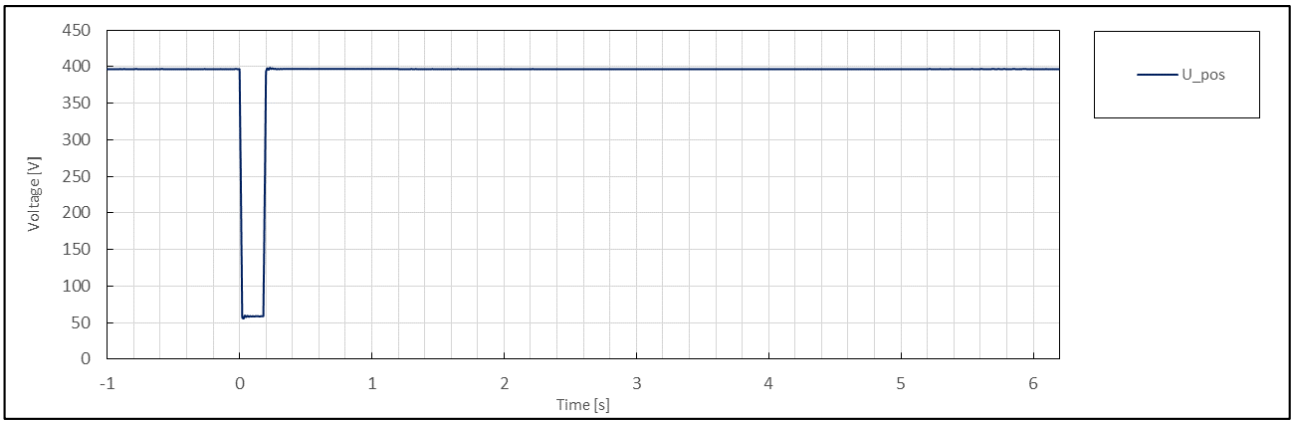

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

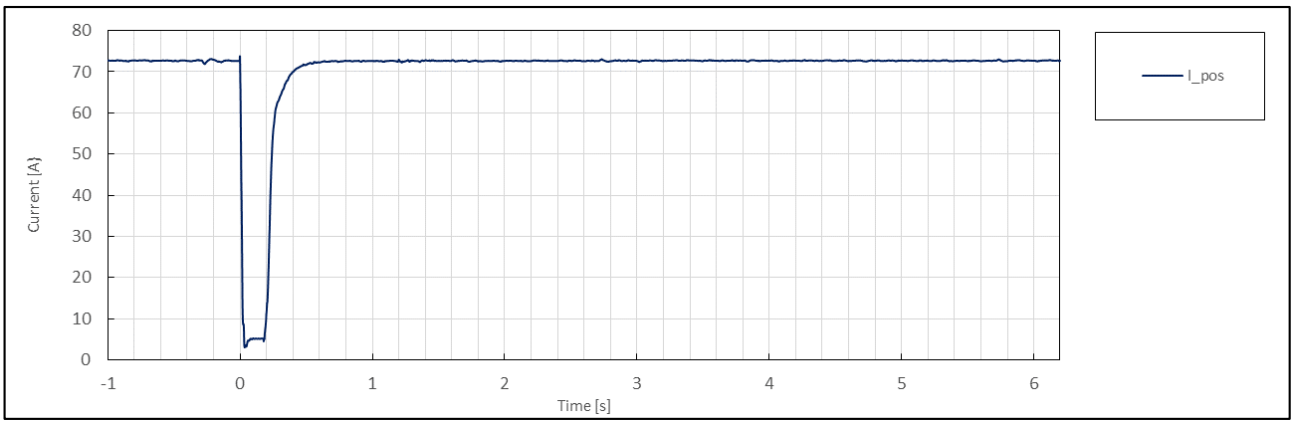

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

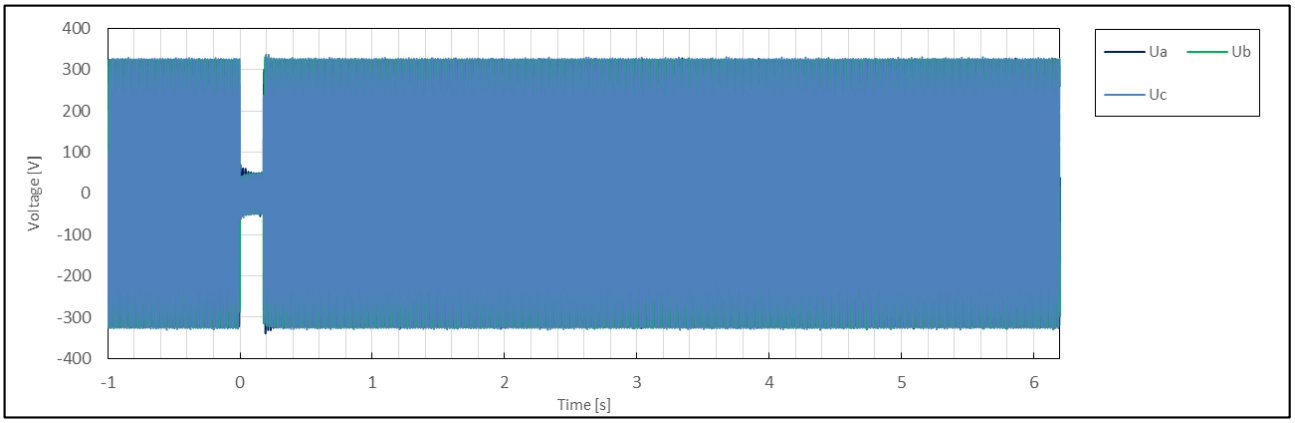

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

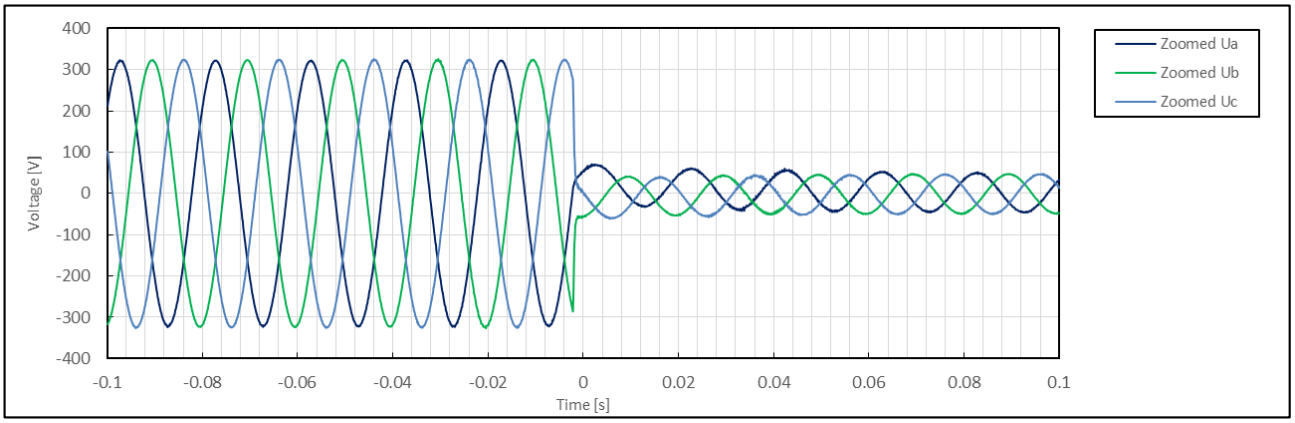

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

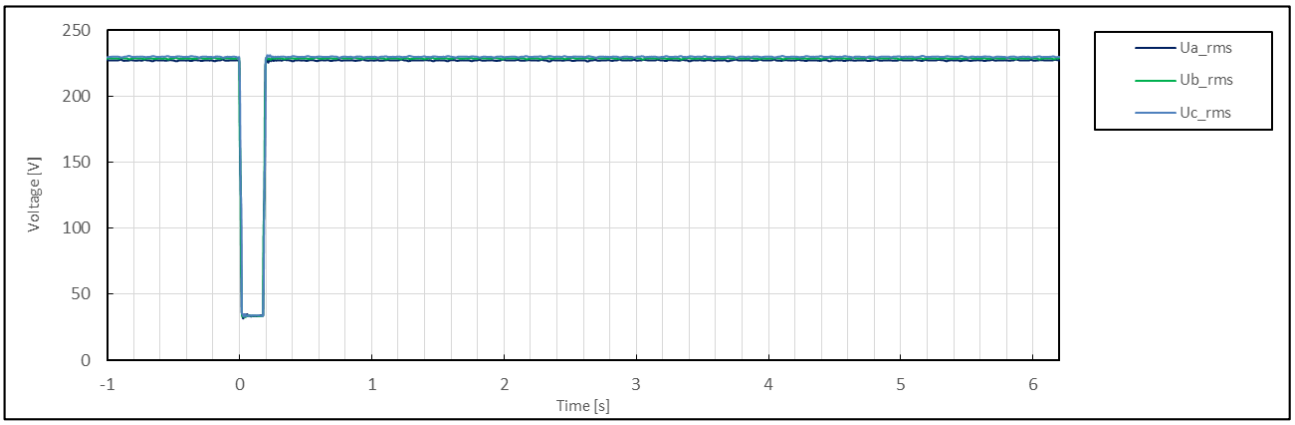

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.2
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:39:40
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		198
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	197
	8	Fault duration in empty load test	Total	--	ms	198
	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.	-0.02
	16		Pos.			-0.02
	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.	0.07
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.01
	26		Pos.			0.01
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	0.106
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

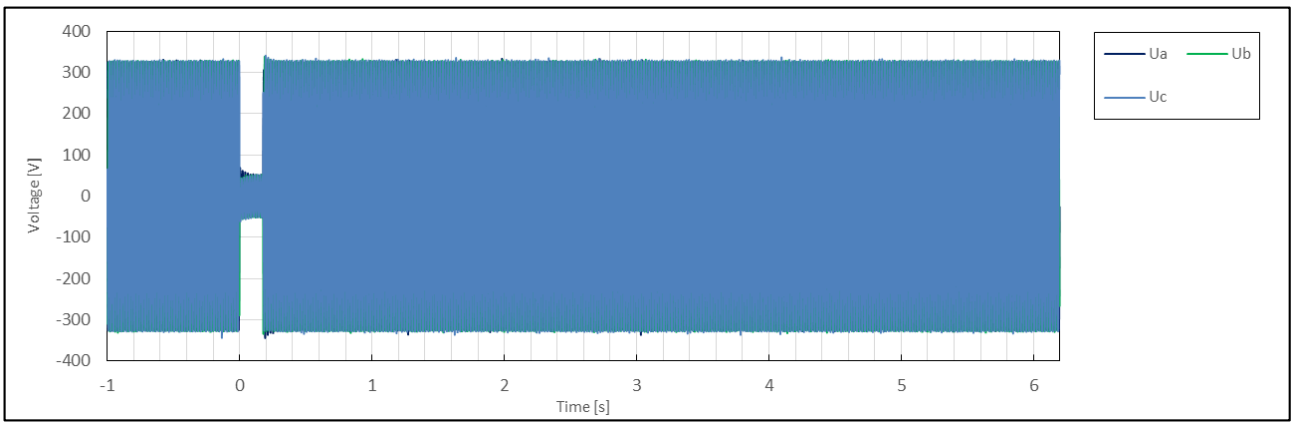
Test No. 1.2 idle test

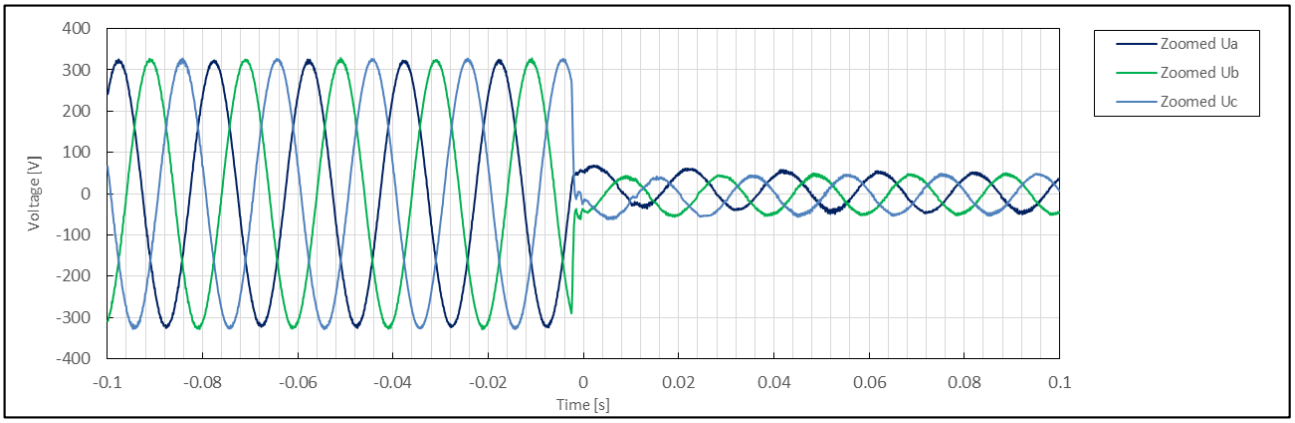


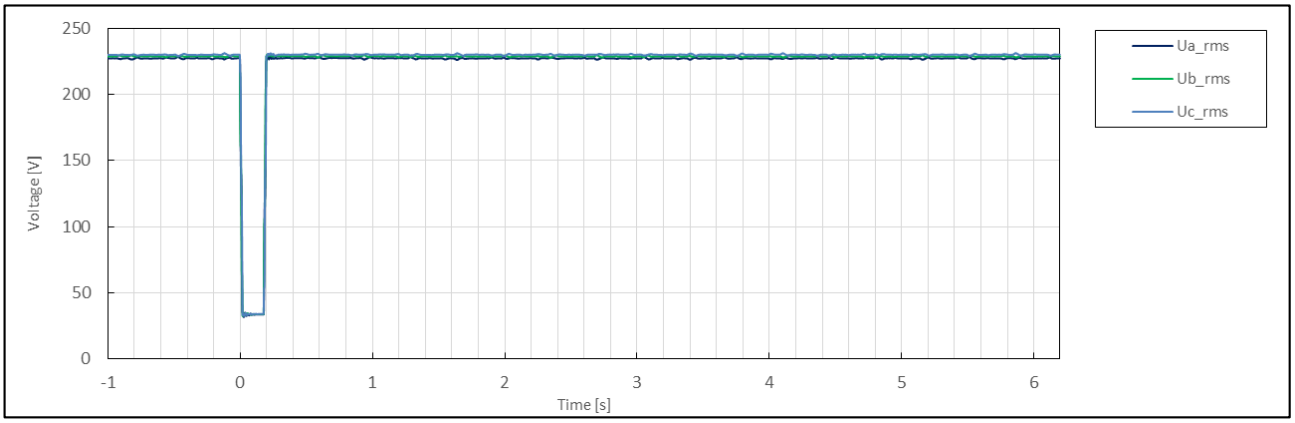


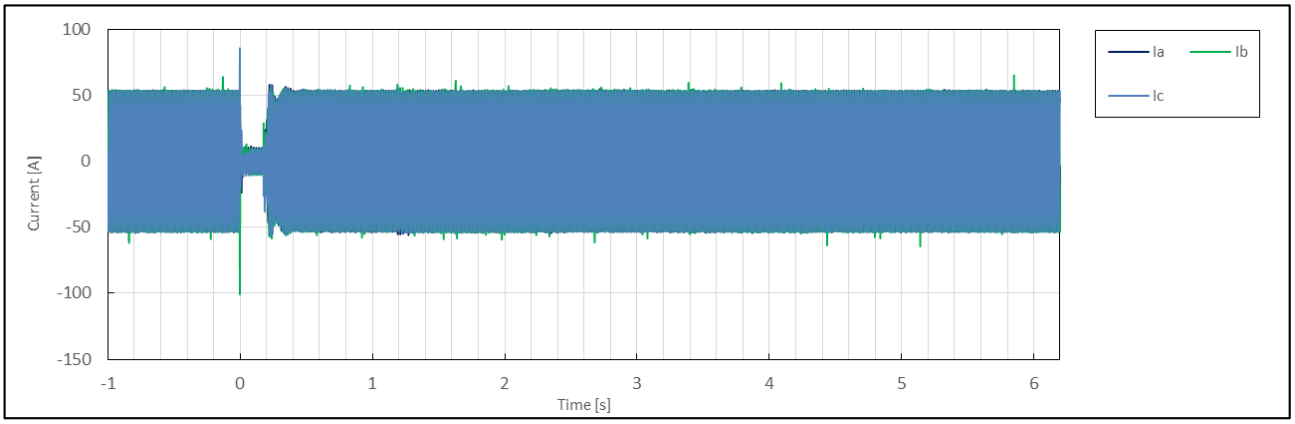


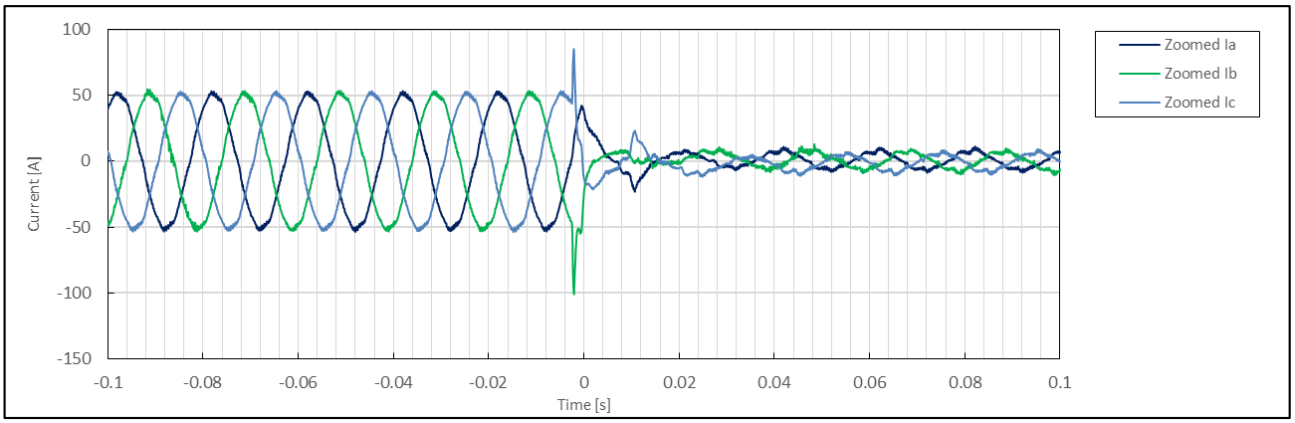
Test No. 1.2 with PGU

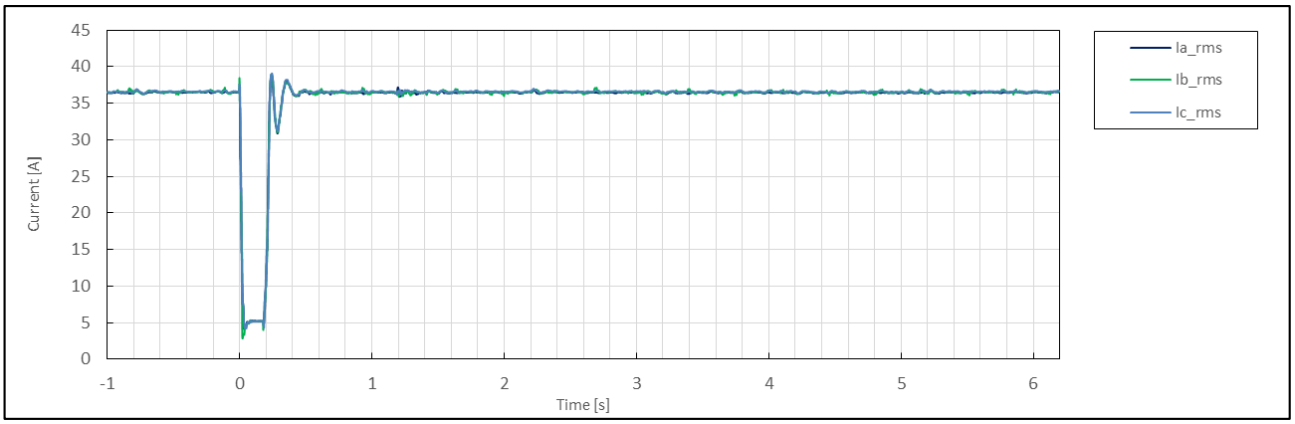


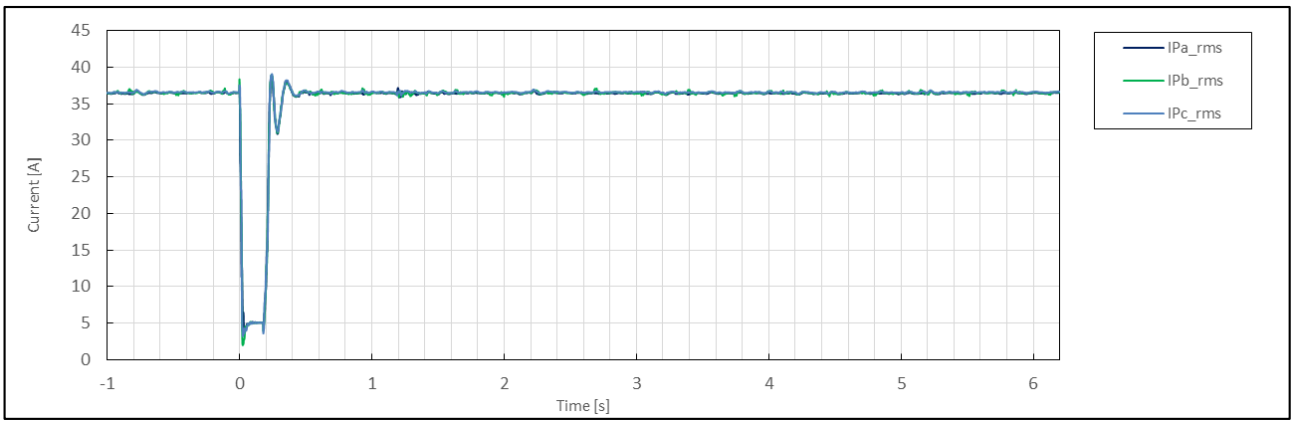


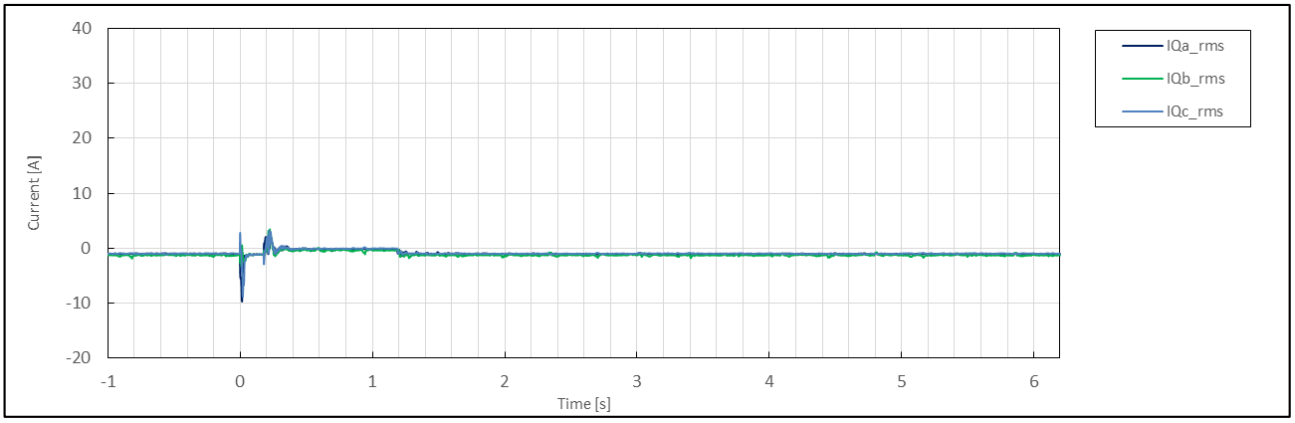


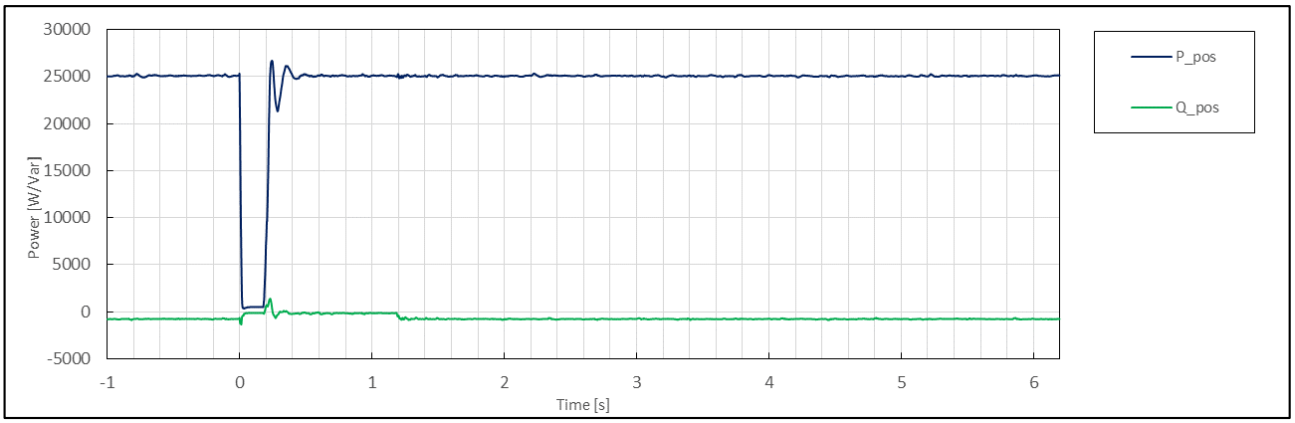


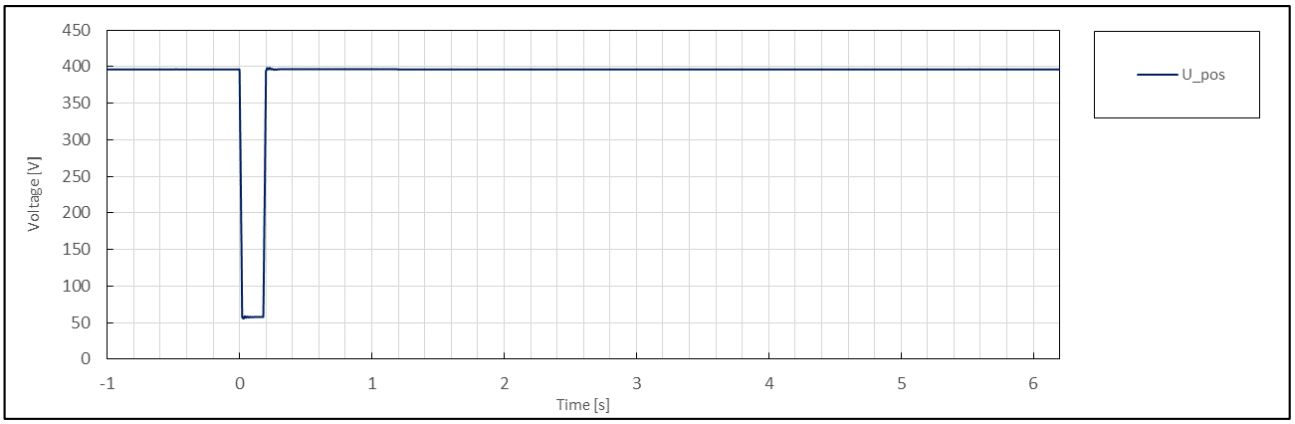

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

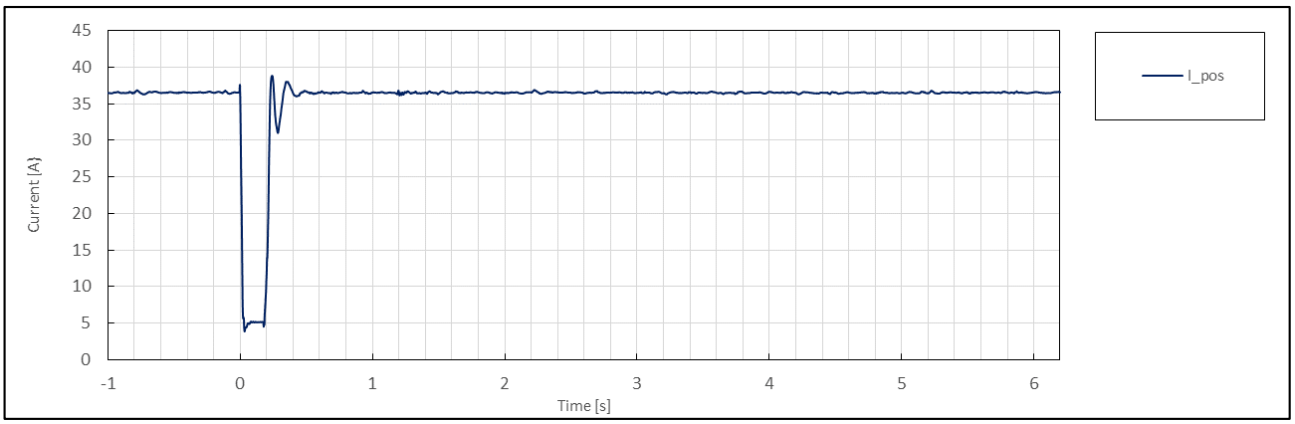

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

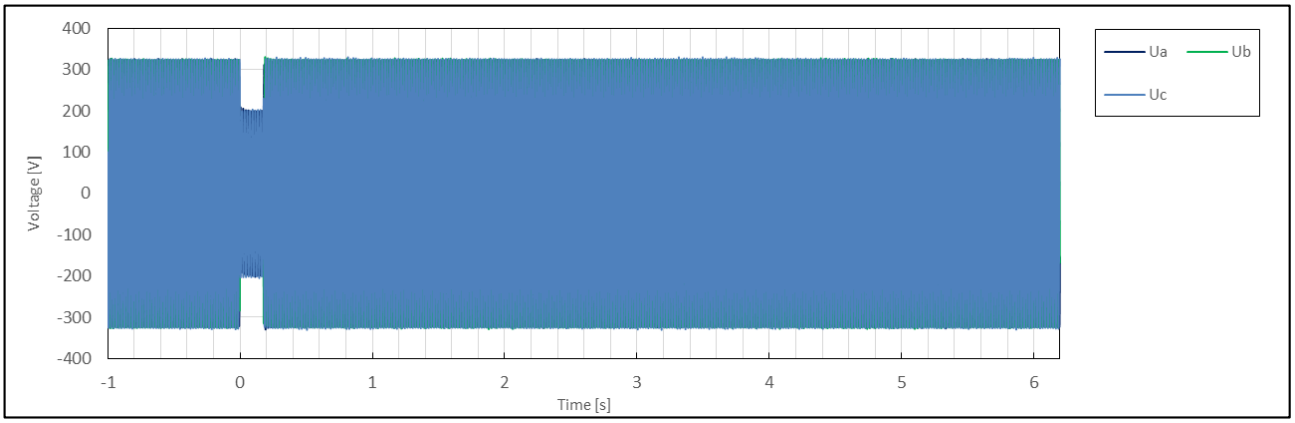

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

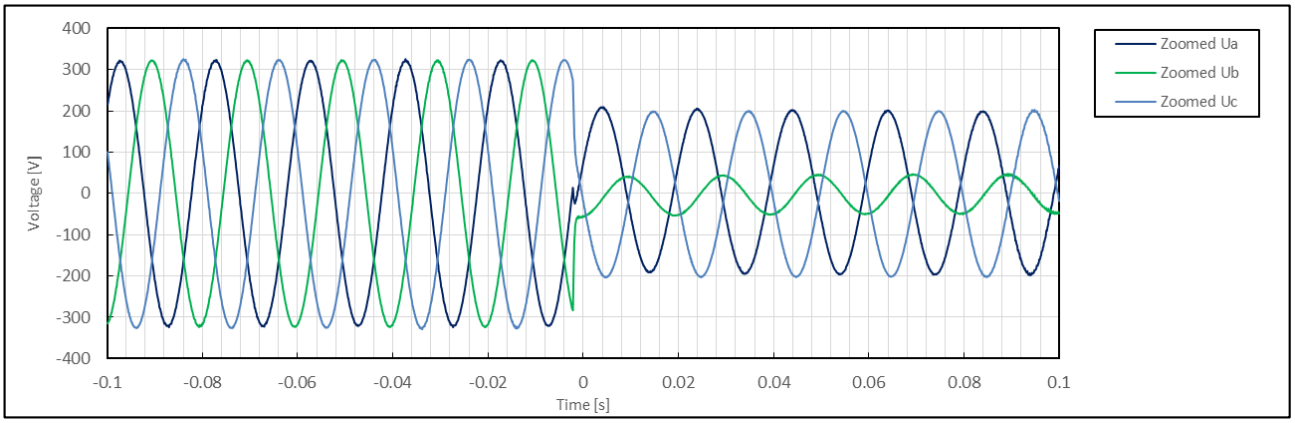

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

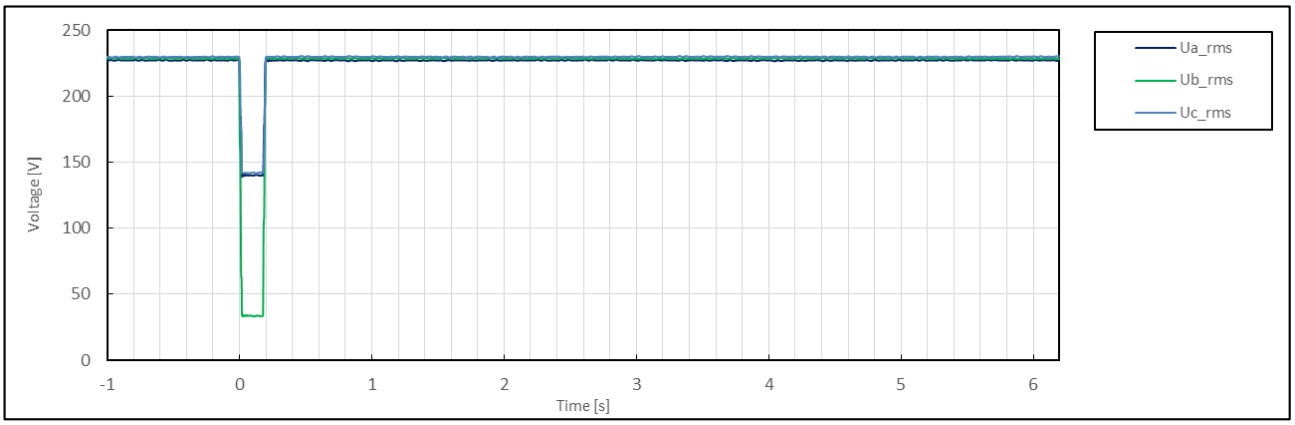

45
40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.3
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	19:24:18
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		196
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	195
	8	Fault duration in empty load test	Total	--	ms	196
	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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.06
	20		Phase 2			0.06
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.06
	23		Phase 2			0.07
	24		Phase 3			0.08
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.099
	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

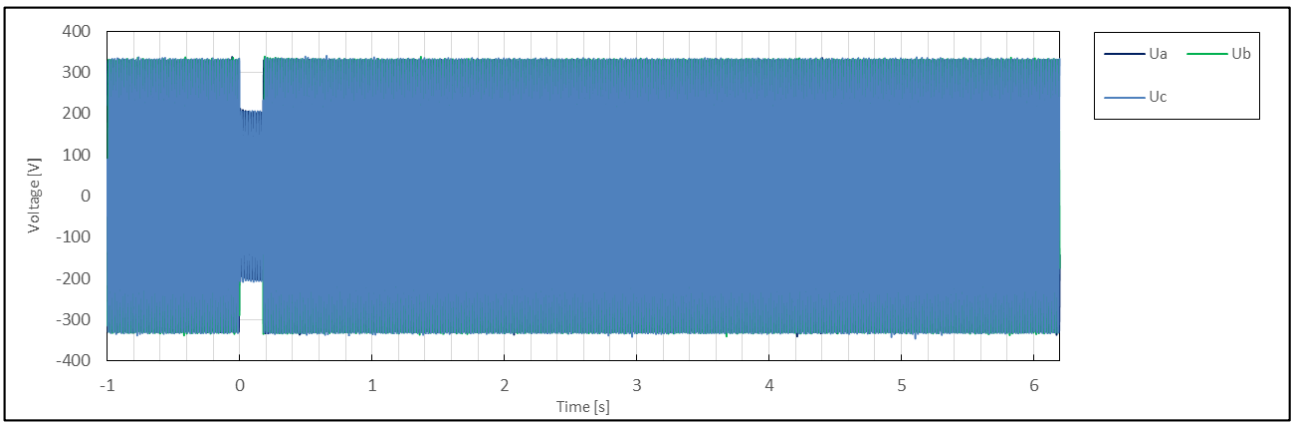
Test No. 1.3 idle test

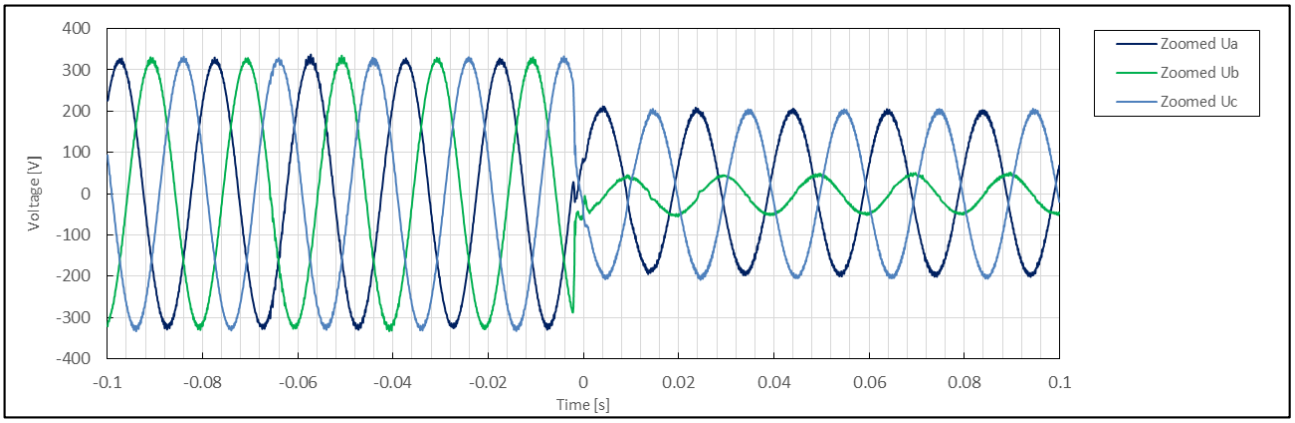


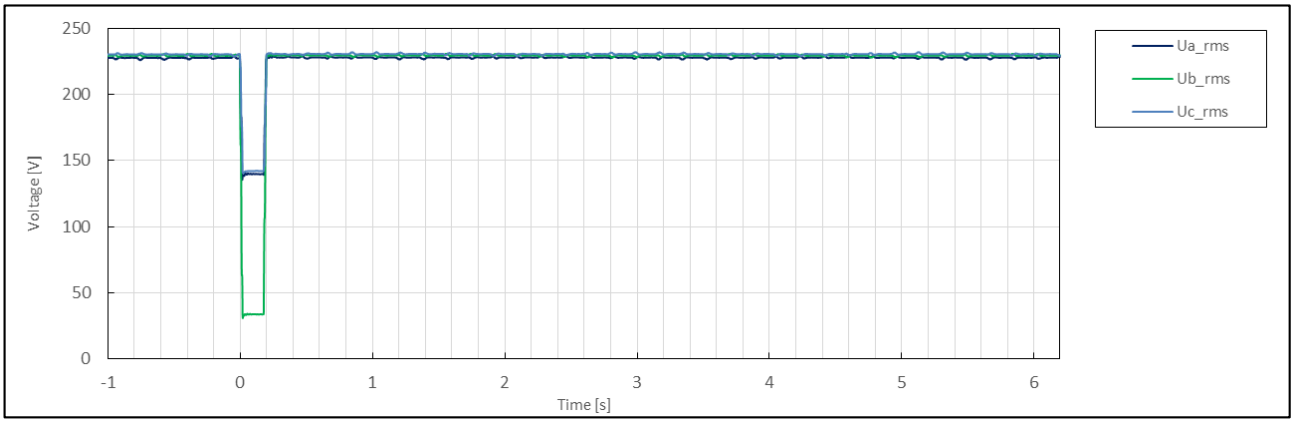


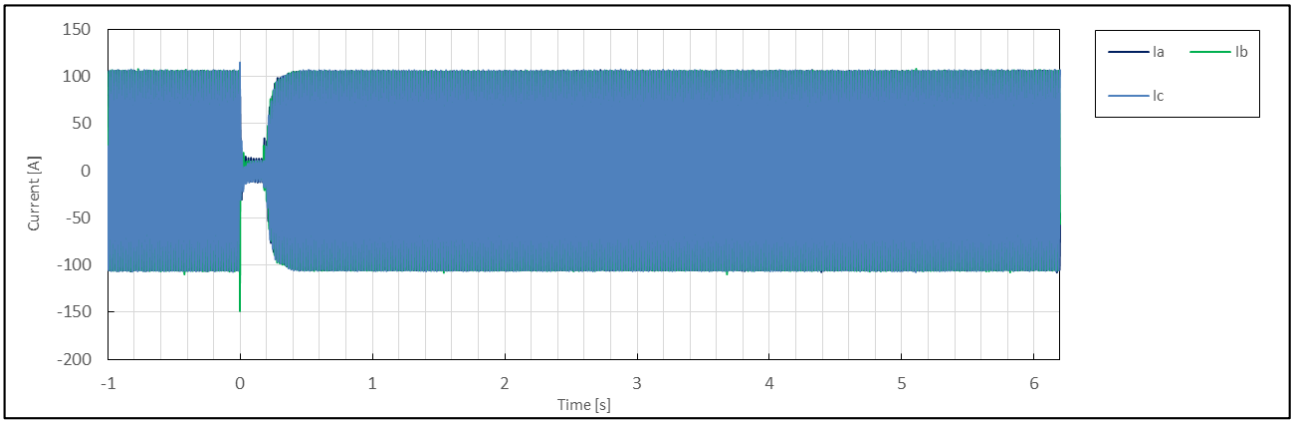


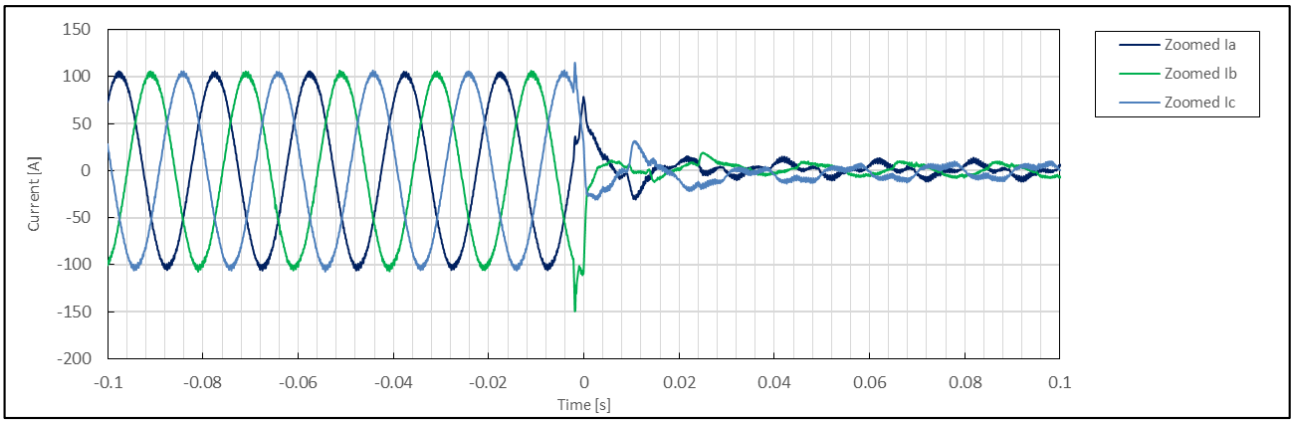
Test No. 1.3 with PGU

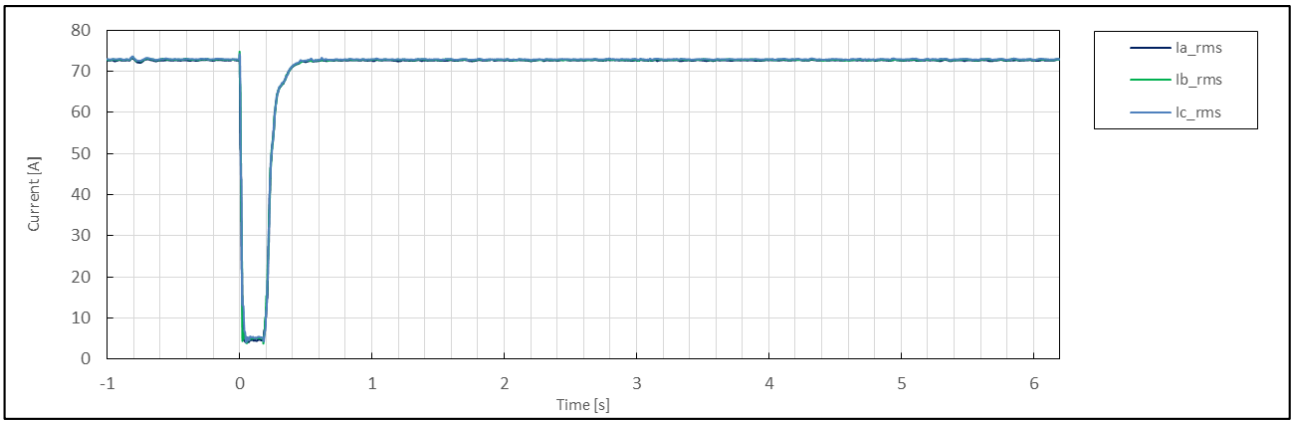


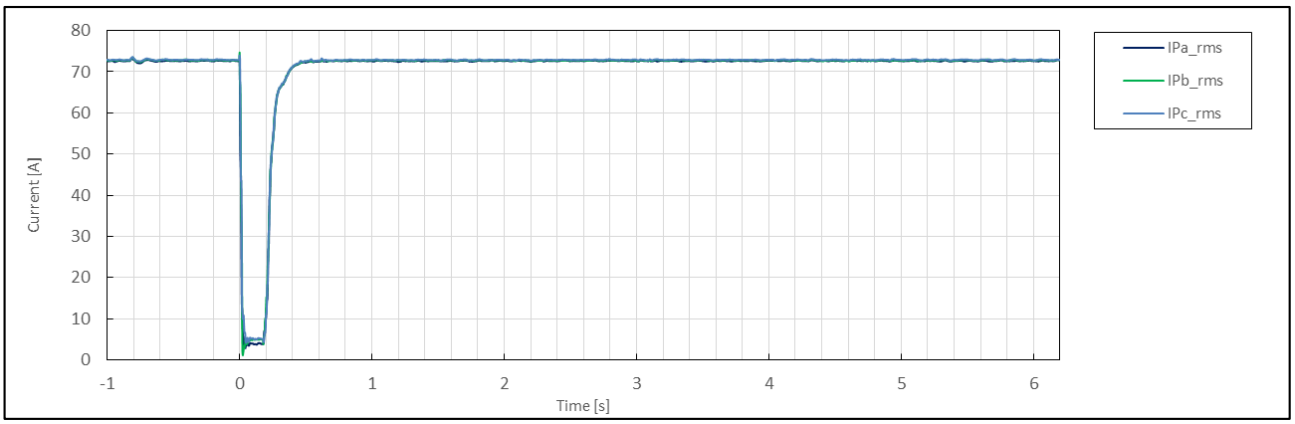


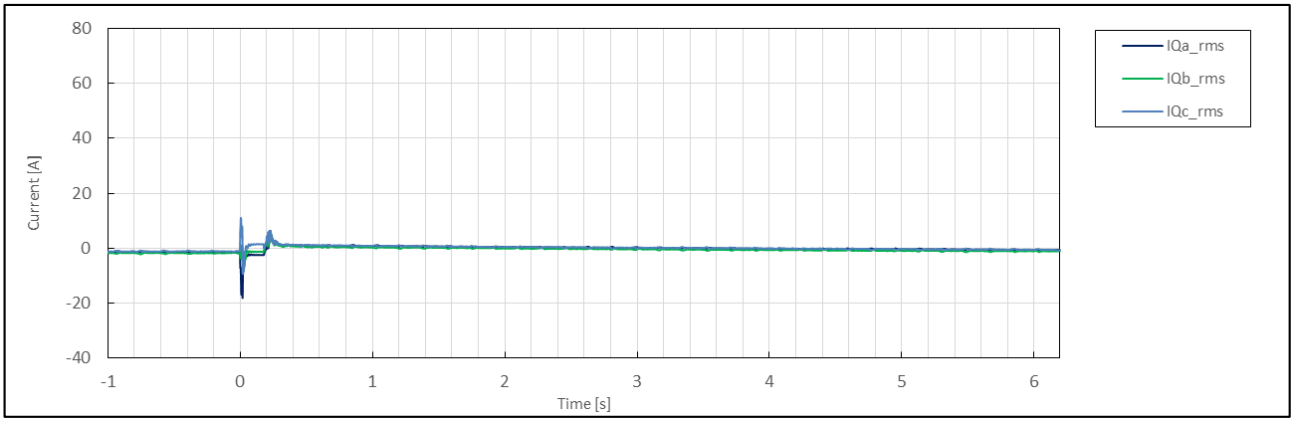


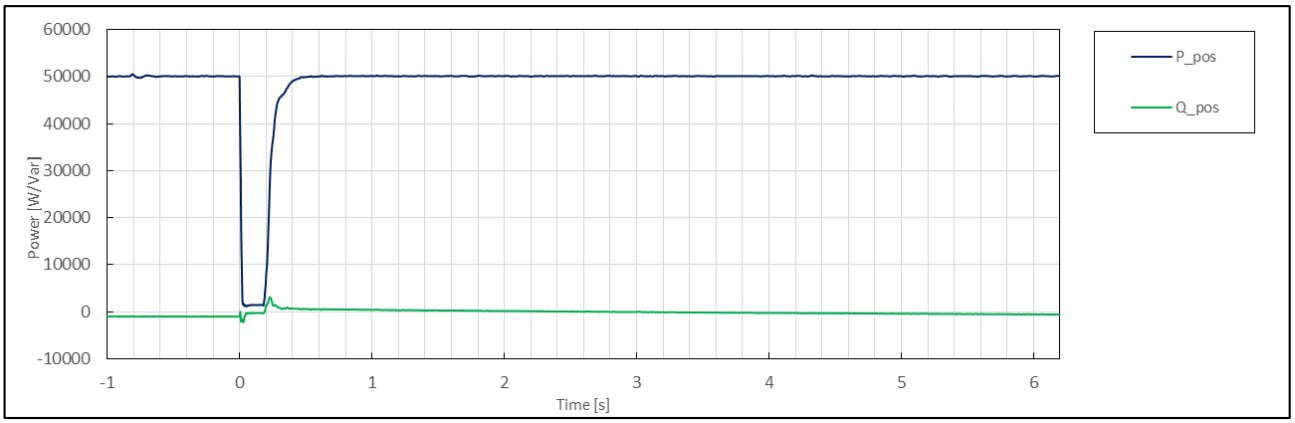


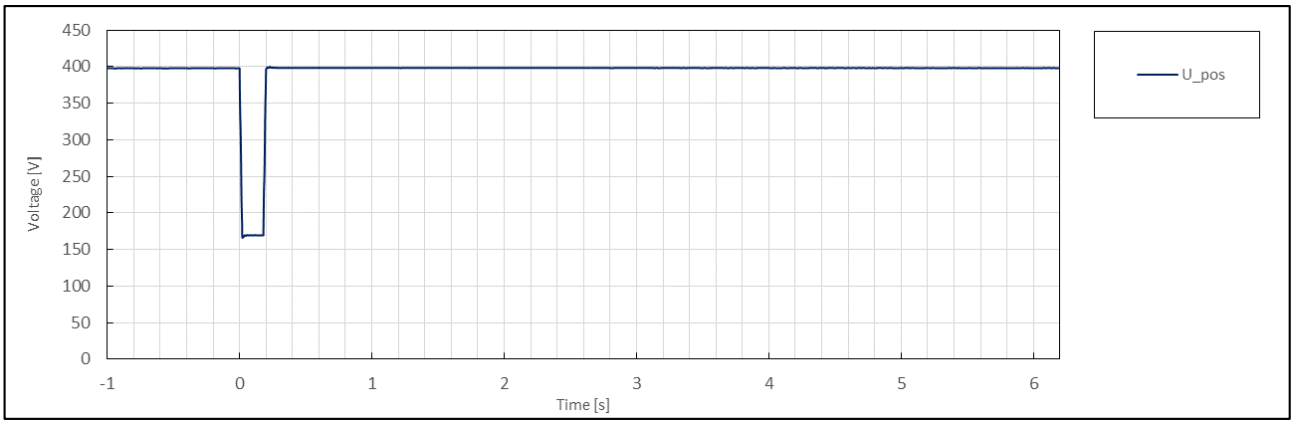

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

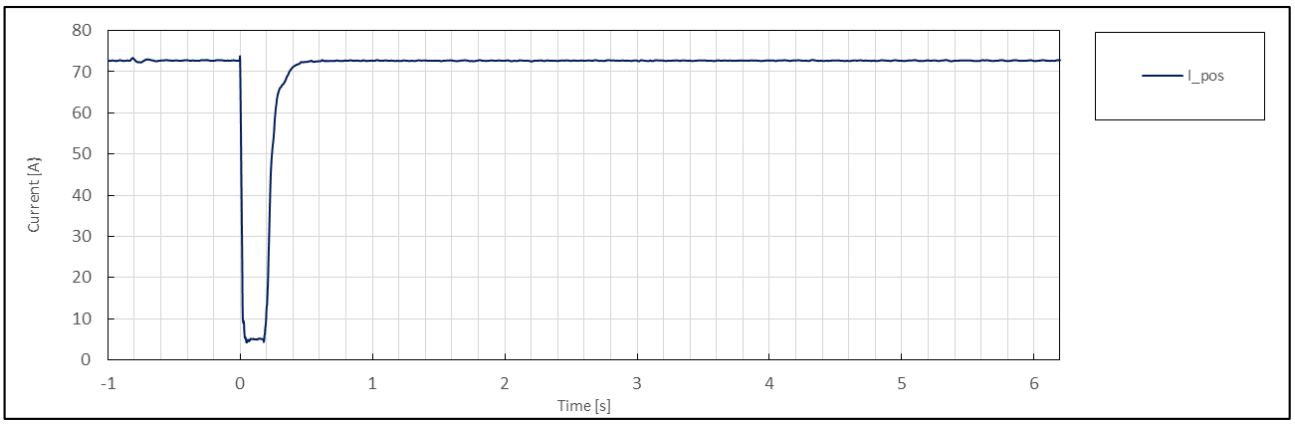

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

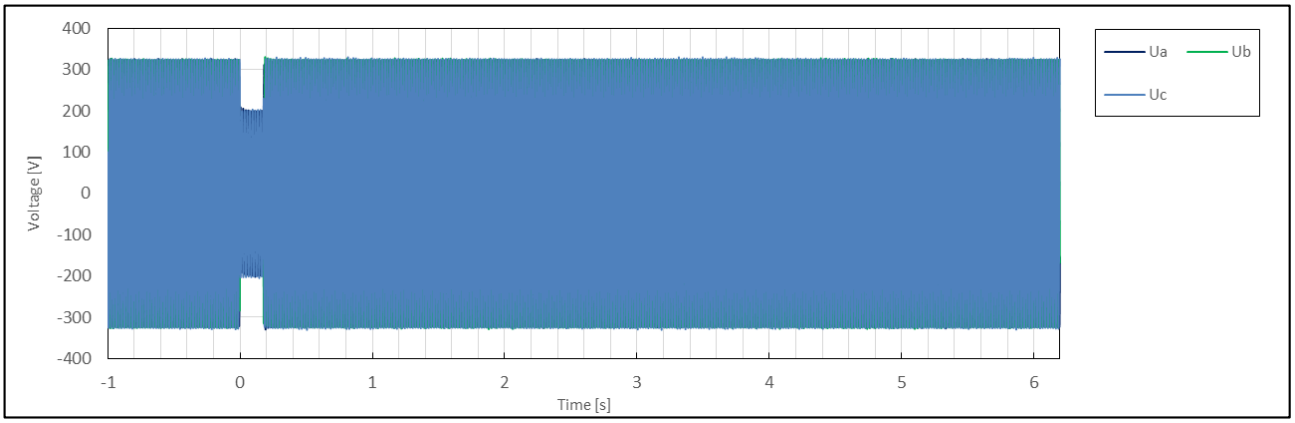

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

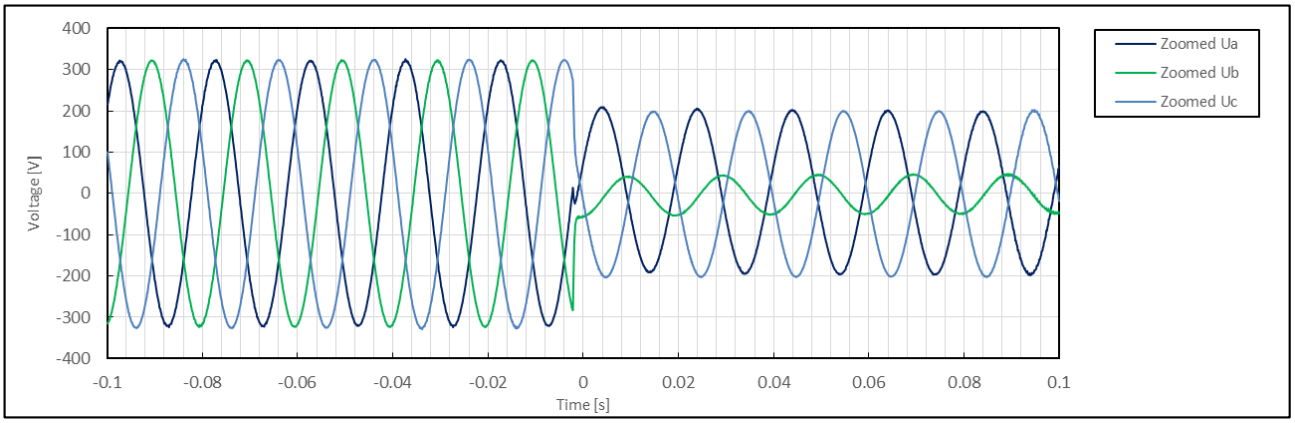

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

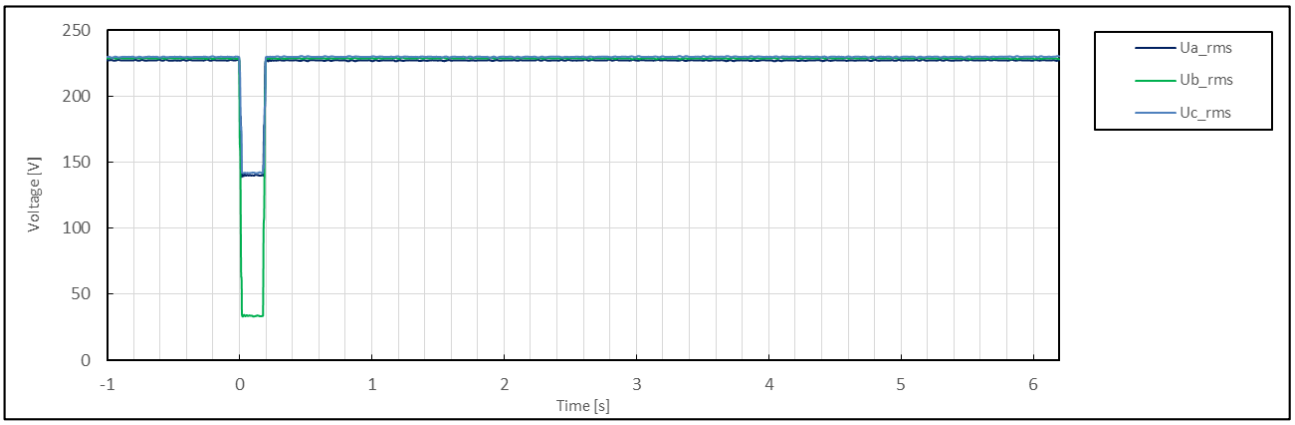

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.3(2)
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	20:24:34
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		196
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	195
	8	Fault duration in empty load test	Total	--	ms	196
	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.	1.01
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.08
	20		Phase 2			0.06
	21		Phase 3			0.06
	22	Line current	Phase 1	t1+100ms	p.u.	0.08
	23		Phase 2			0.06
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.098
	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

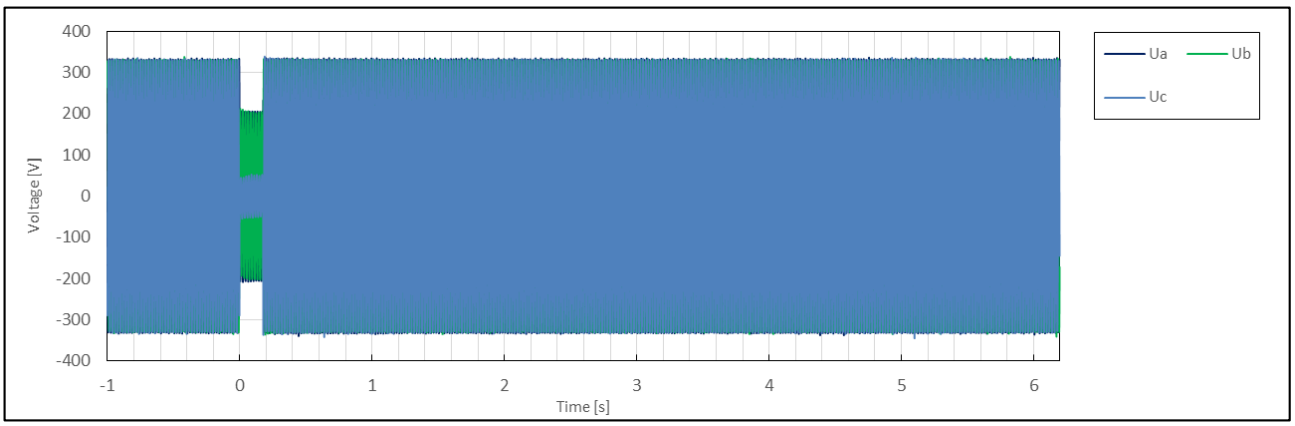
Test No. 1.3(D2) idle test

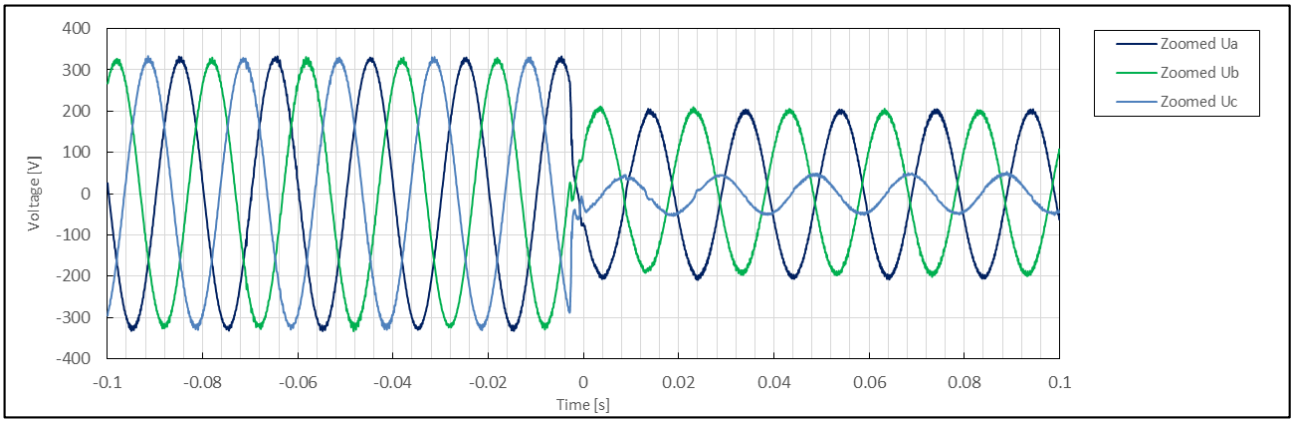


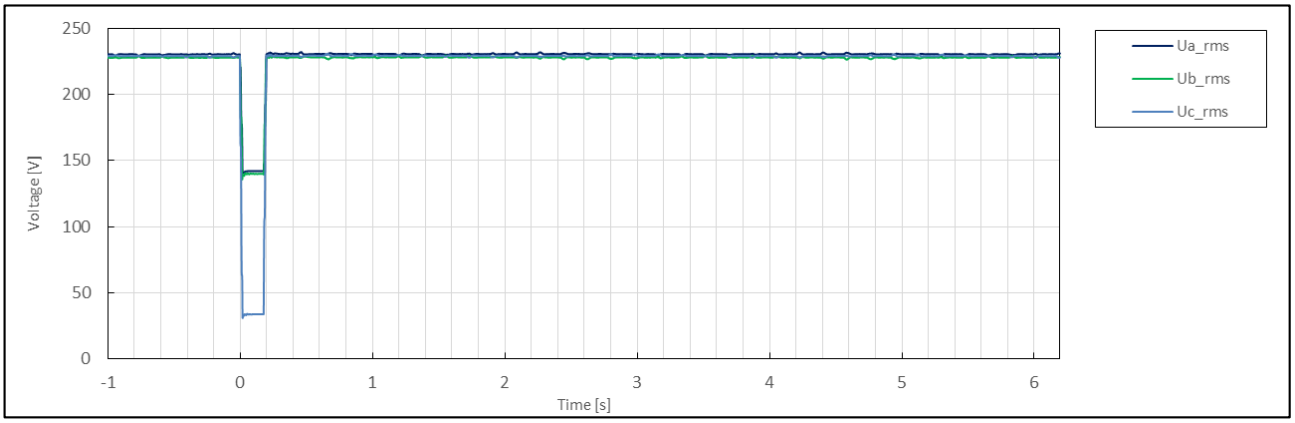


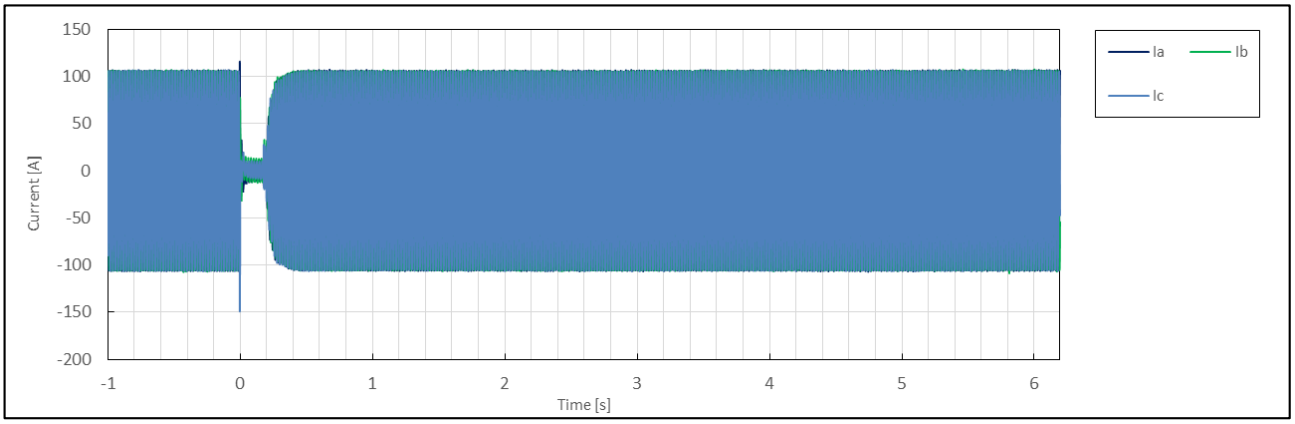


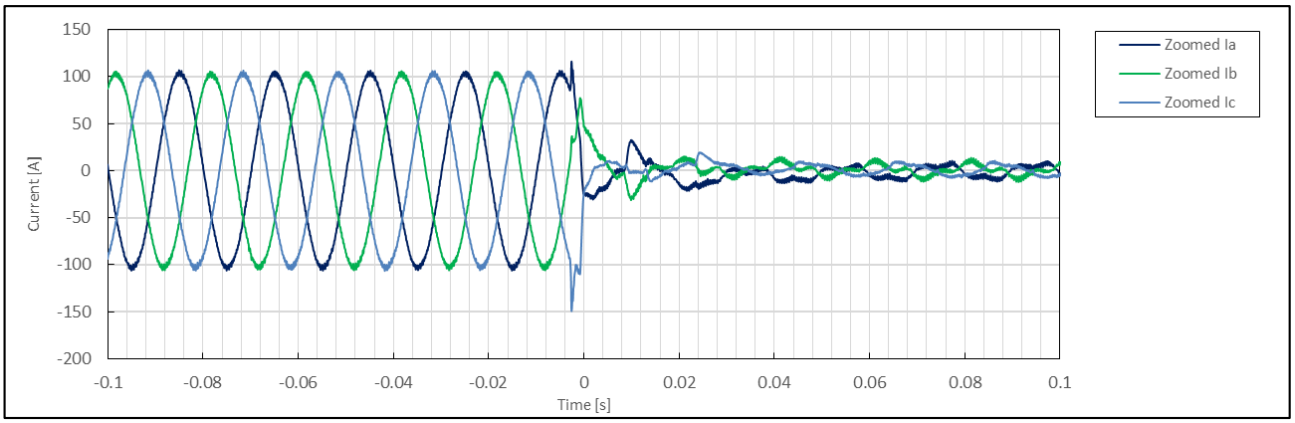
Test No. 1.3(D2) with PGU

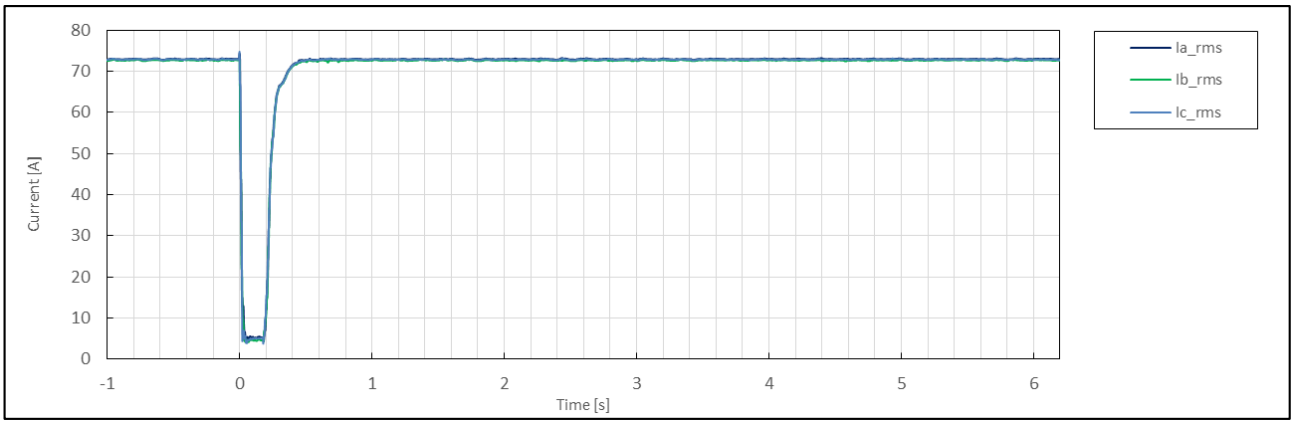


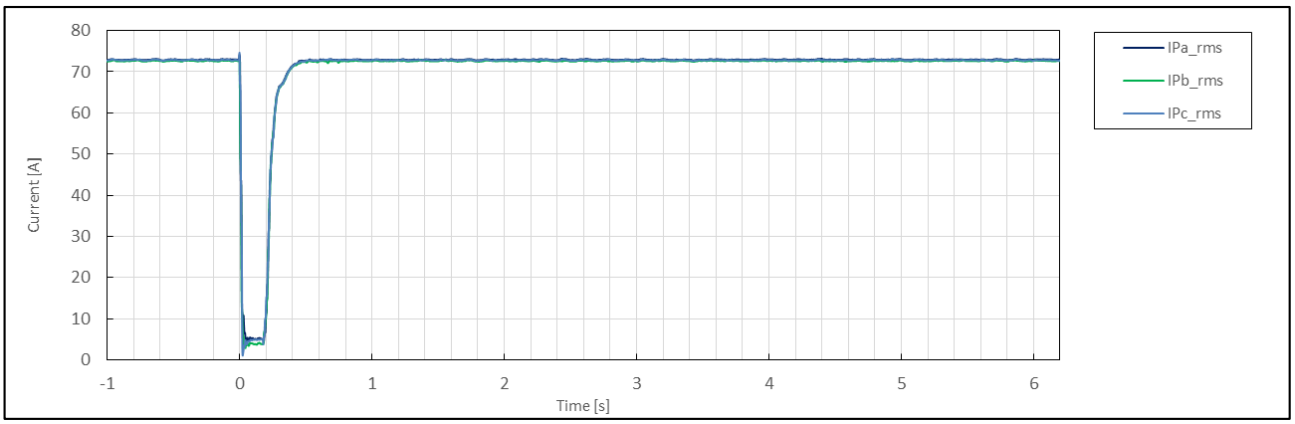


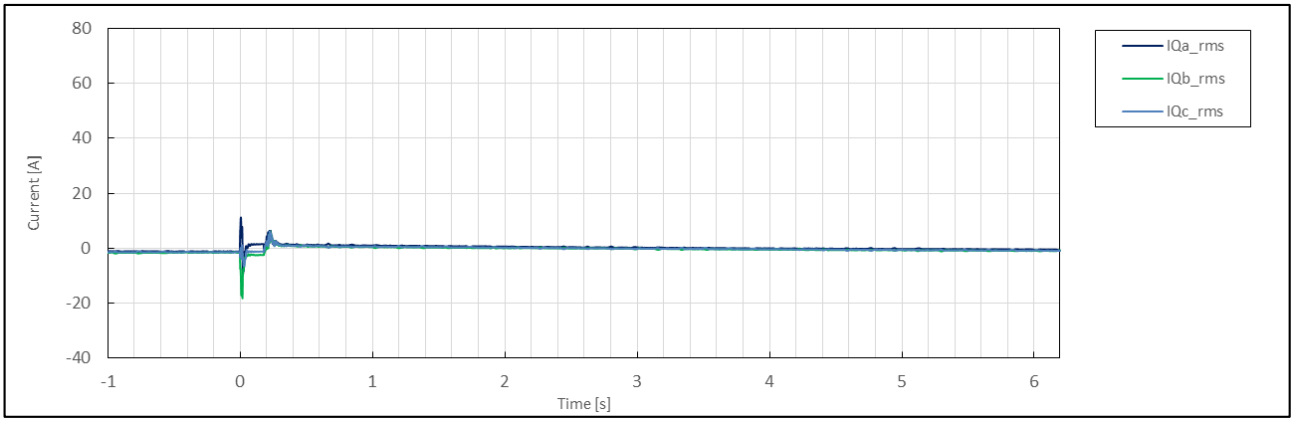


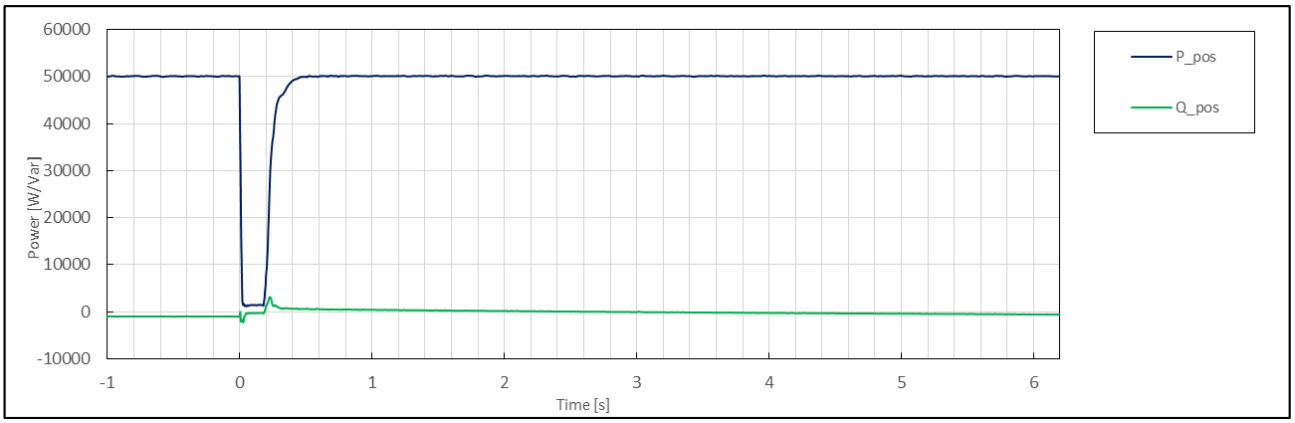


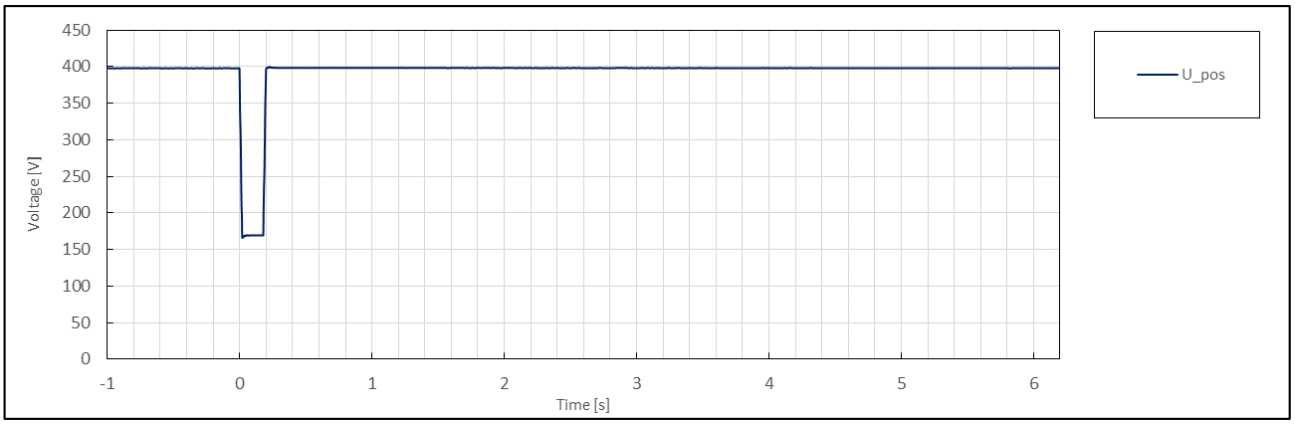

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

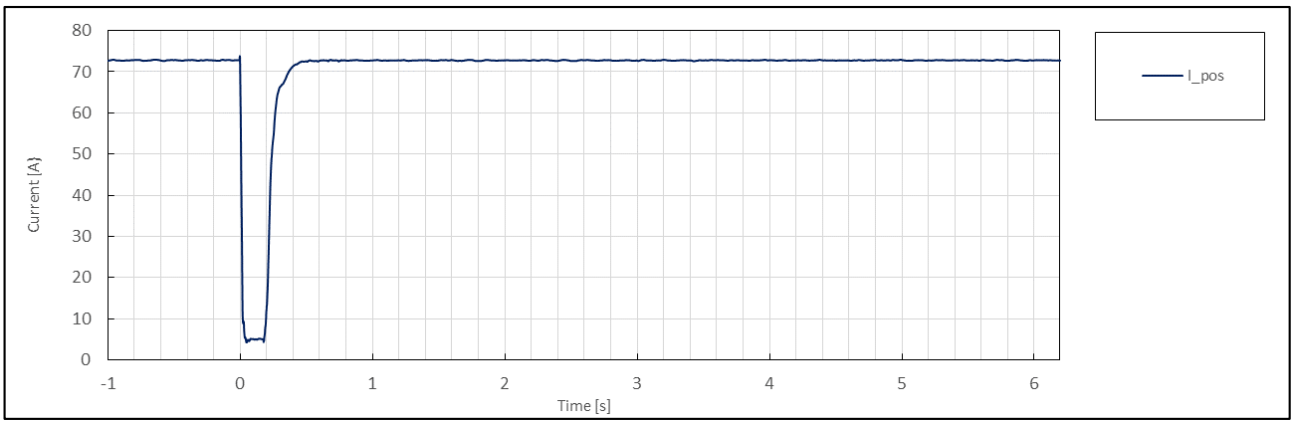

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

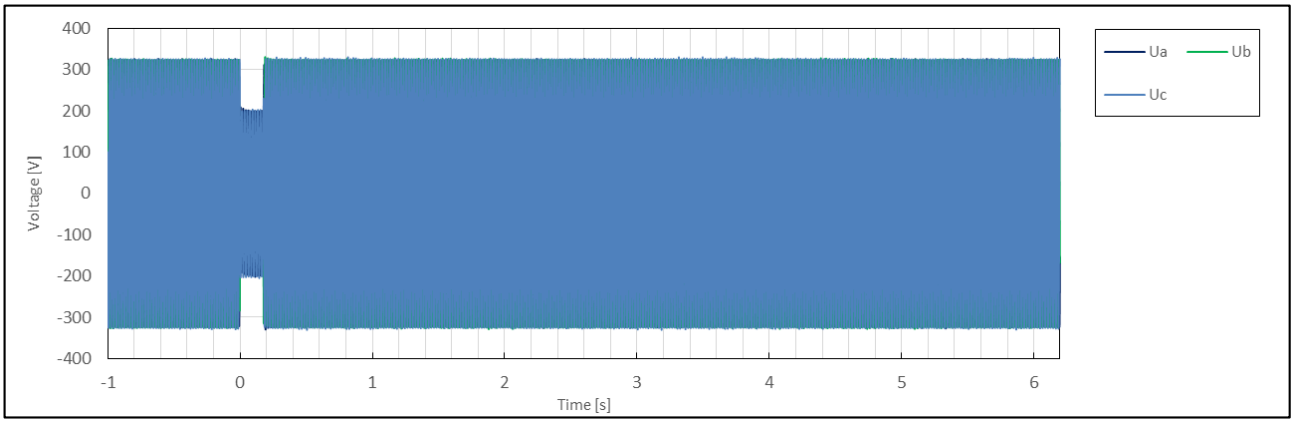

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

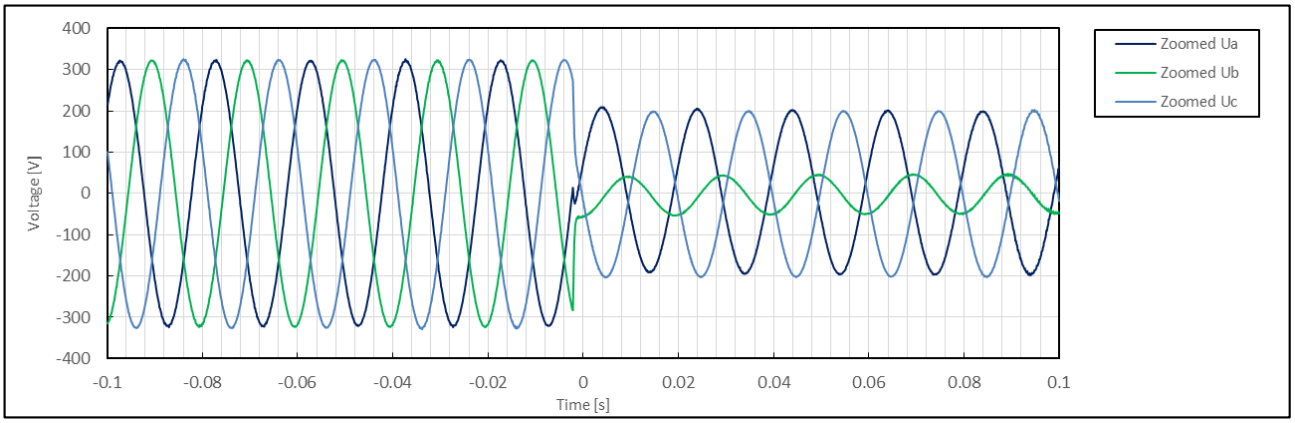

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

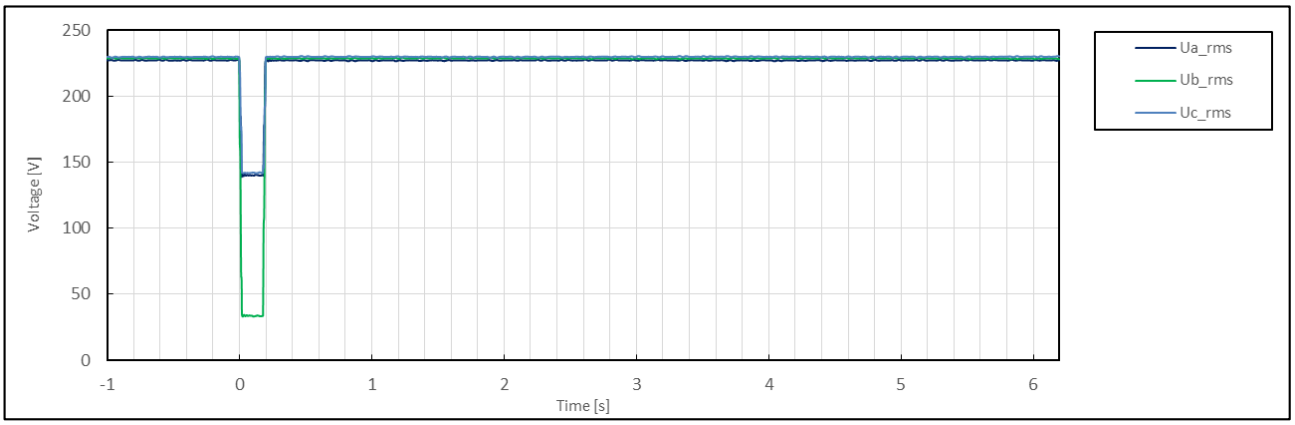

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.4
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	19:29:04
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		196
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	195
	8	Fault duration in empty load test	Total	--	ms	196
	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.	0.51
	13	Active power	Total	t1-10s to t1	p.u.	0.51
	14		Pos.			0.51
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.07
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.06
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	0.51
	29		Pos.			0.51
	39	Active power rising time	Pos.	--	s	0.108
	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

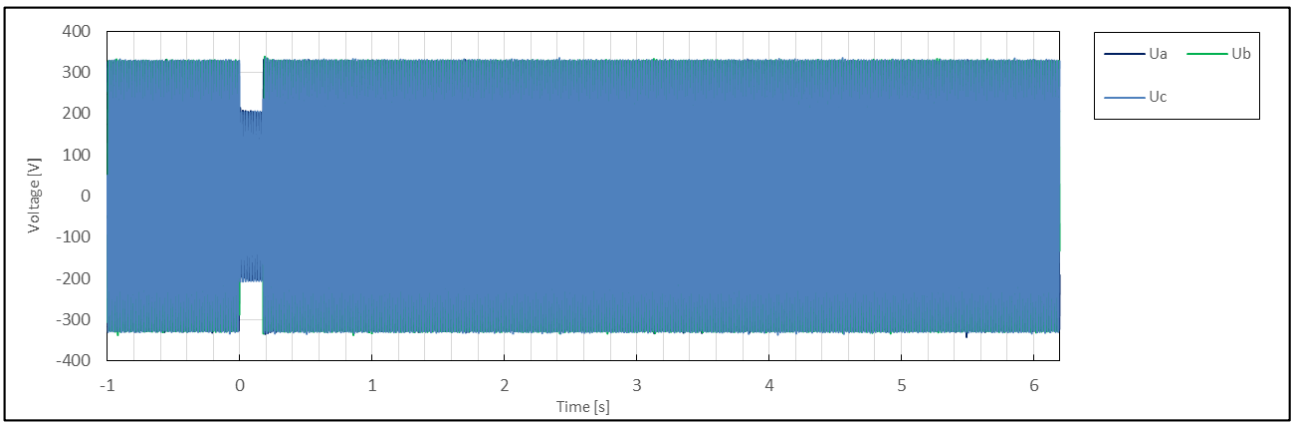
Test No. 1.4 idle test

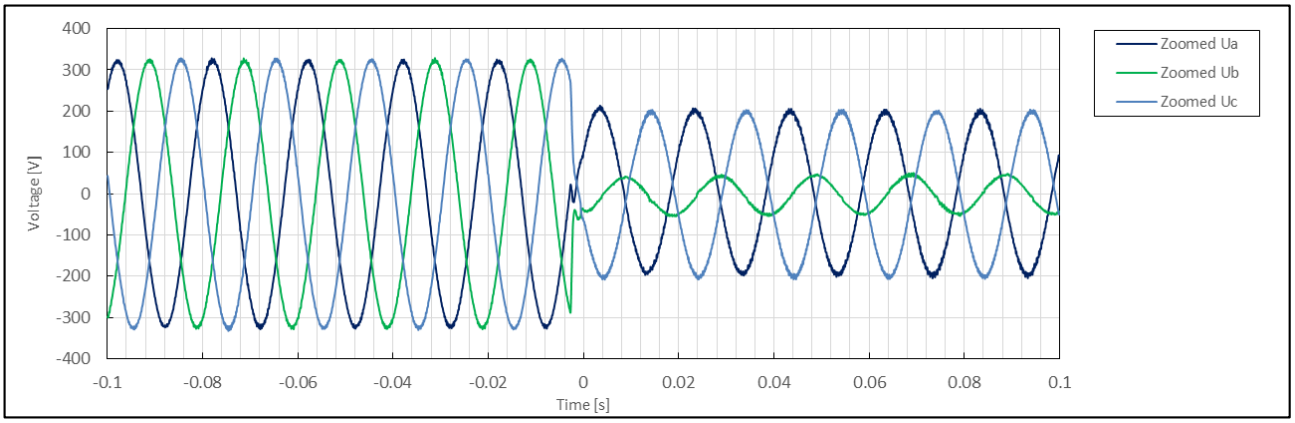


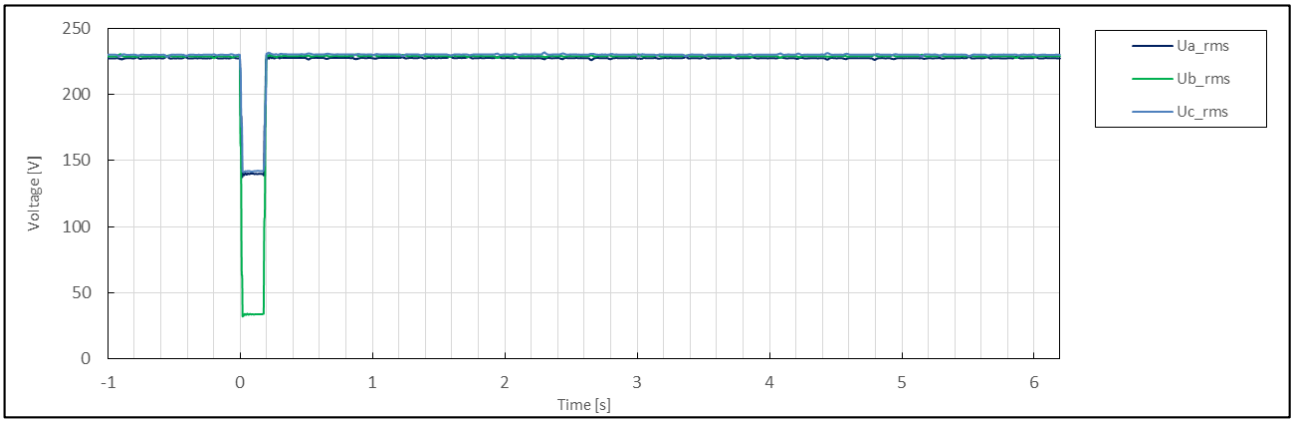


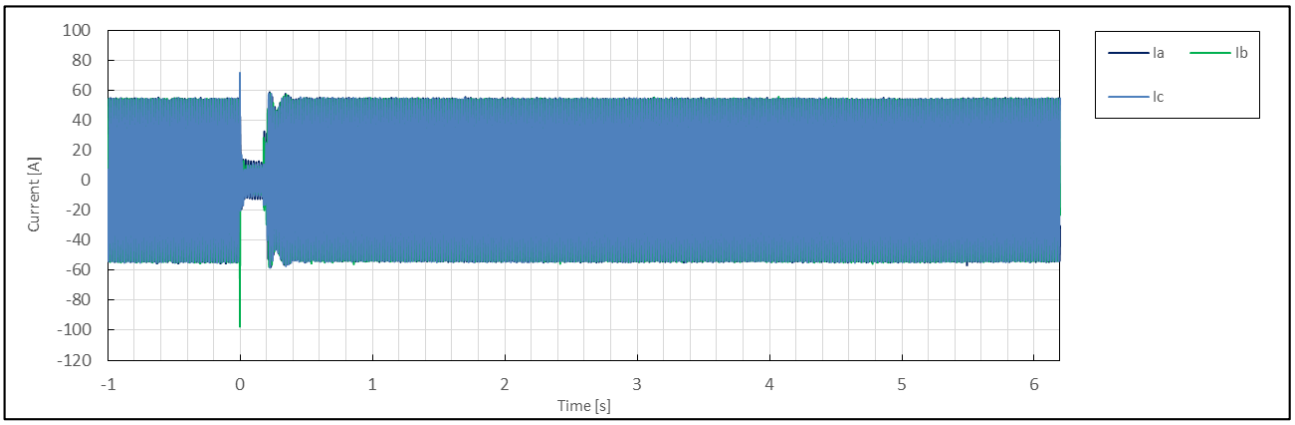


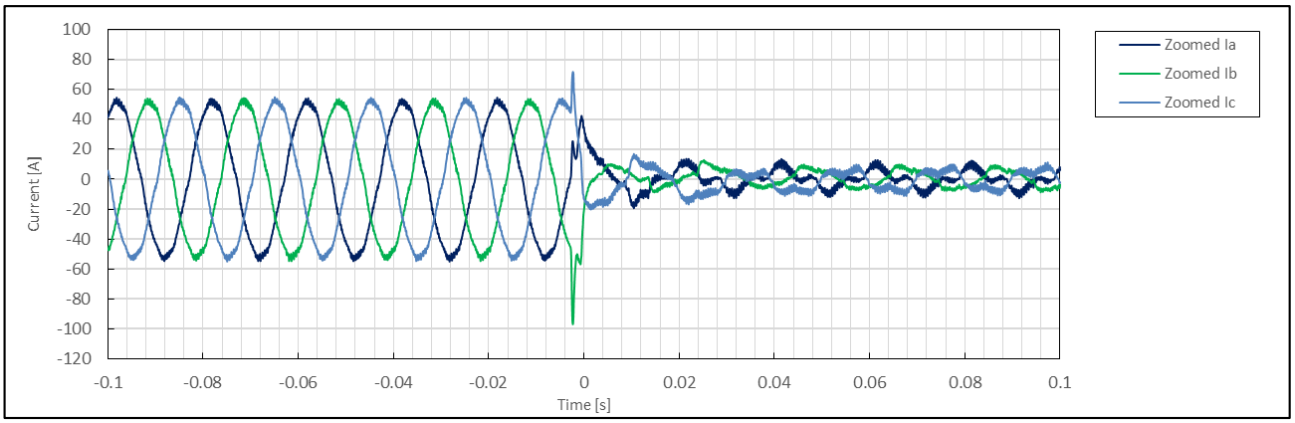
Test No. 1.4 with PGU

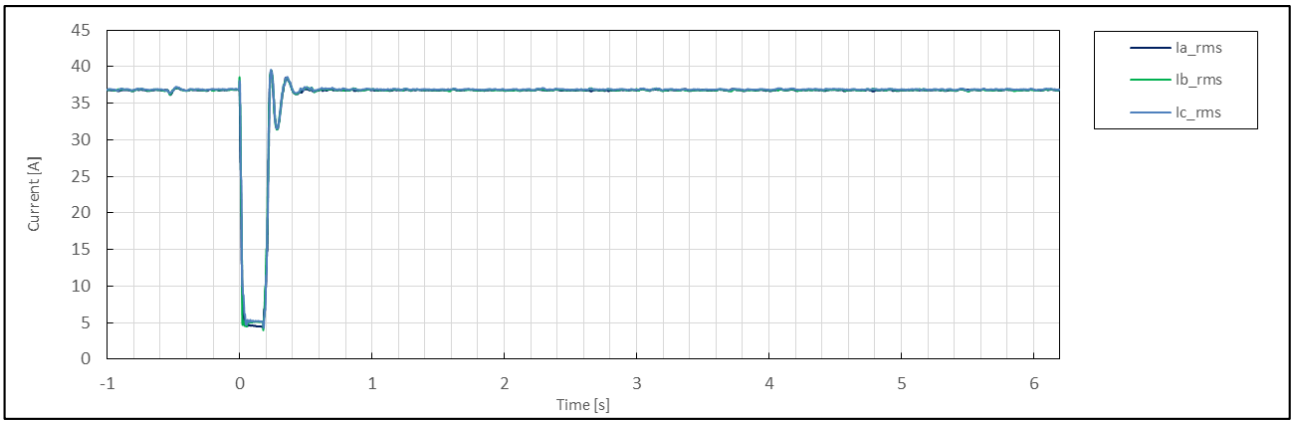


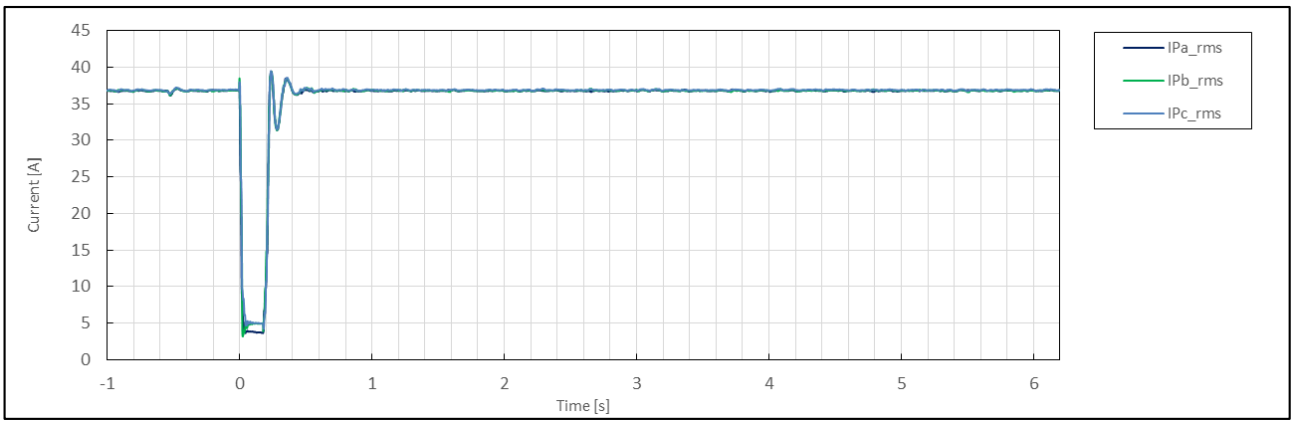


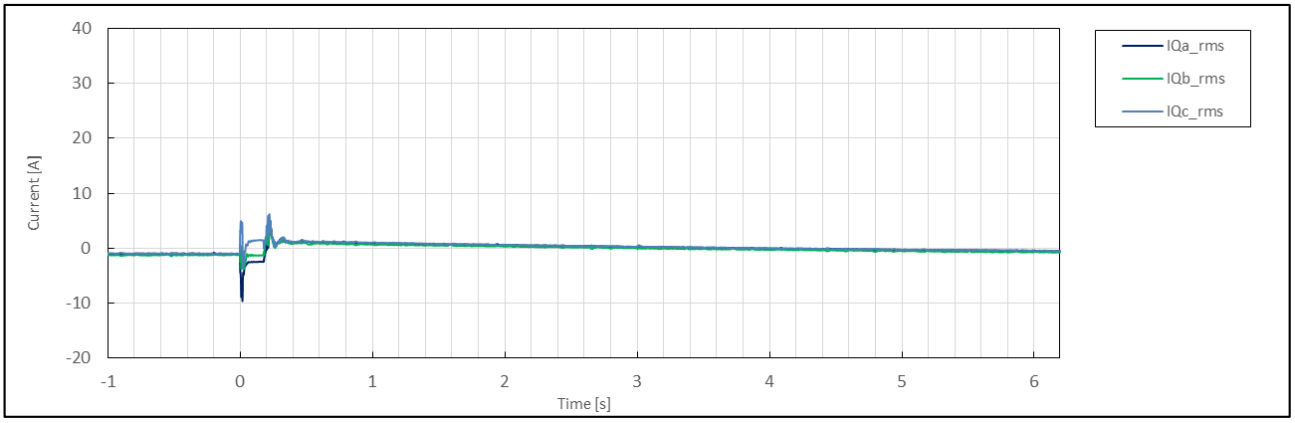


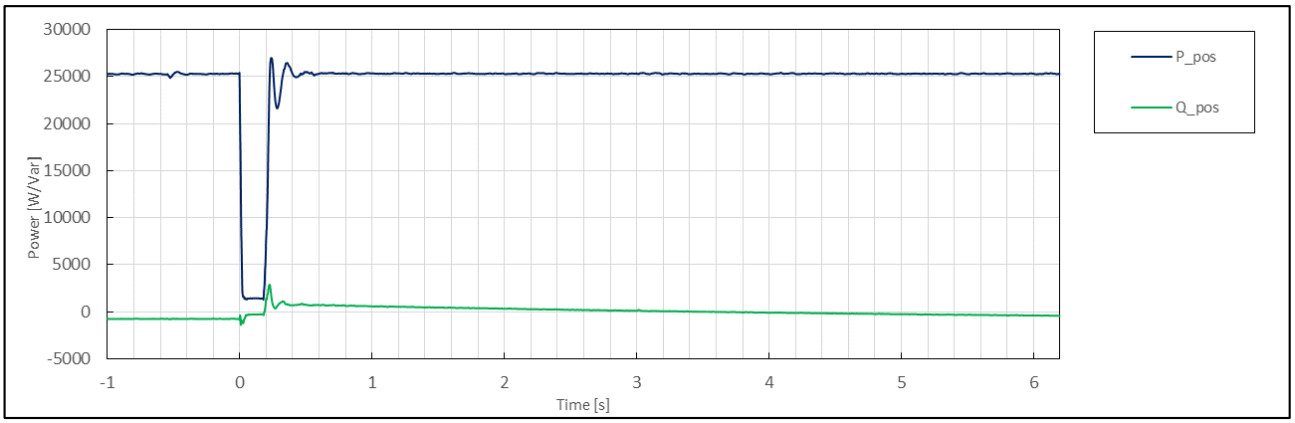


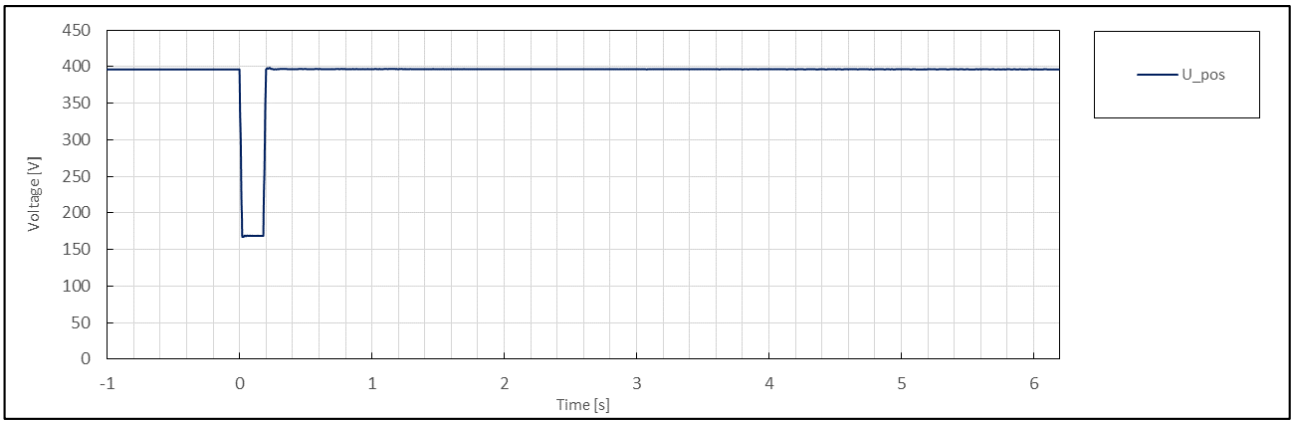

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

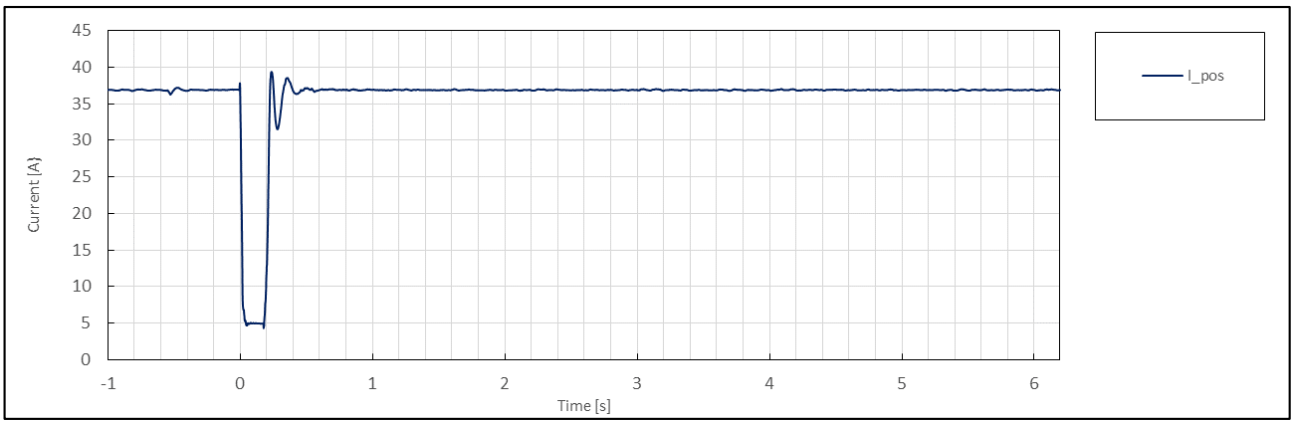

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

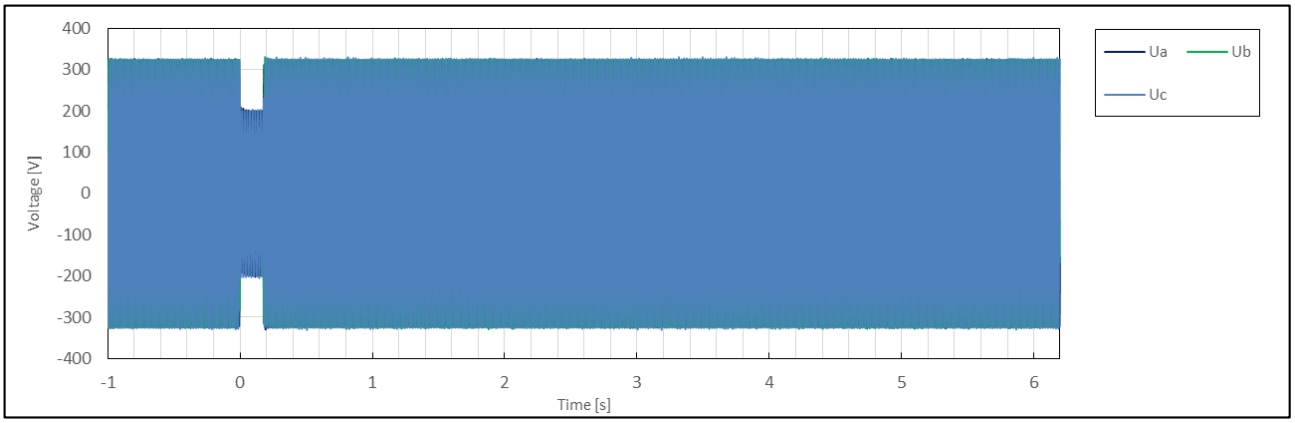

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

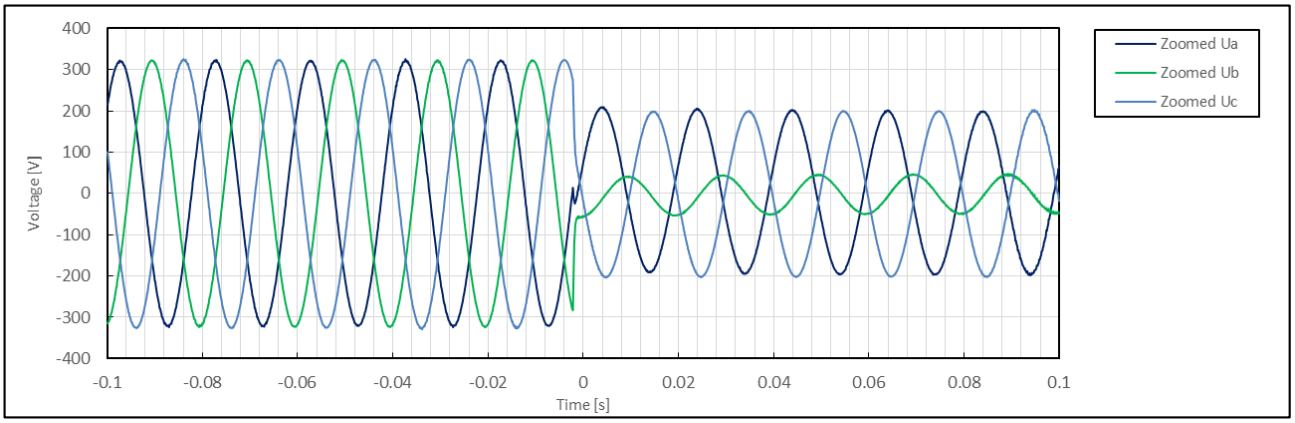

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

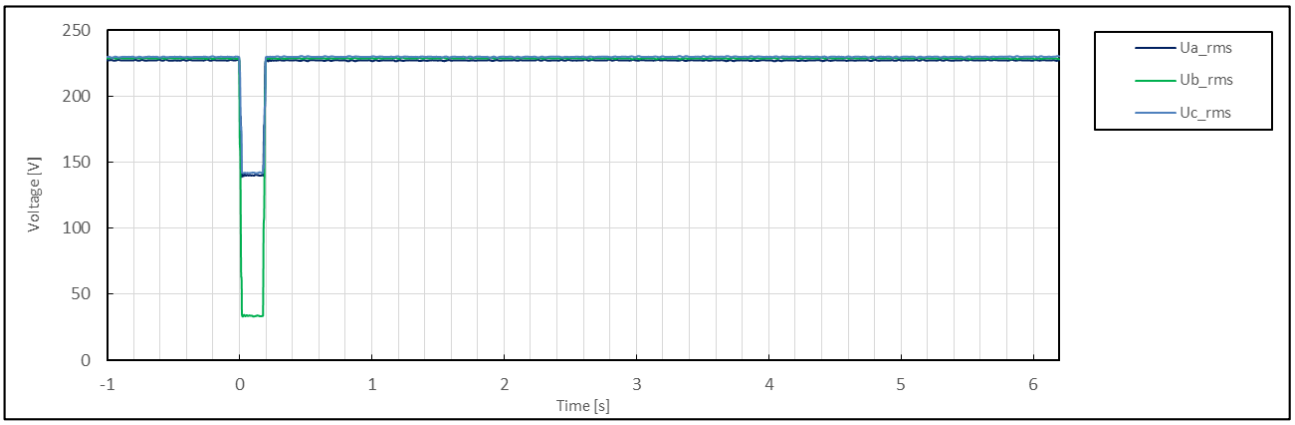

45
40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	1.4(2)
	1	Date	--	--	dd.mm.yyyy	02.20.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	20:18:16
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.15
	5	Setting dip duration		--		196
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	195
	8	Fault duration in empty load test	Total	--	ms	196
	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.	0.99
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.51
	13	Active power	Total	t1-10s to t1	p.u.	0.51
	14		Pos.			0.51
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.07
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.06
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	0.51
	29		Pos.			0.51
	39	Active power rising time	Pos.	--	s	0.109
	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

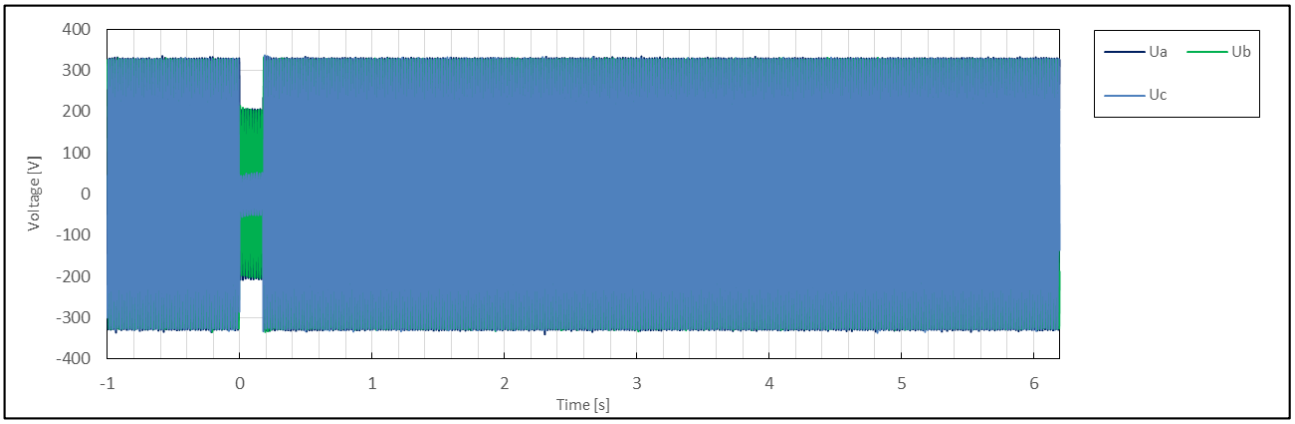
Test No. 1.4(D2) idle test

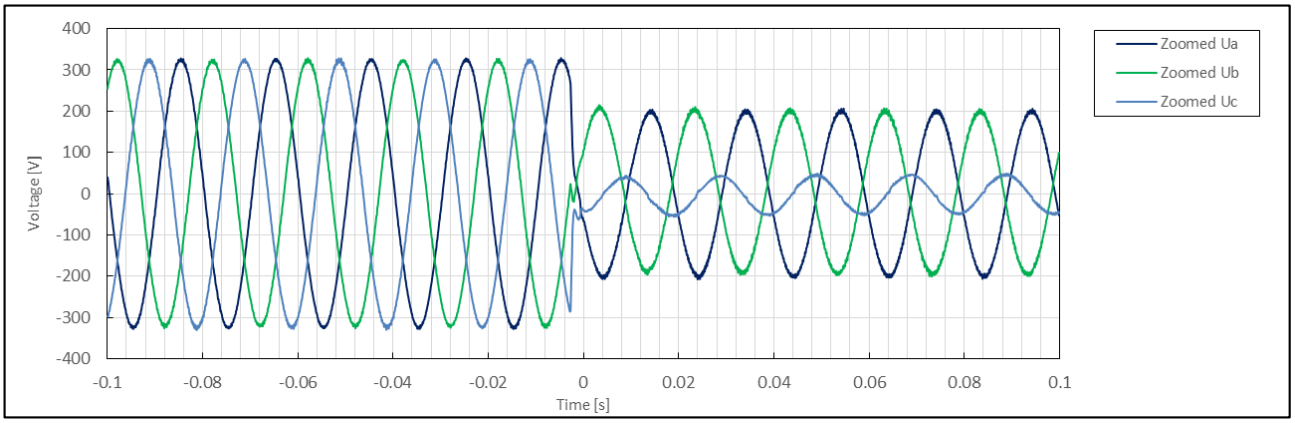


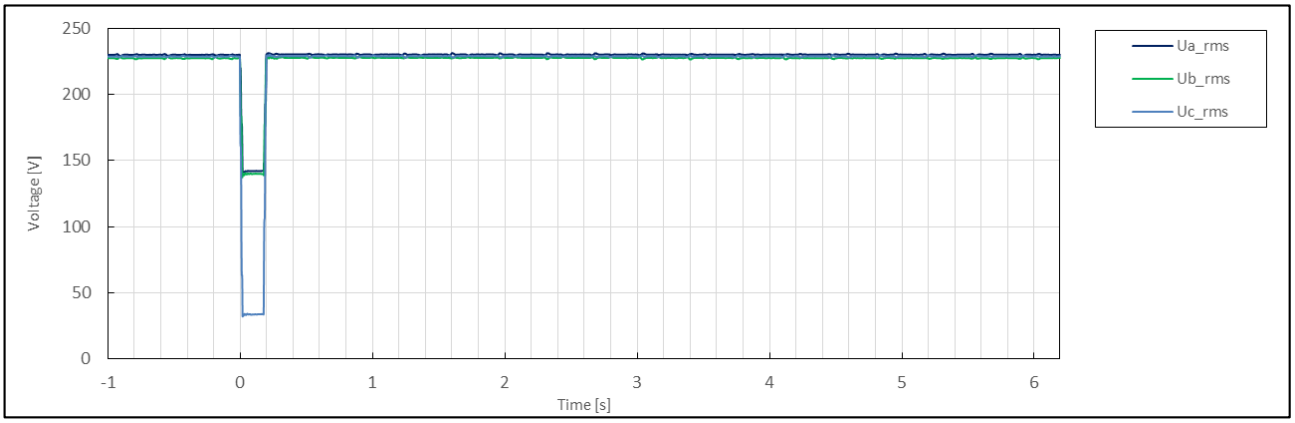


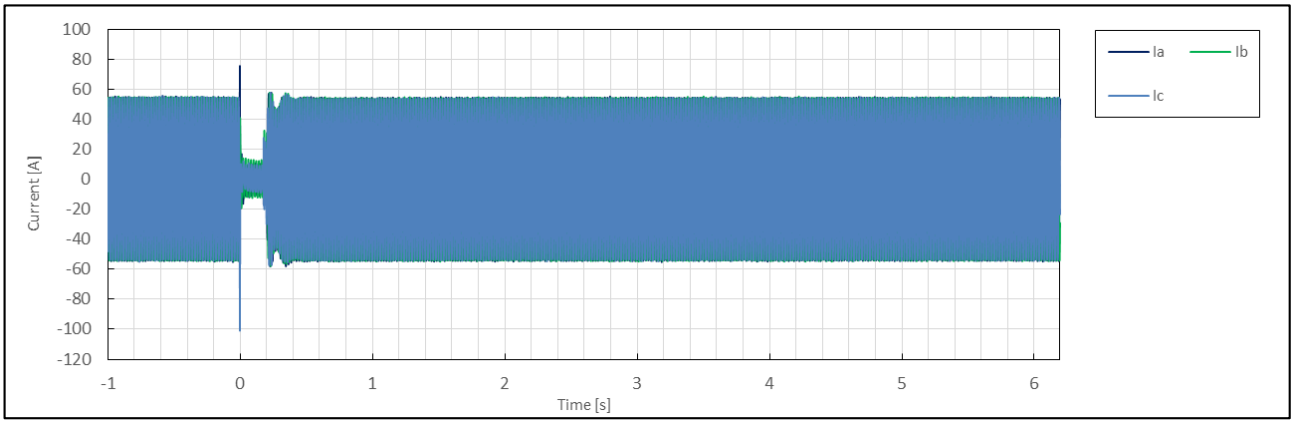


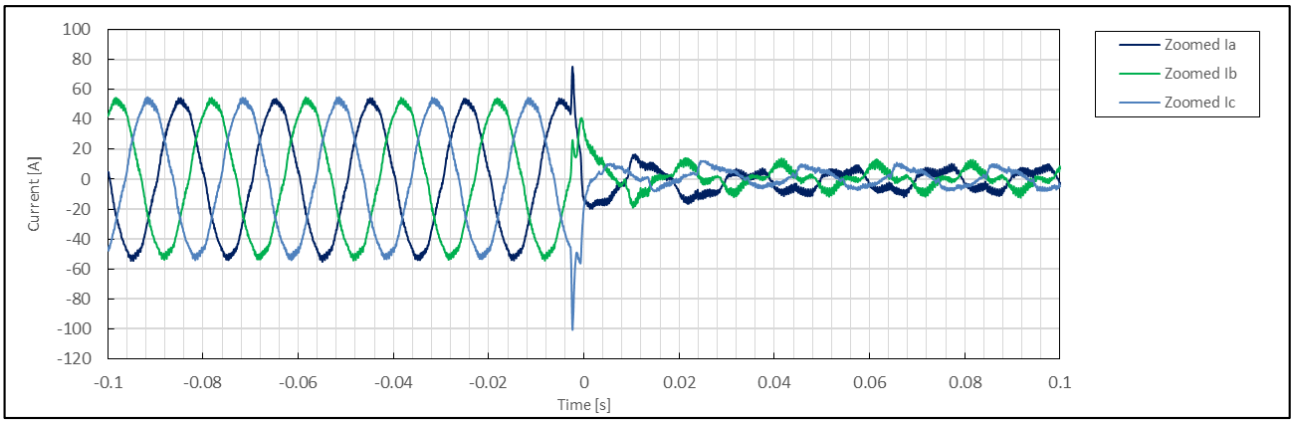
Test No. 1.4(D2) with PGU

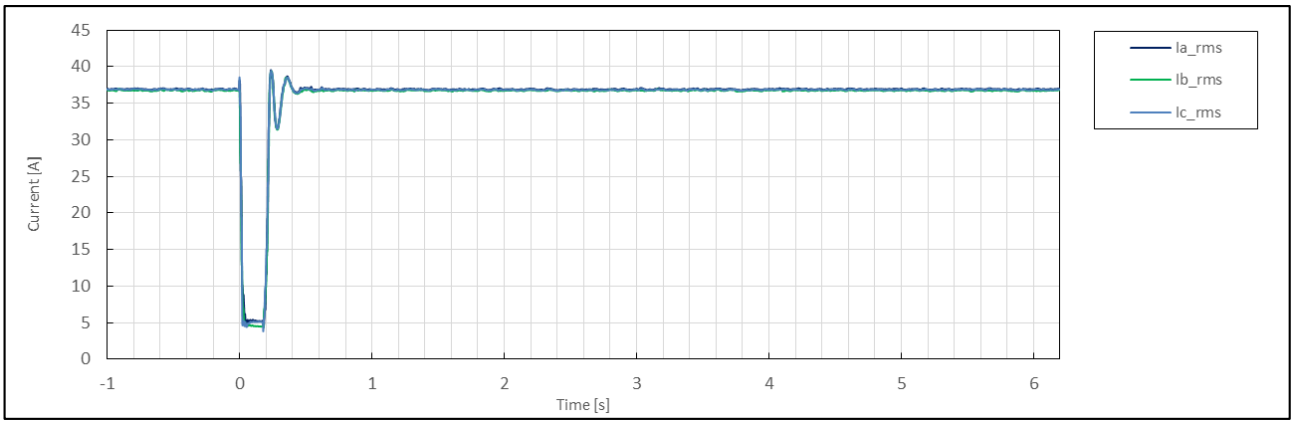


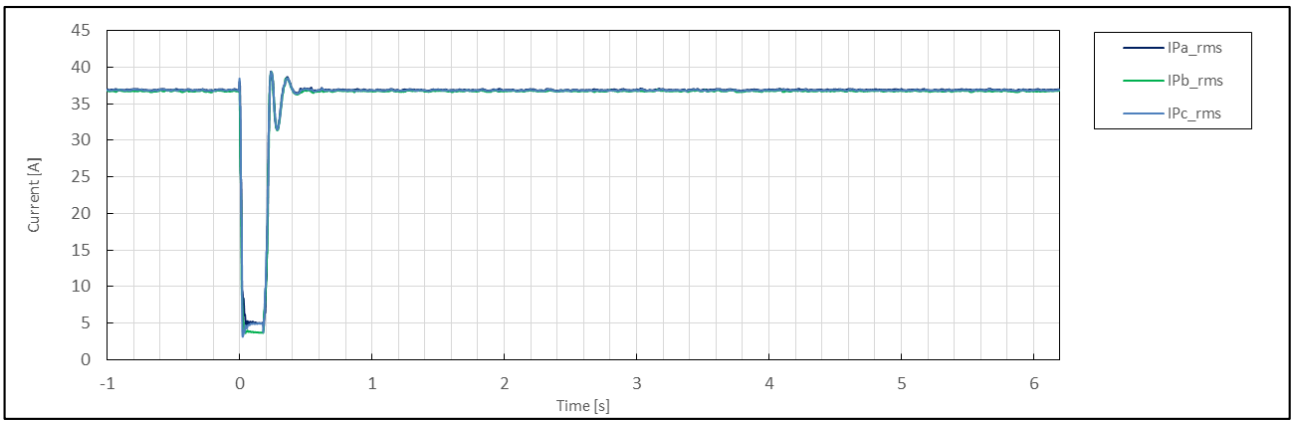


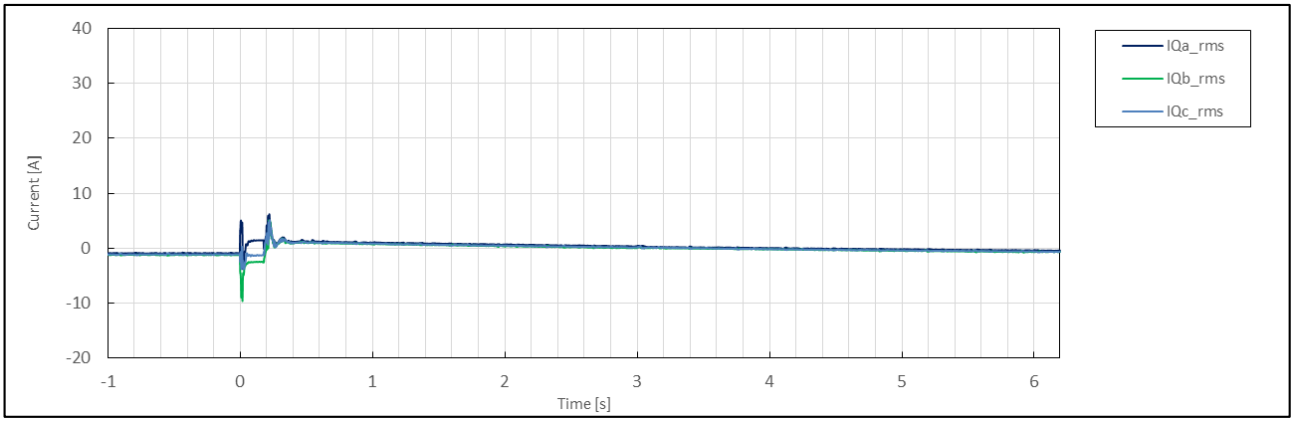


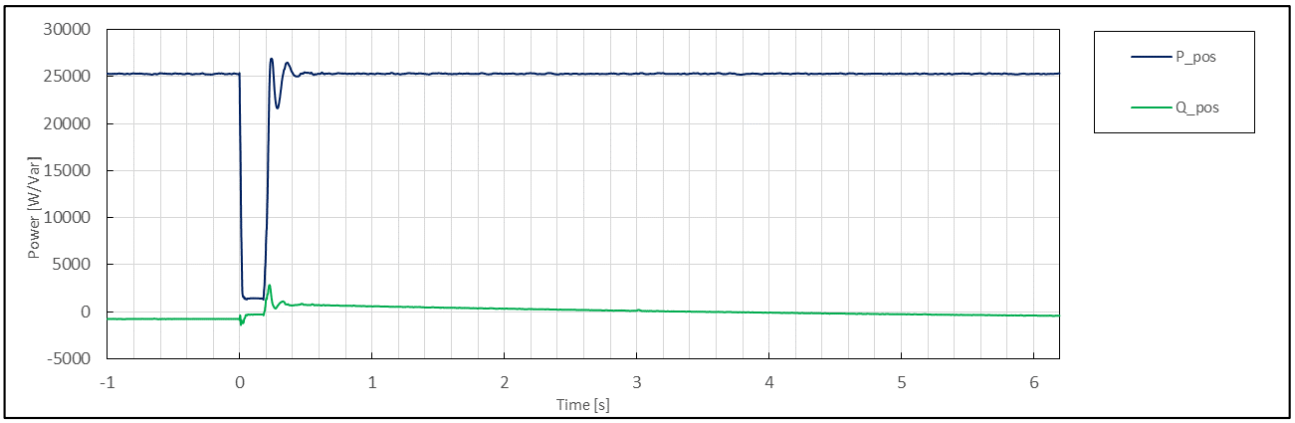


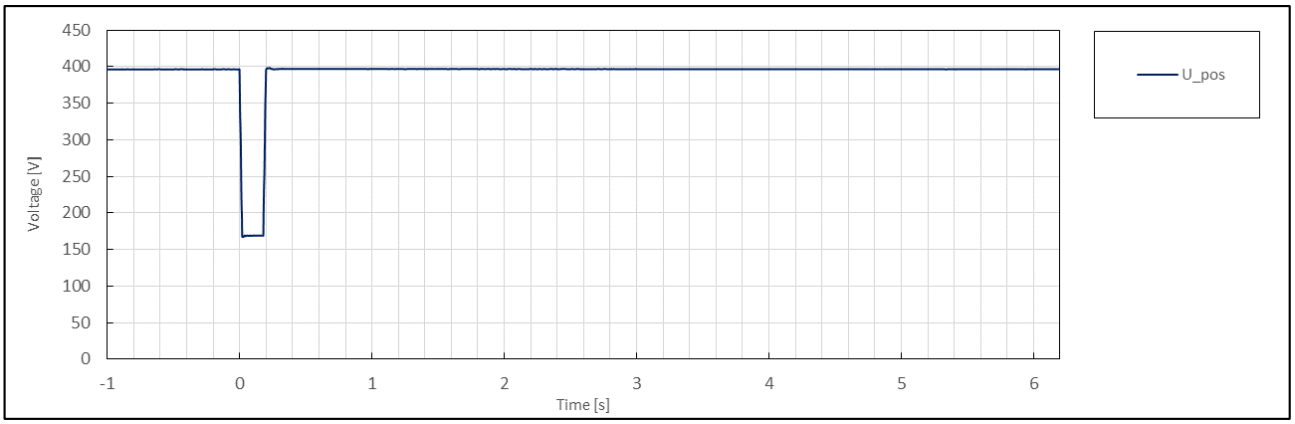

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

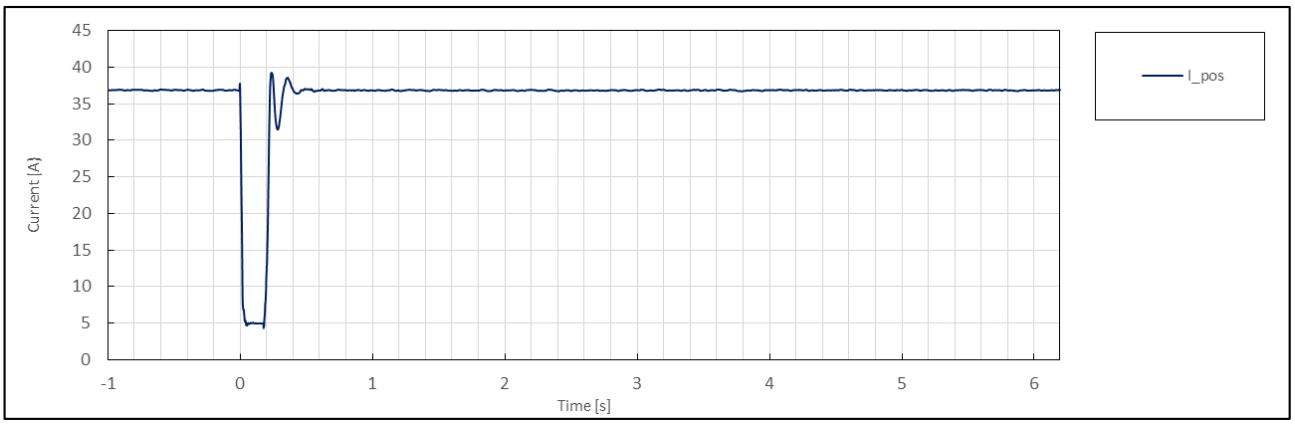

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

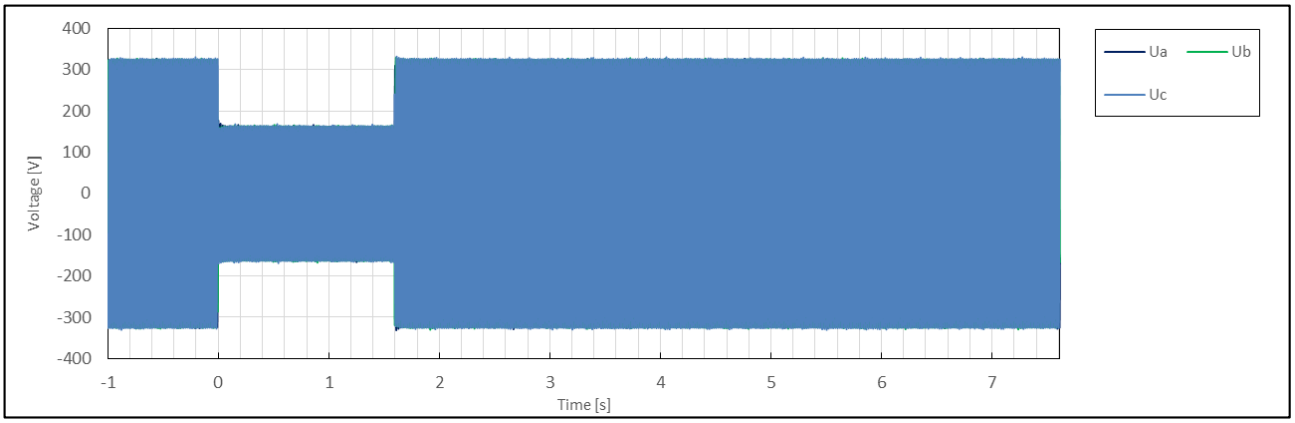

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

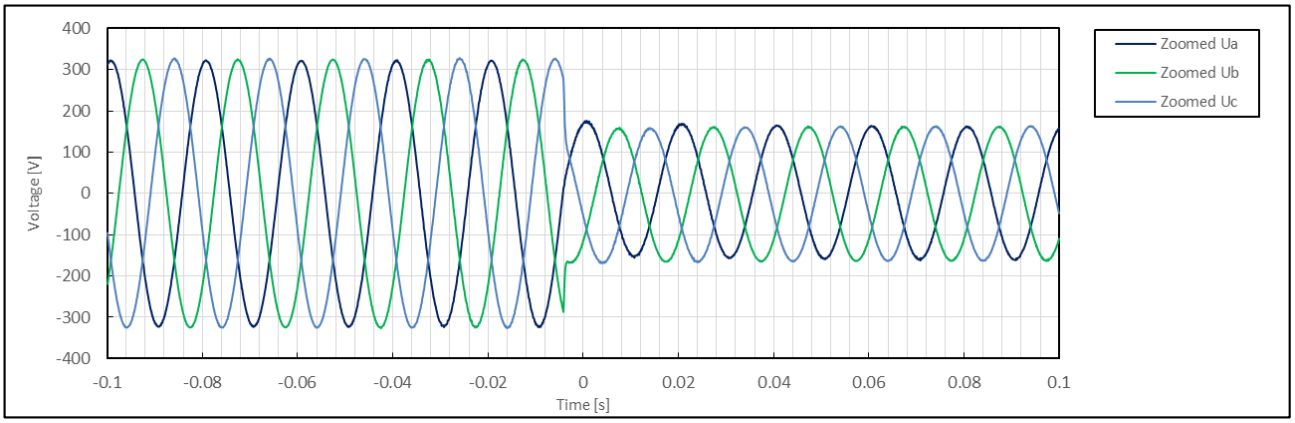

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

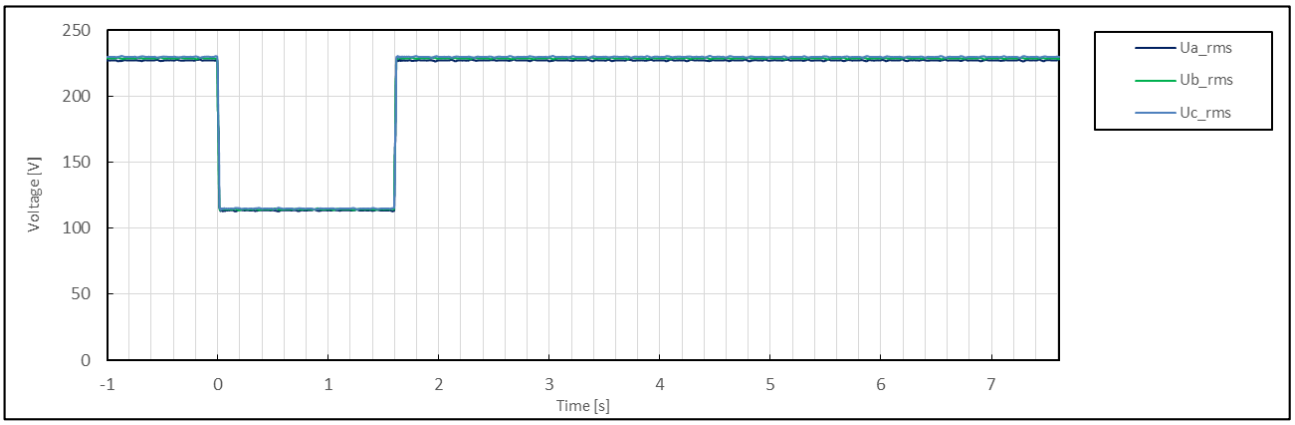

45
40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	2.1
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	17:33:14
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.49
	5	Setting dip duration		--		1614
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1613
	8	Fault duration in empty load test	Total	--	ms	1614
	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.	1.02
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.08
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	0.46
	16		Pos.			0.46
	17	Cos_{φ}	--	t1-10s to t1	--	0.907
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.	0.07
	20		Phase 2			0.08
	21		Phase 3			0.08
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.149
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.34
	32		Pos.			0.34
	33	Reactive power rising time	Pos.	--	s	15.00
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

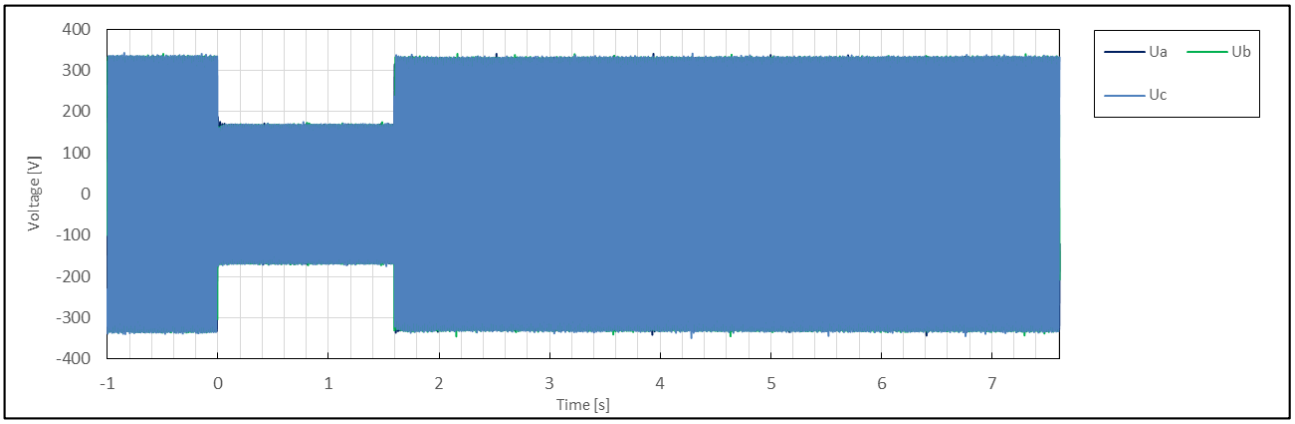
Test No. 2.1 idle test

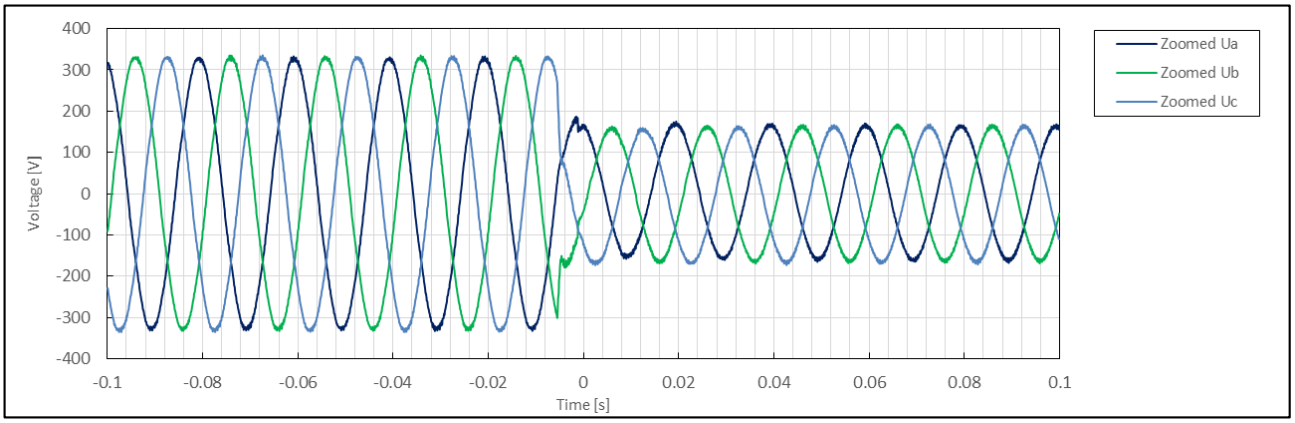


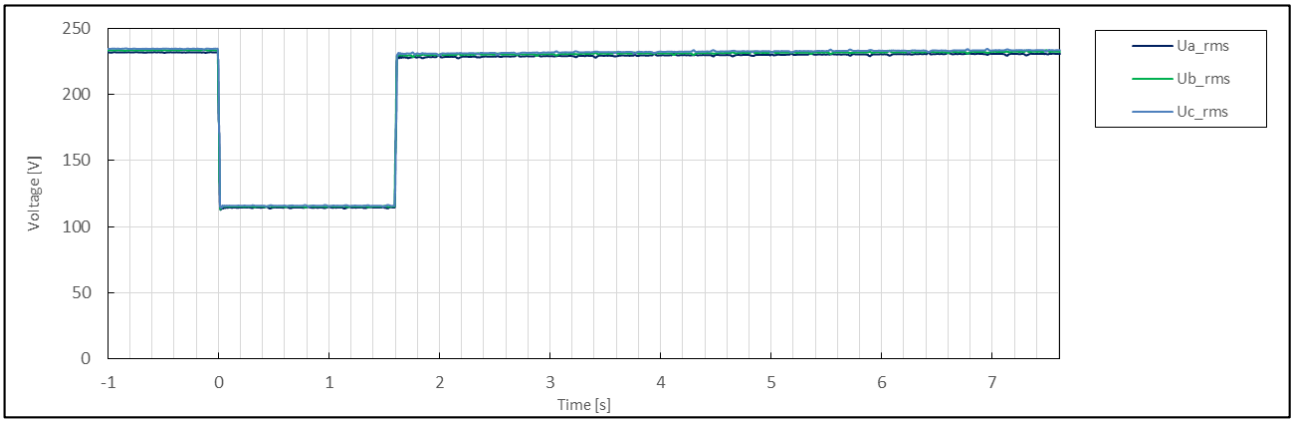


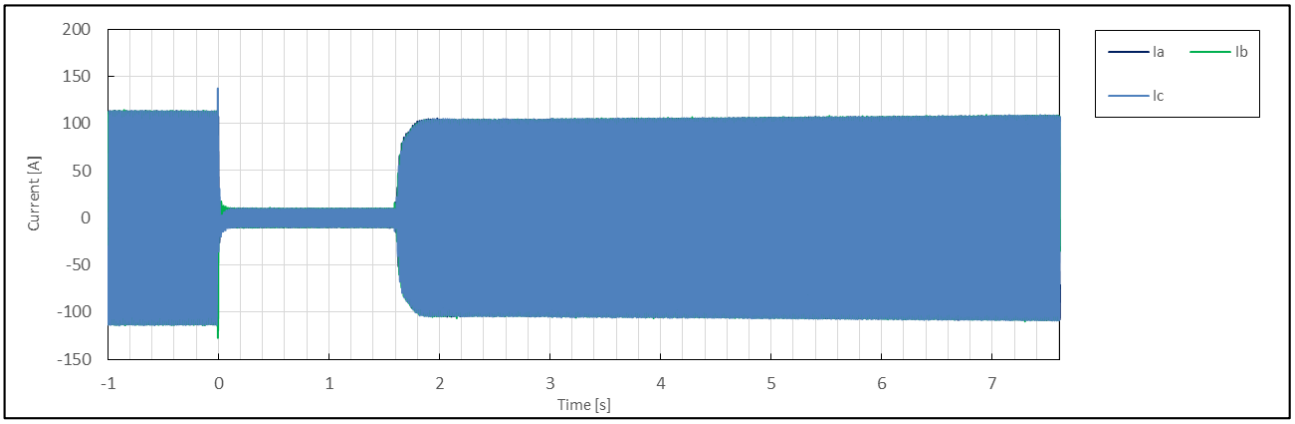


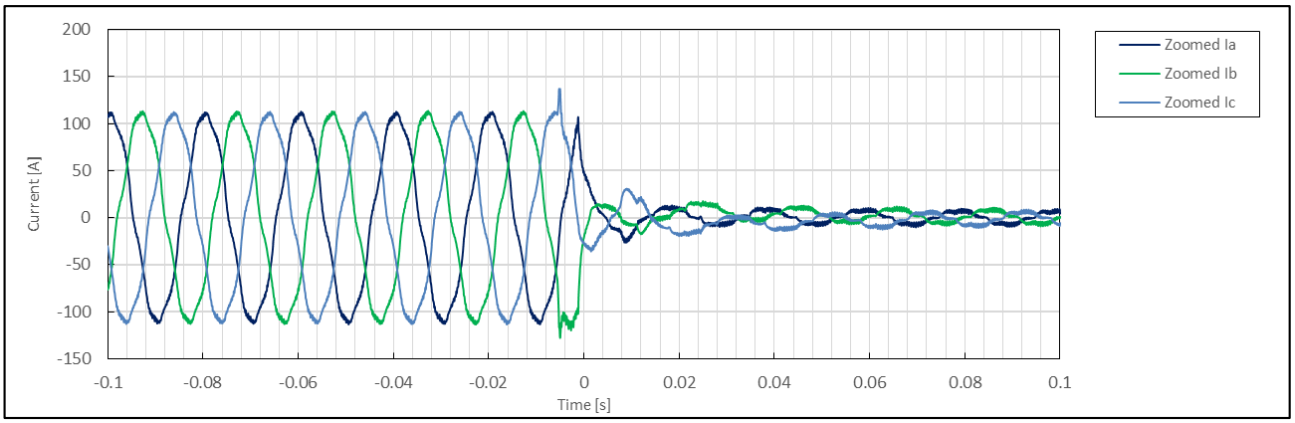
Test No. 2.1 with PGU

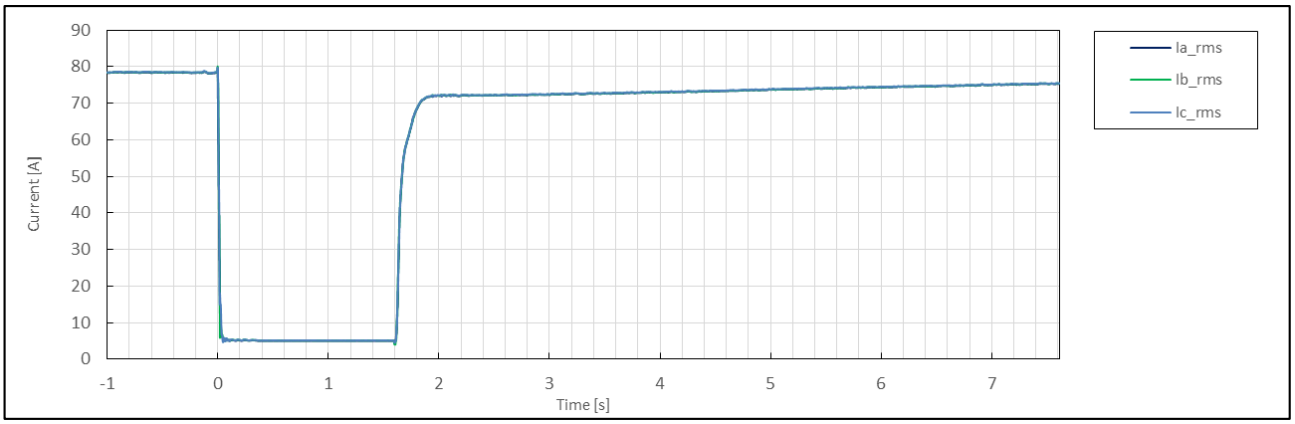


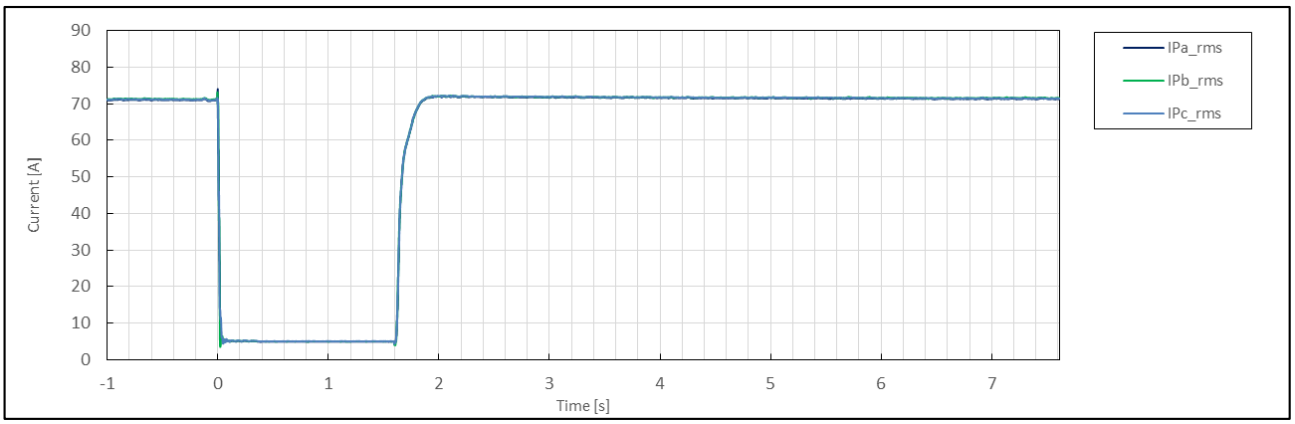


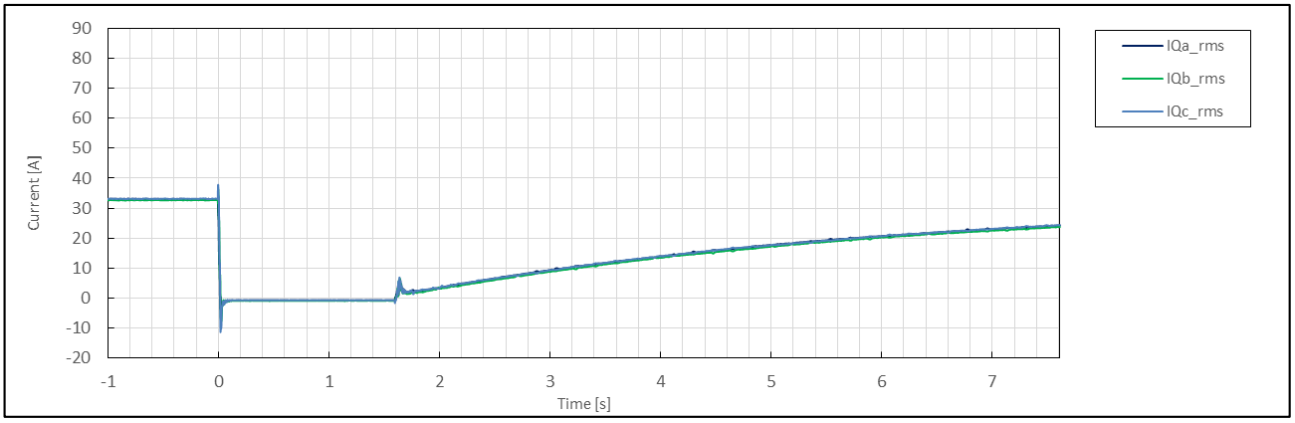


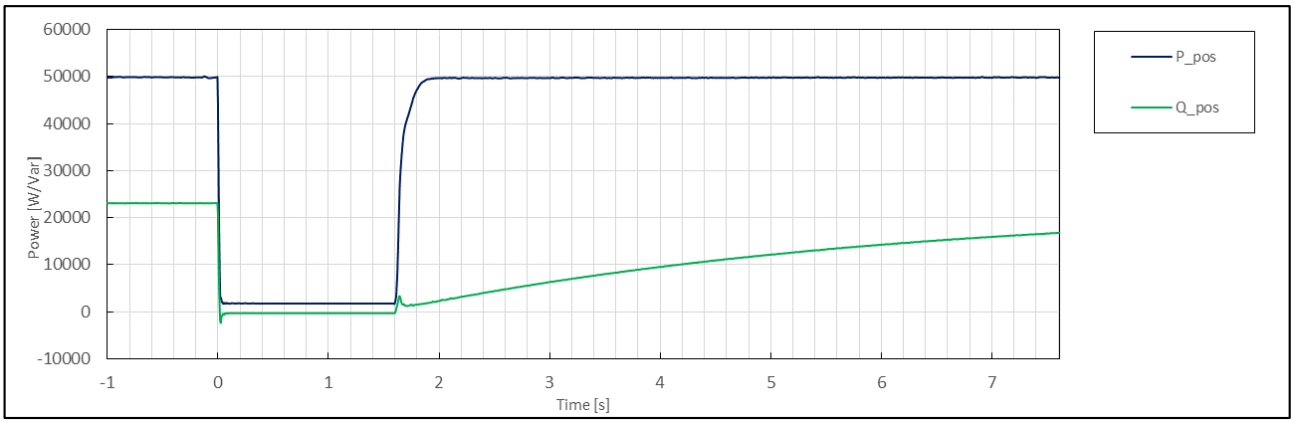


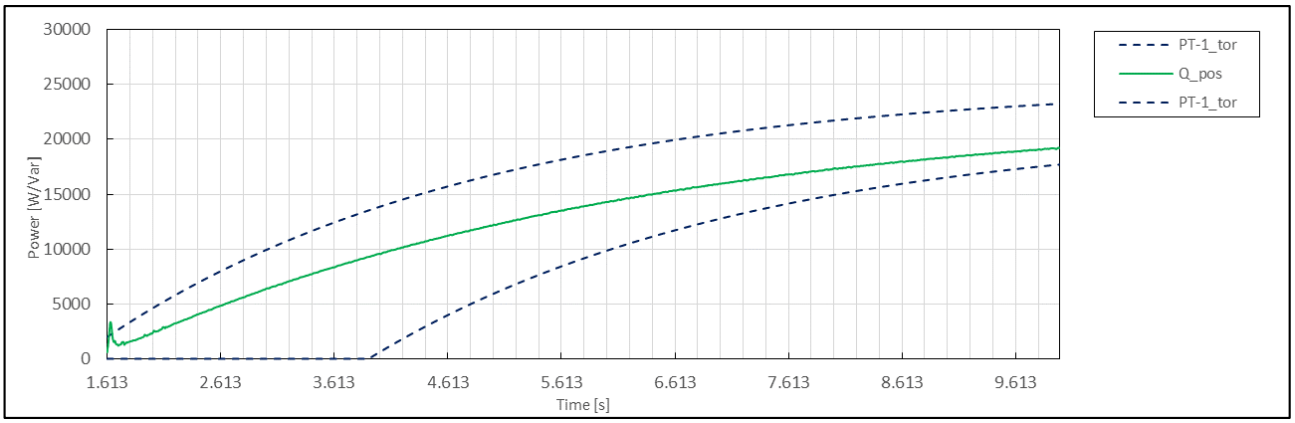

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

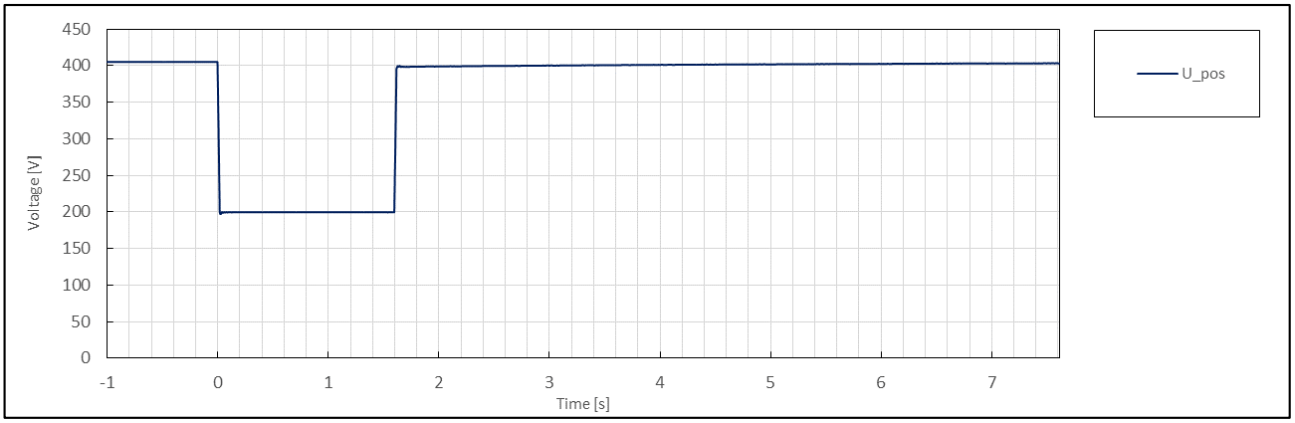

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

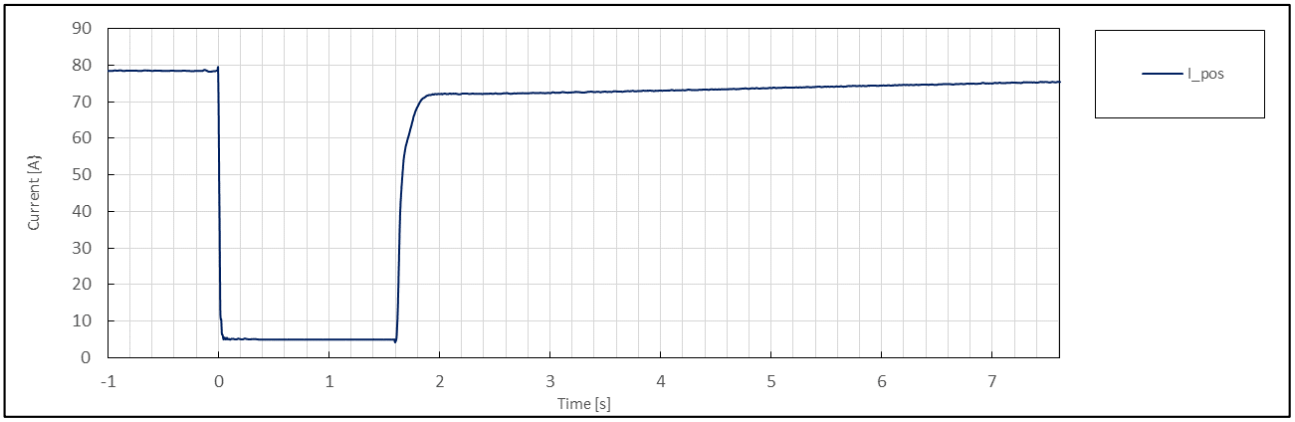

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

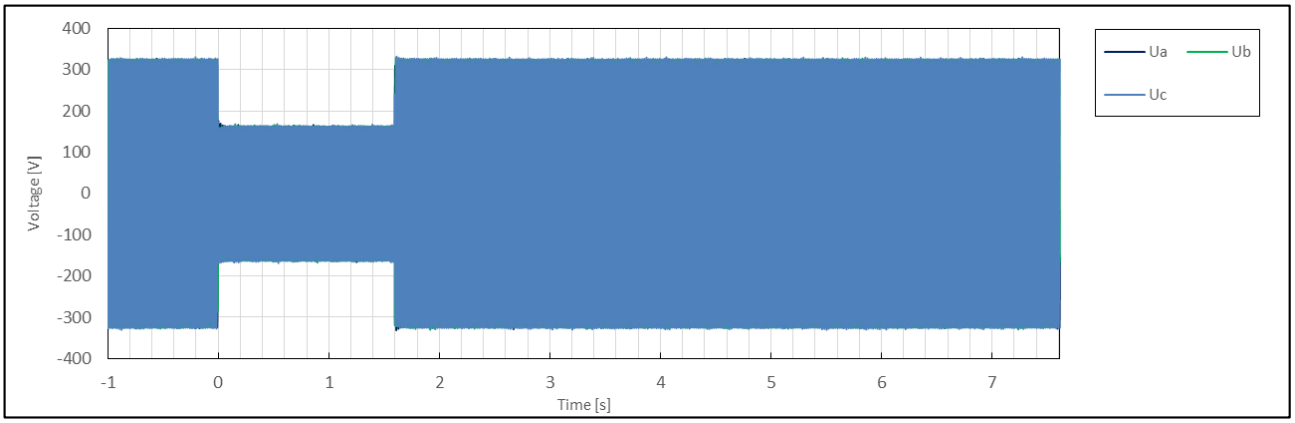

30000
25000
20000
15000
10000
5000
0
Power [W/Var]
1.613
2.613
3.613
4.613
5.613
6.613
7.613
8.613
9.613
Time [s]
PT-1_tor
Q_pos
PT-1_tor

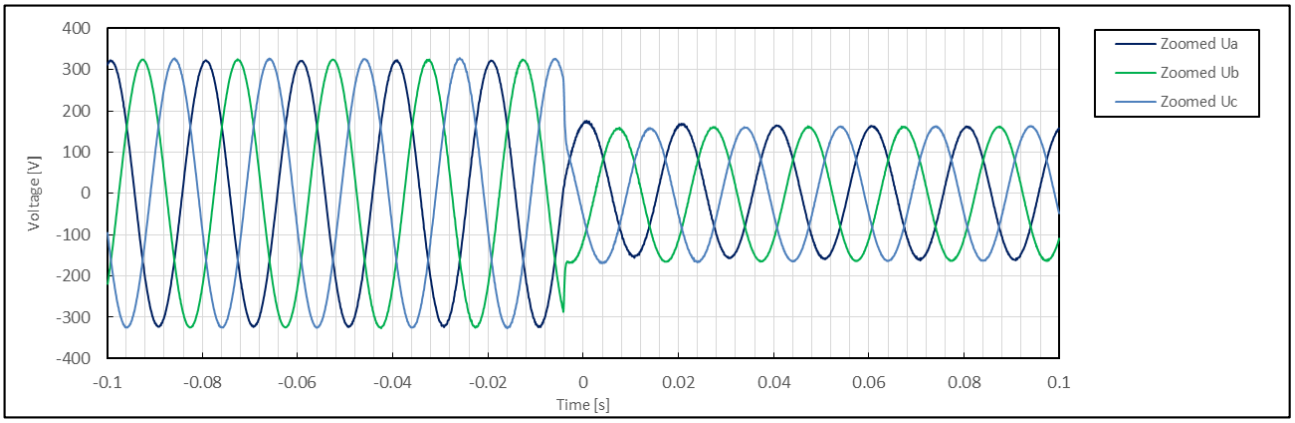

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

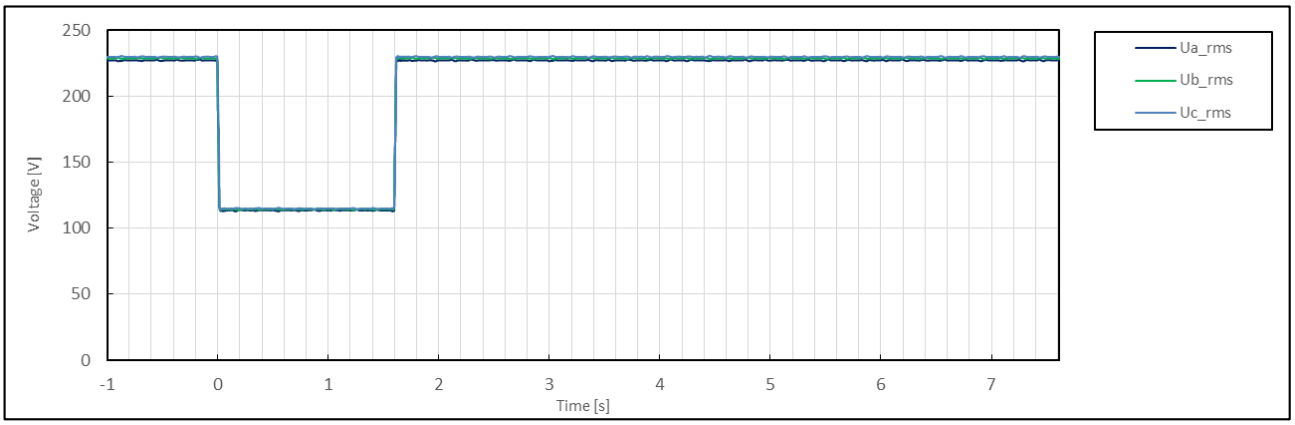

90
80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	2.2
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	17:23:36
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.49
	5	Setting dip duration		--		1614
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1613
	8	Fault duration in empty load test	Total	--	ms	1614
	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.	0.68
	13	Active power	Total	t1-10s to t1	p.u.	0.51
	14		Pos.			0.51
	15	Reactive power	Total	t1-10s to t1	p.u.	0.47
	16		Pos.			0.47
	17	Cos_{φ}	--	t1-10s to t1	--	0.732
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.	0.08
	20		Phase 2			0.08
	21		Phase 3			0.08
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	0.51
	29		Pos.			0.51
	39	Active power rising time	Pos.	--	s	0.081
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.35
	32		Pos.			0.35
	33	Reactive power rising time	Pos.	--	s	15.00
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

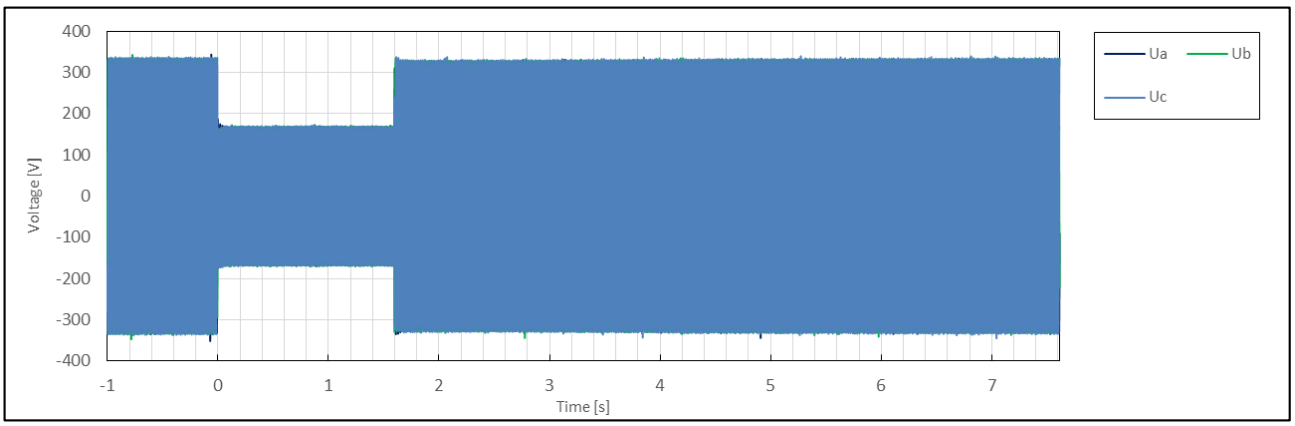
Test No. 2.2 idle test

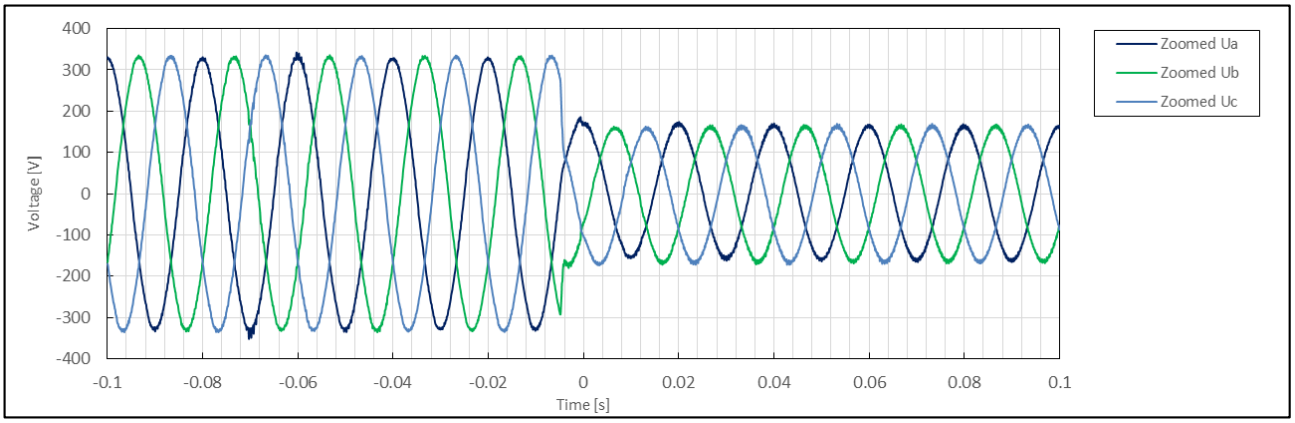


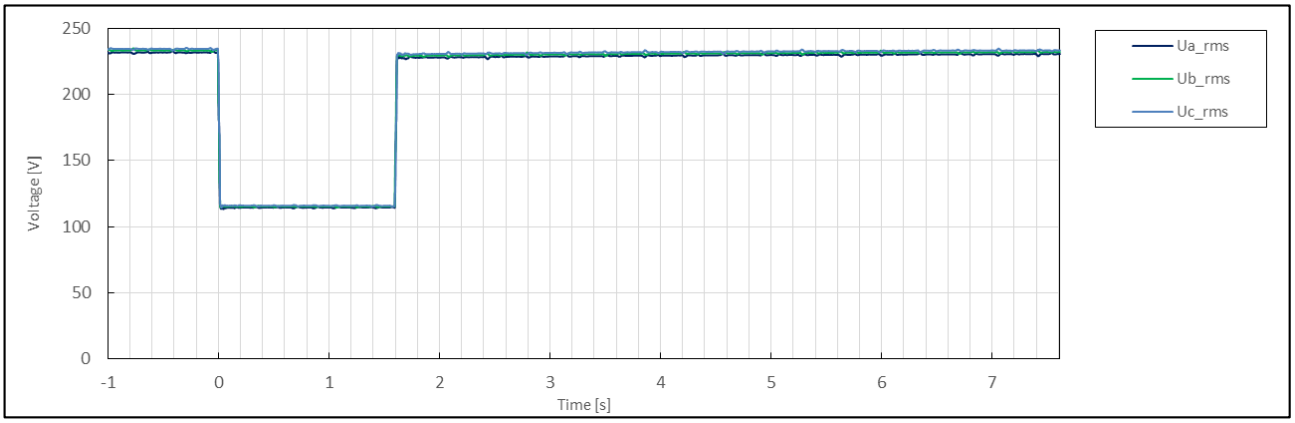


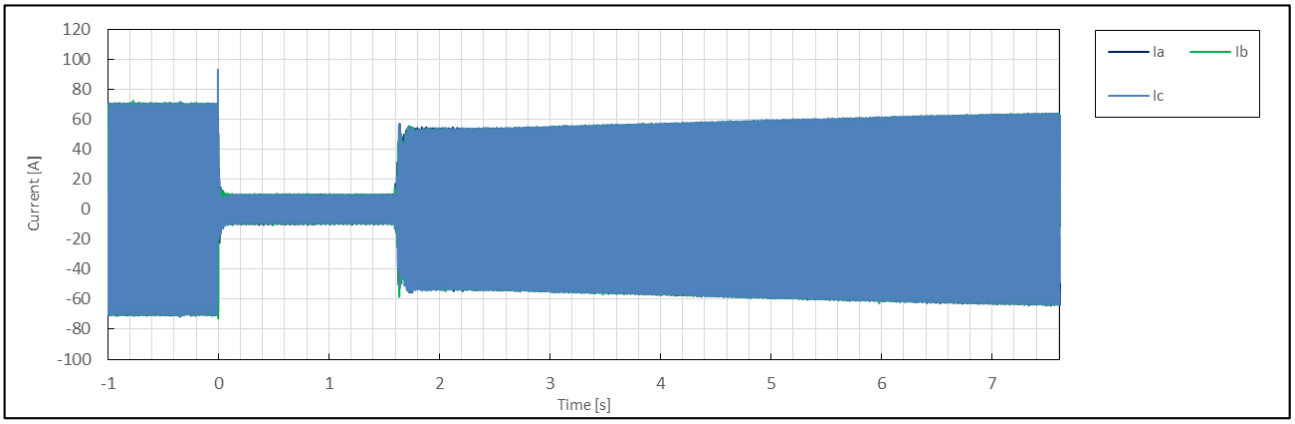


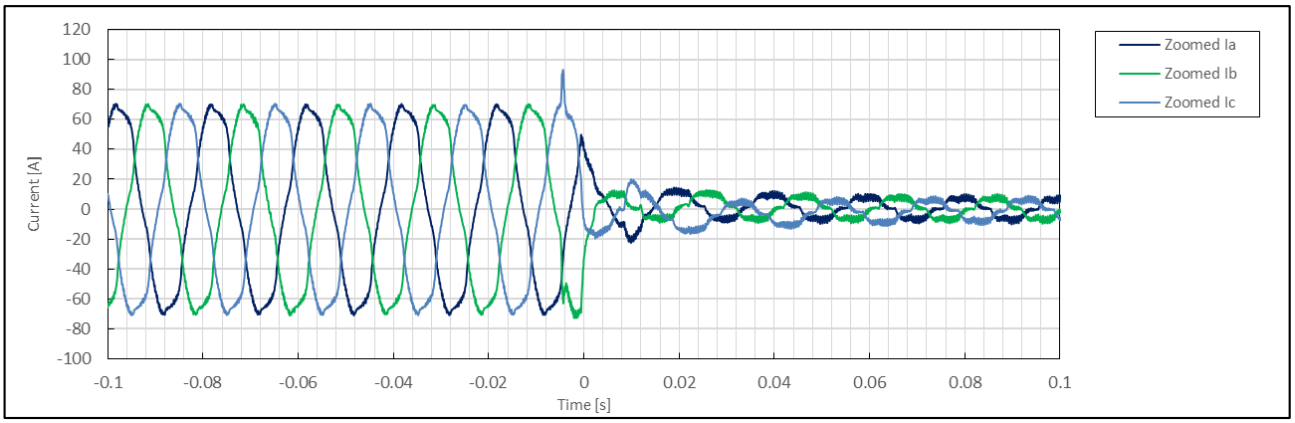
Test No. 2.2 with PGU

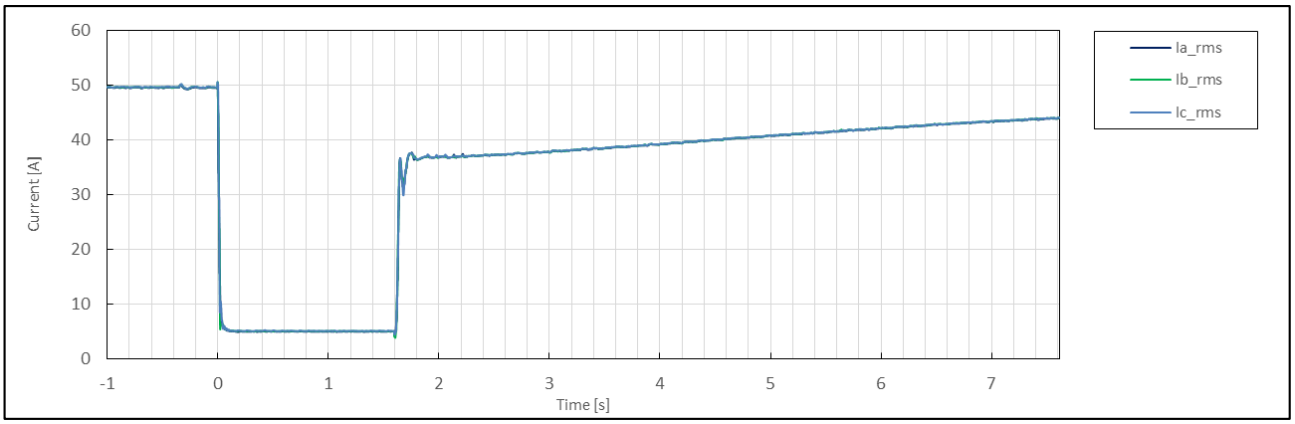


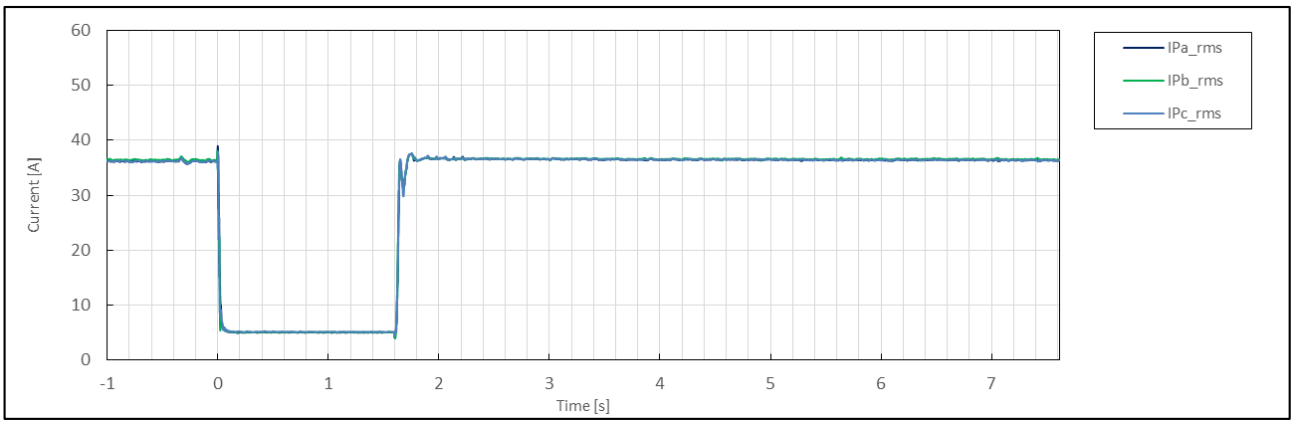


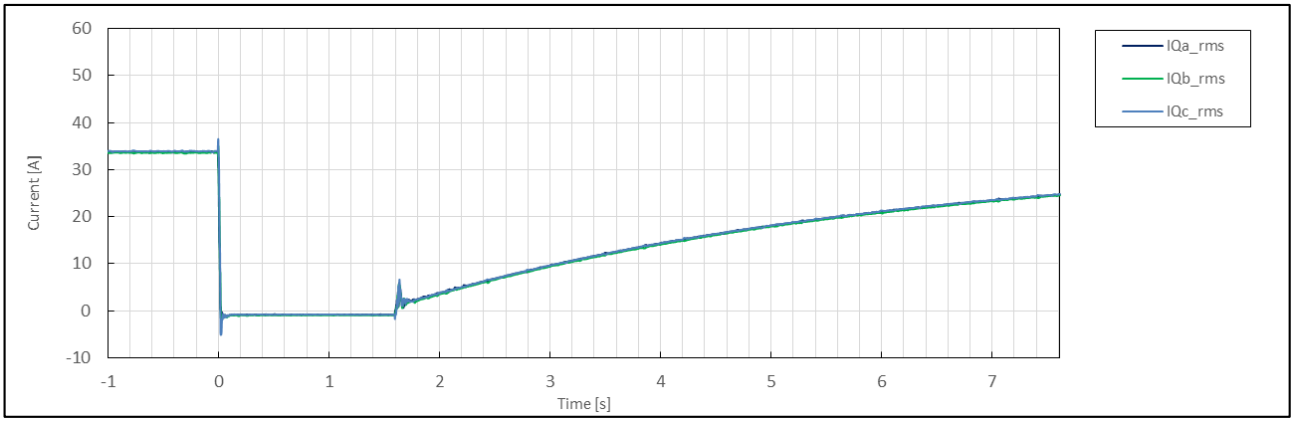


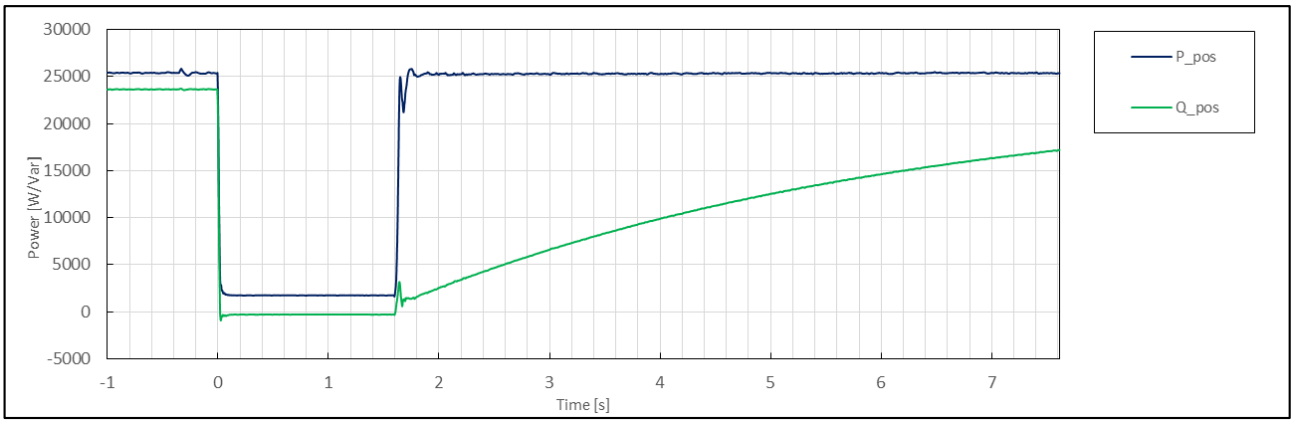


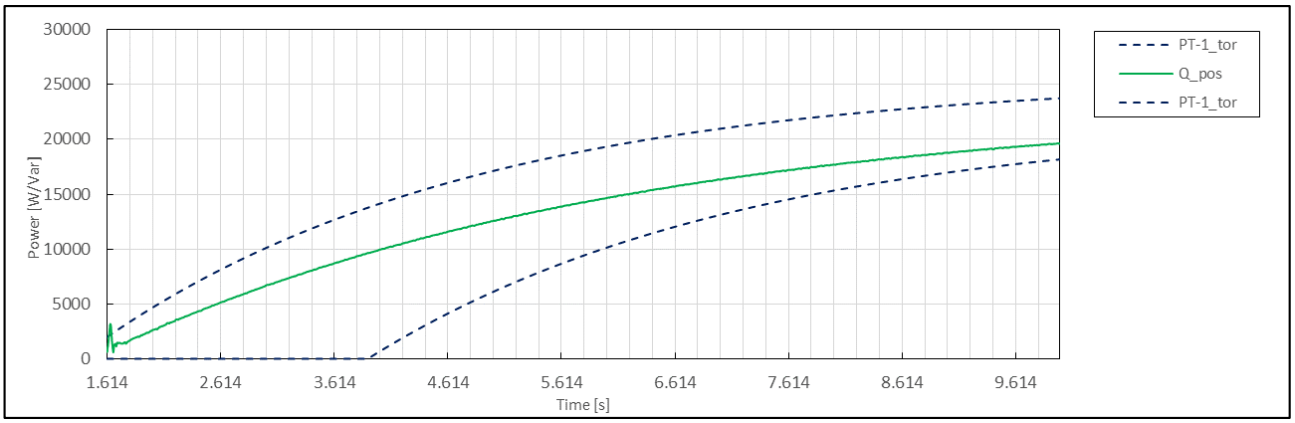

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

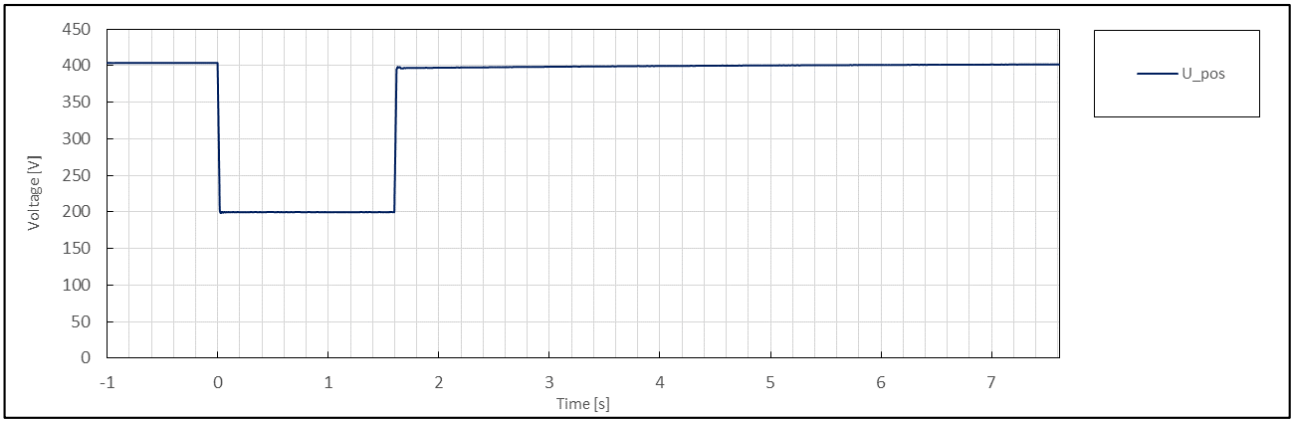

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

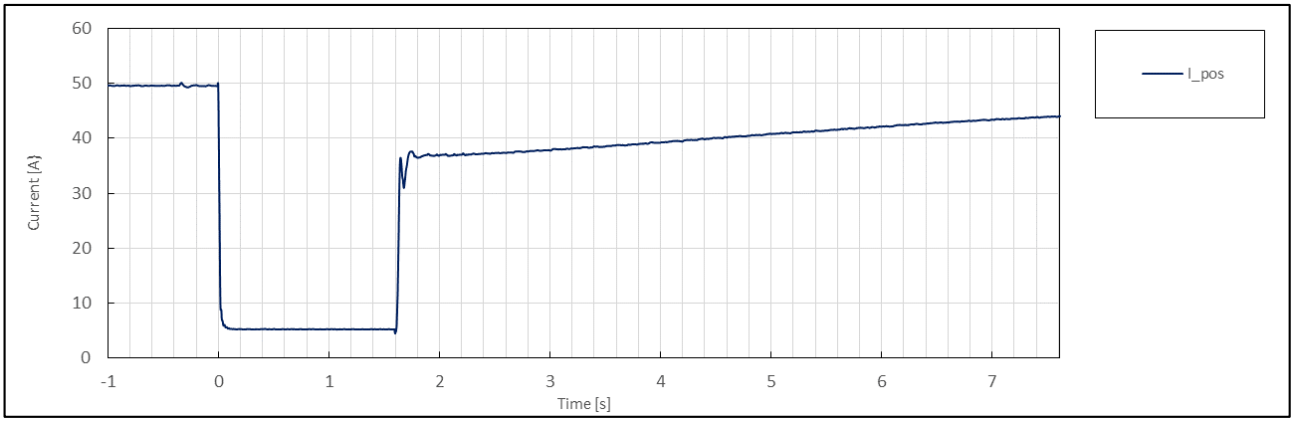

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

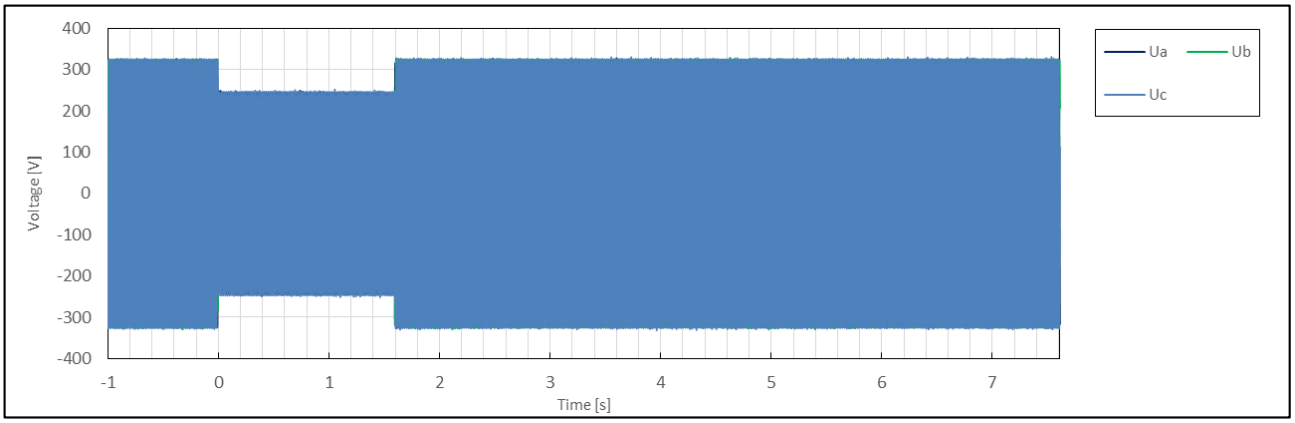

30000
25000
20000
15000
10000
5000
0
Power [W/Var]
1.614
2.614
3.614
4.614
5.614
6.614
7.614
8.614
9.614
Time [s]
PT-1_tor
Q_pos
PT-1_tor

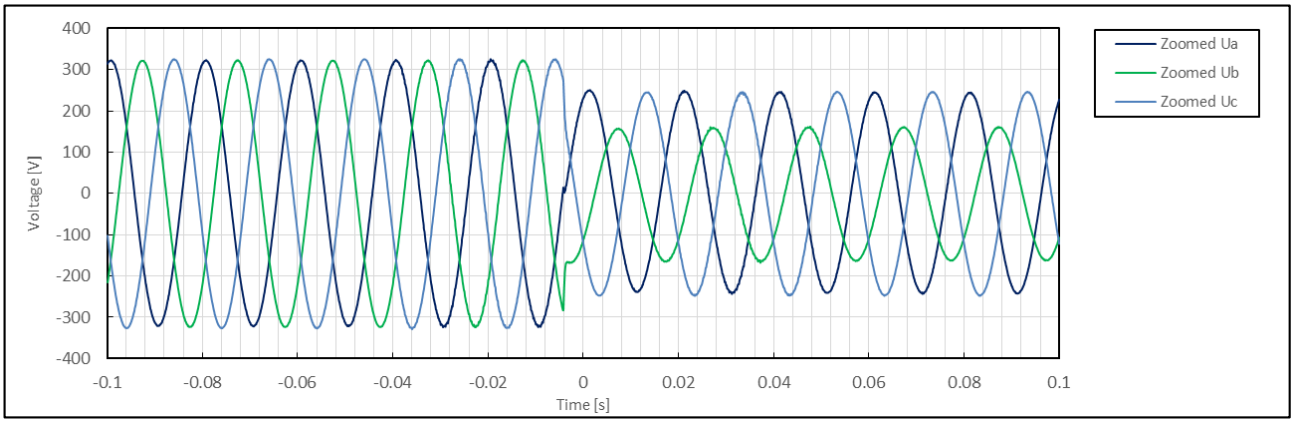

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

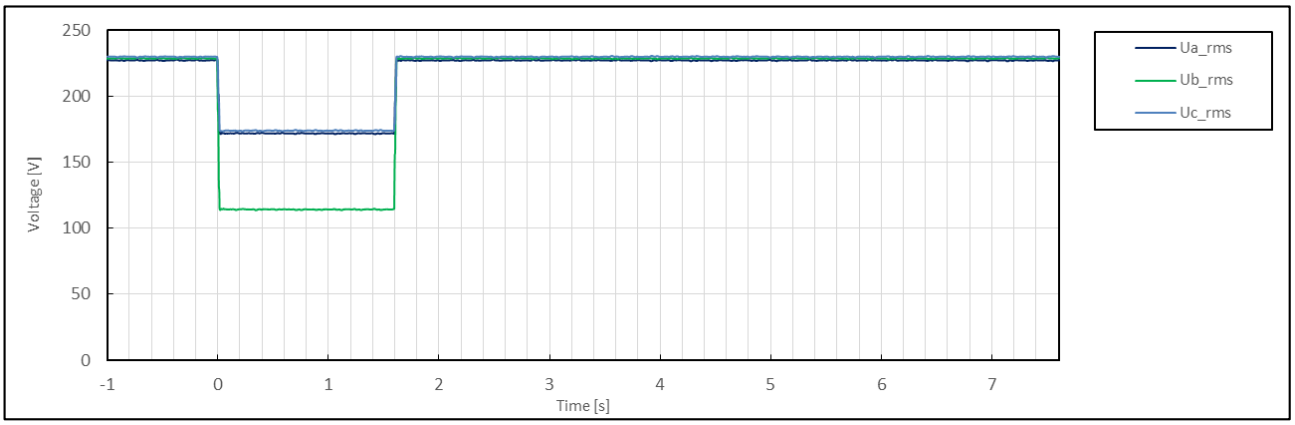

60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	2.3
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	18:54:28
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1610
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1609
	8	Fault duration in empty load test	Total	--	ms	1610
	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.	1.02
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.08
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	0.46
	16		Pos.			0.46
	17	Cos_{φ}	--	t1-10s to t1	--	0.907
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.	0.06
	20		Phase 2			0.07
	21		Phase 3			0.06
	22	Line current	Phase 1	t1+100ms	p.u.	0.05
	23		Phase 2			0.07
	24		Phase 3			0.06
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.144
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.34
	32		Pos.			0.34
	33	Reactive power rising time	Pos.	--	s	15.00
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

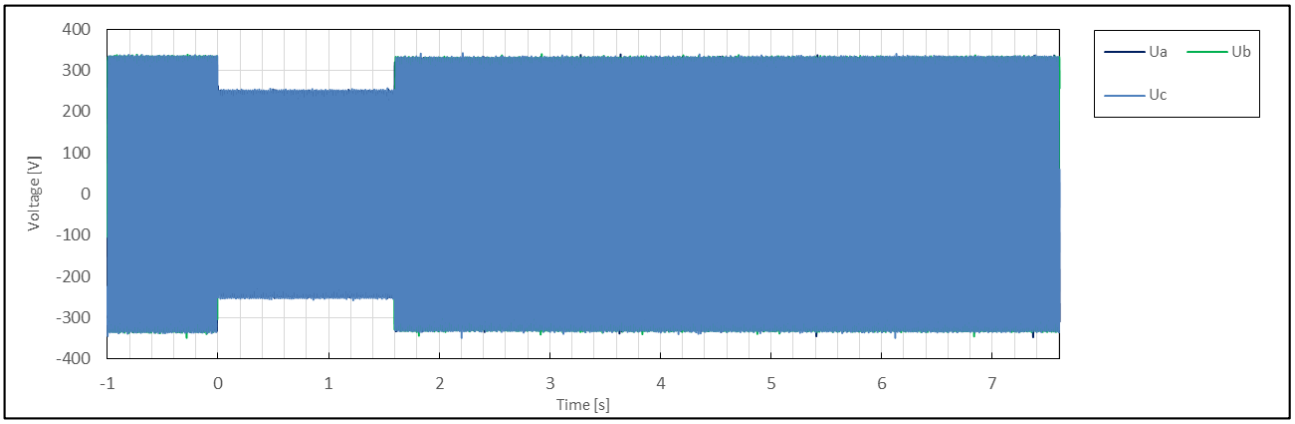
Test No. 2.3 idle test

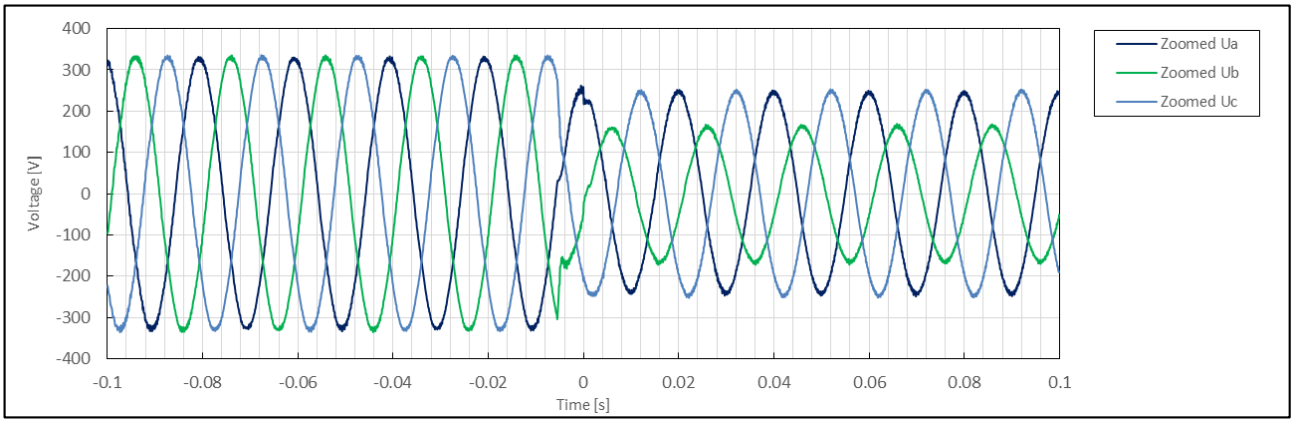


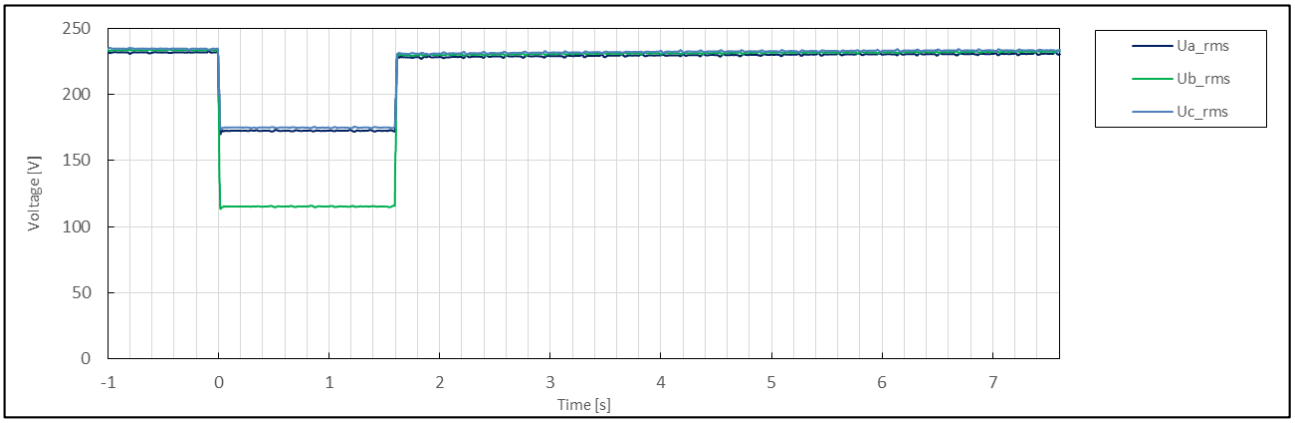


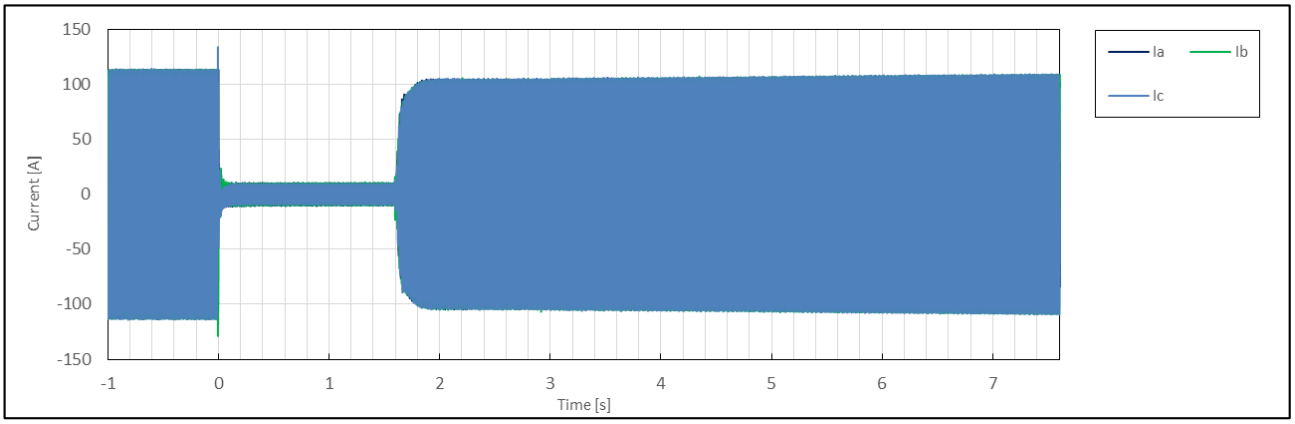


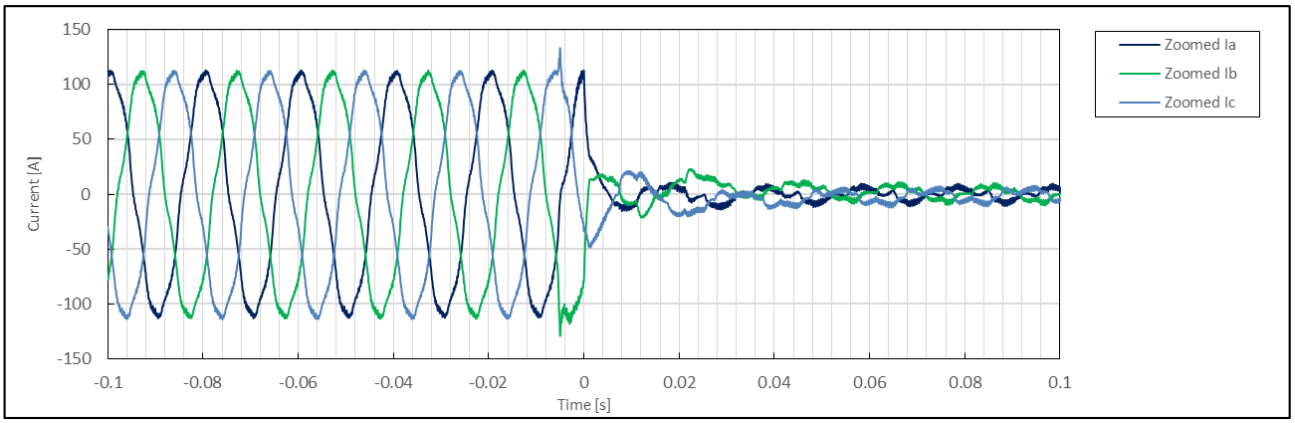
Test No. 2.3 with PGU

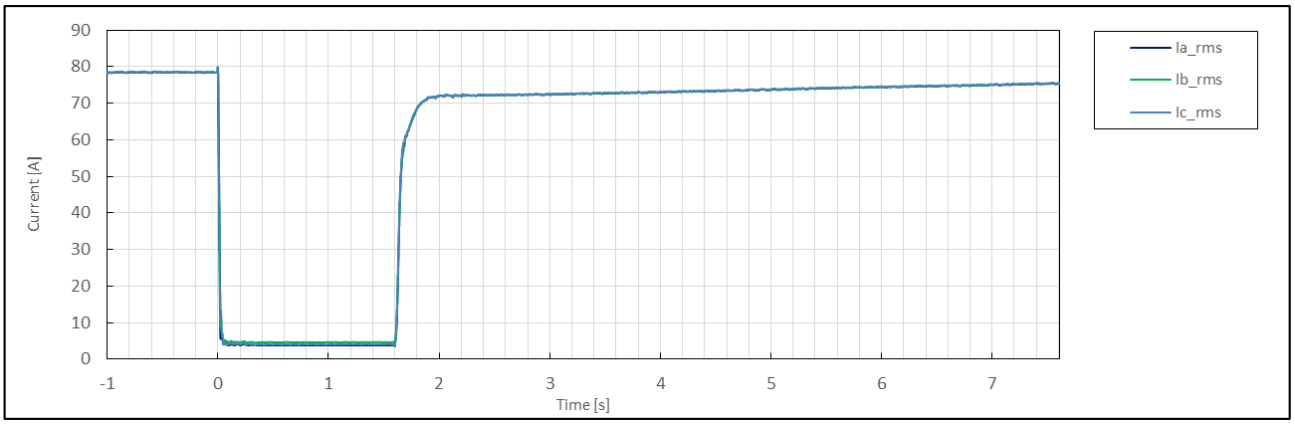


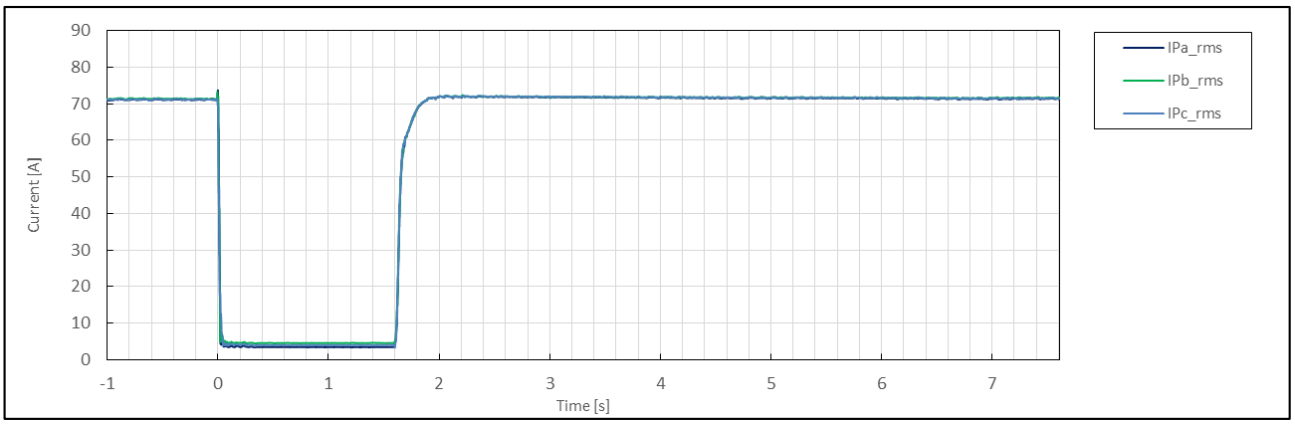


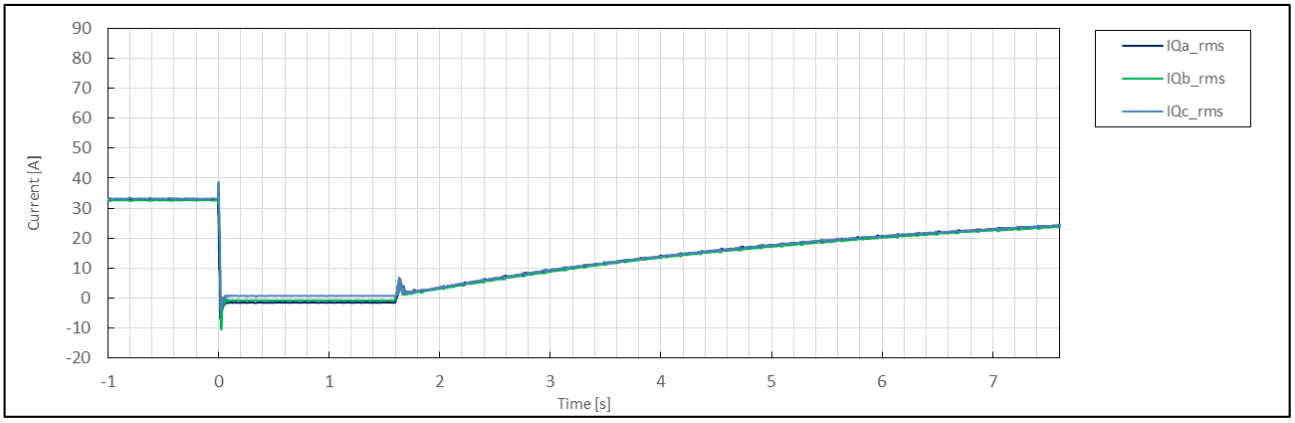


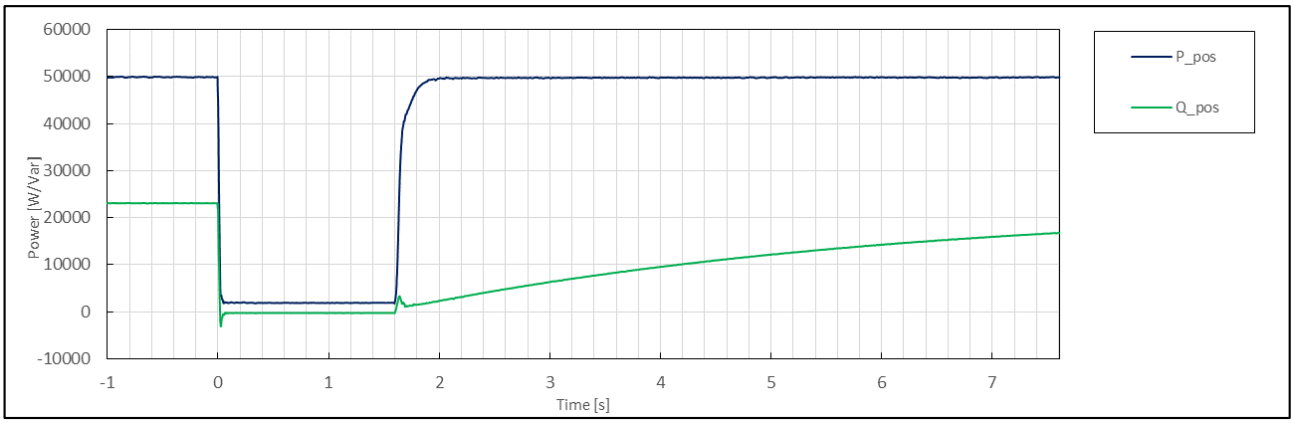


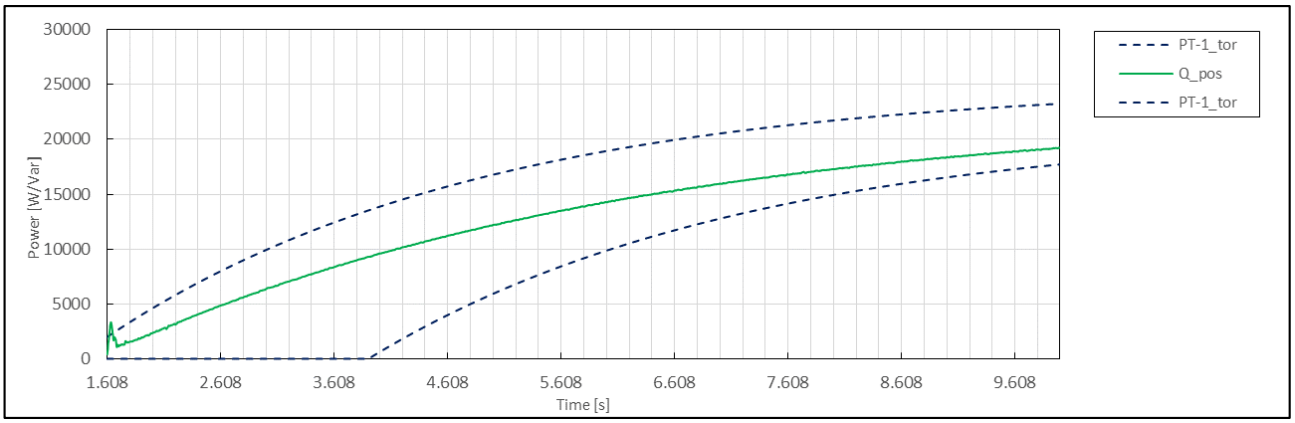

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

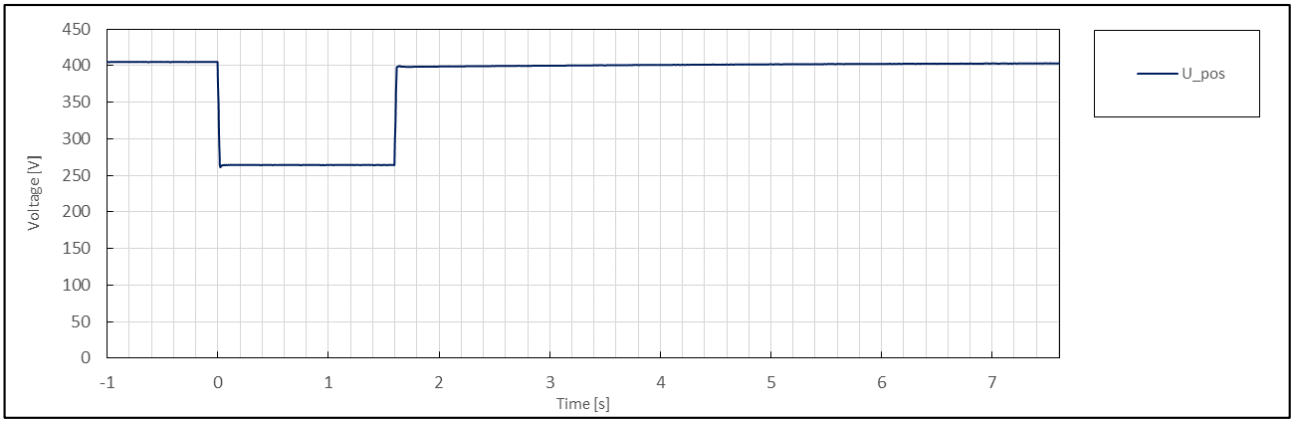

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

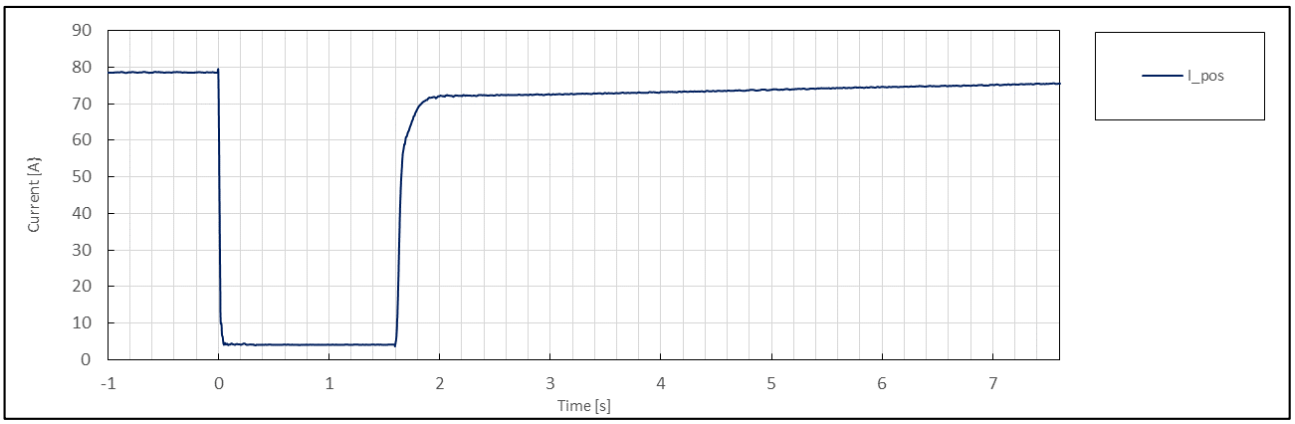

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

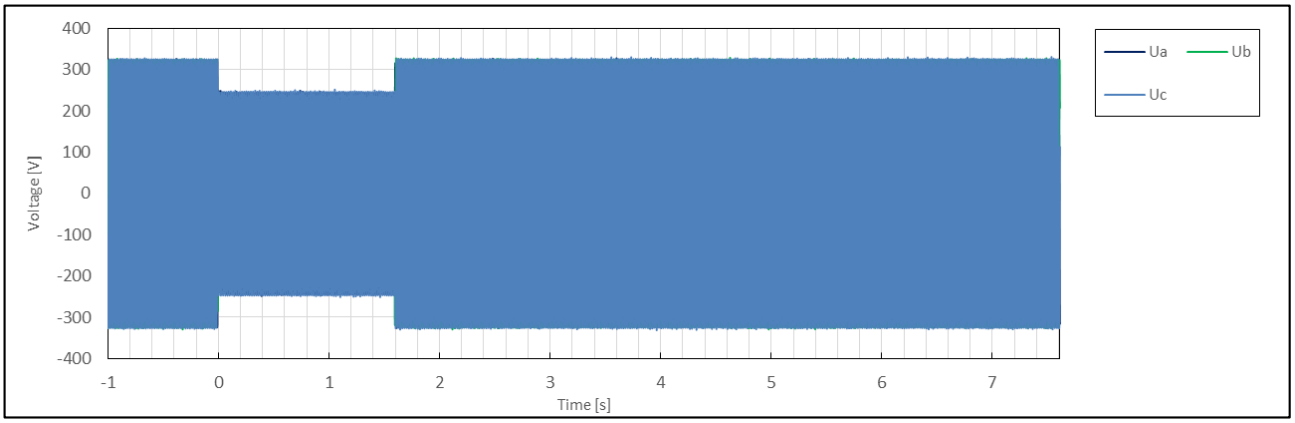

30000
25000
20000
15000
10000
5000
0
Power [W/Var]
1.608
2.608
3.608
4.608
5.608
6.608
7.608
8.608
9.608
Time [s]
PT-1_tor
Q_pos
PT-1_tor

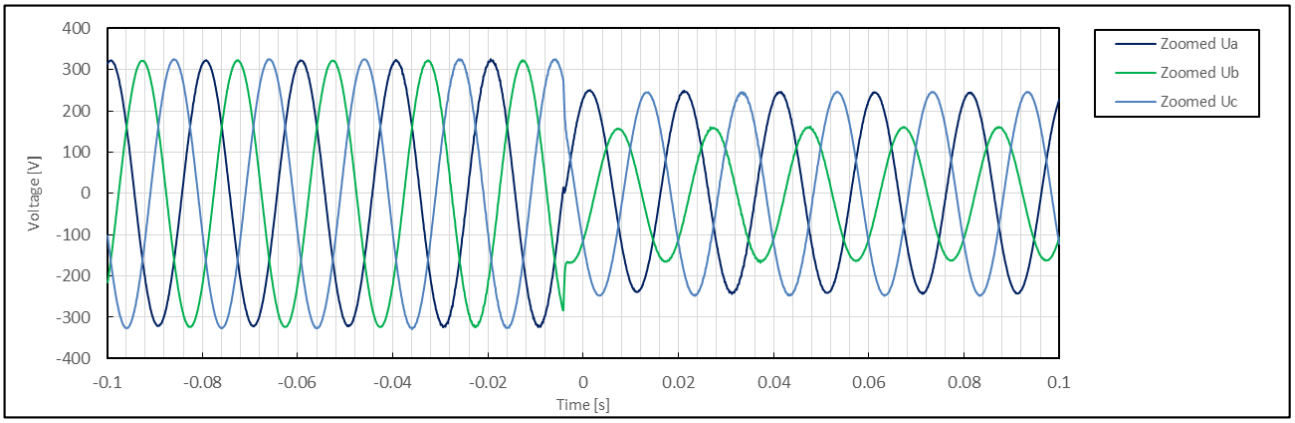

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

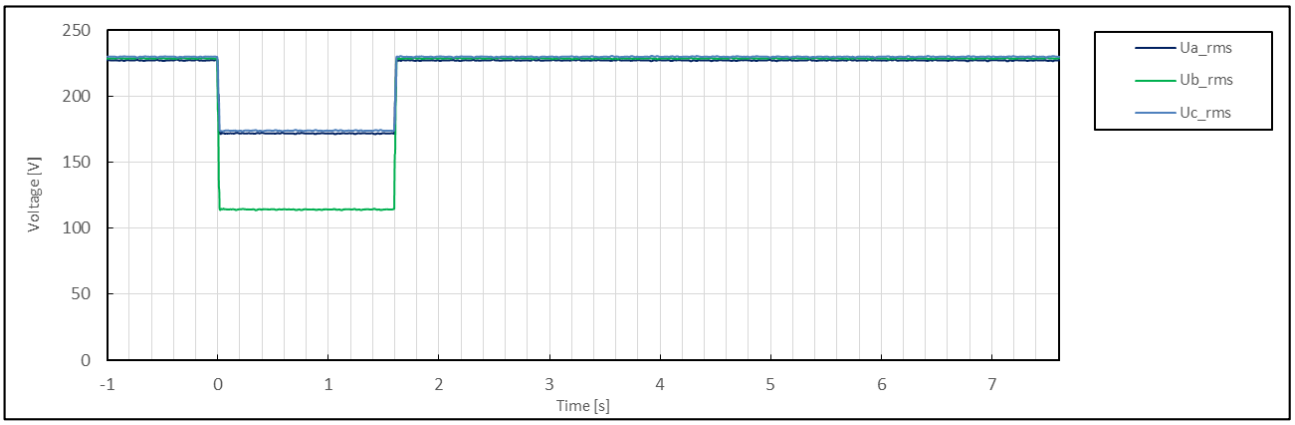

90
80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	2.4
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	18:44:14
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1610
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1609
	8	Fault duration in empty load test	Total	--	ms	1610
	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.	0.68
	13	Active power	Total	t1-10s to t1	p.u.	0.51
	14		Pos.			0.51
	15	Reactive power	Total	t1-10s to t1	p.u.	0.47
	16		Pos.			0.47
	17	Cos_{φ}	--	t1-10s to t1	--	0.735
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.	0.06
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.05
	23		Phase 2			0.07
	24		Phase 3			0.06
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
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.	0.51
	29		Pos.			0.51
	39	Active power rising time	Pos.	--	s	0.095
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	0.34
	32		Pos.			0.34
	33	Reactive power rising time	Pos.	--	s	15.00
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

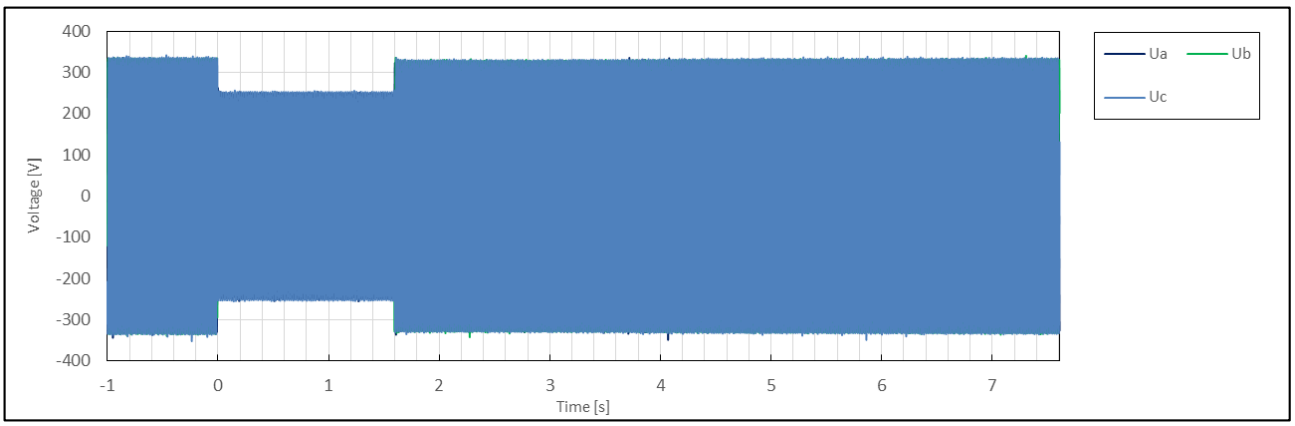
Test No. 2.4 idle test

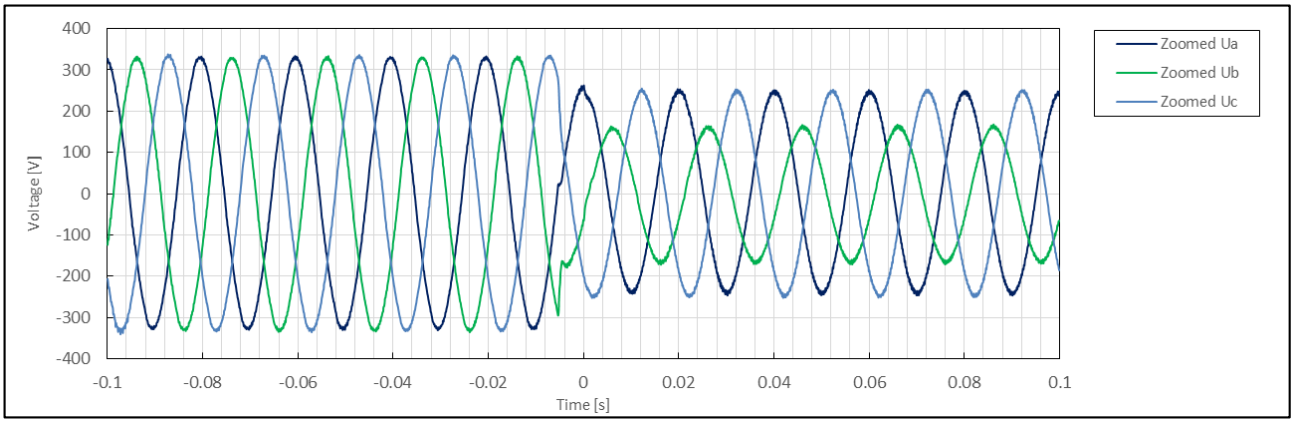


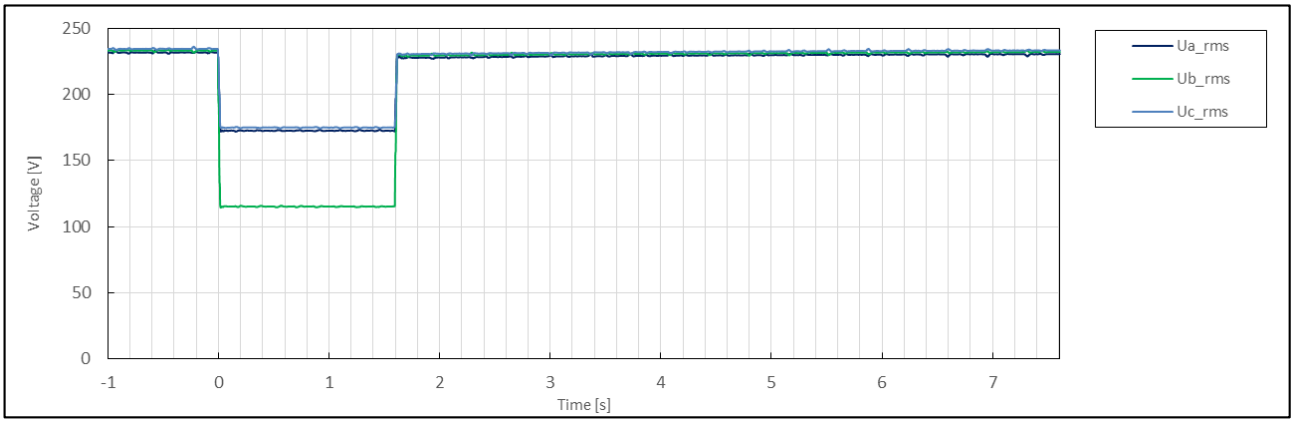


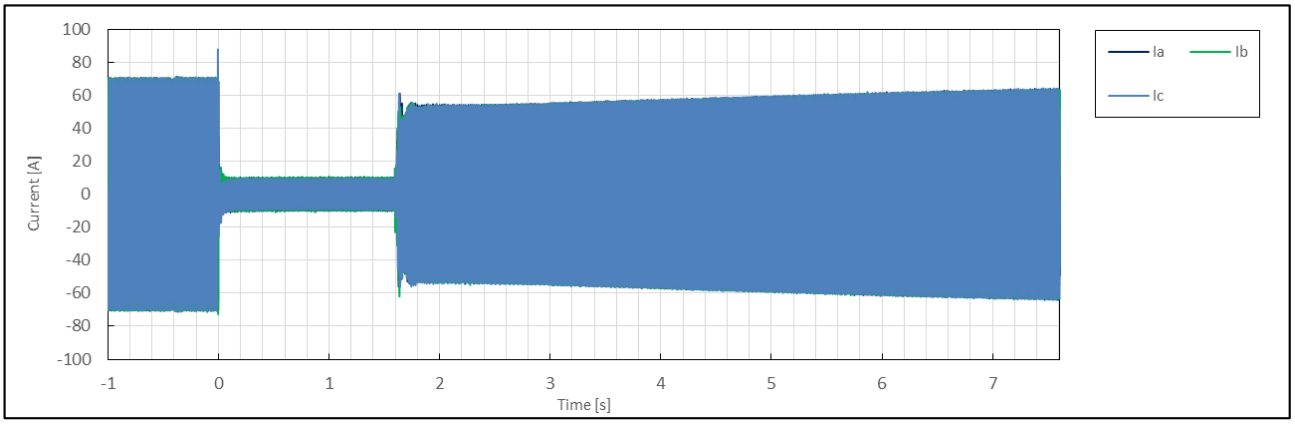


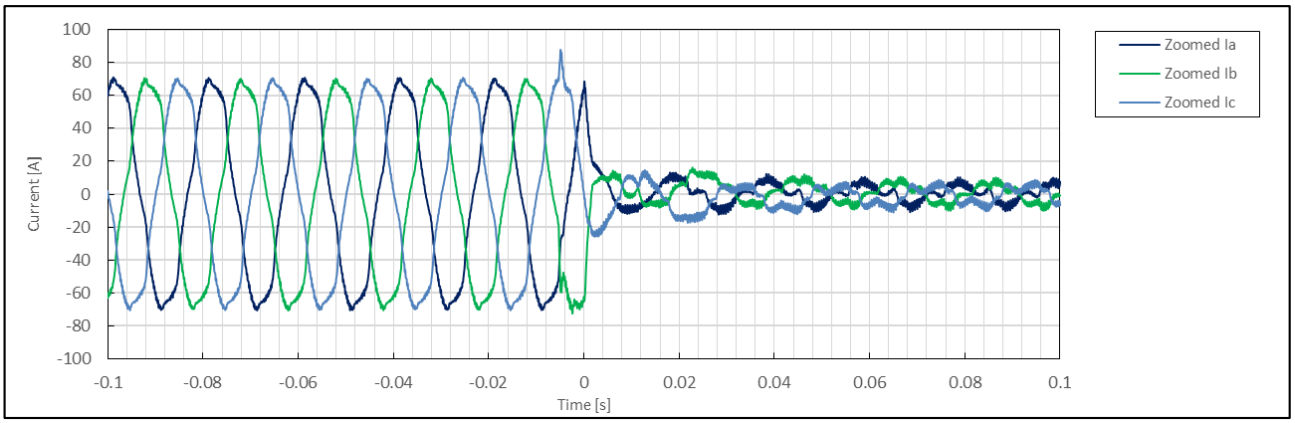
Test No. 2.4 with PGU

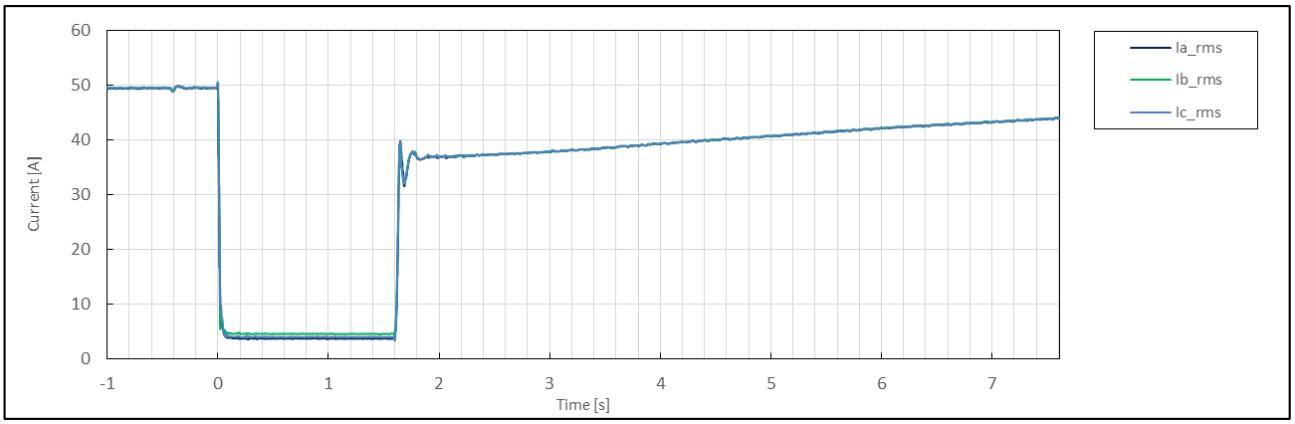


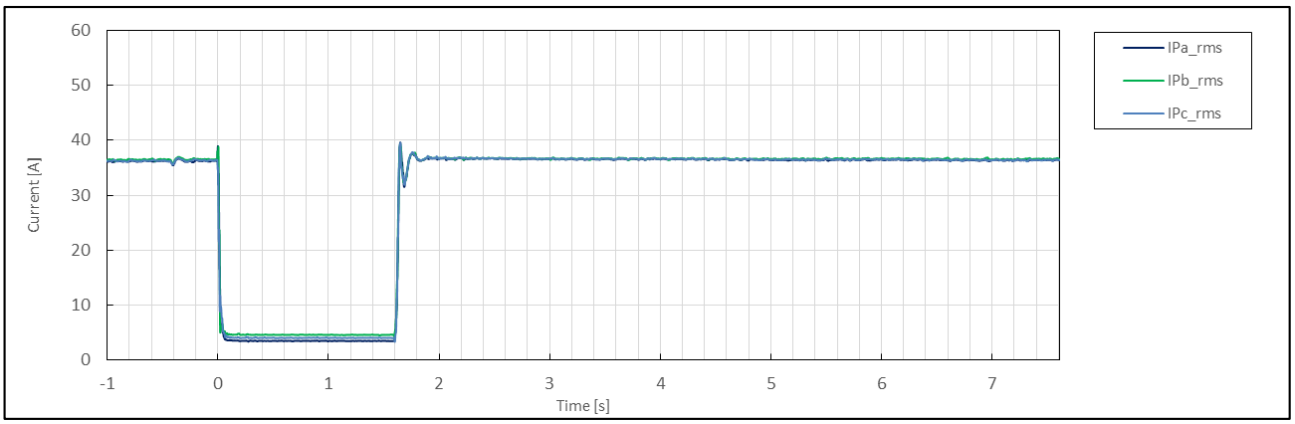


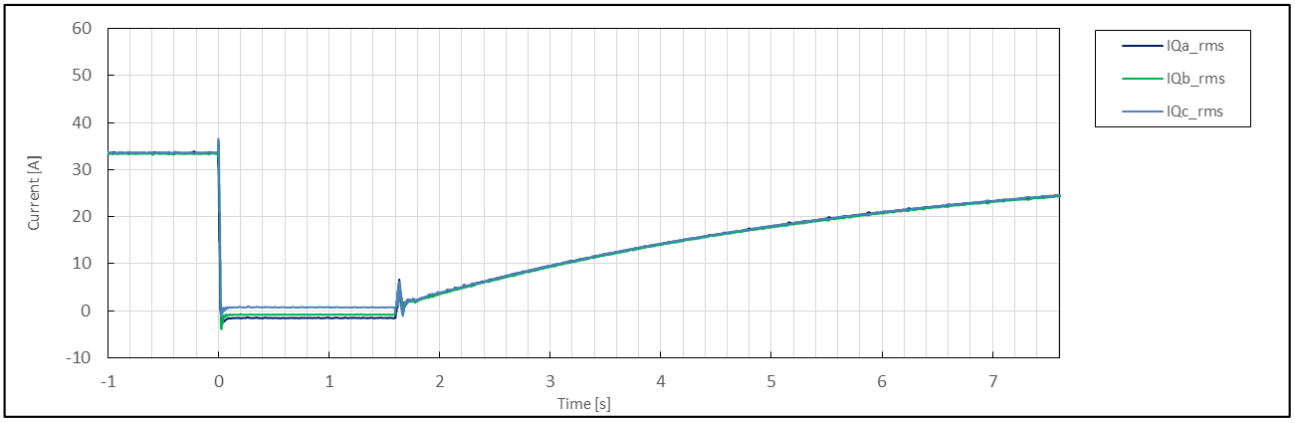


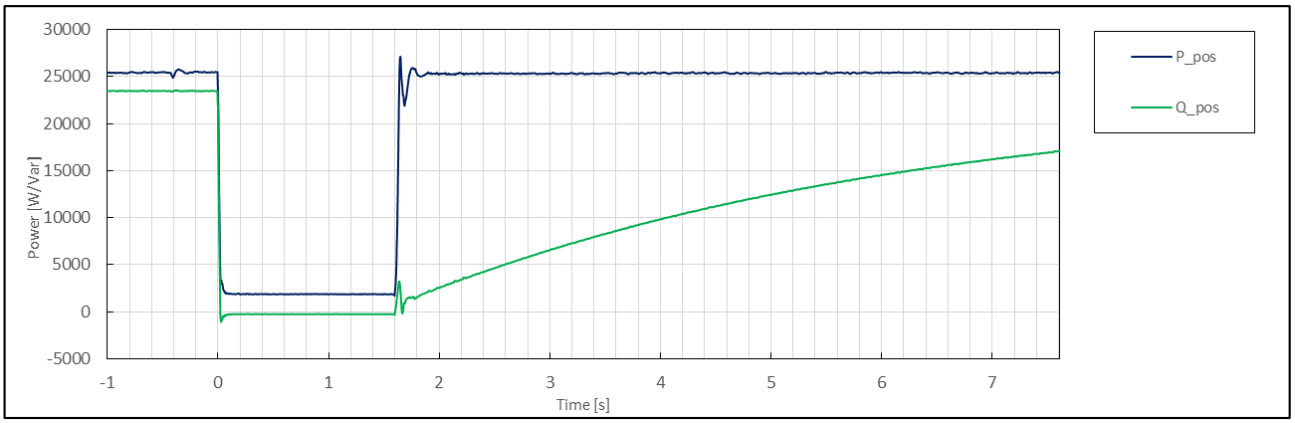


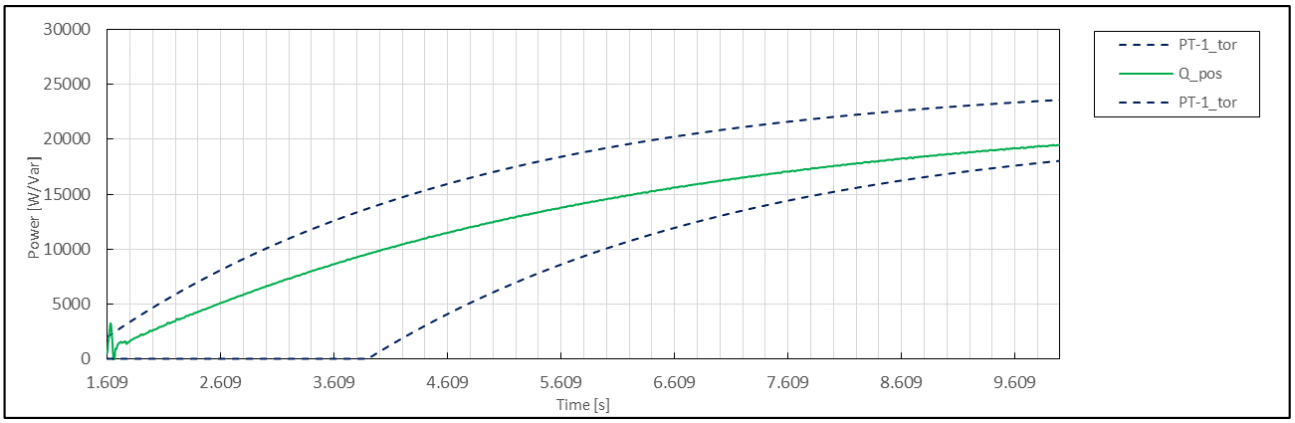

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

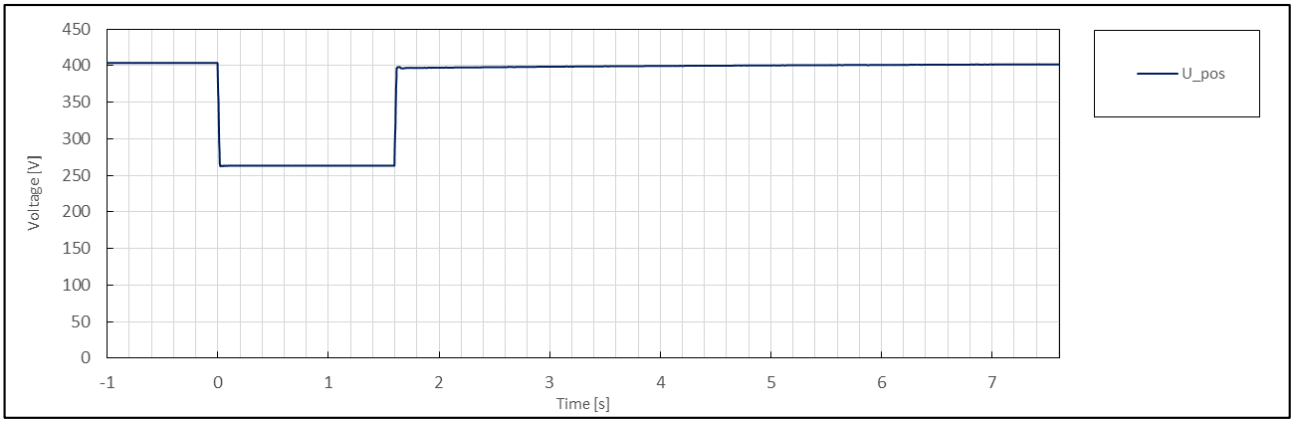

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

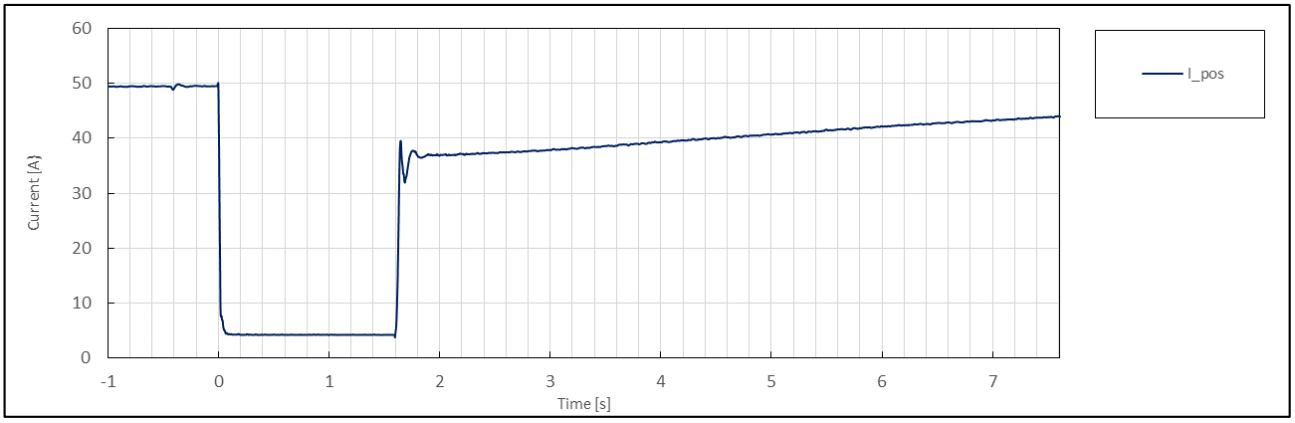

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

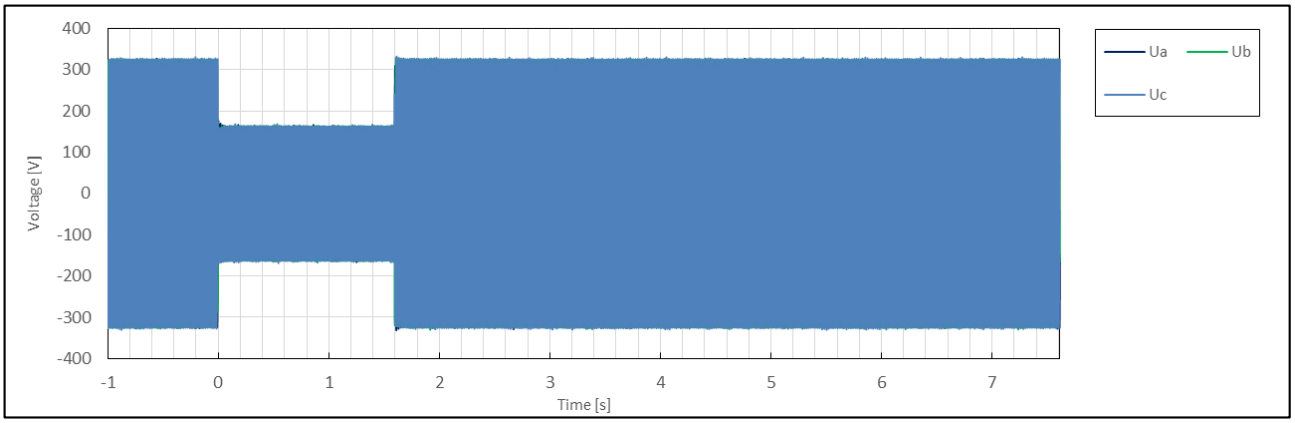

30000
25000
20000
15000
10000
5000
0
Power [W/Var]
1.609
2.609
3.609
4.609
5.609
6.609
7.609
8.609
9.609
Time [s]
PT-1_tor
Q_pos
PT-1_tor

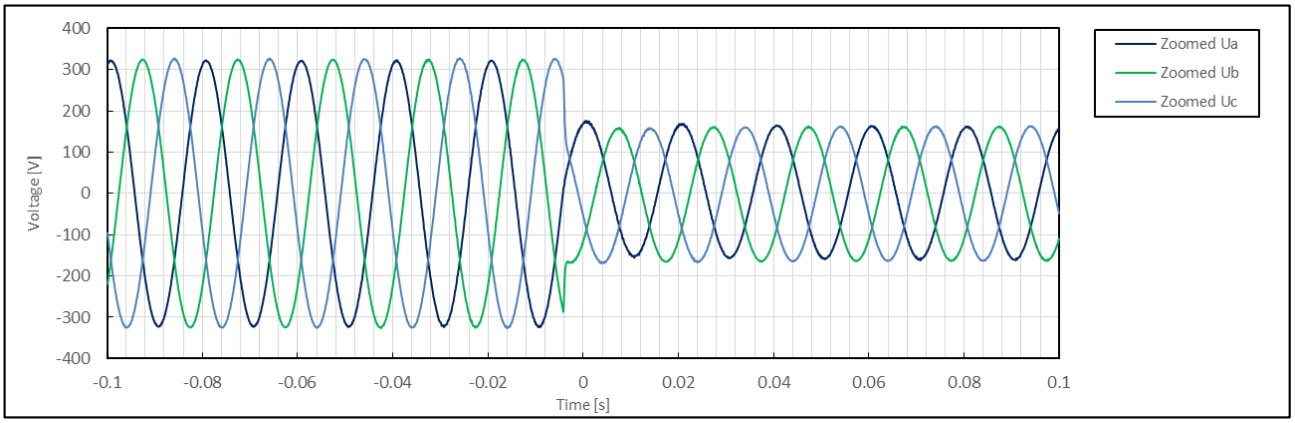

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

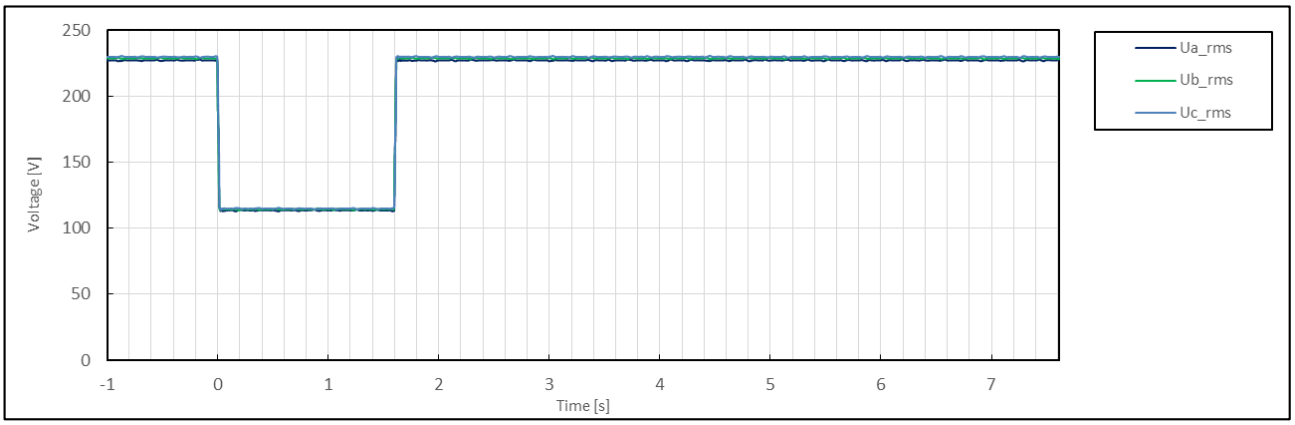

60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	3.1
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	16:56:10
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.49
	5	Setting dip duration		--		1614
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1613
	8	Fault duration in empty load test	Total	--	ms	1614
	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.	0.98
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.12
	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.	-0.49
	16		Pos.			-0.49
	17	Cos_{φ}	--	t1-10s to t1	--	0.895
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.	0.07
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	0.98
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.98
	29		Pos.			0.98
	39	Active power rising time	Pos.	--	s	0.173
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.37
	32		Pos.			-0.37
	33	Reactive power rising time	Pos.	--	s	11.76
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

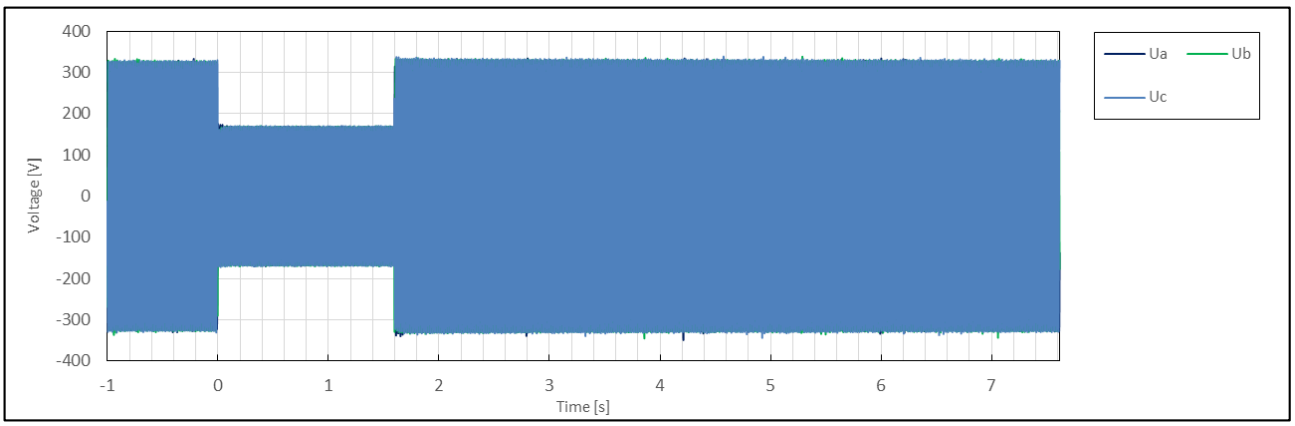
Test No. 3.1 idle test

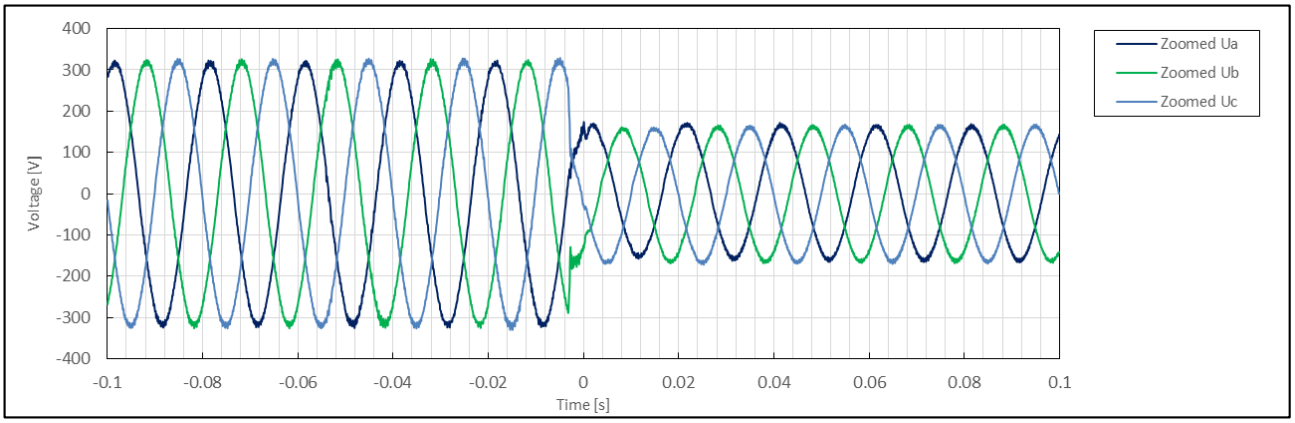


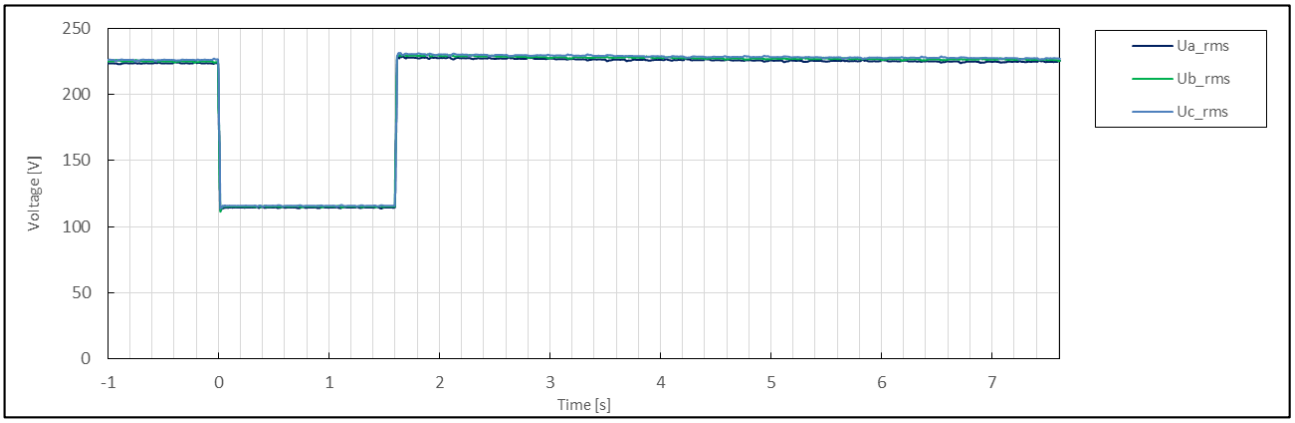


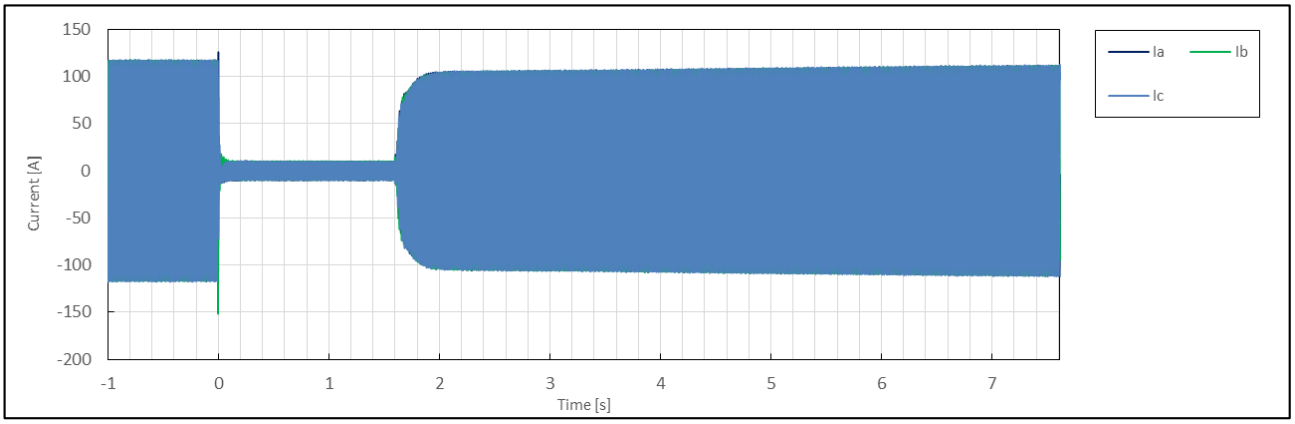


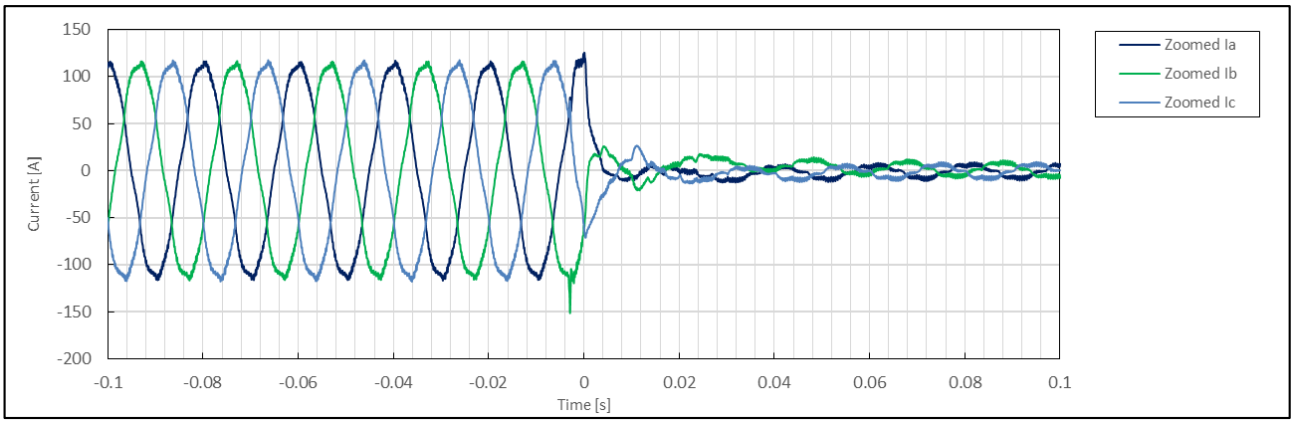
Test No. 3.1 with PGU

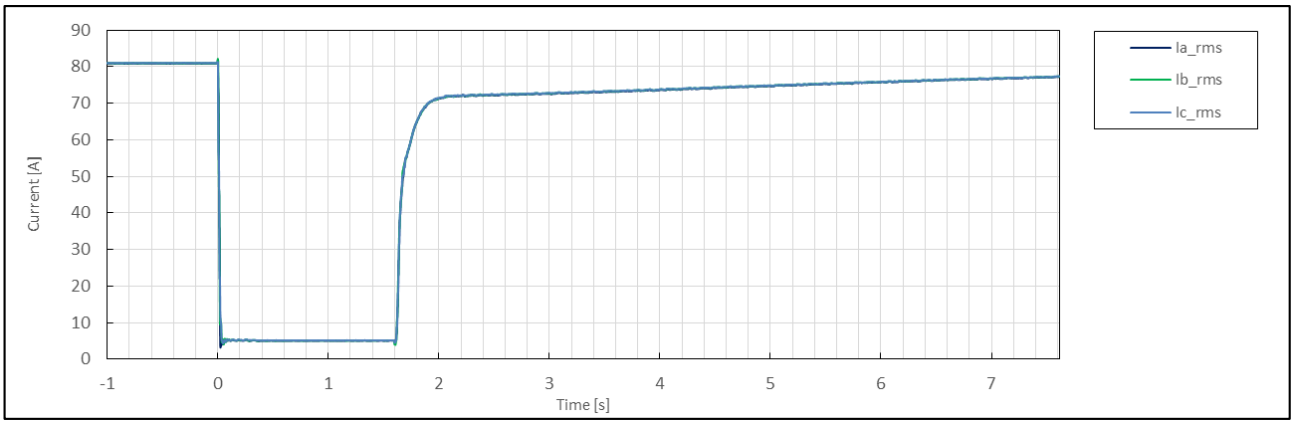


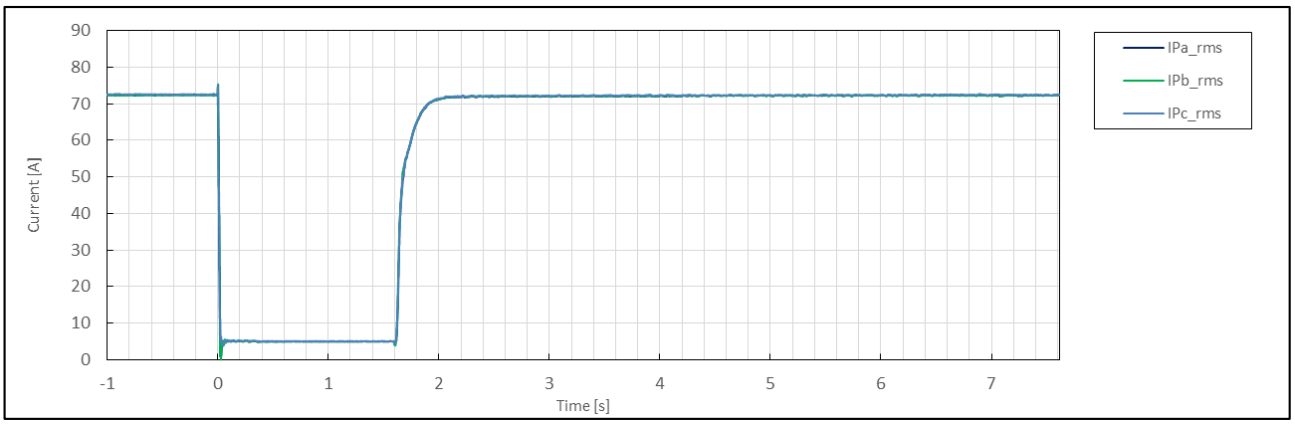


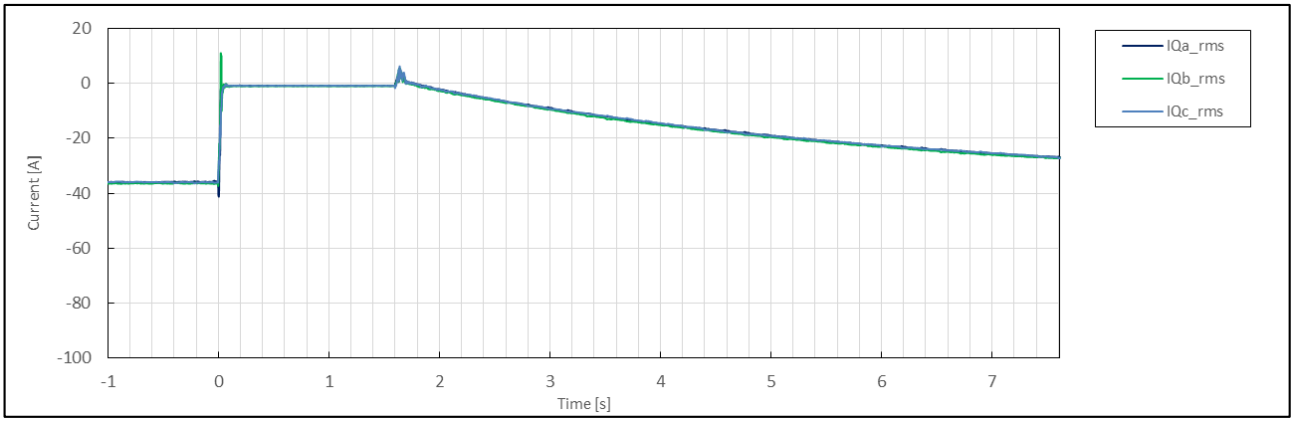


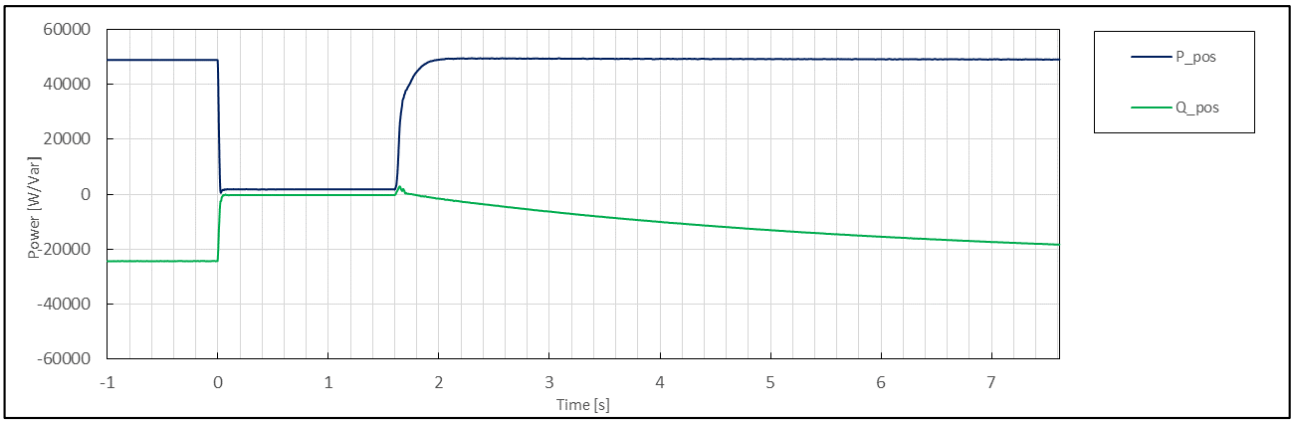


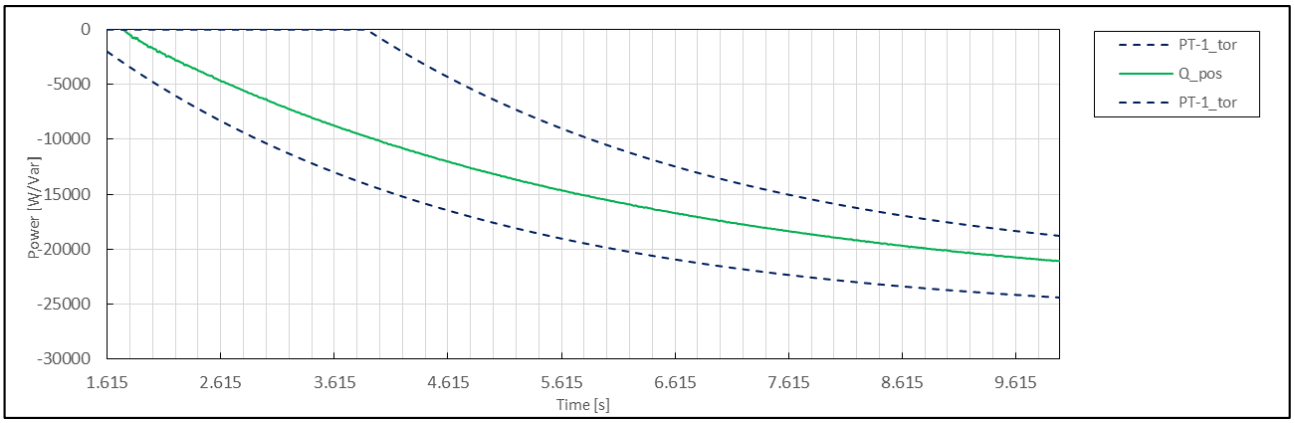

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

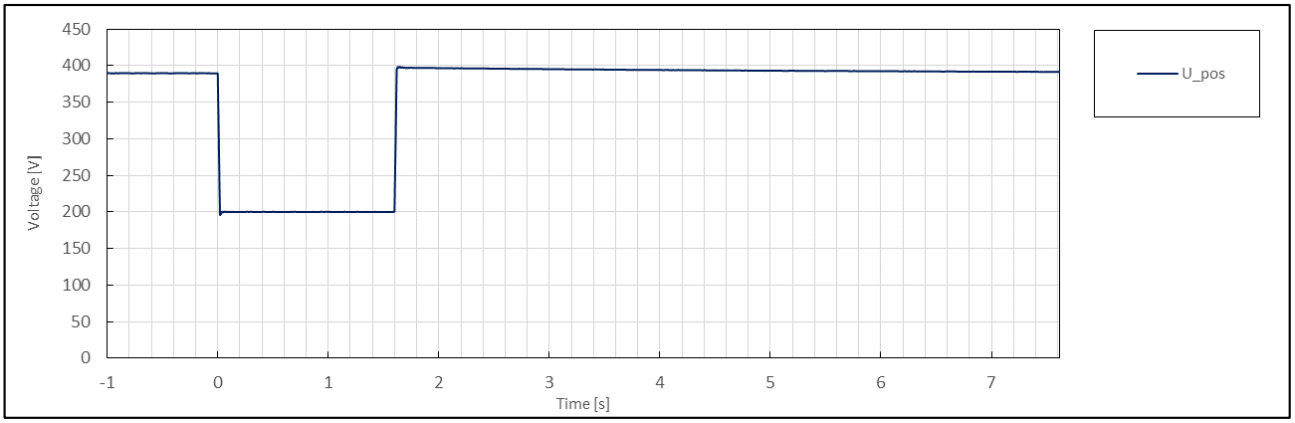

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

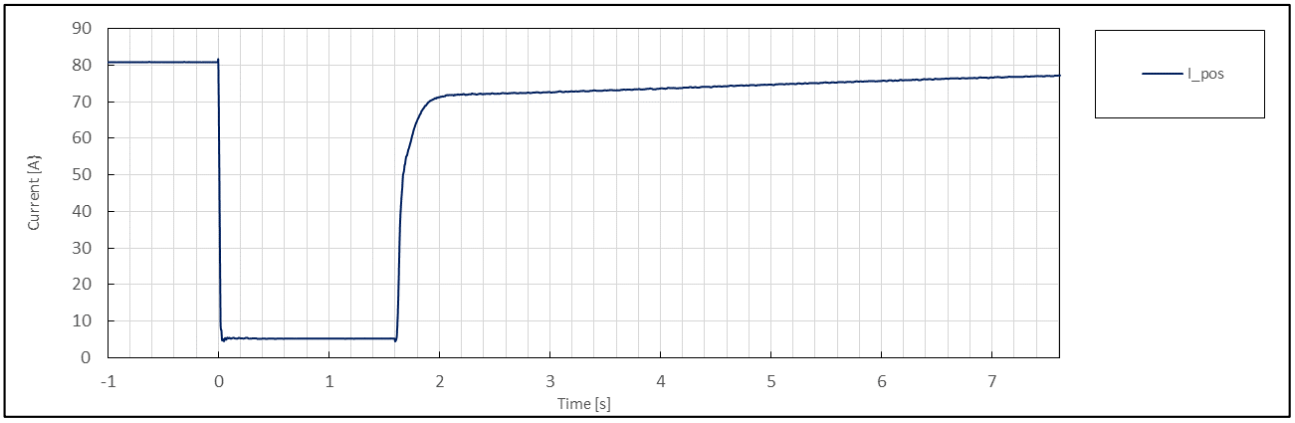

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


60000
40000
20000
0
-20000
-40000
-60000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

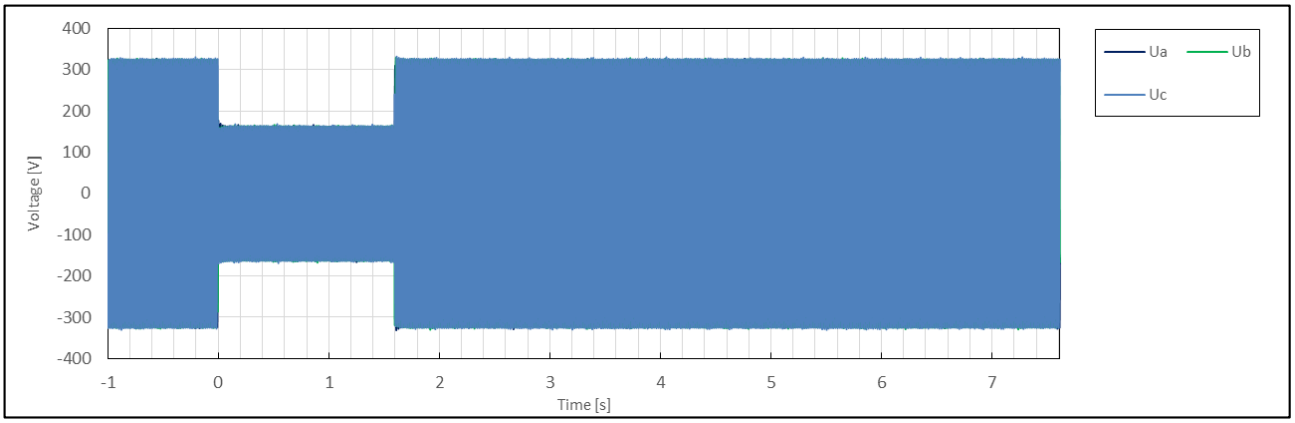

0
-5000
-10000
-15000
-20000
-25000
-30000
Power [W/Var]
1.615
2.615
3.615
4.615
5.615
6.615
7.615
8.615
9.615
Time [s]
PT-1_tor
Q_pos
PT-1_tor

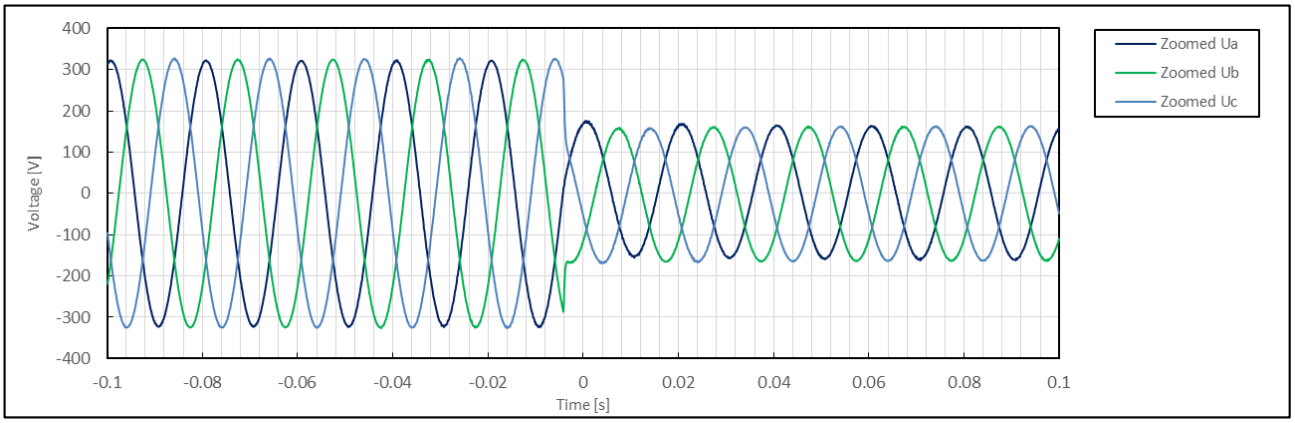

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

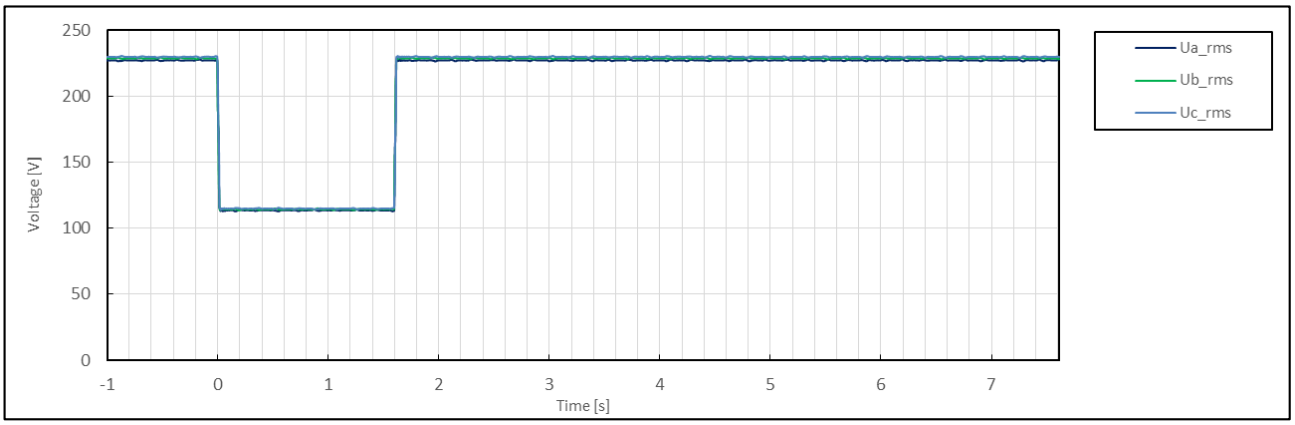

90
80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	3.2
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	17:10:08
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.49
	5	Setting dip duration		--		1614
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1613
	8	Fault duration in empty load test	Total	--	ms	1614
	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.	0.98
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.70
	13	Active power	Total	t1-10s to t1	p.u.	0.49
	14		Pos.			0.49
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos_{φ}	--	t1-10s to t1	--	0.713
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.	0.07
	20		Phase 2			0.07
	21		Phase 3			0.07
	22	Line current	Phase 1	t1+100ms	p.u.	0.07
	23		Phase 2			0.07
	24		Phase 3			0.07
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	0.98
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.49
	29		Pos.			0.49
	39	Active power rising time	Pos.	--	s	0.077
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.37
	32		Pos.			-0.37
	33	Reactive power rising time	Pos.	--	s	11.51
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

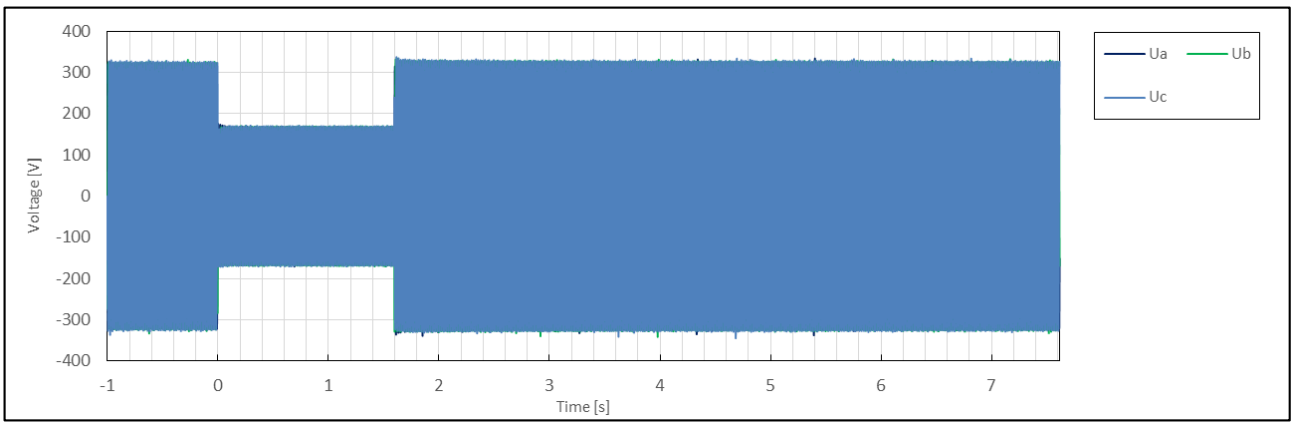
Test No. 3.2 idle test

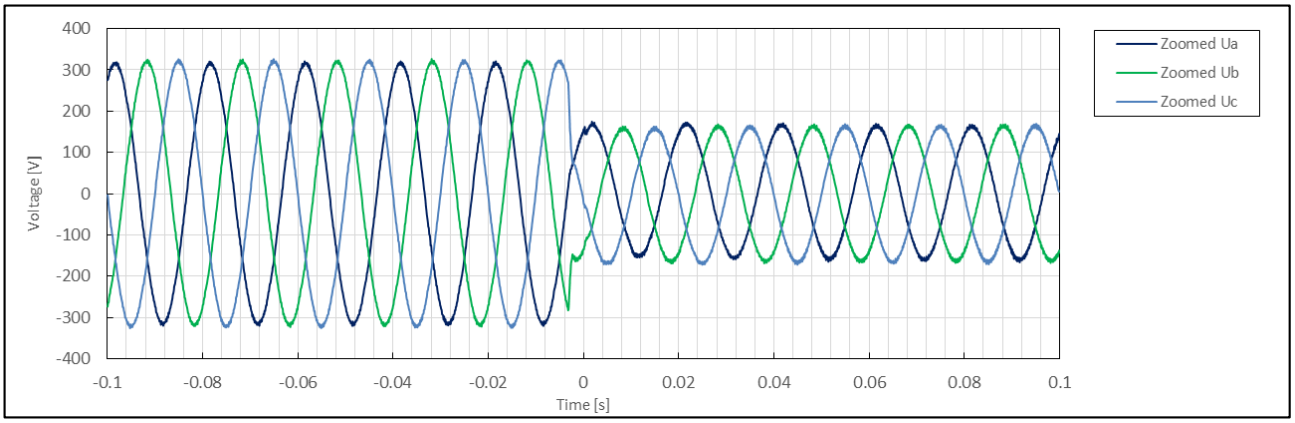


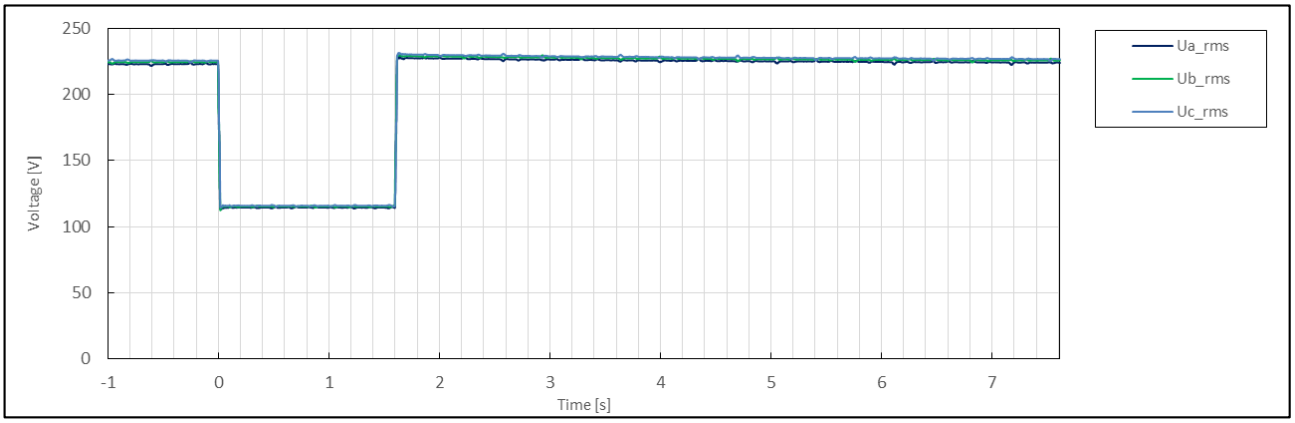


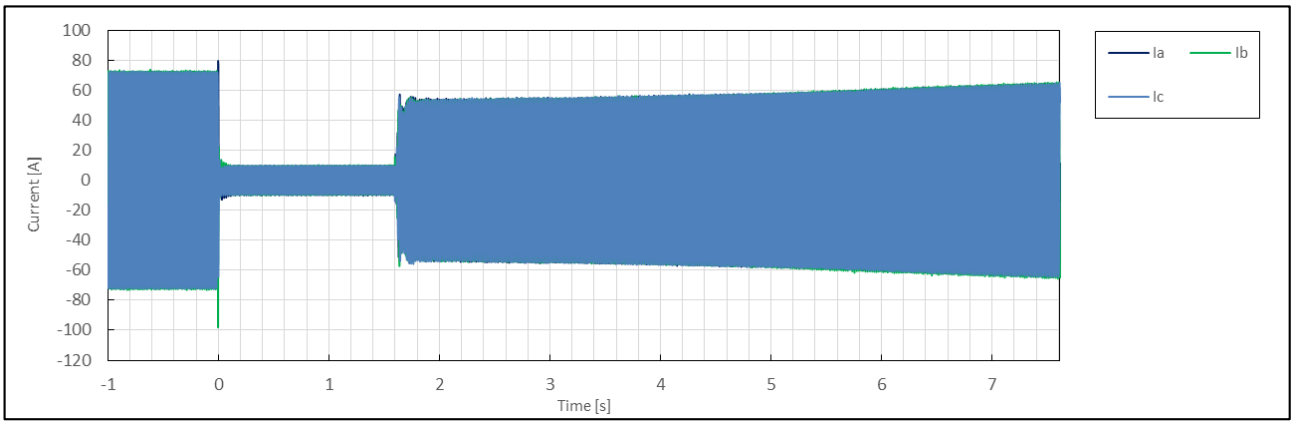


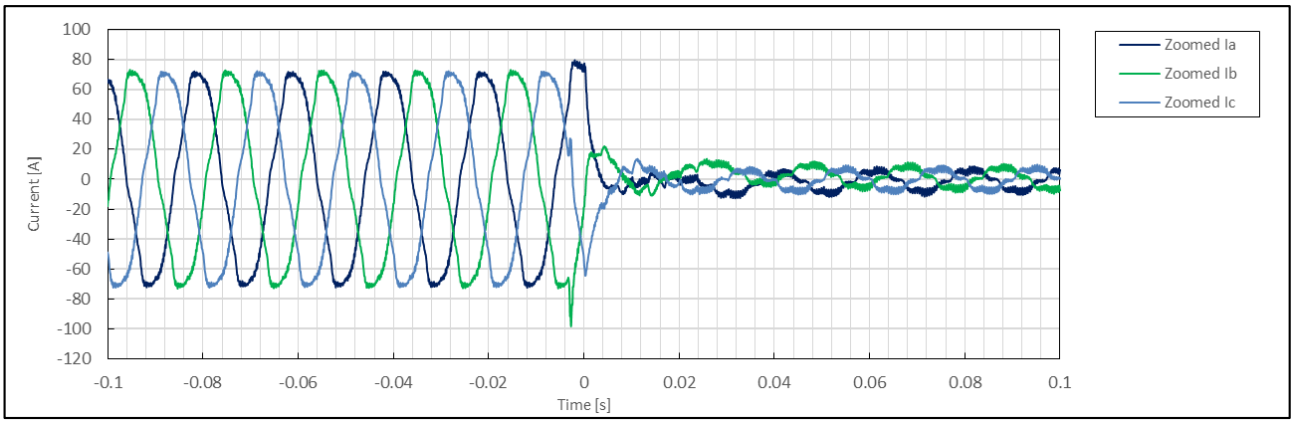
Test No. 3.2 with PGU

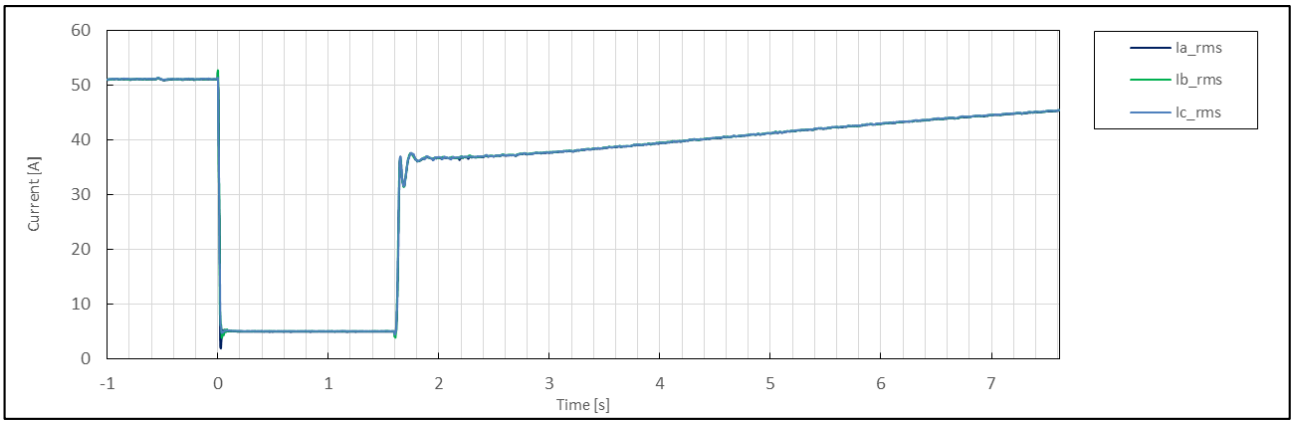


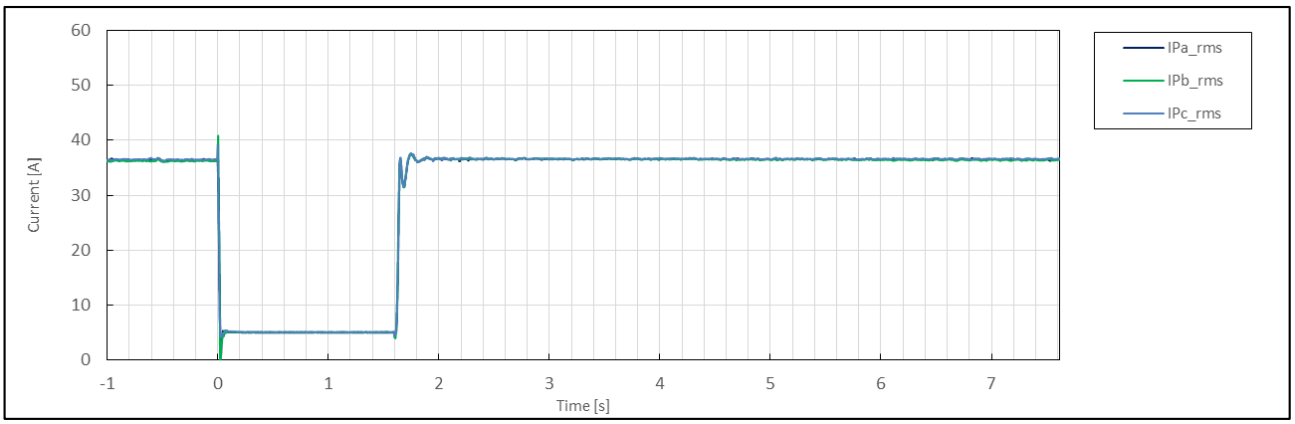


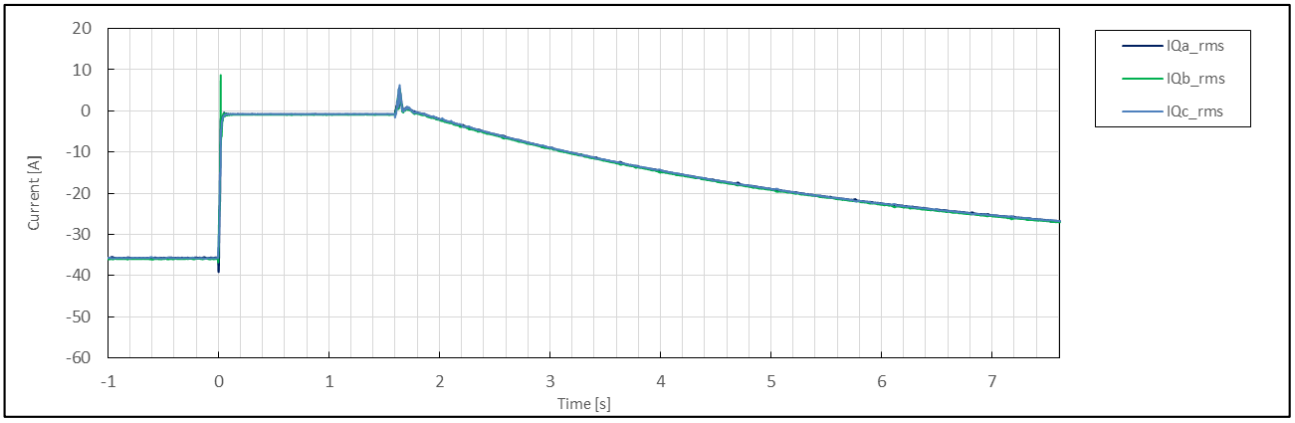


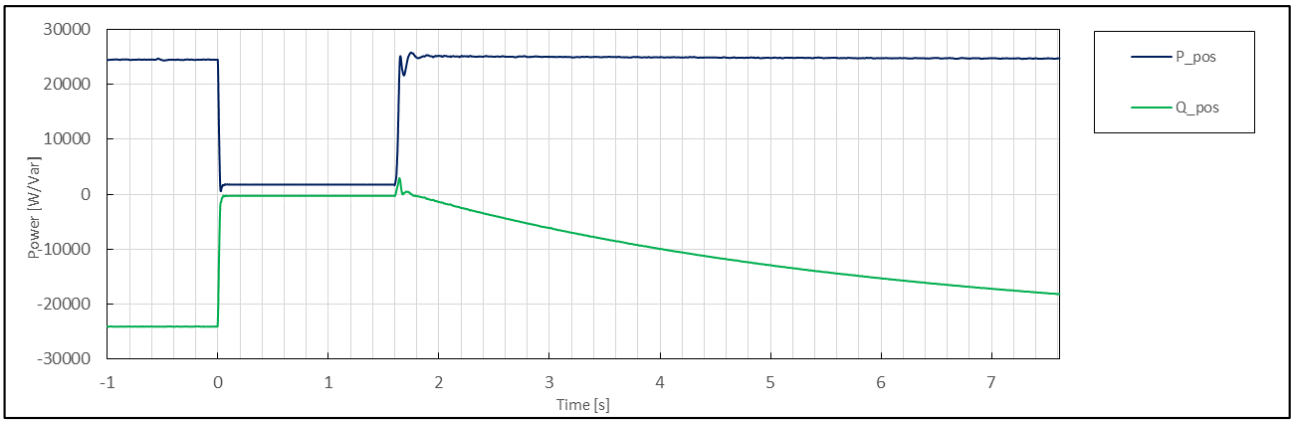


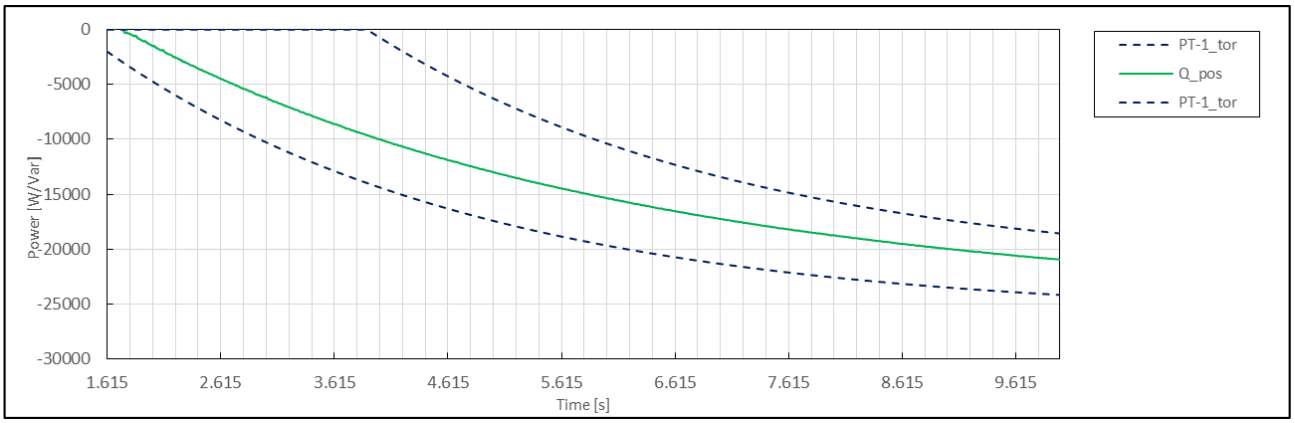

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

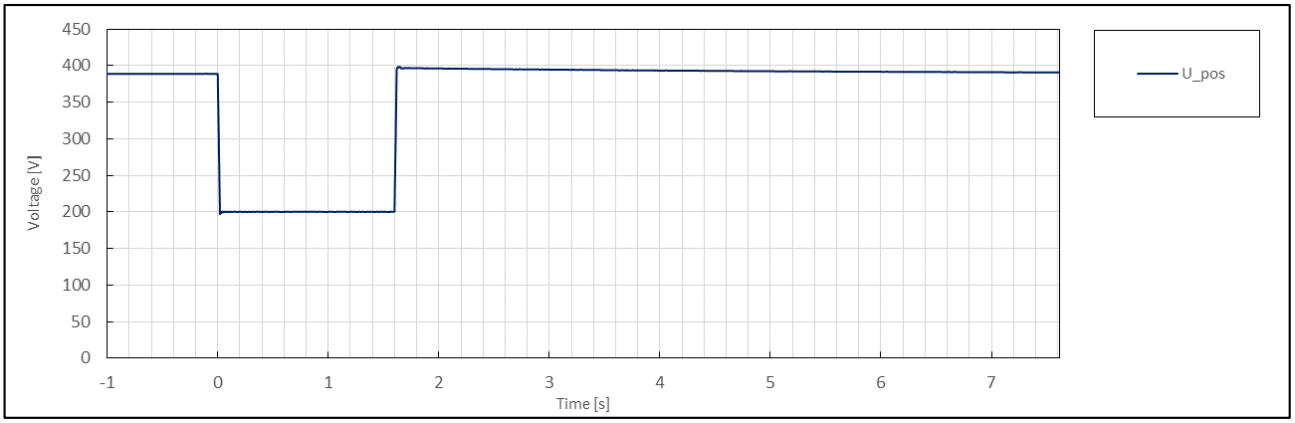

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

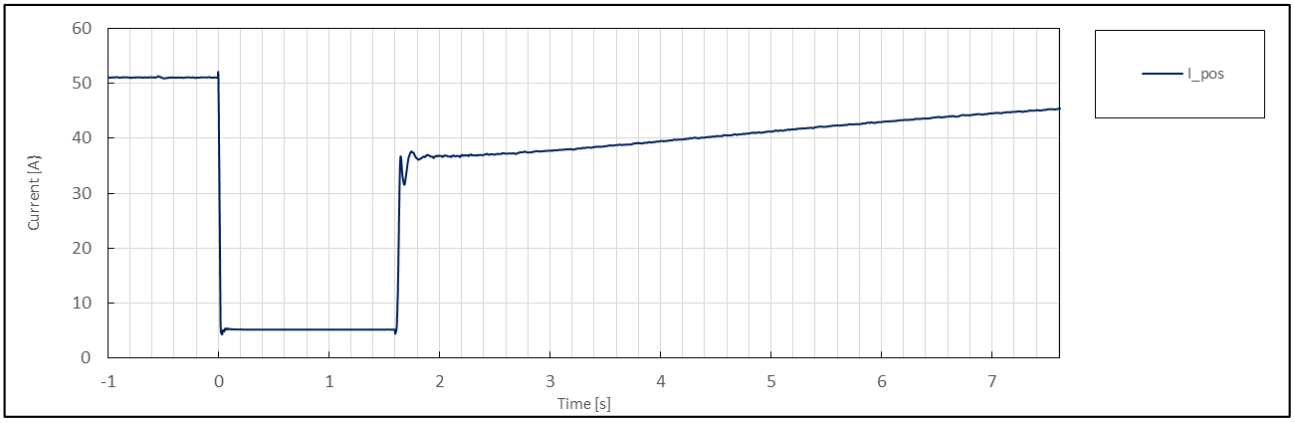

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


30000
20000
10000
0
-10000
-20000
-30000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

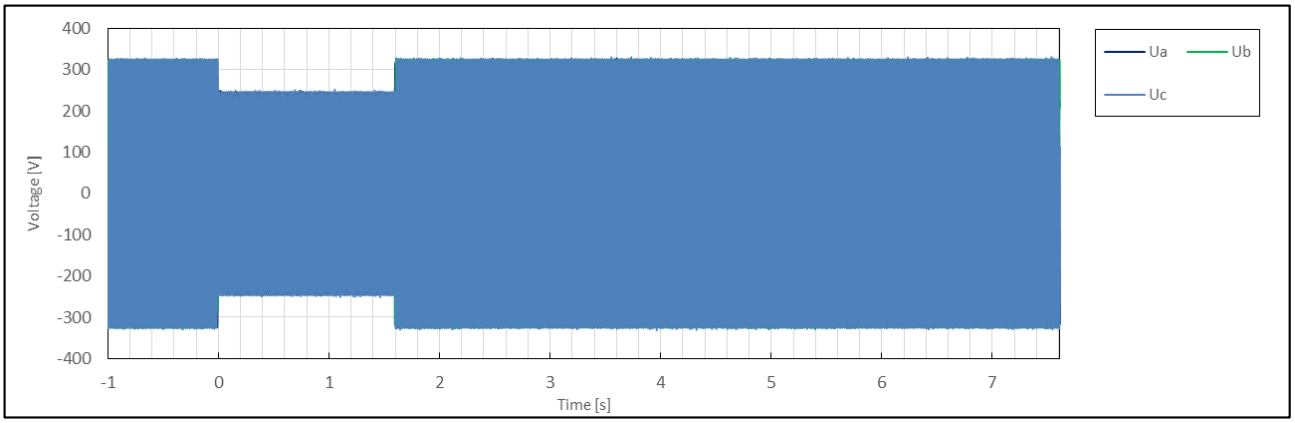

0
-5000
-10000
-15000
-20000
-25000
-30000
Power [W/Var]
1.615
2.615
3.615
4.615
5.615
6.615
7.615
8.615
9.615
Time [s]
PT-1_tor
Q_pos
PT-1_tor

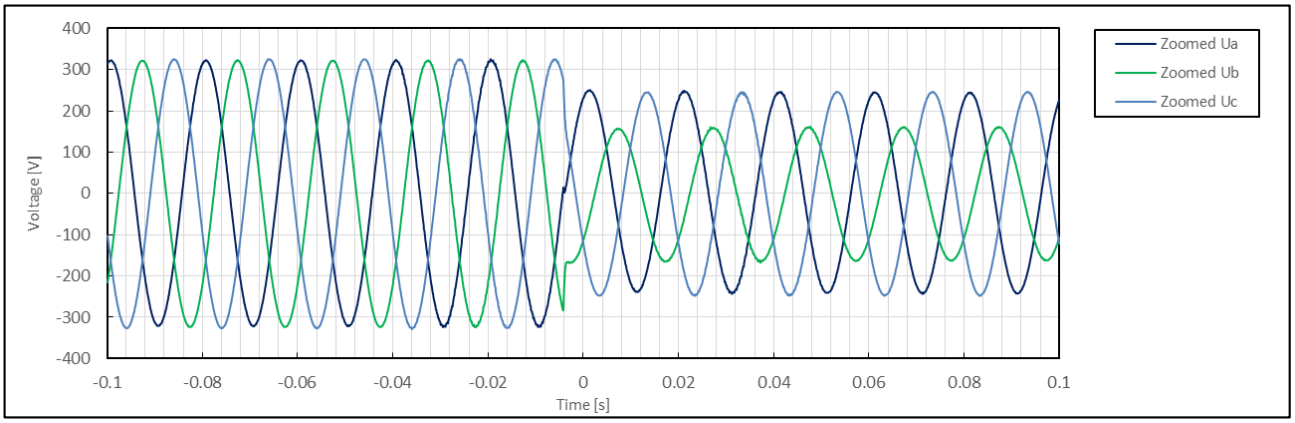

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

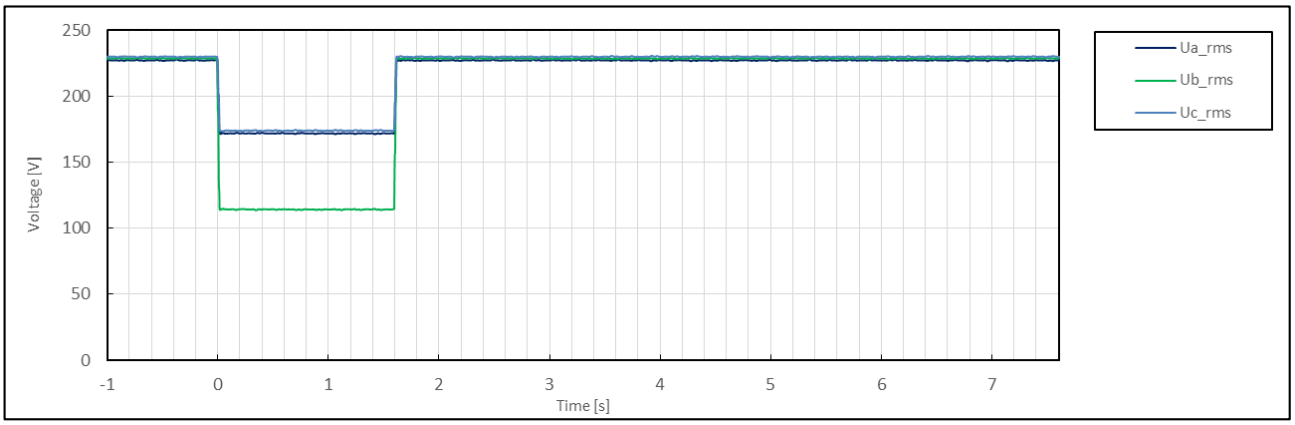

60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	3.3
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	19:09:34
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1610
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1609
	8	Fault duration in empty load test	Total	--	ms	1610
	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.	0.98
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	1.12
	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.	-0.49
	16		Pos.			-0.49
	17	Cos_{φ}	--	t1-10s to t1	--	0.895
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.	0.05
	20		Phase 2			0.06
	21		Phase 3			0.06
	22	Line current	Phase 1	t1+100ms	p.u.	0.05
	23		Phase 2			0.07
	24		Phase 3			0.06
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	0.98
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.98
	29		Pos.			0.98
	39	Active power rising time	Pos.	--	s	0.143
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.37
	32		Pos.			-0.37
	33	Reactive power rising time	Pos.	--	s	11.76
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

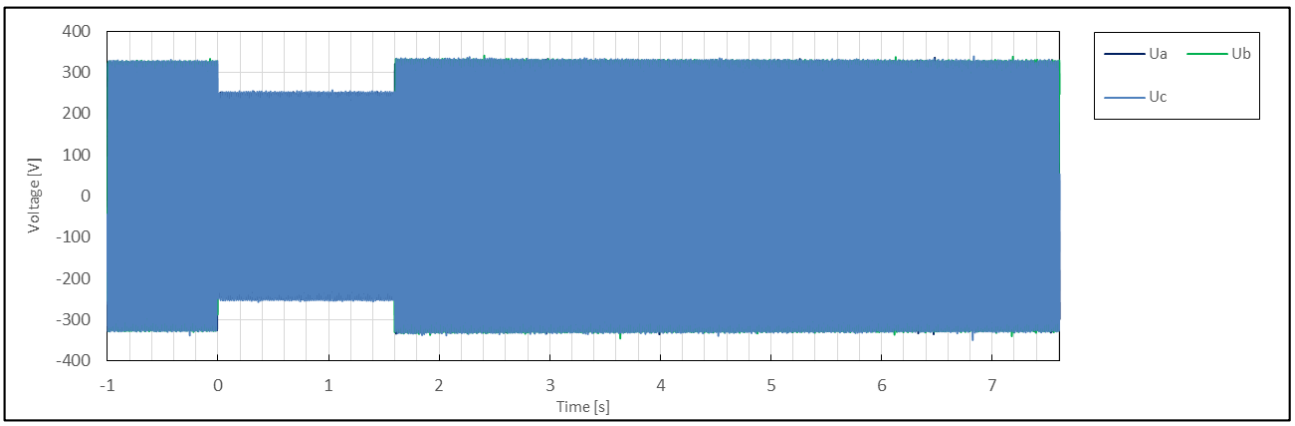
Test No. 3.3 idle test

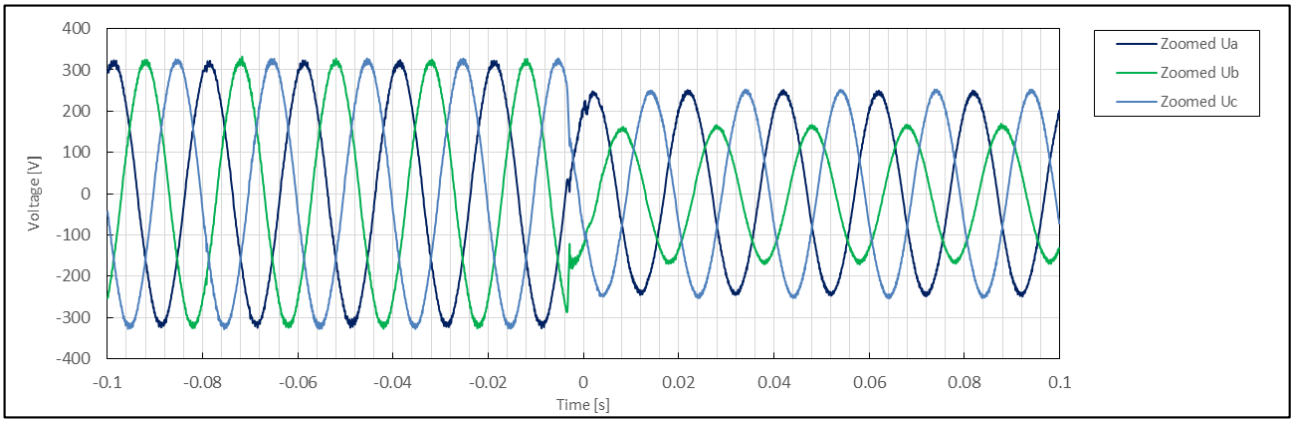


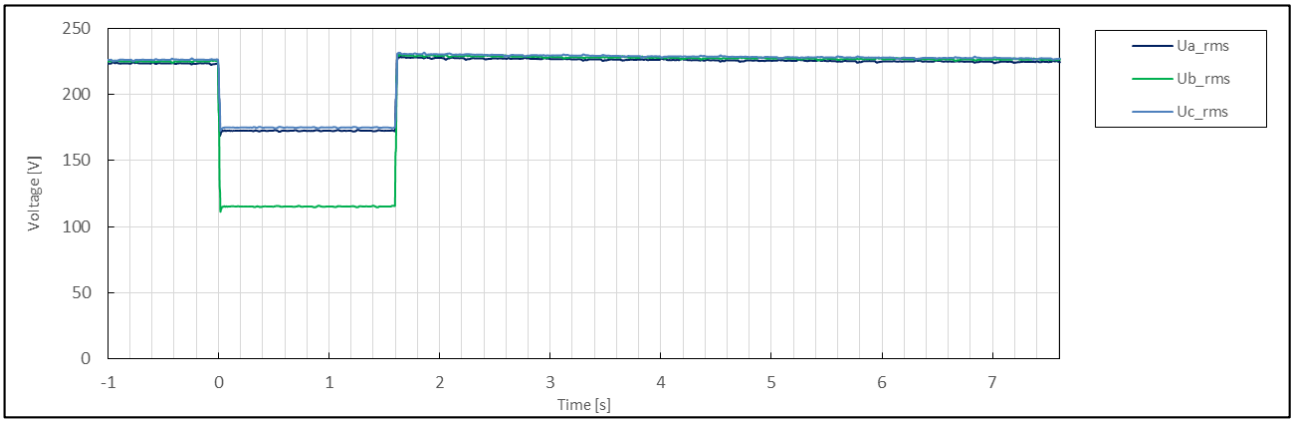


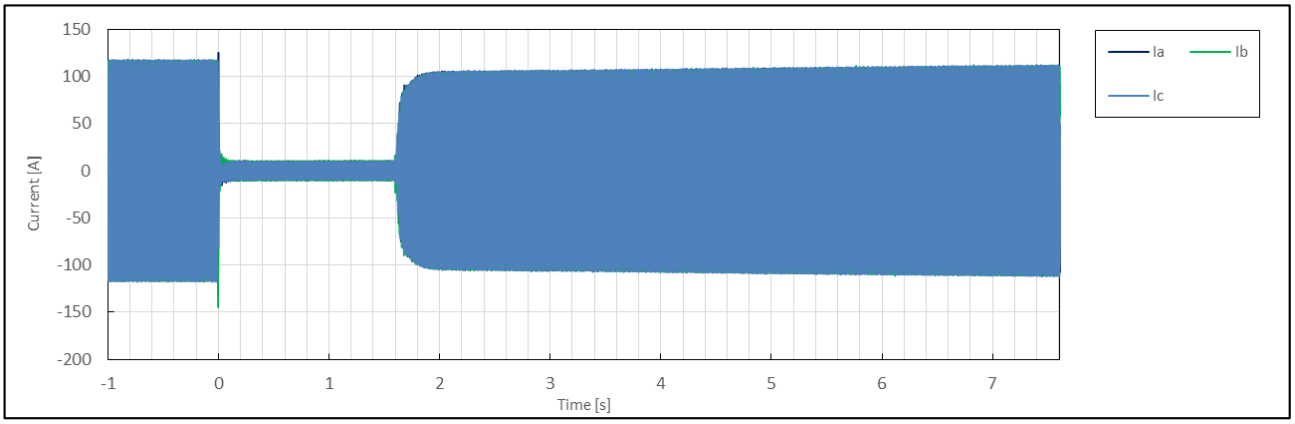


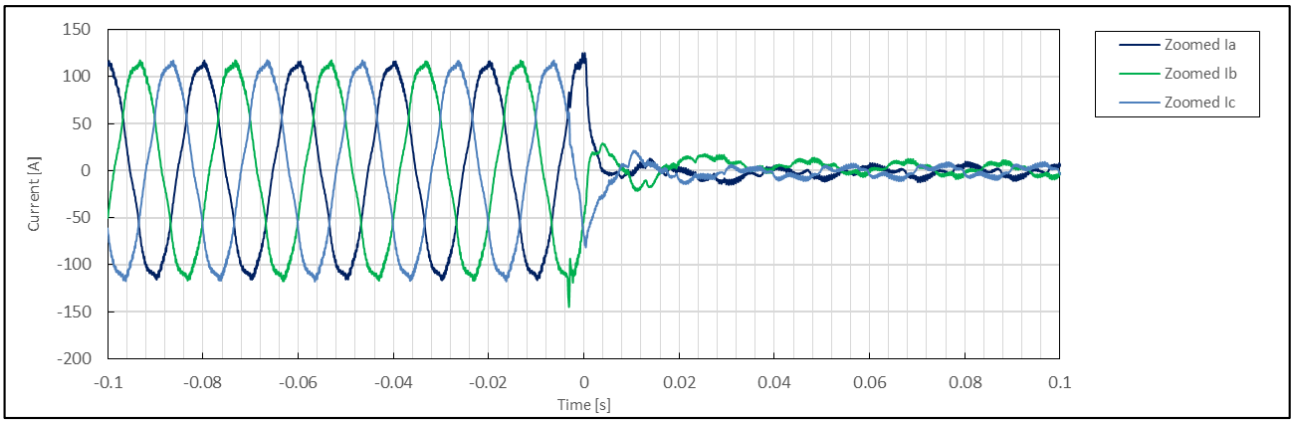
Test No. 3.3 with PGU

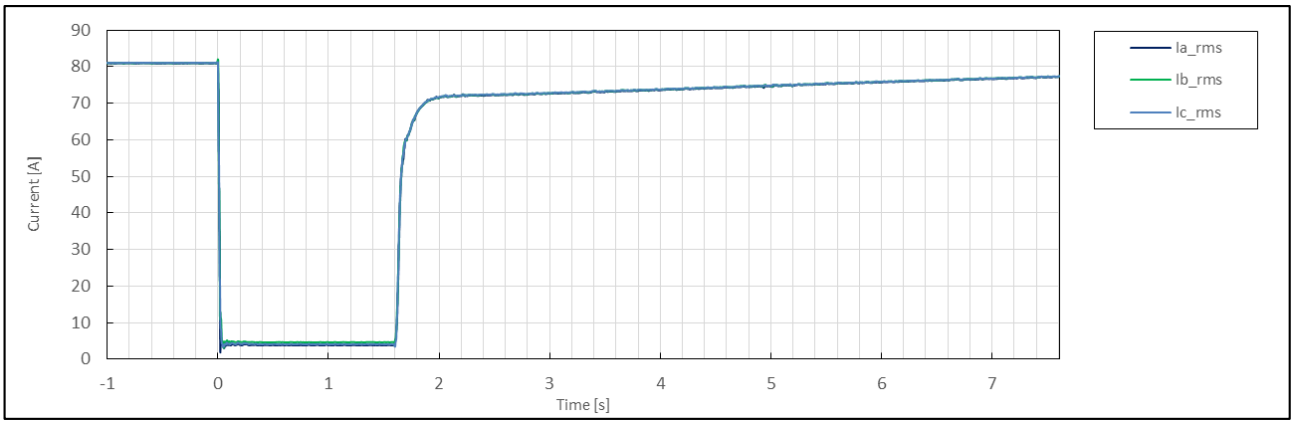


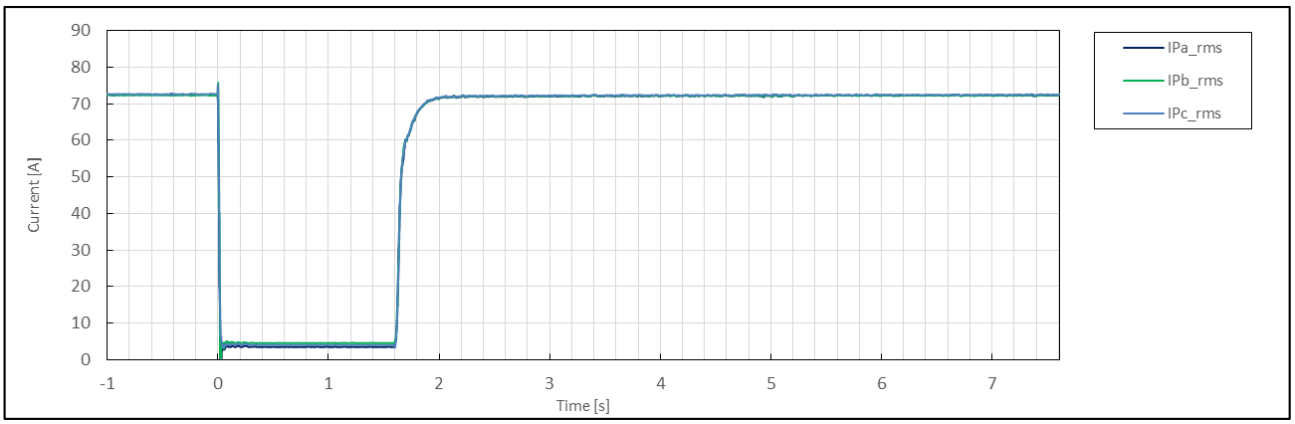


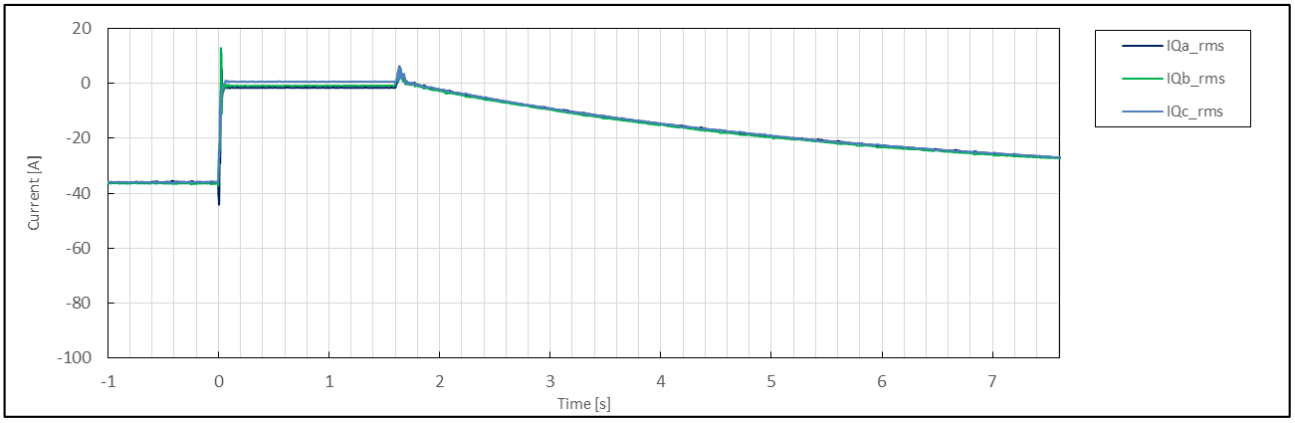


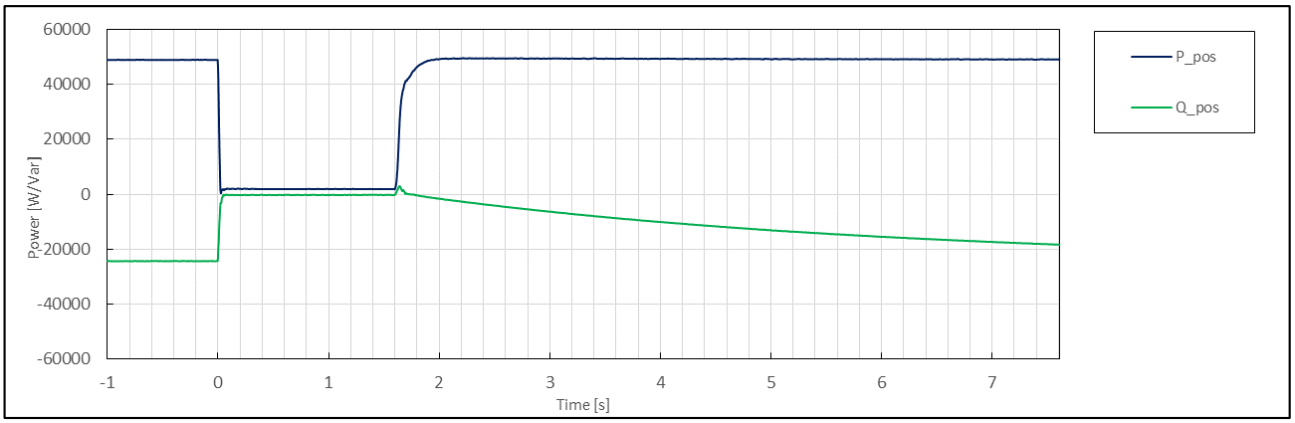


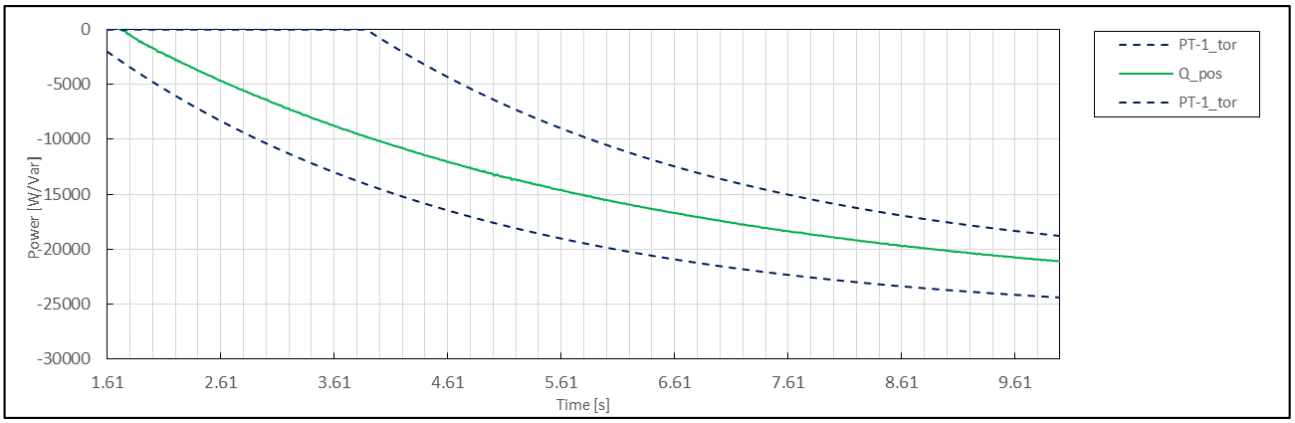

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

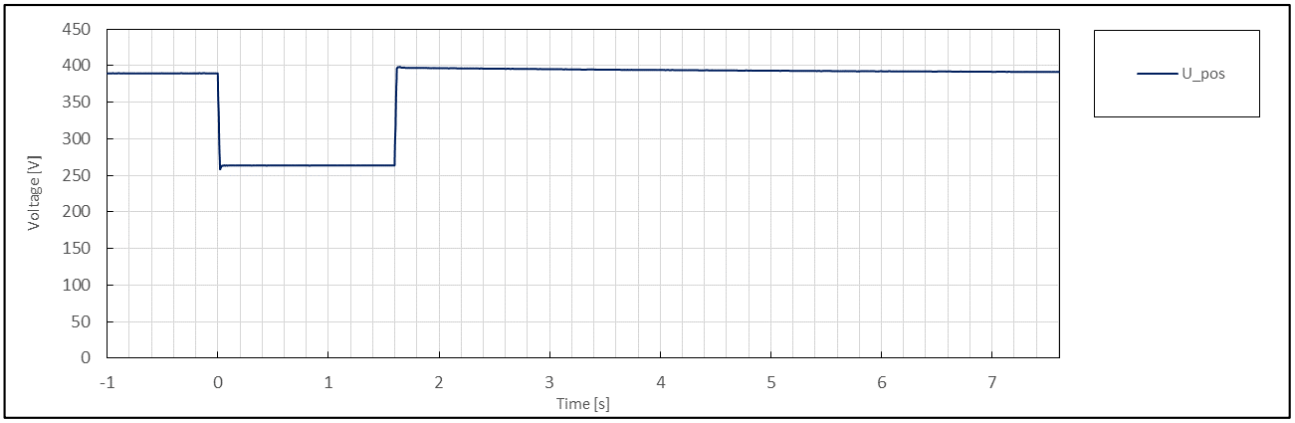

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

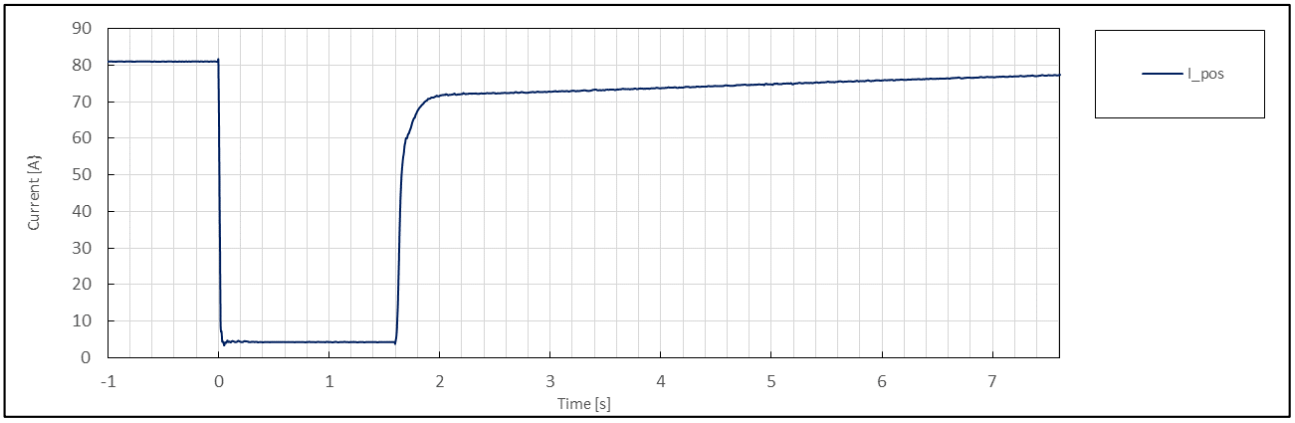

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


60000
40000
20000
0
-20000
-40000
-60000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

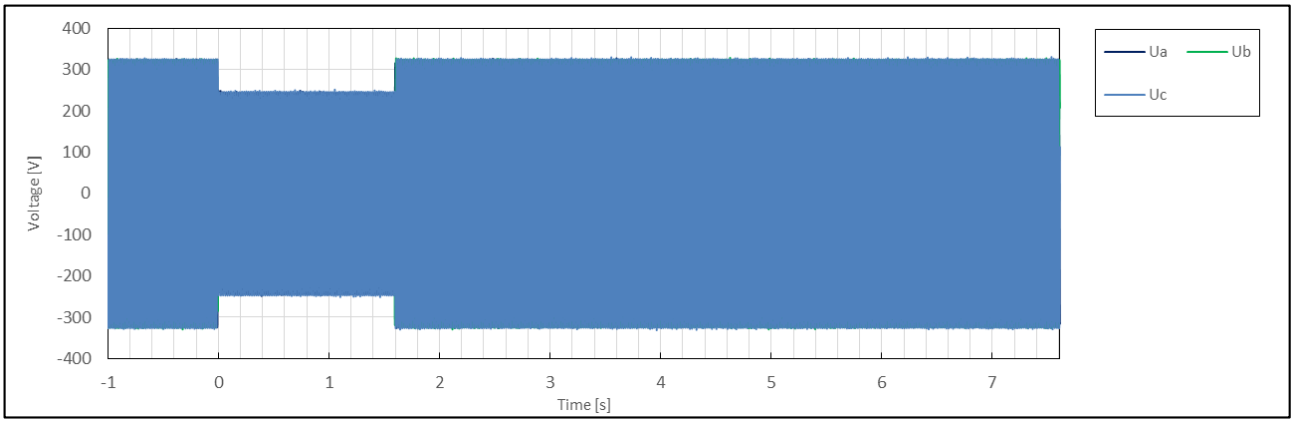

0
-5000
-10000
-15000
-20000
-25000
-30000
Power [W/Var]
1.61
2.61
3.61
4.61
5.61
6.61
7.61
8.61
9.61
Time [s]
PT-1_tor
Q_pos
PT-1_tor

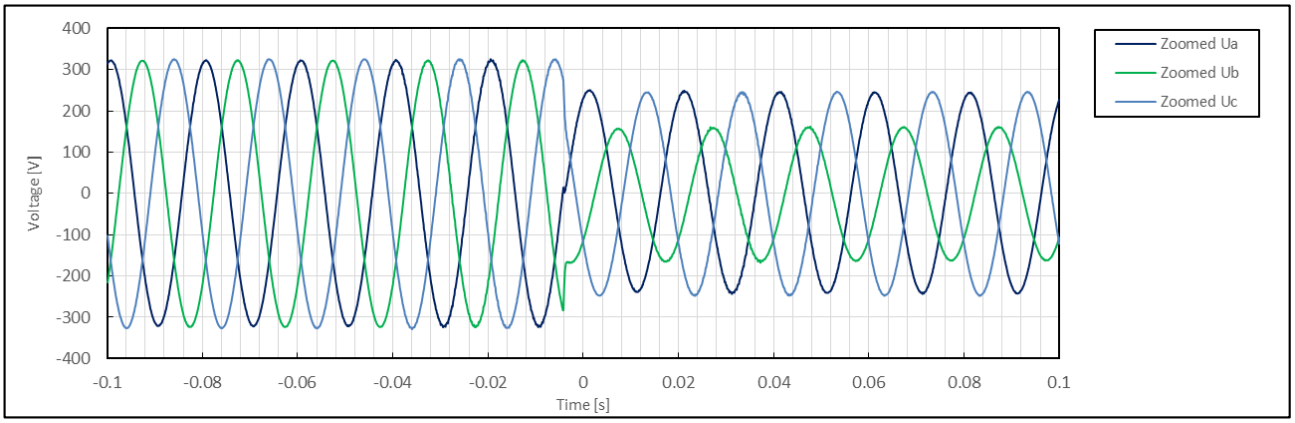

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

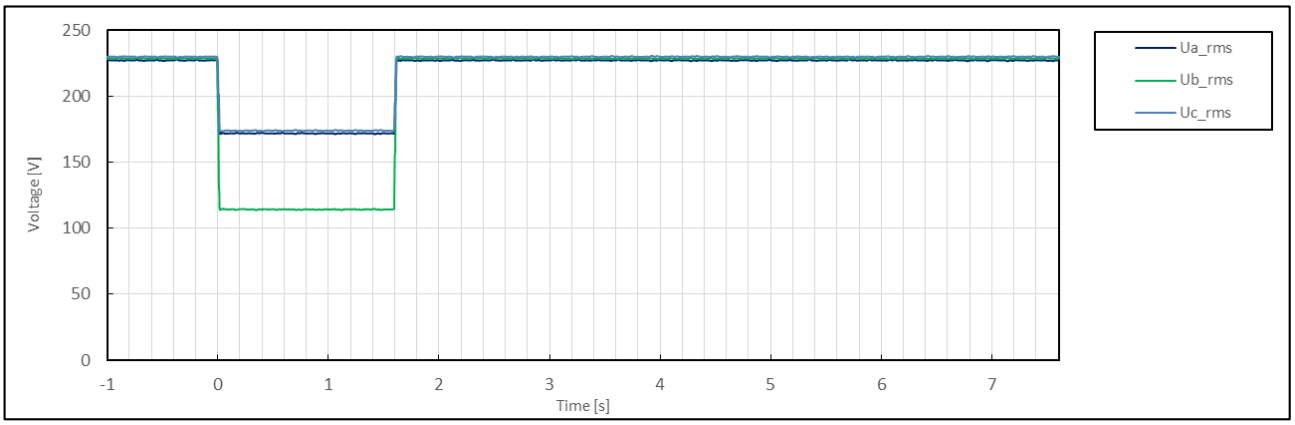

90
80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	3.4
	1	Date	--	--	dd.mm.yyyy	02.27.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	19:34:50
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.50
	5	Setting dip duration		--		1610
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	1609
	8	Fault duration in empty load test	Total	--	ms	1610
	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.	0.98
	12	Current	Pos.	t1-500ms to t1-100ms	p.u.	0.71
	13	Active power	Total	t1-10s to t1	p.u.	0.49
	14		Pos.			0.49
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.48
	16		Pos.			-0.48
	17	Cos_{φ}	--	t1-10s to t1	--	0.714
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.	0.05
	20		Phase 2			0.07
	21		Phase 3			0.06
	22	Line current	Phase 1	t1+100ms	p.u.	0.05
	23		Phase 2			0.07
	24		Phase 3			0.06
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
After dip > t2	27	Voltage	Line to neutral	t2+3s to t2+10s	p.u.	0.98
	28	Active power	Total	t2+3s to t2+10s	p.u.	0.50
	29		Pos.			0.50
	39	Active power rising time	Pos.	--	s	0.088
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.37
	32		Pos.			-0.37
	33	Reactive power rising time	Pos.	--	s	11.53
	34	PGU does not disconnect from grid till 60s after fault	--	t2 to t2+60s	Yes / No	No

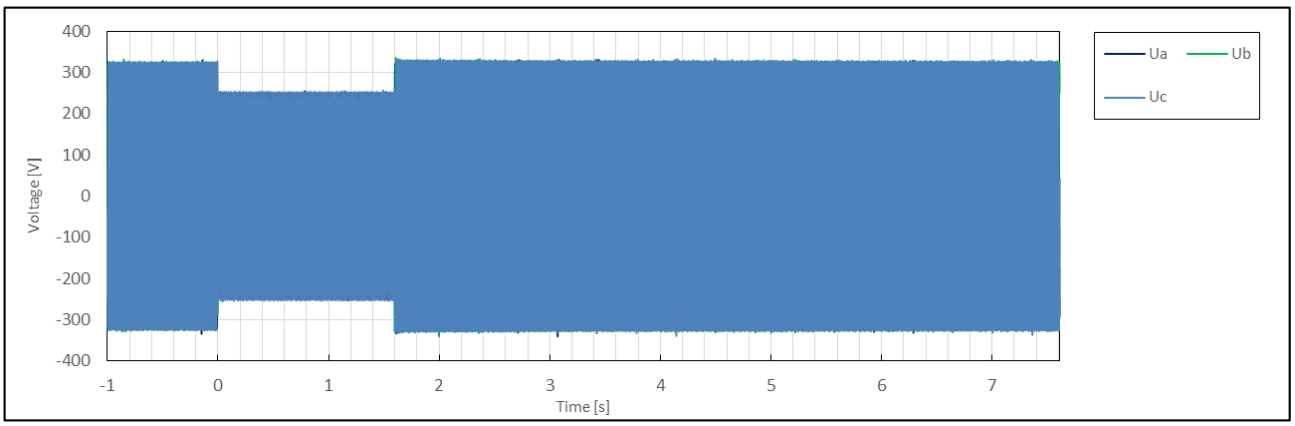
Test No. 3.4 idle test

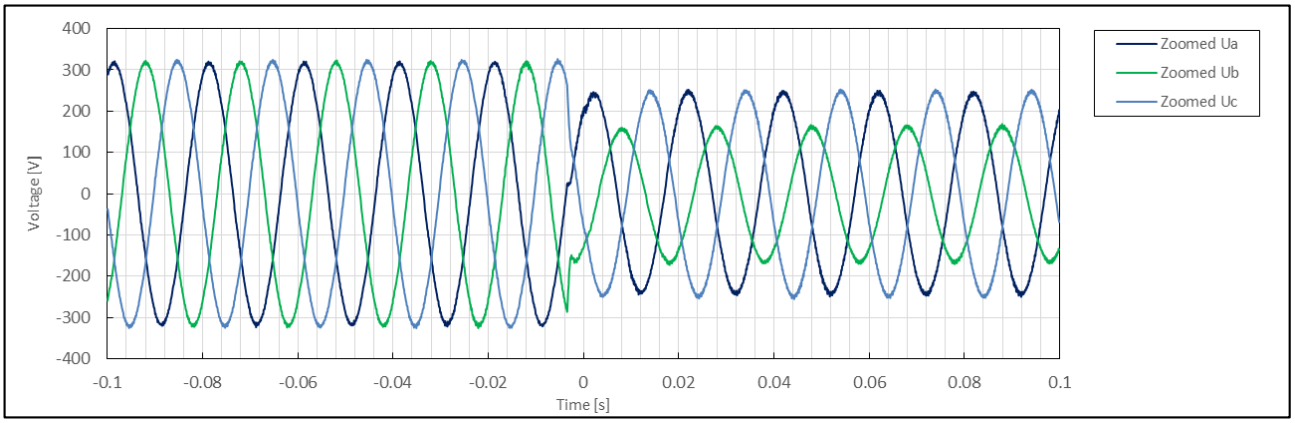


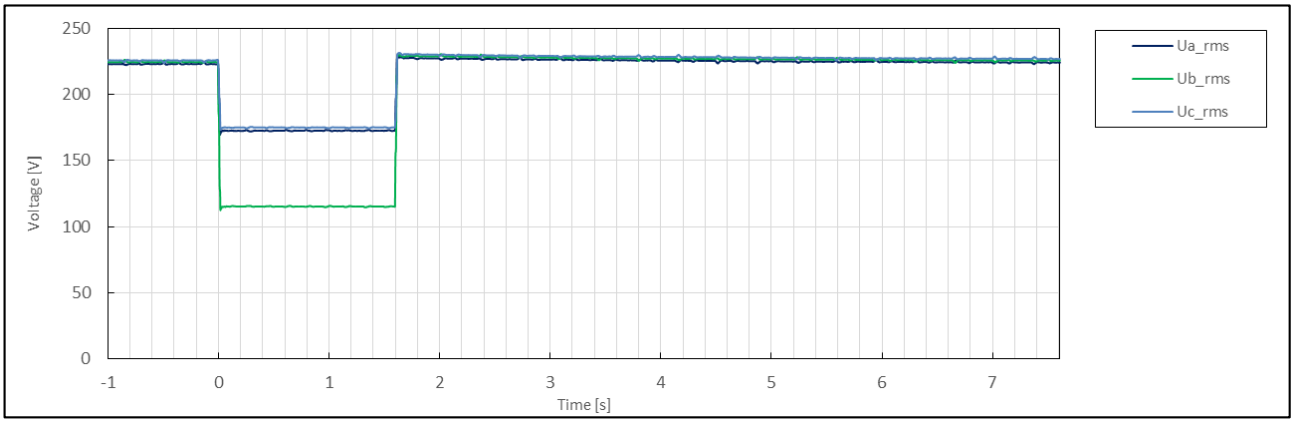


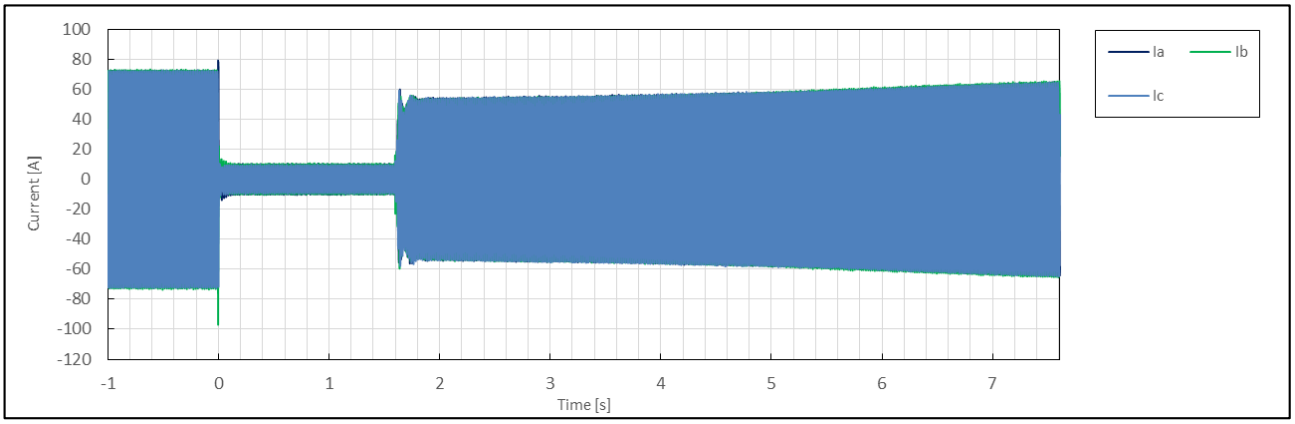


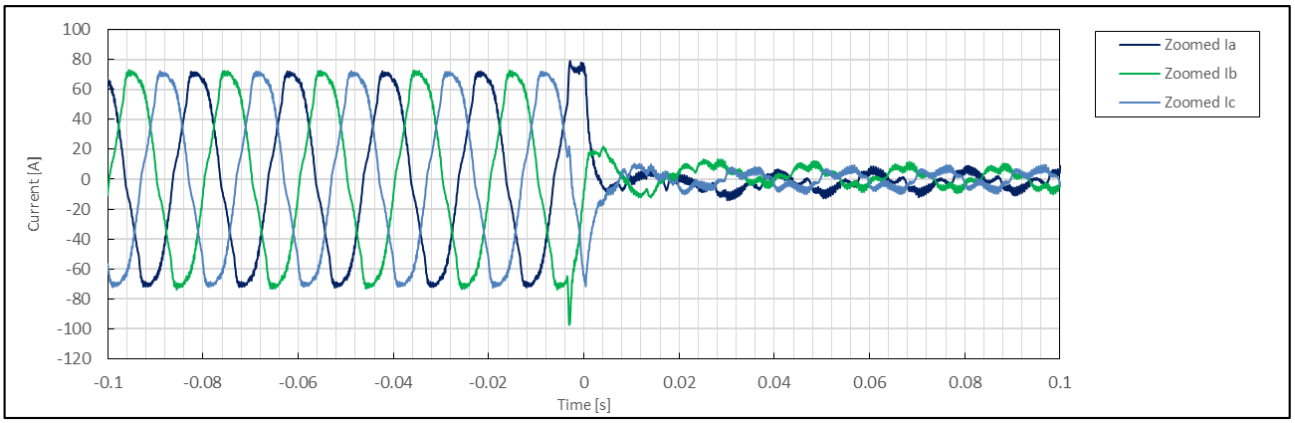
Test No. 3.4 with PGU

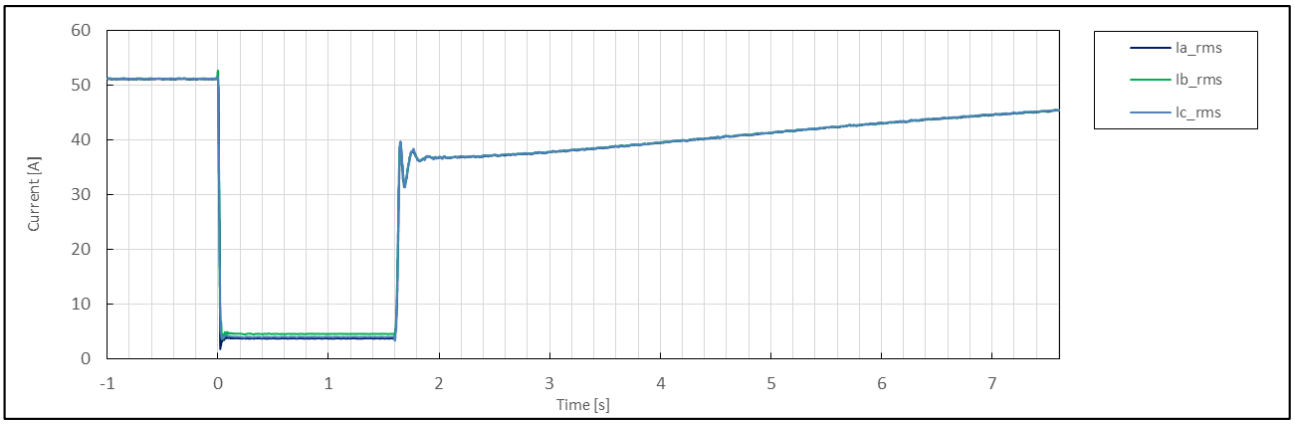


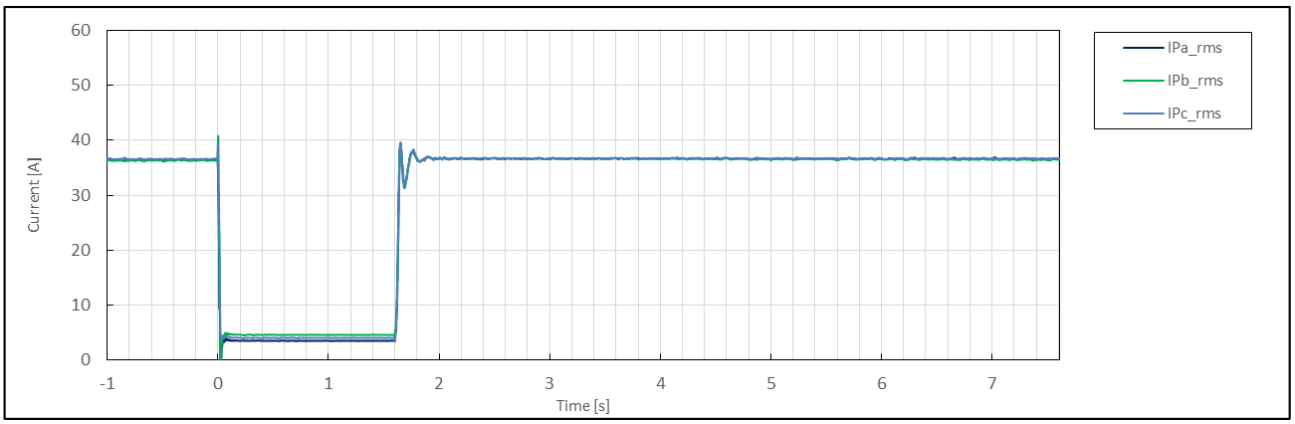


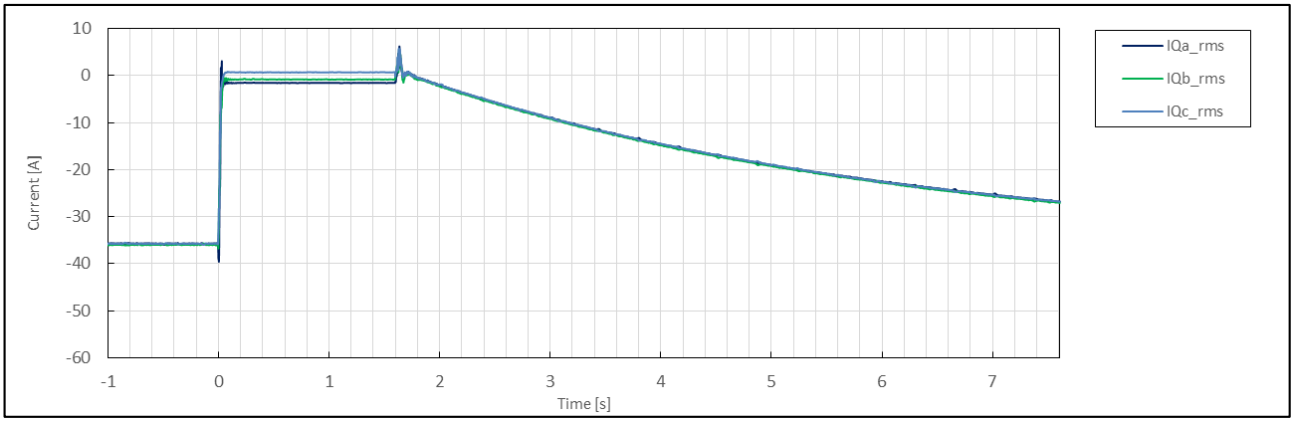


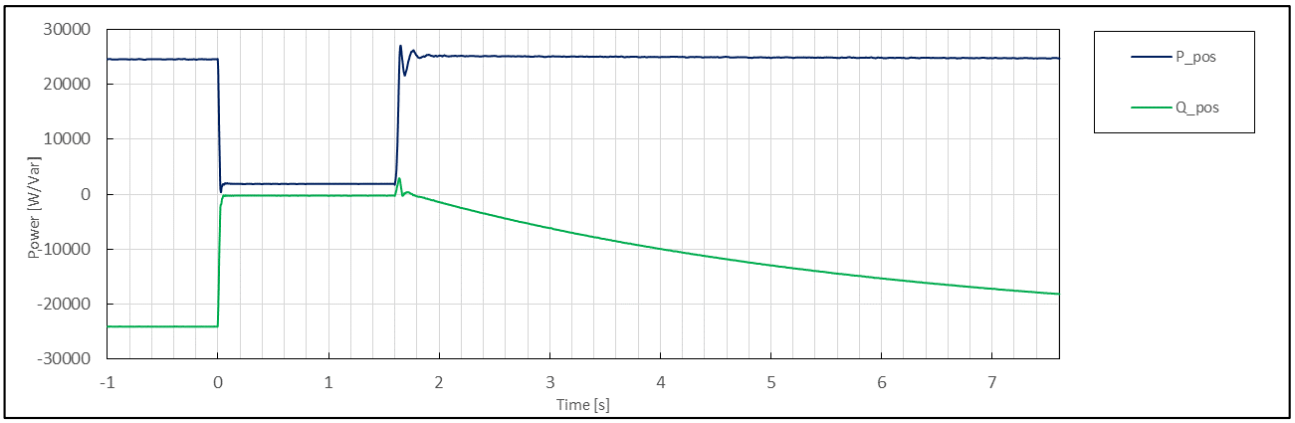


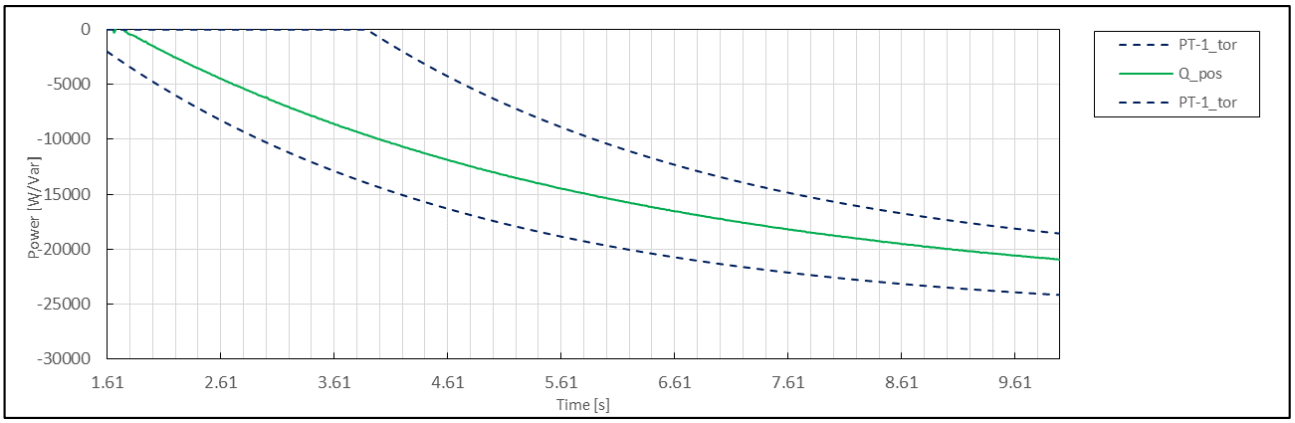

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

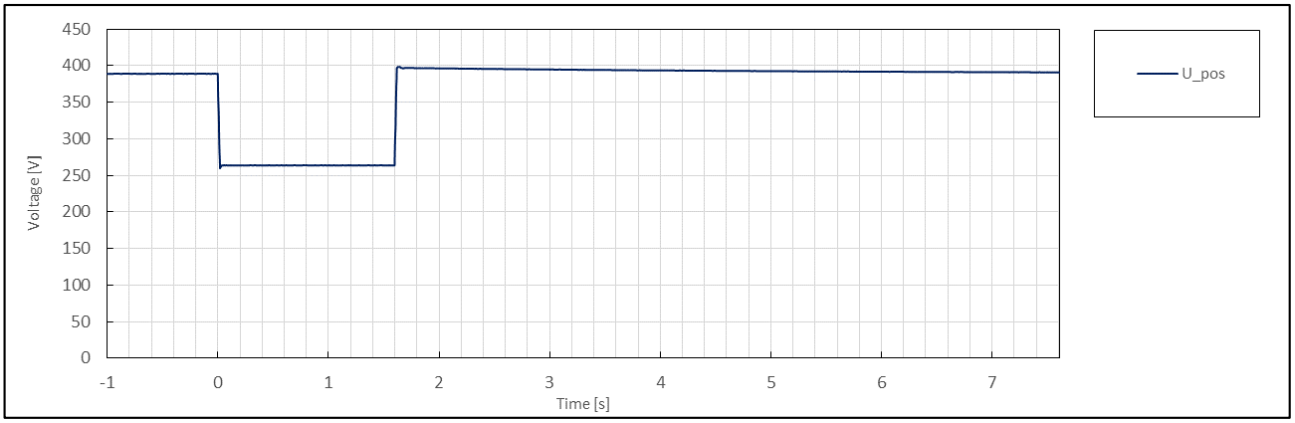

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]

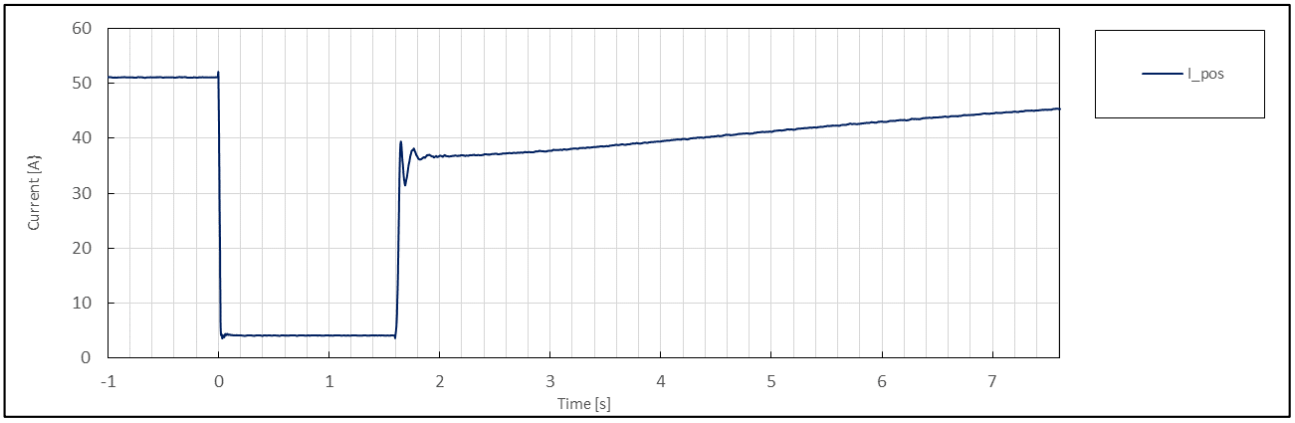

IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]


30000
20000
10000
0
-10000
-20000
-30000
Power [W/Var]
-1
0
1
2
3
4
5
6
7
Time [s]
P_pos
Q_pos

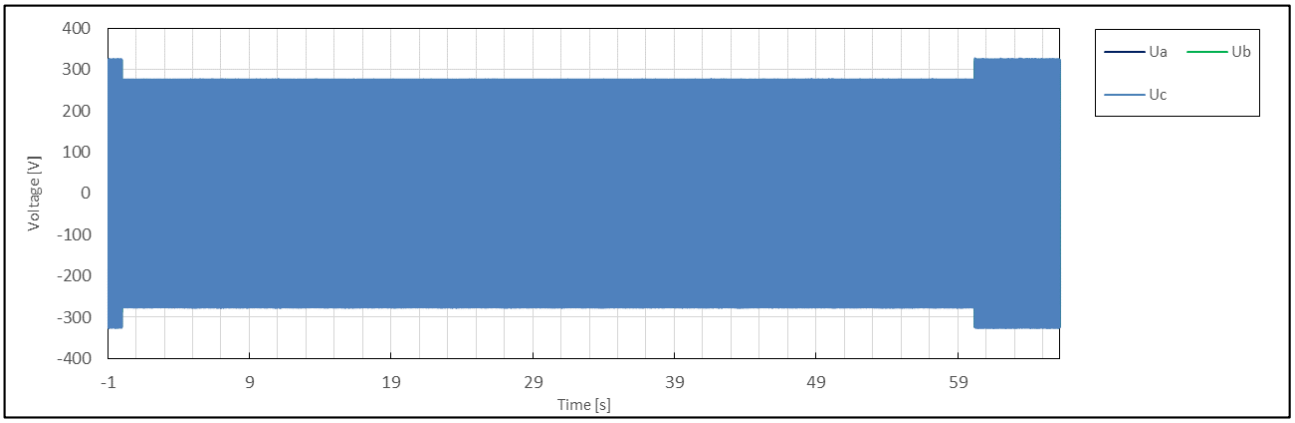

0
-5000
-10000
-15000
-20000
-25000
-30000
Power [W/Var]
1.61
2.61
3.61
4.61
5.61
6.61
7.61
8.61
9.61
Time [s]
PT-1_tor
Q_pos
PT-1_tor

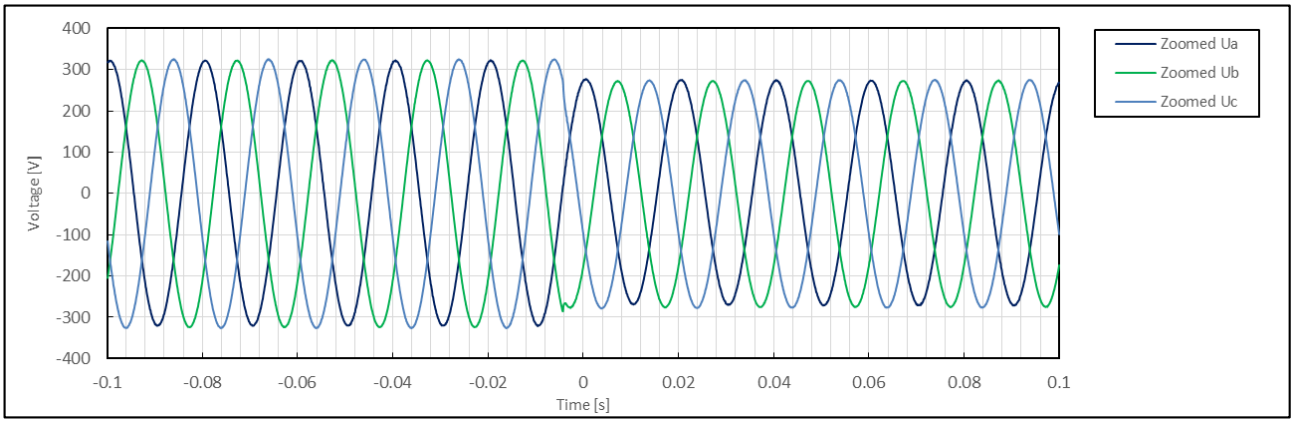

450
400
350
300
250
200
150
100
50
0
Voltage [V]
-1
0
1
2
3
4
5
6
7
Time [s]
U_pos

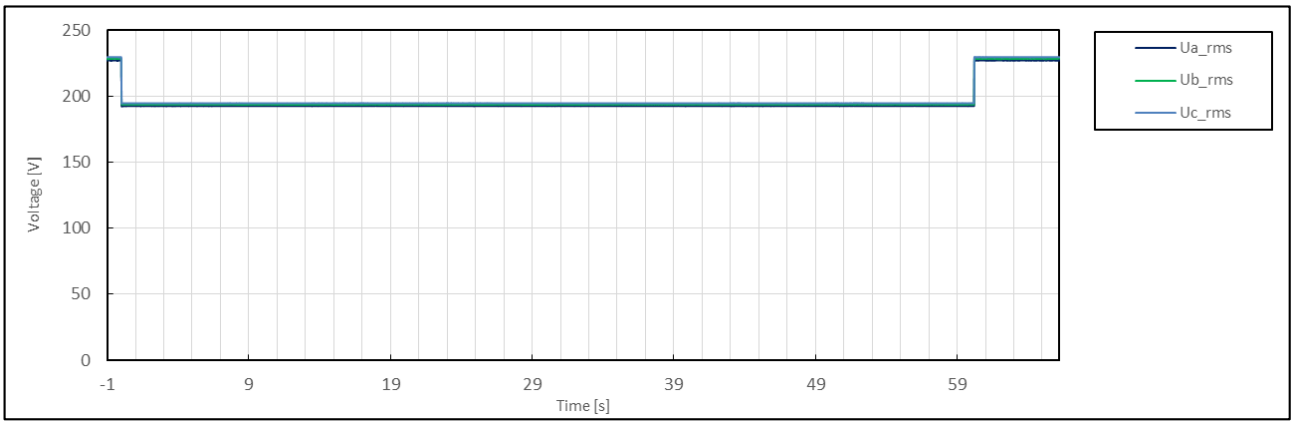

60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
7
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	4.1
	1	Date	--	--	dd.mm.yyyy	02.16.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:38:24
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.84
	5	Setting dip duration		--		60213
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60212
	8	Fault duration in empty load test	Total	--	ms	60213
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.85
	10		Pos.		p.u.	0.85
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.85
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.04
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.04
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.032
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

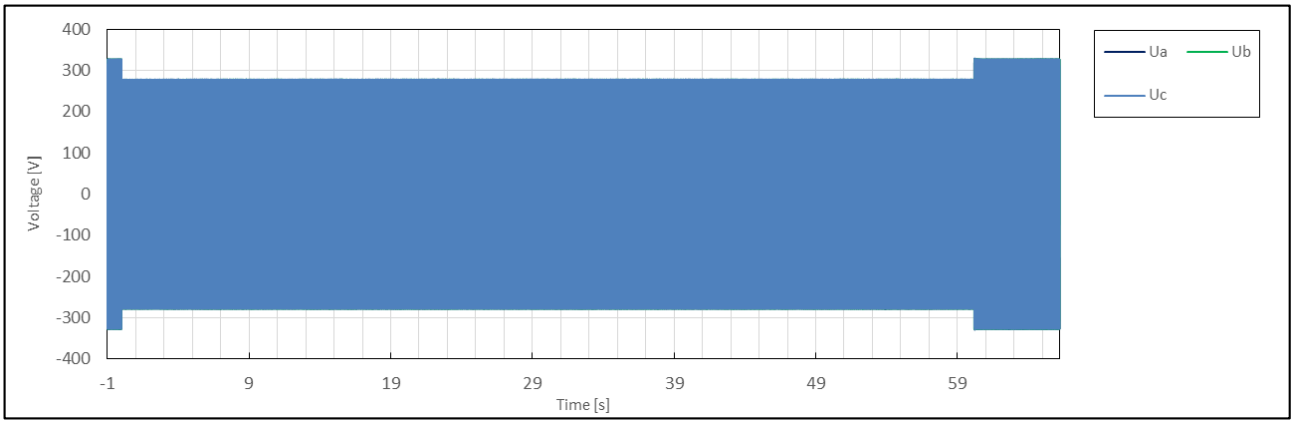
Test No. 4.1 idle test

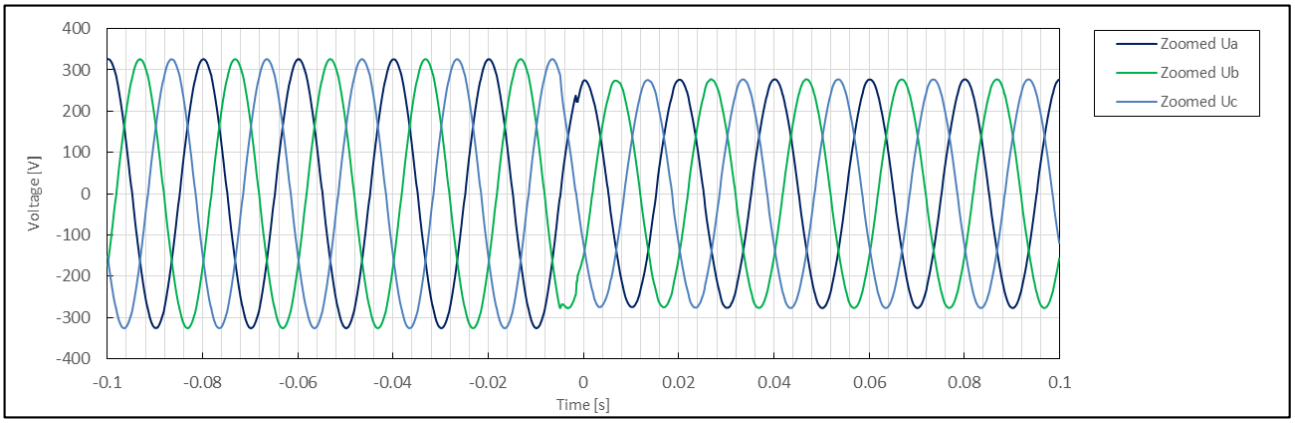


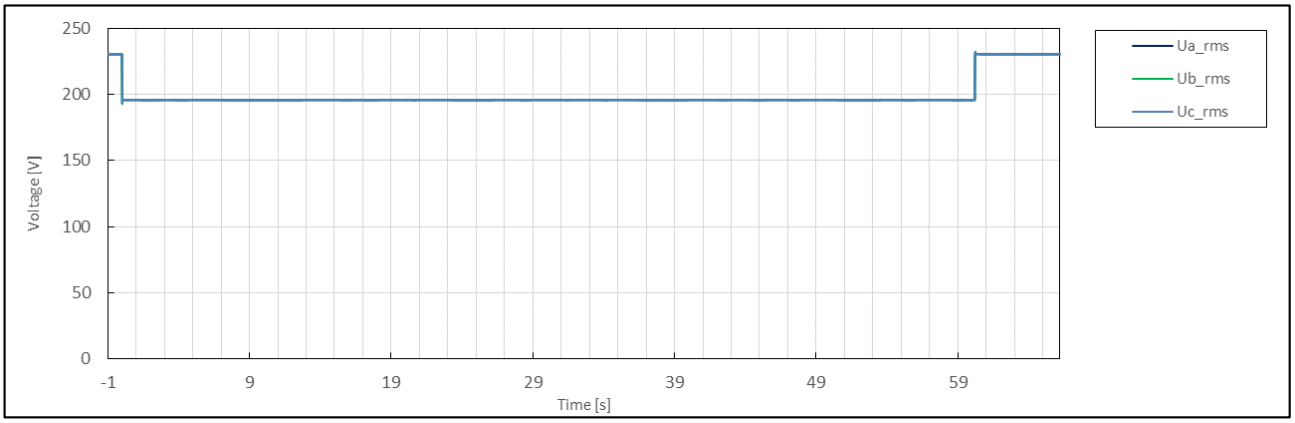


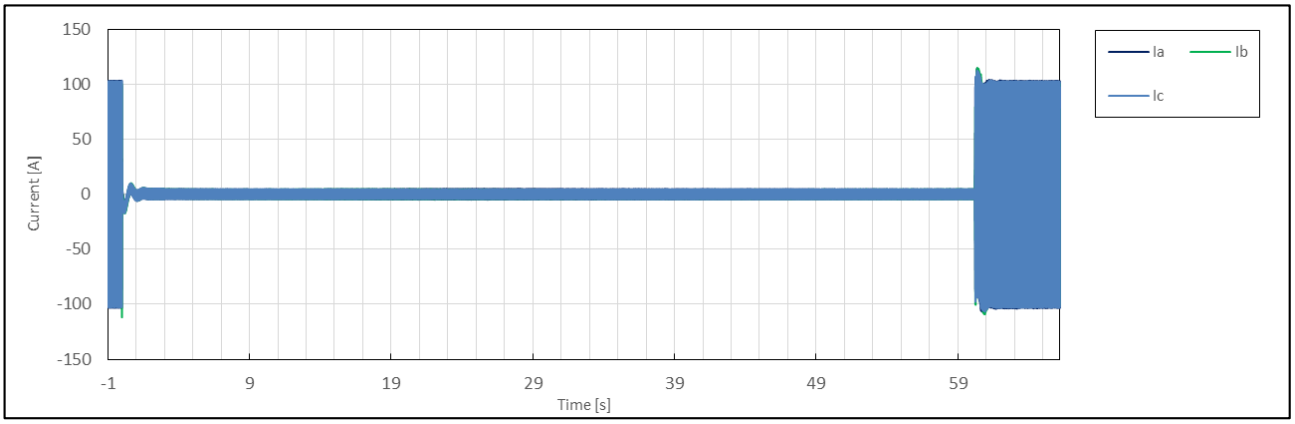


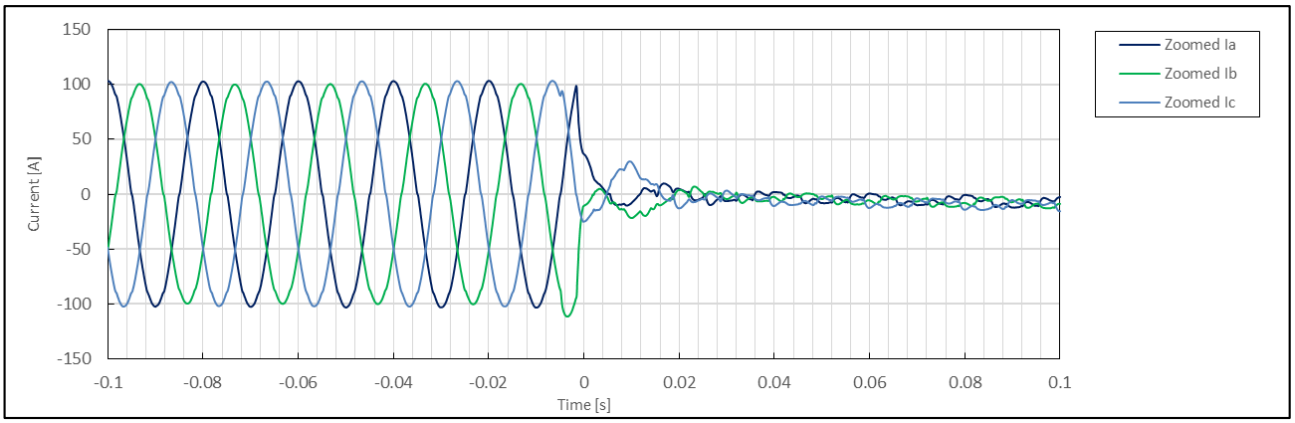
Test No. 4.1with PGU

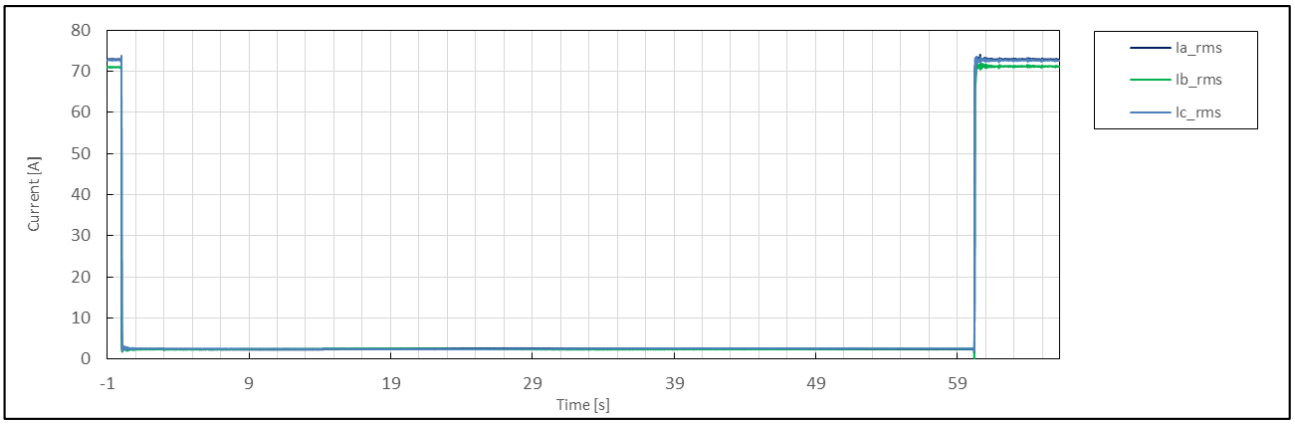


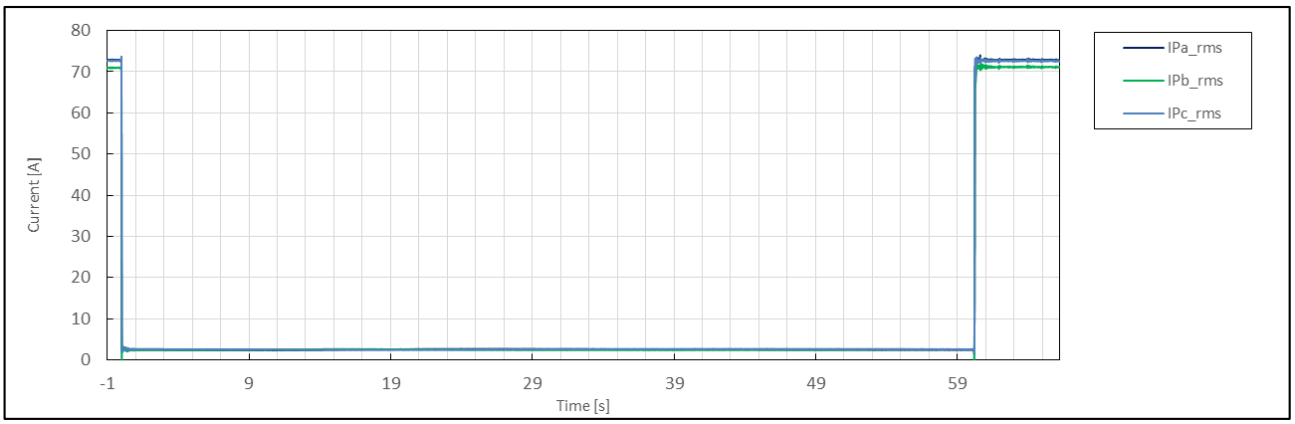


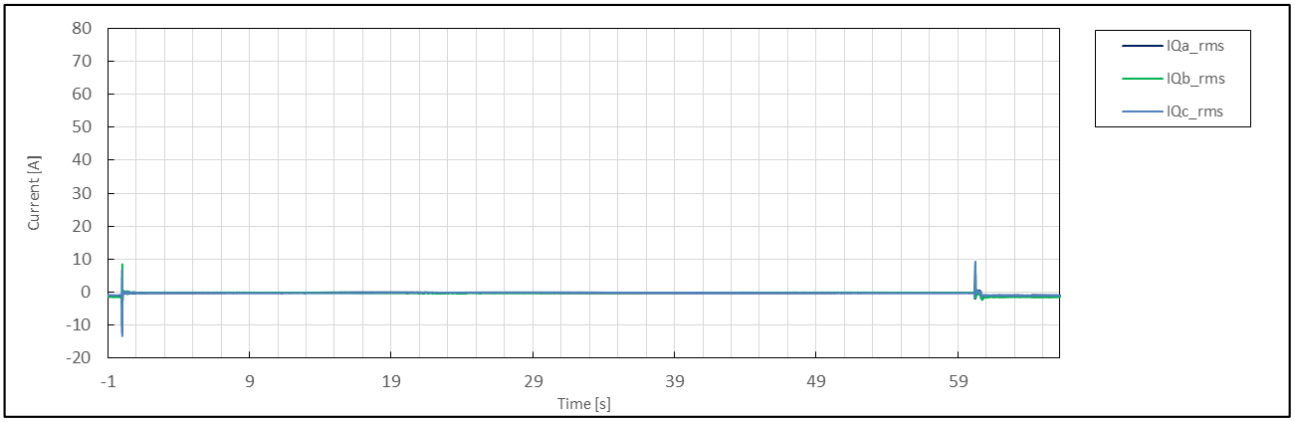


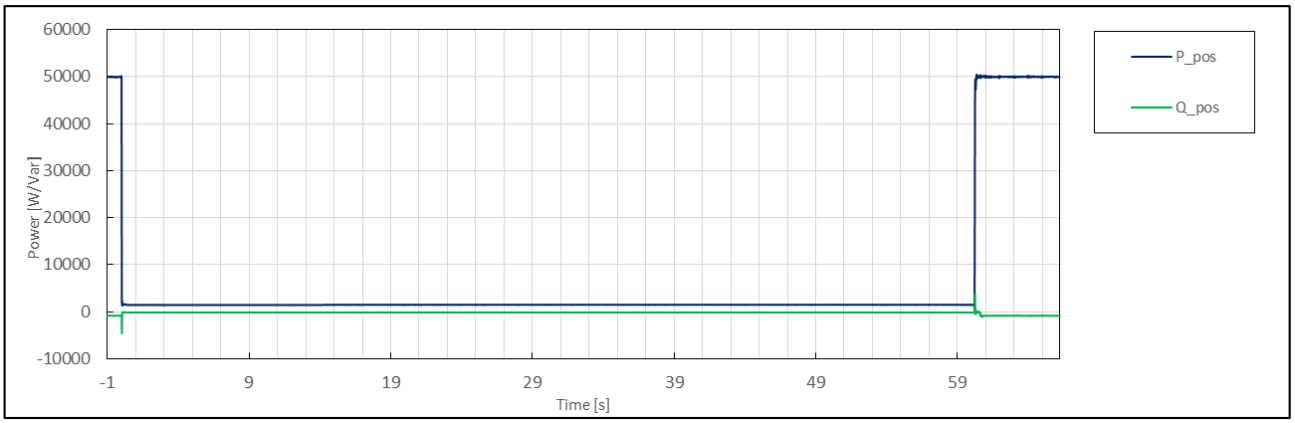


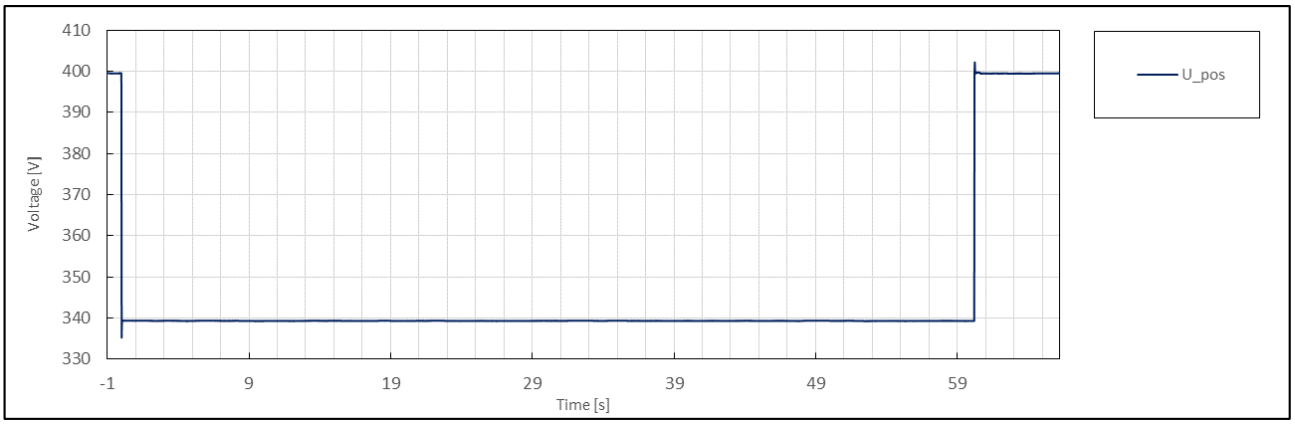

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

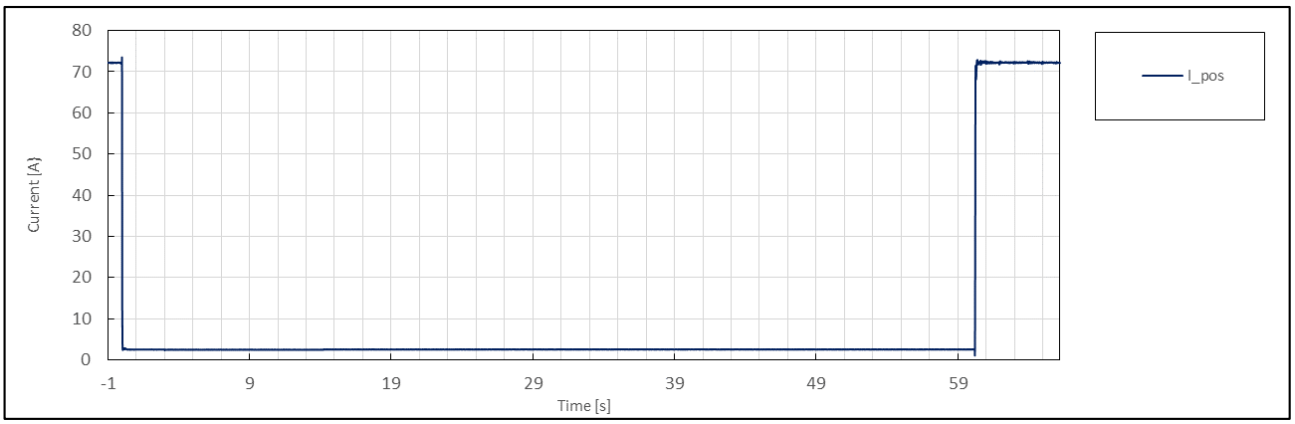

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

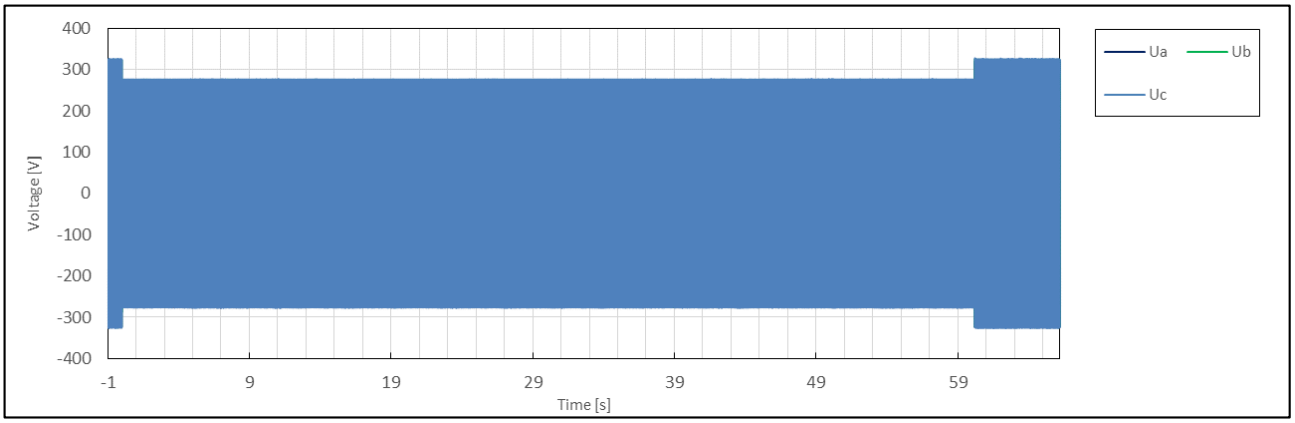

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

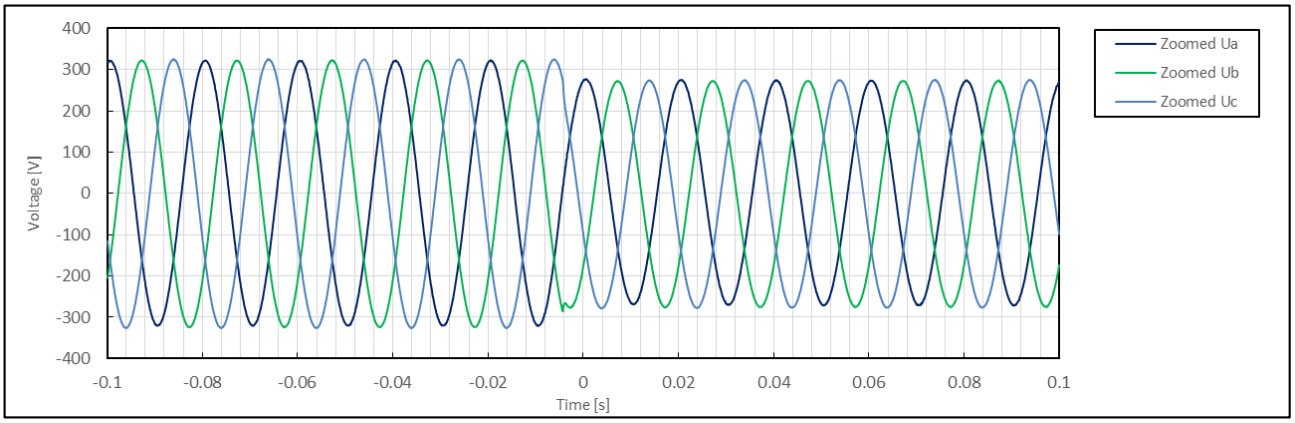

410
400
390
380
370
360
350
340
330
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

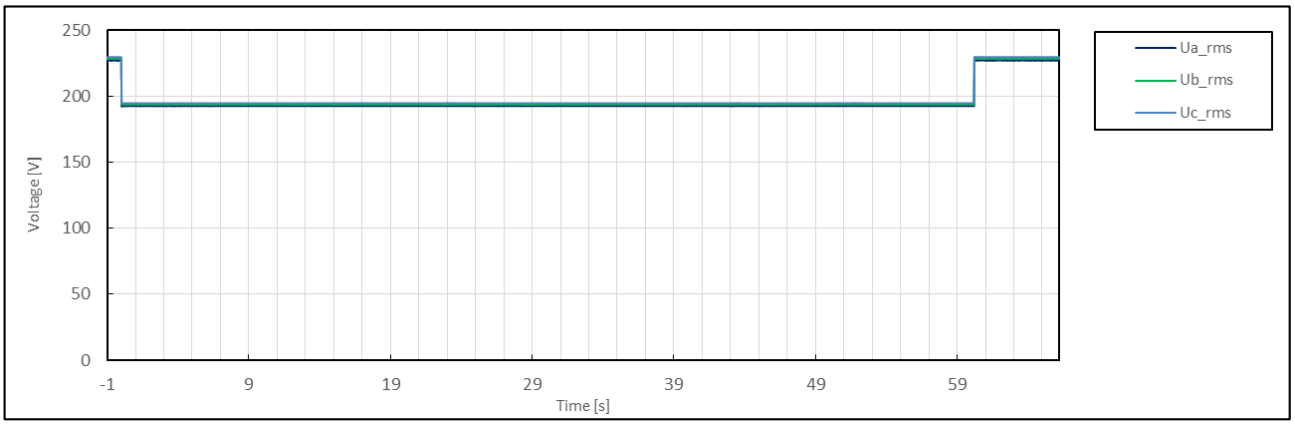

80
70
60
50
40
30
20
10
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	4.2
	1	Date	--	--	dd.mm.yyyy	02.16.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:37:16
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.84
	5	Setting dip duration		--		60213
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60212
	8	Fault duration in empty load test	Total	--	ms	60213
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.85
	10		Pos.		p.u.	0.85
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.	-0.01
	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.	0.85
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.04
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.04
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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	0.142
	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

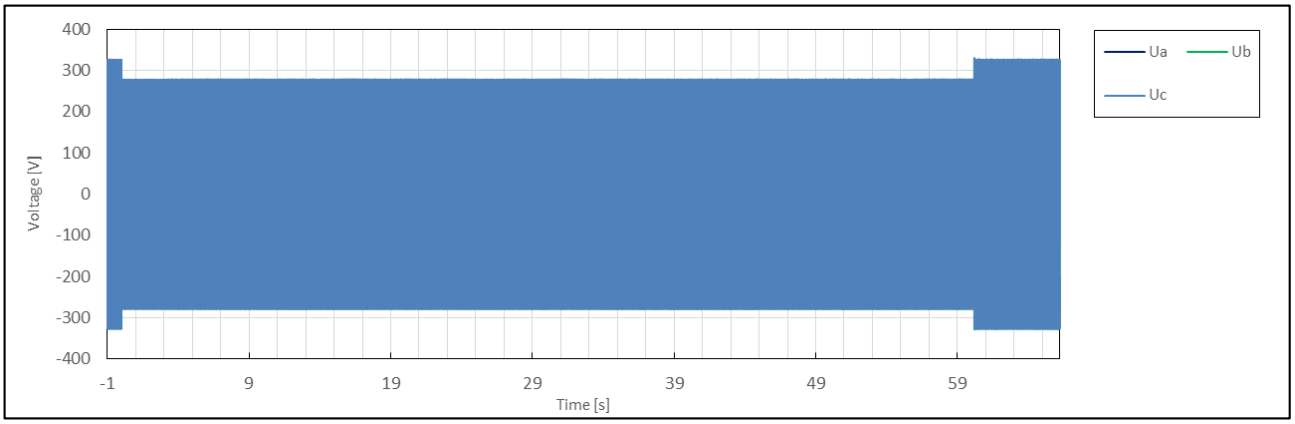
Test No. 4.2 idle test

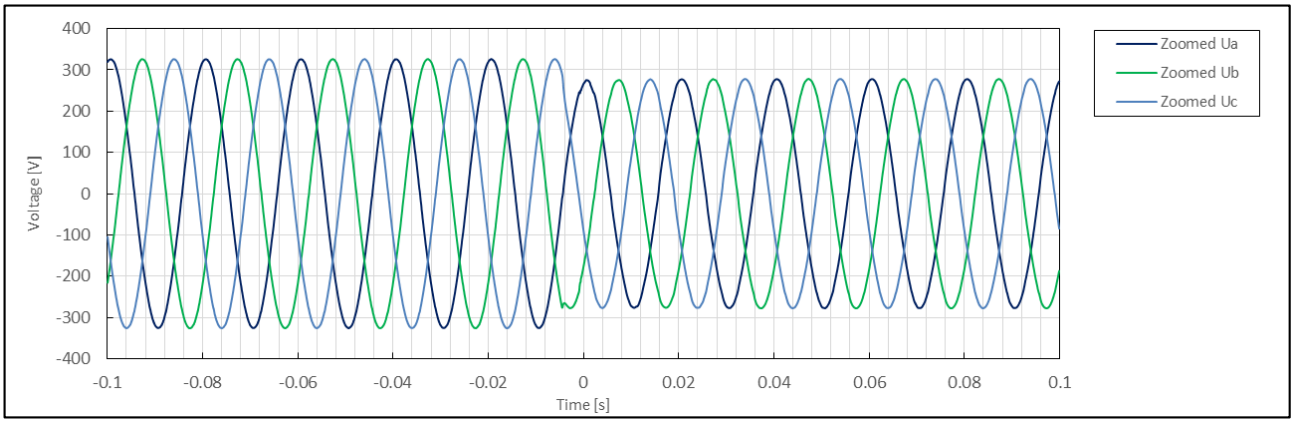


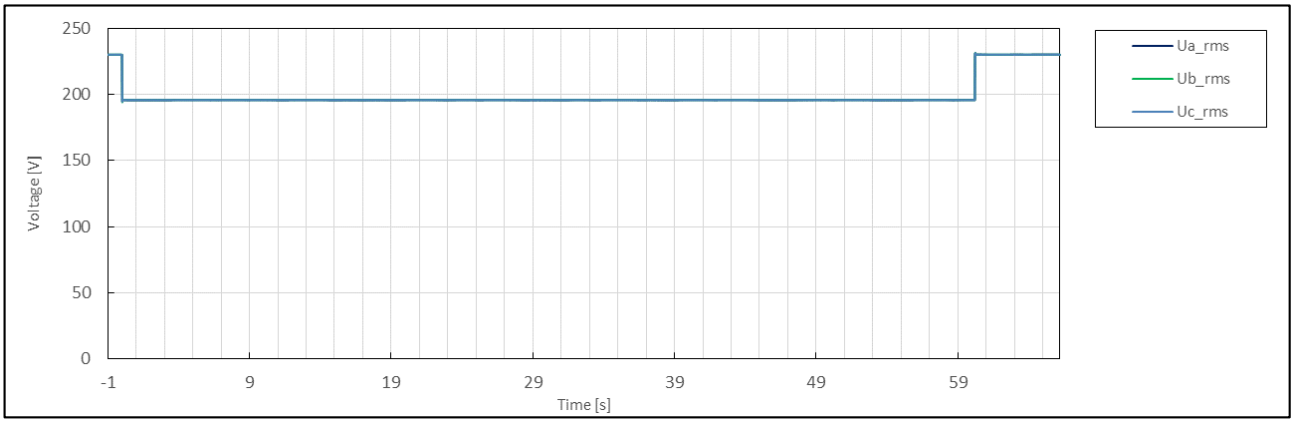


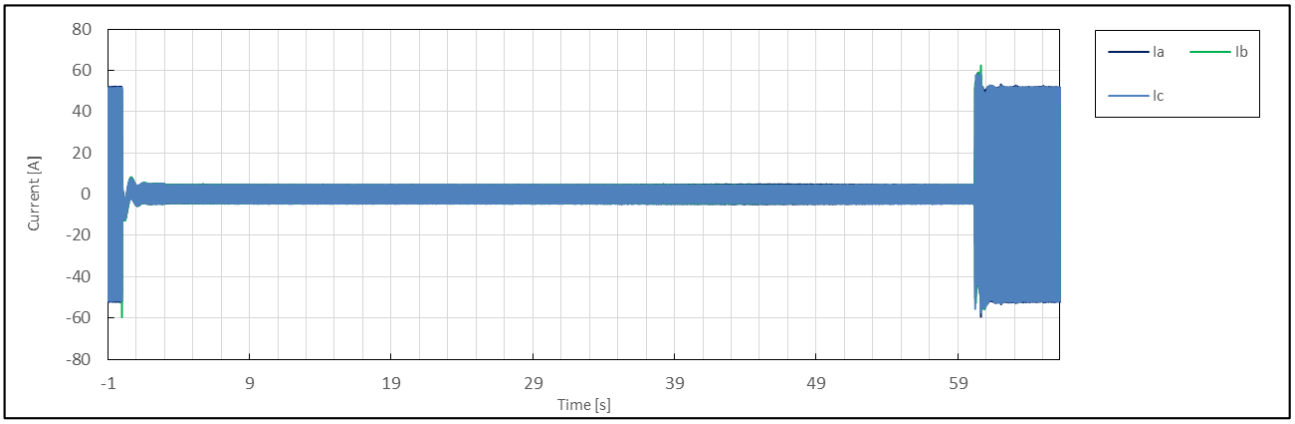


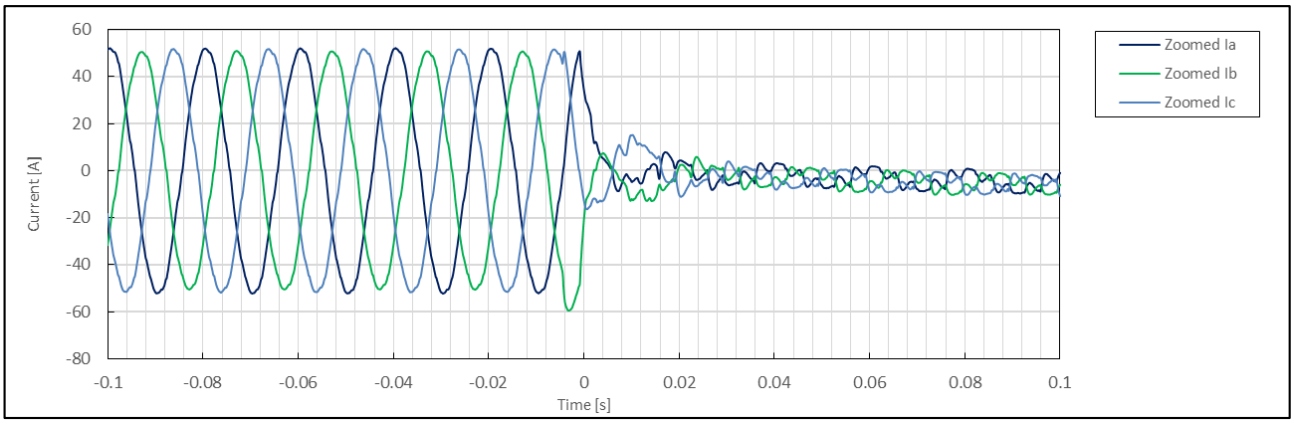
Test No. 4.2 with PGU

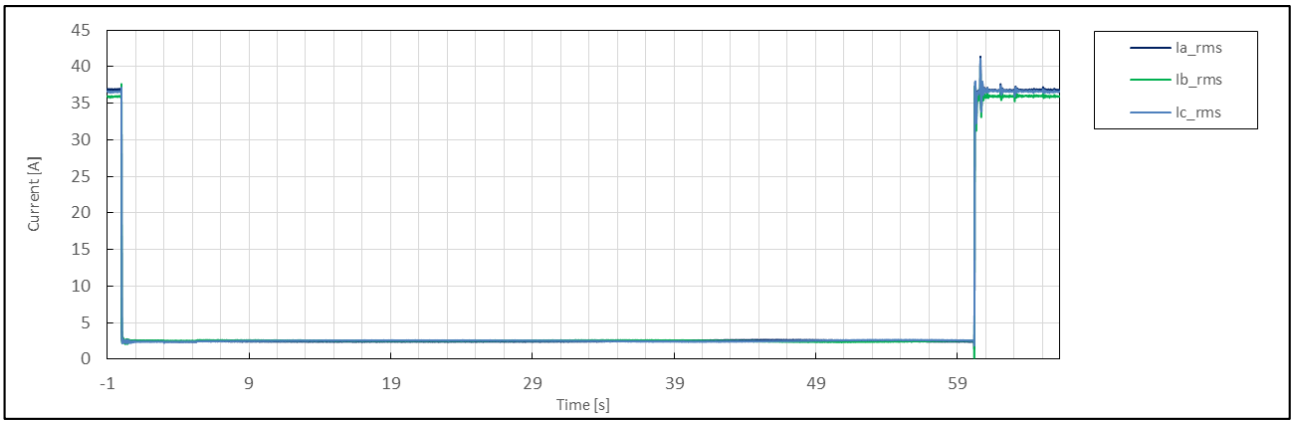


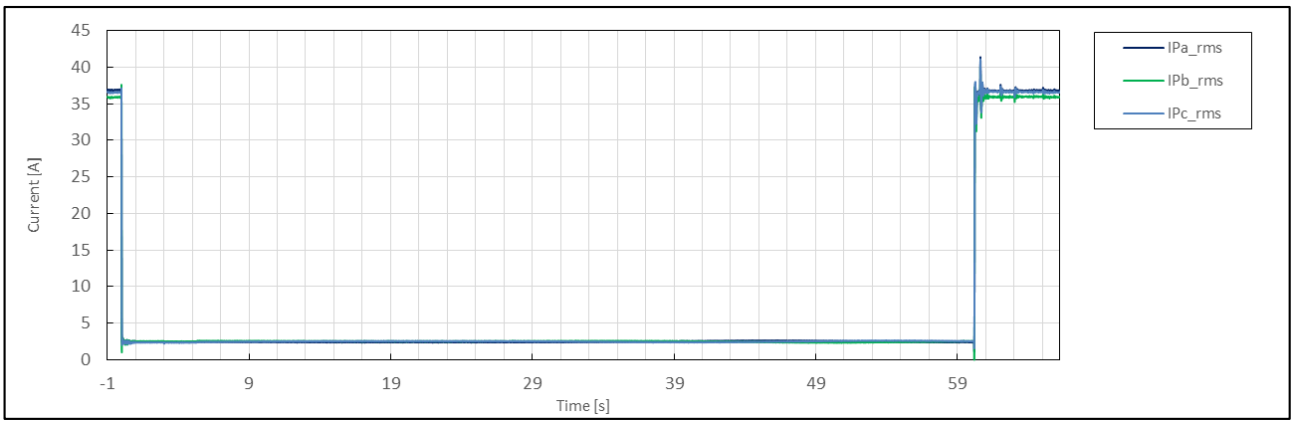


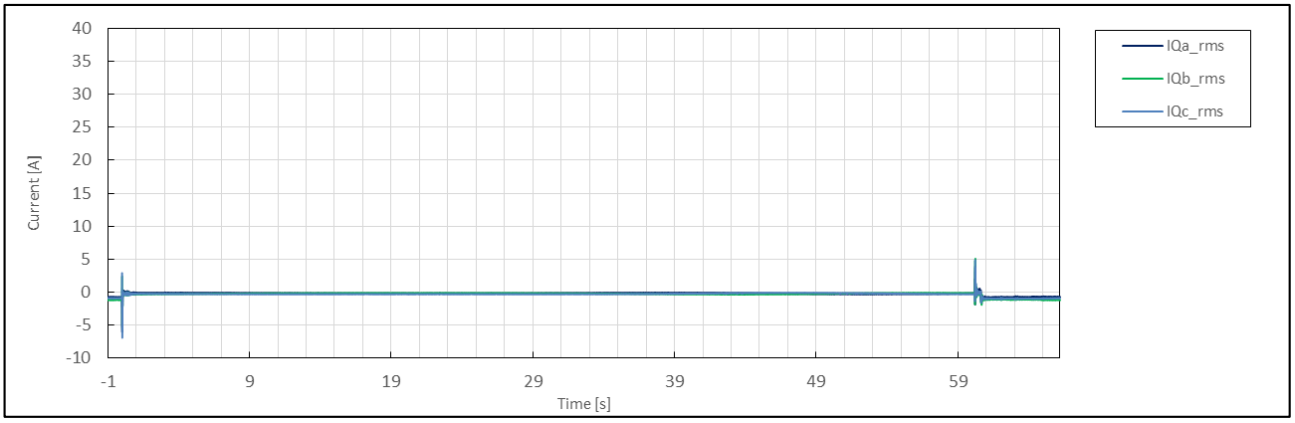


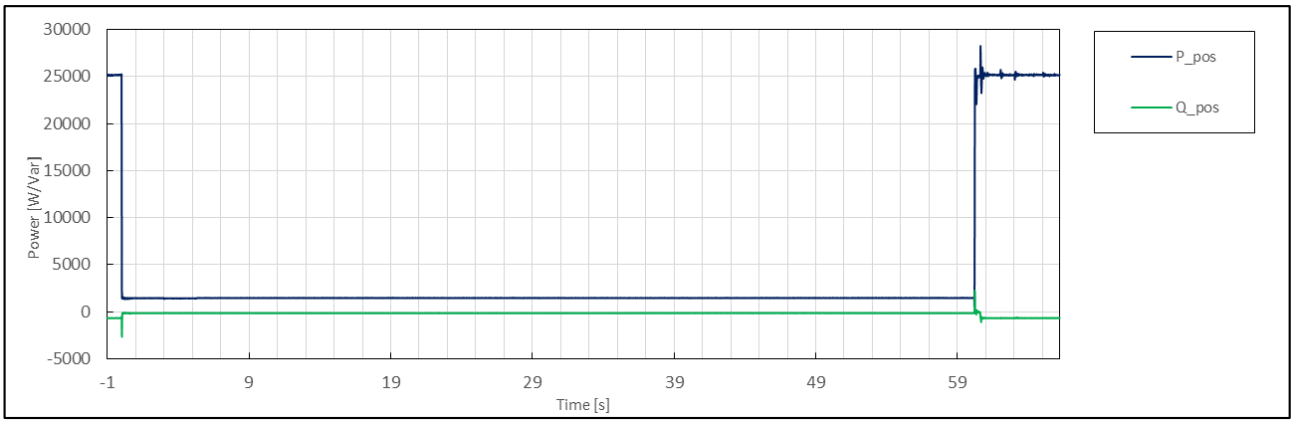


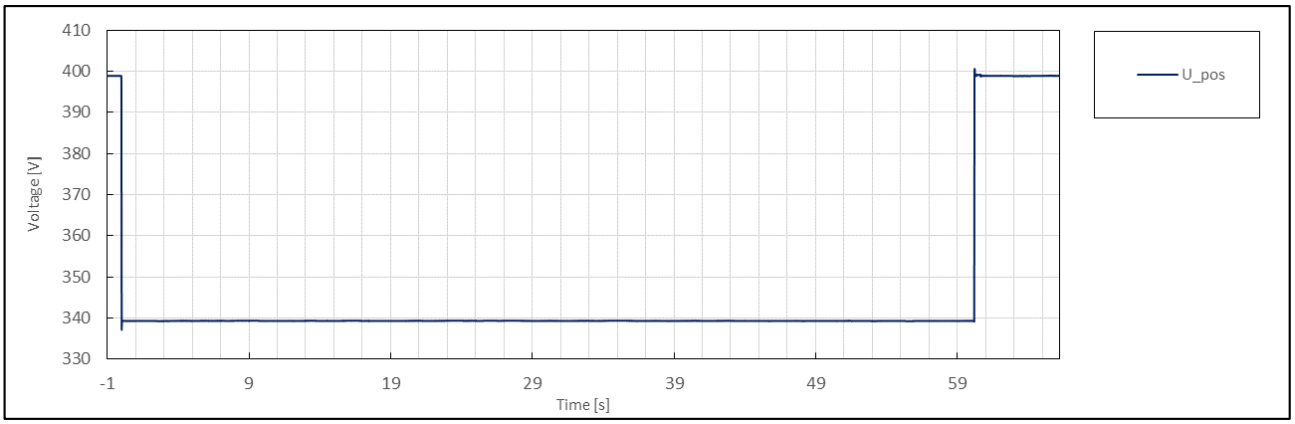

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

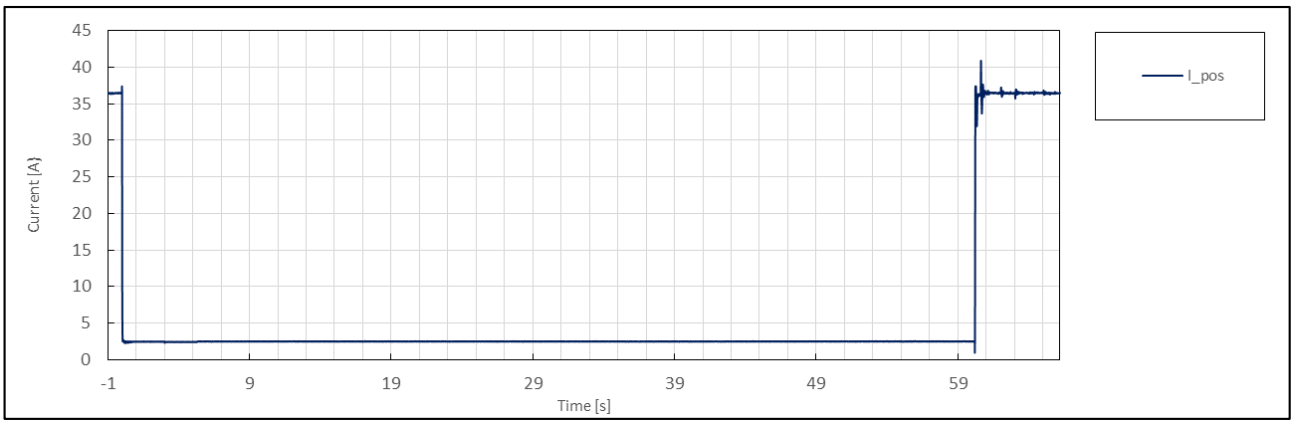

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

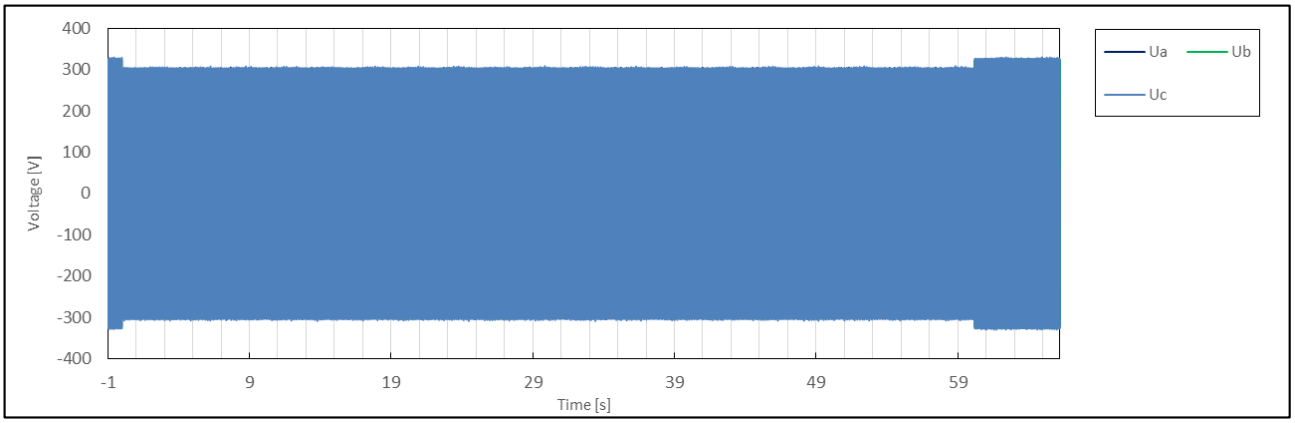

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

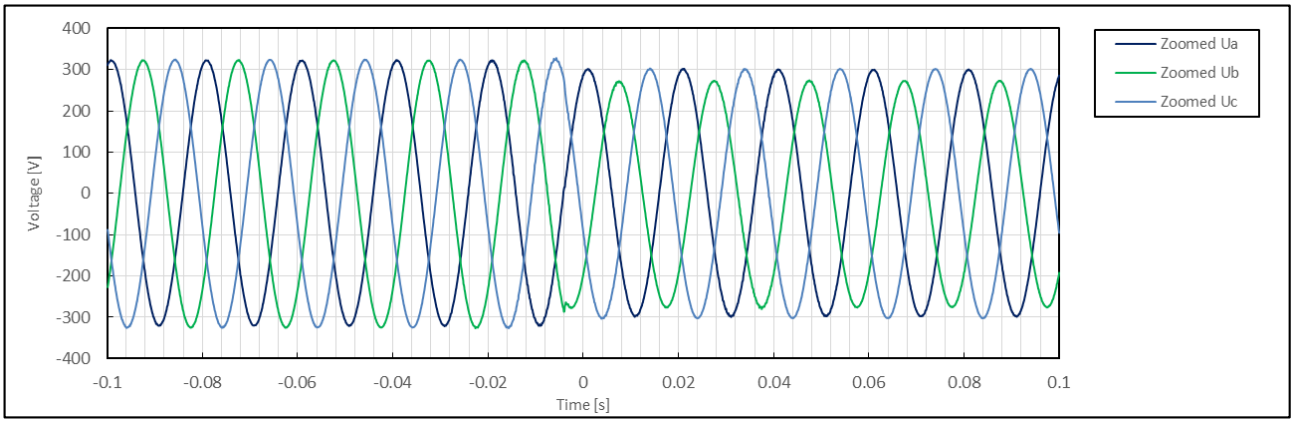

410
400
390
380
370
360
350
340
330
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

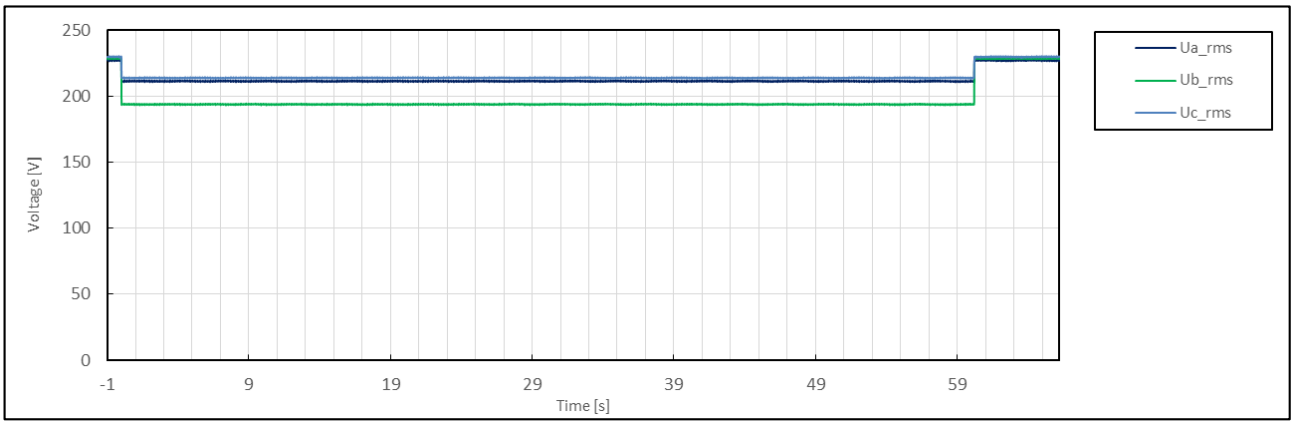

45
40
35
30
25
20
15
10
5
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	4.3
	1	Date	--	--	dd.mm.yyyy	02.16.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:39:08
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.84
	5	Setting dip duration		--		60209
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60208
	8	Fault duration in empty load test	Total	--	ms	60209
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.85
	10		Pos.		p.u.	0.90
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	0.85
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03
	21		Phase 3			0.02
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.04
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.032
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

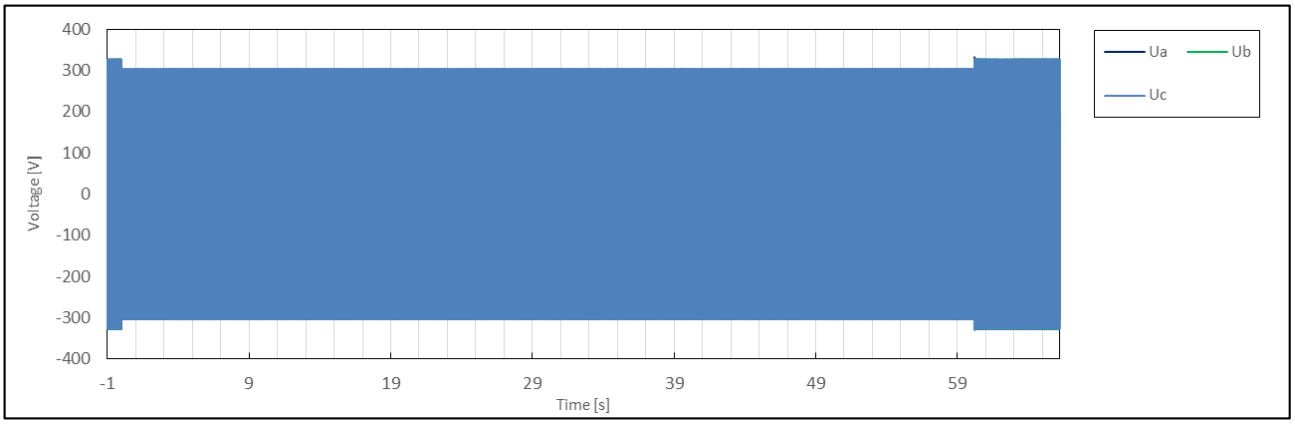
Test No. 4.3 idle test

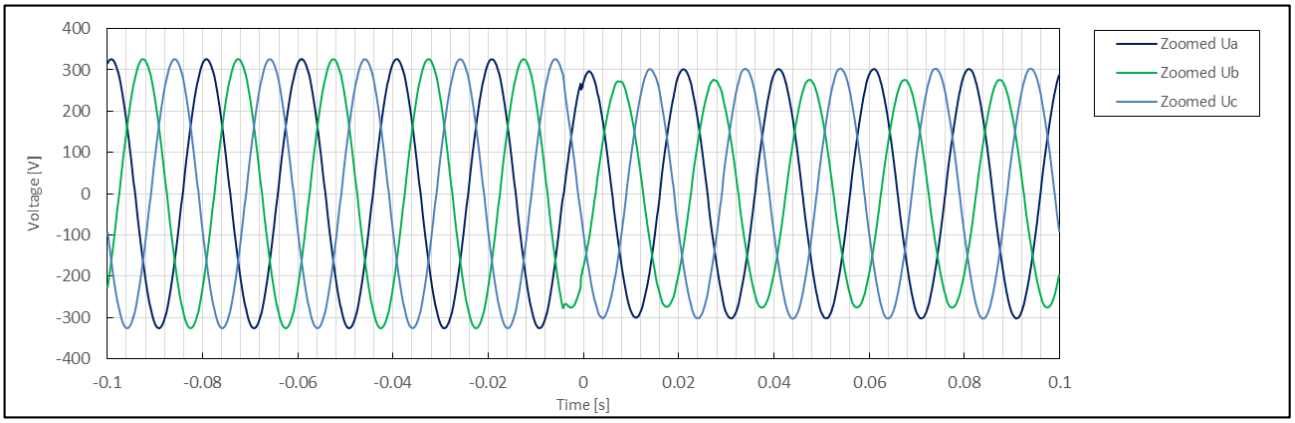


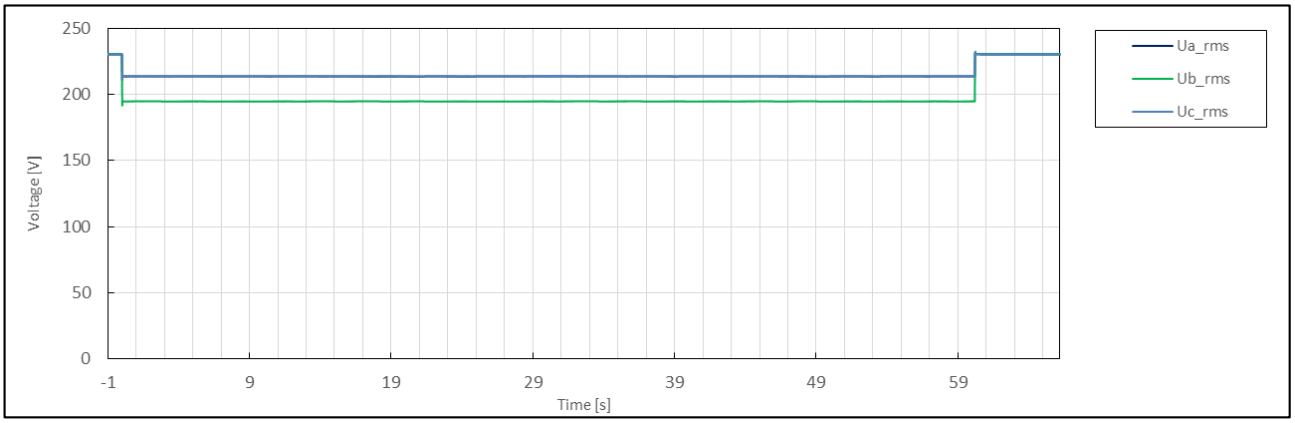


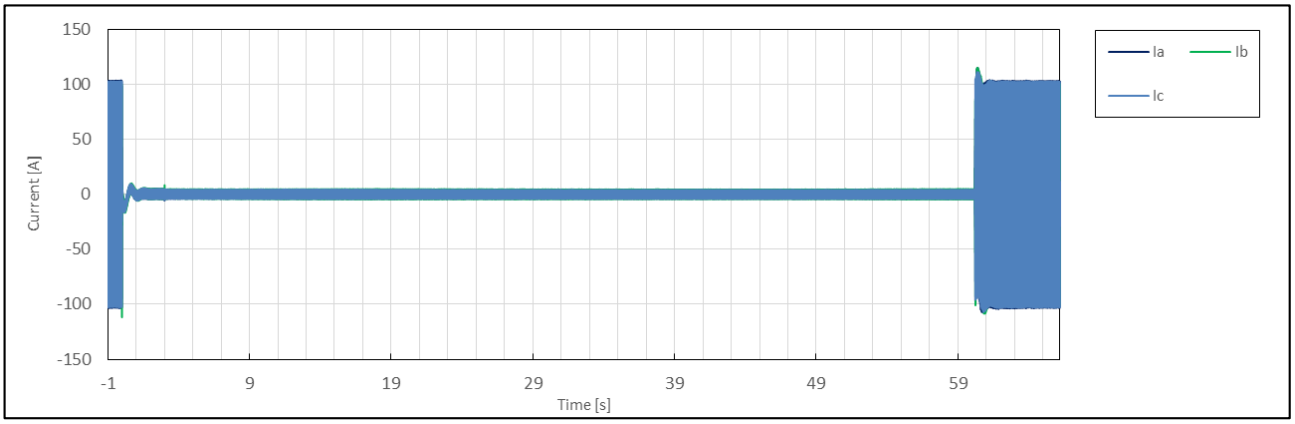


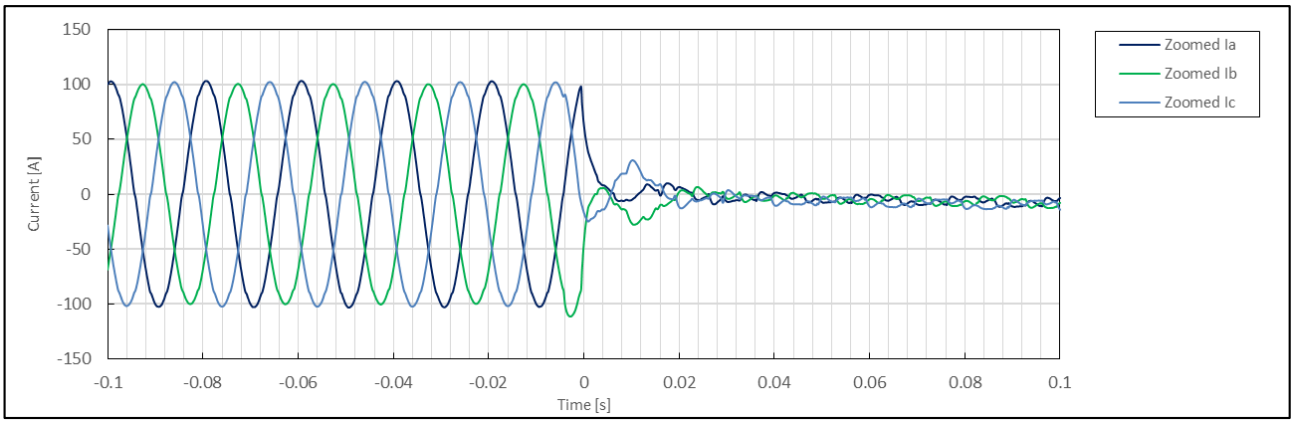
Test No. 4.3 with PGU

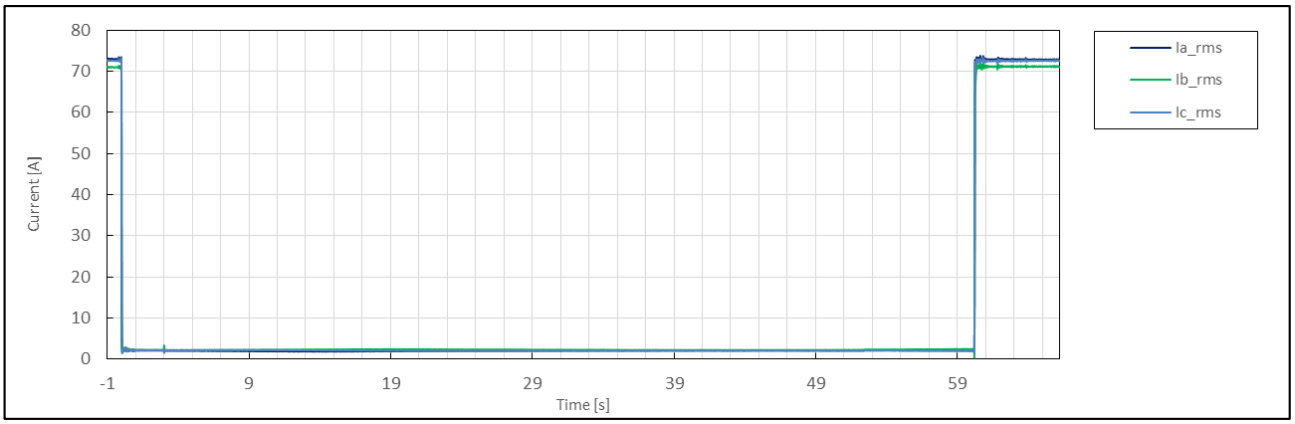


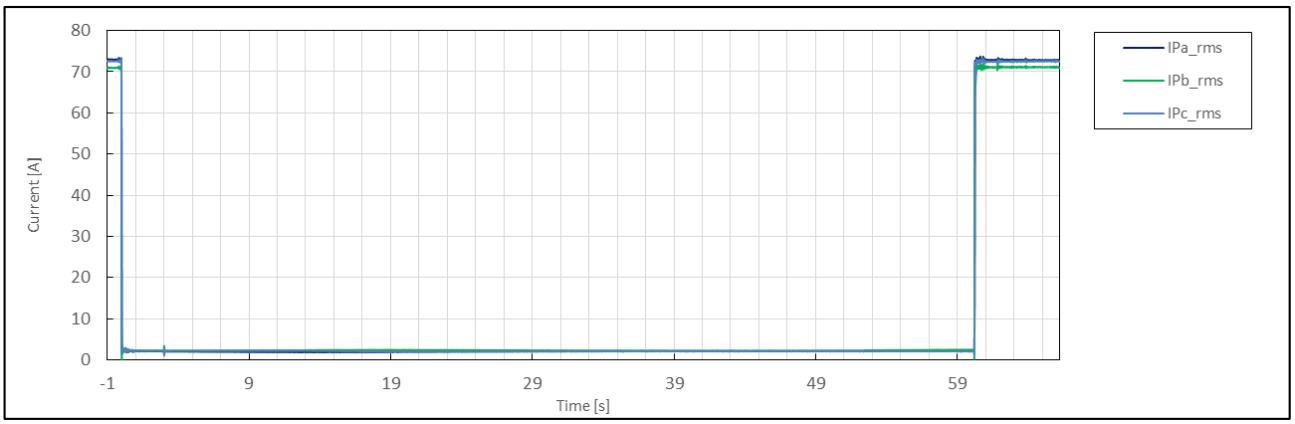


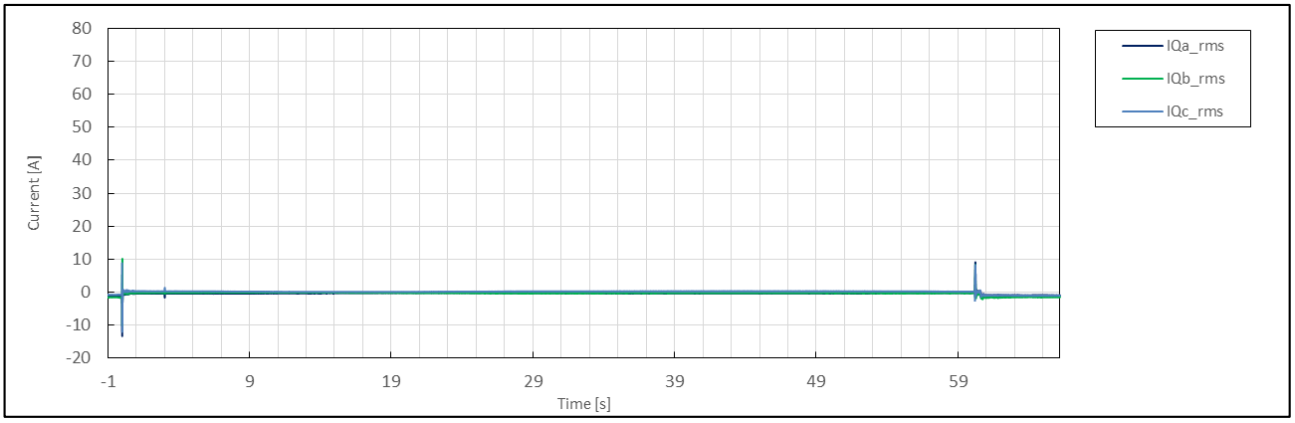


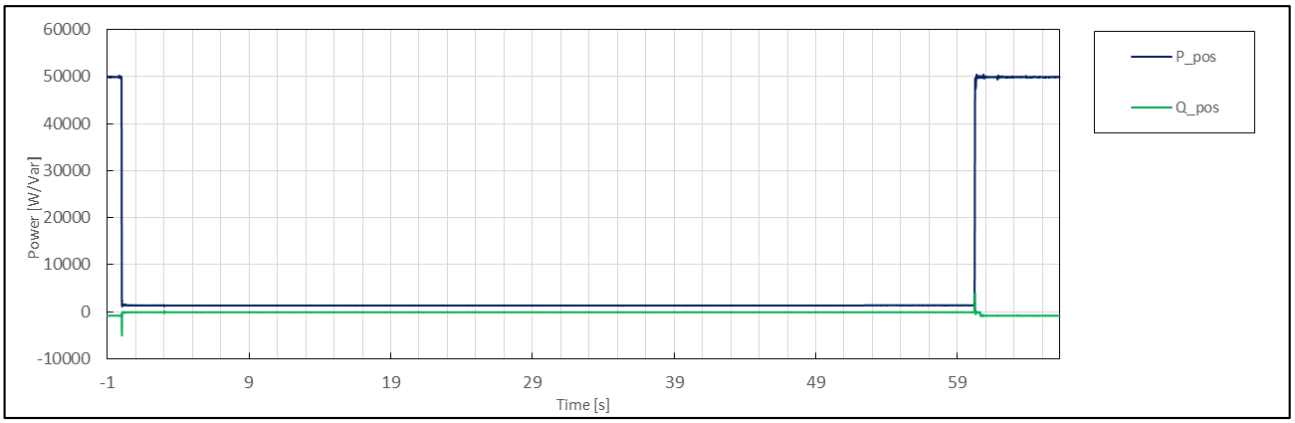


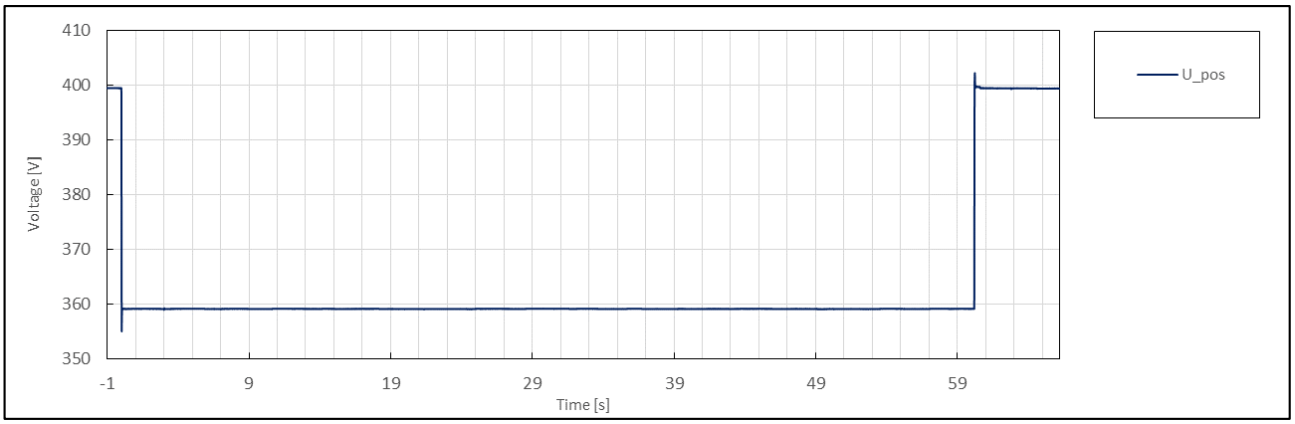

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

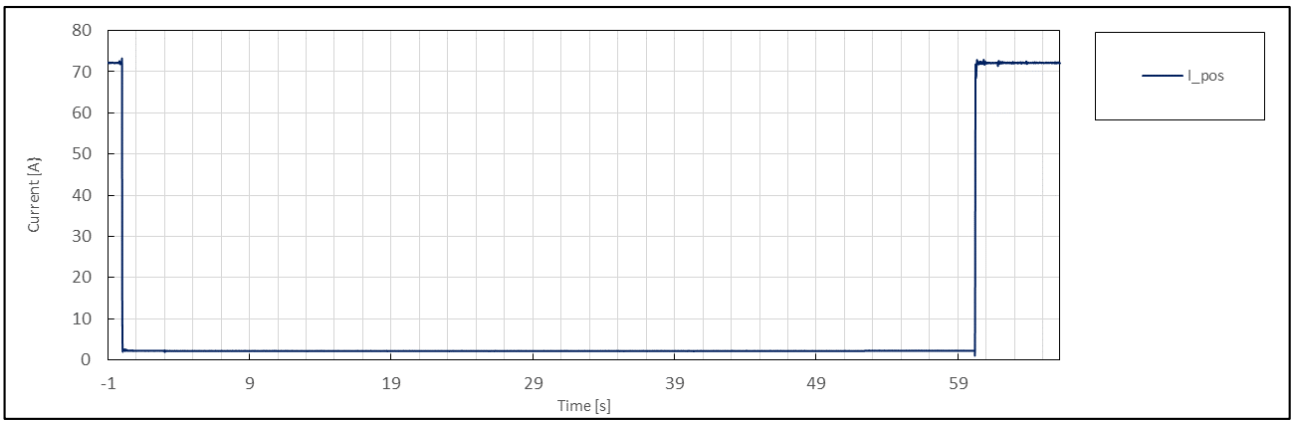

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

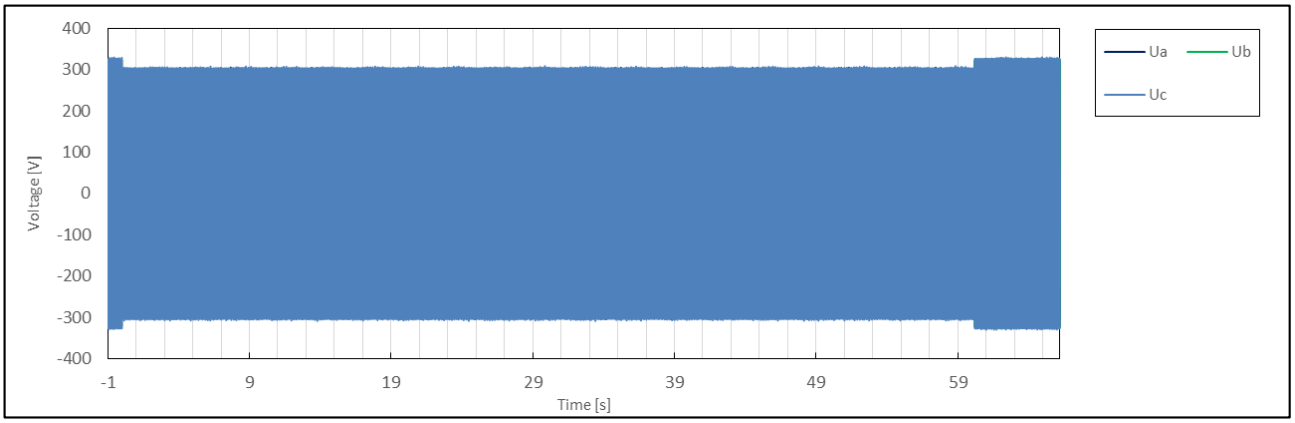

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

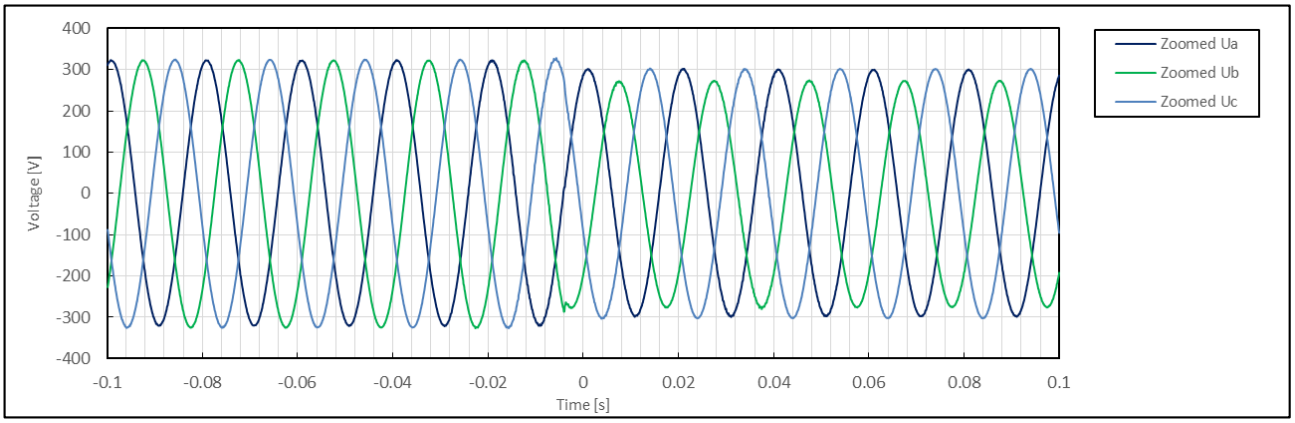

410
400
390
380
370
360
350
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

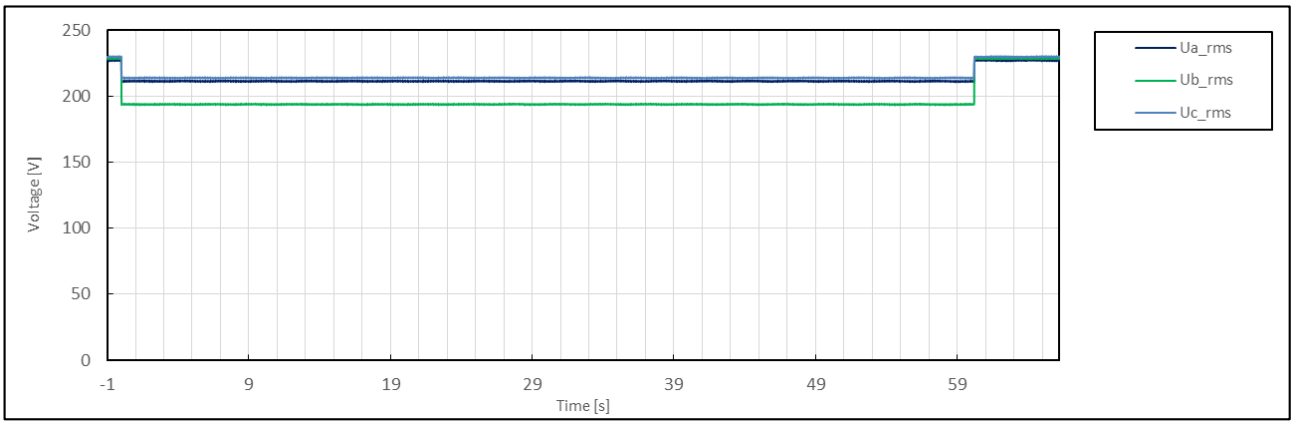

80
70
60
50
40
30
20
10
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	4.4
	1	Date	--	--	dd.mm.yyyy	02.16.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:39:36
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	0.84
	5	Setting dip duration		--		60209
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60208
	8	Fault duration in empty load test	Total	--	ms	60209
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	0.85
	10		Pos.		p.u.	0.90
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.	-0.01
	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.	0.85
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.04
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.04
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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	0.144
	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

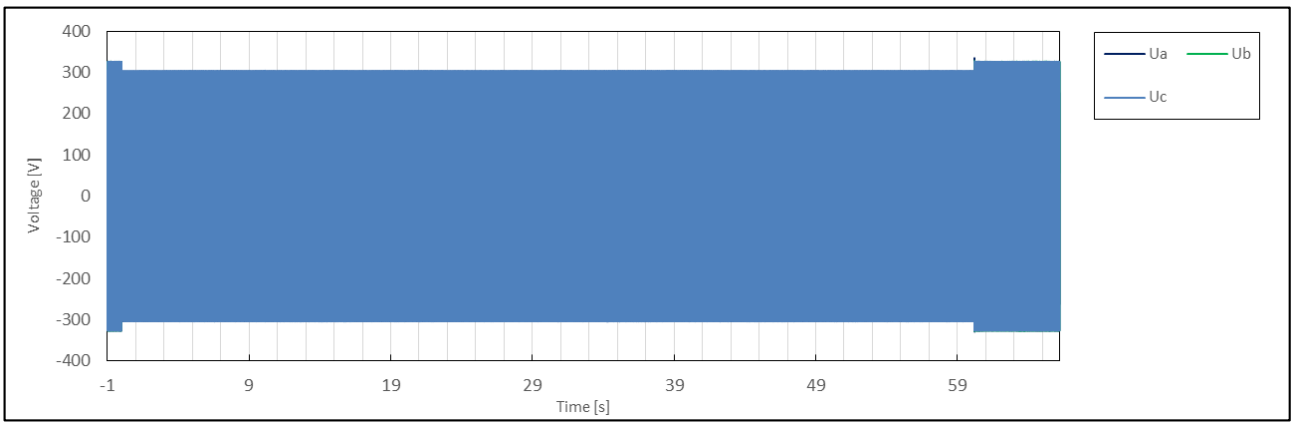
Test No. 4.4 idle test

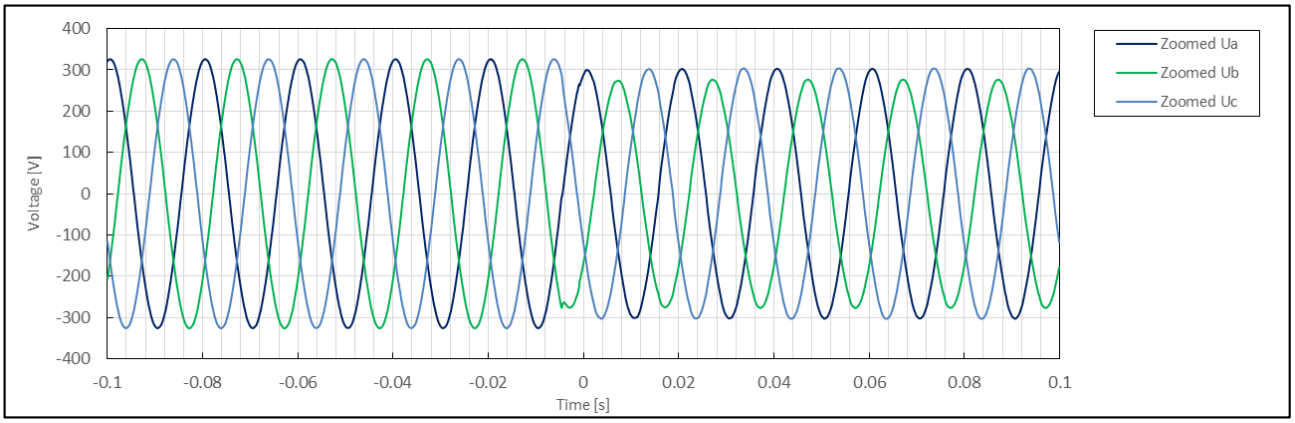


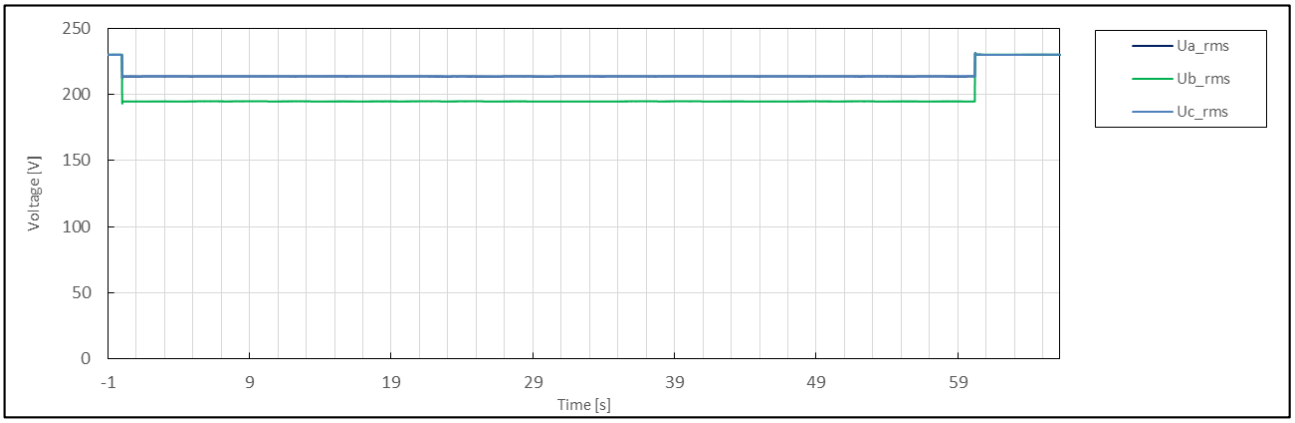


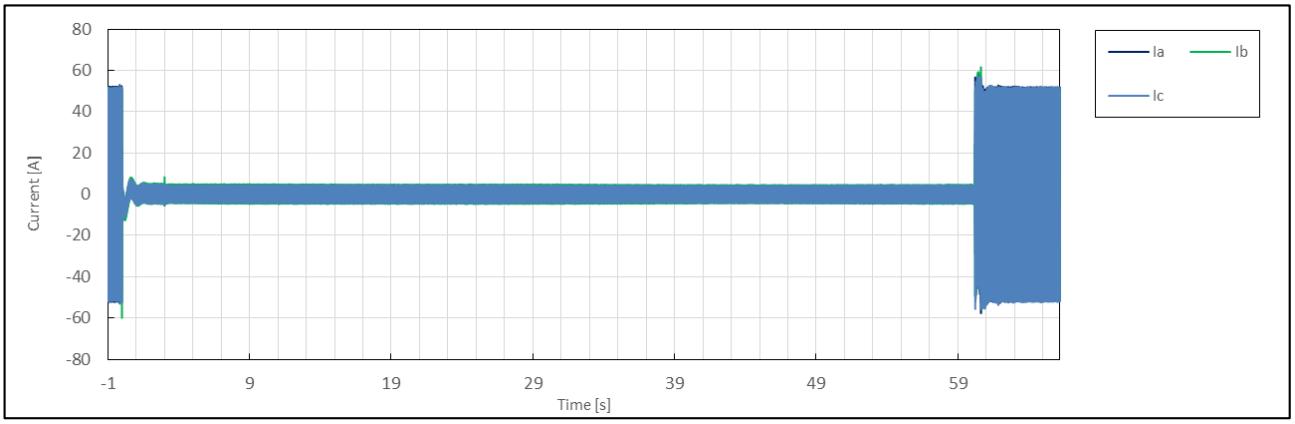


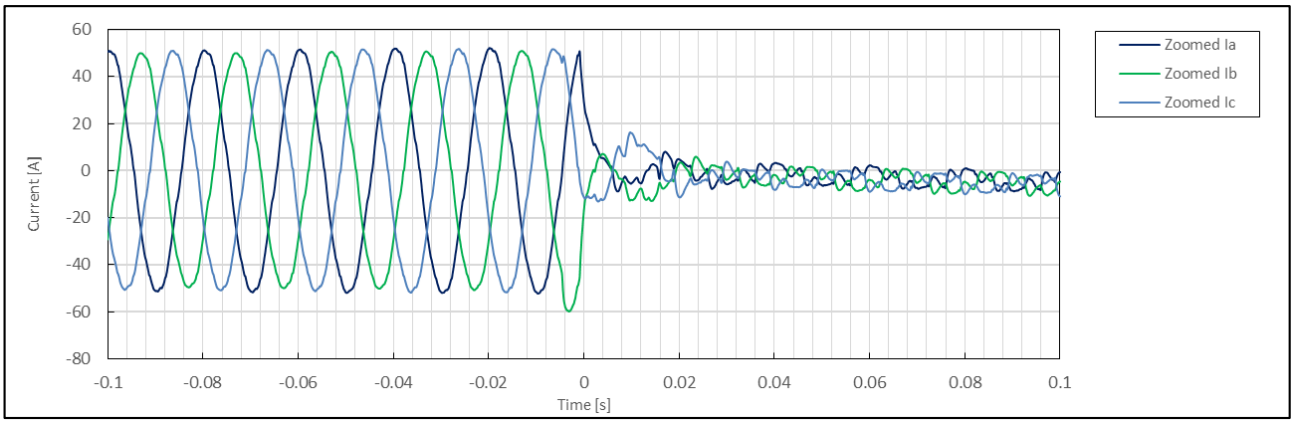
Test No. 4.4 with PGU

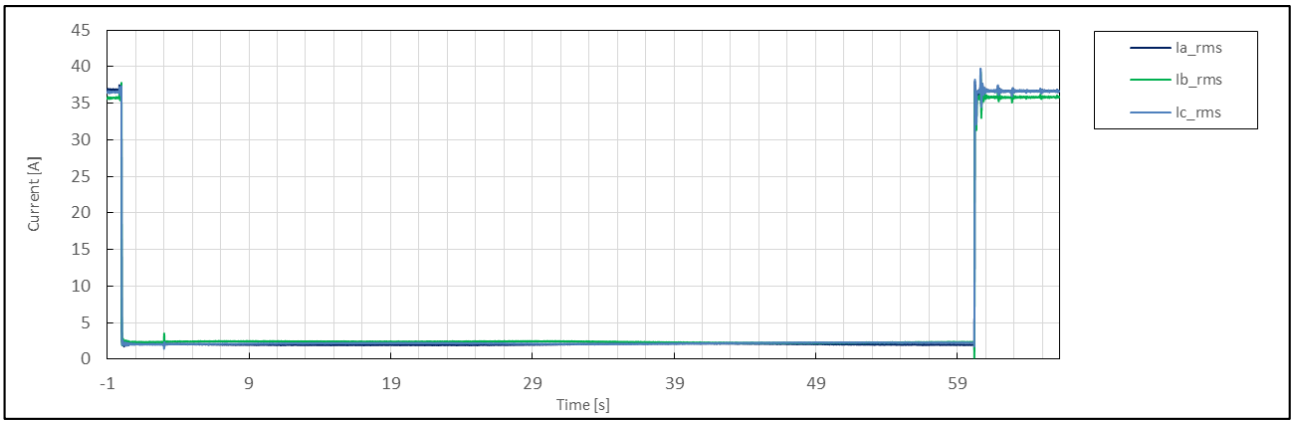


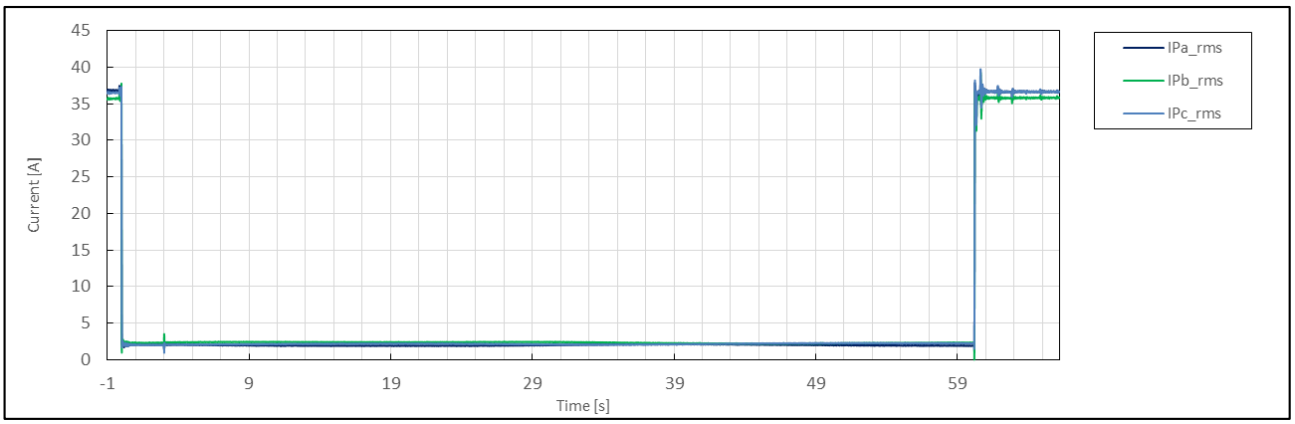


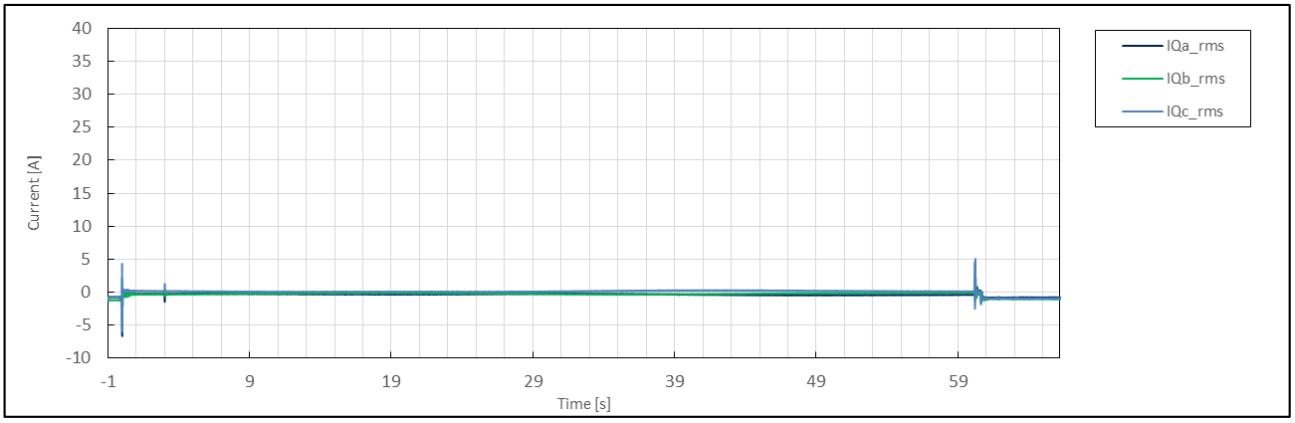


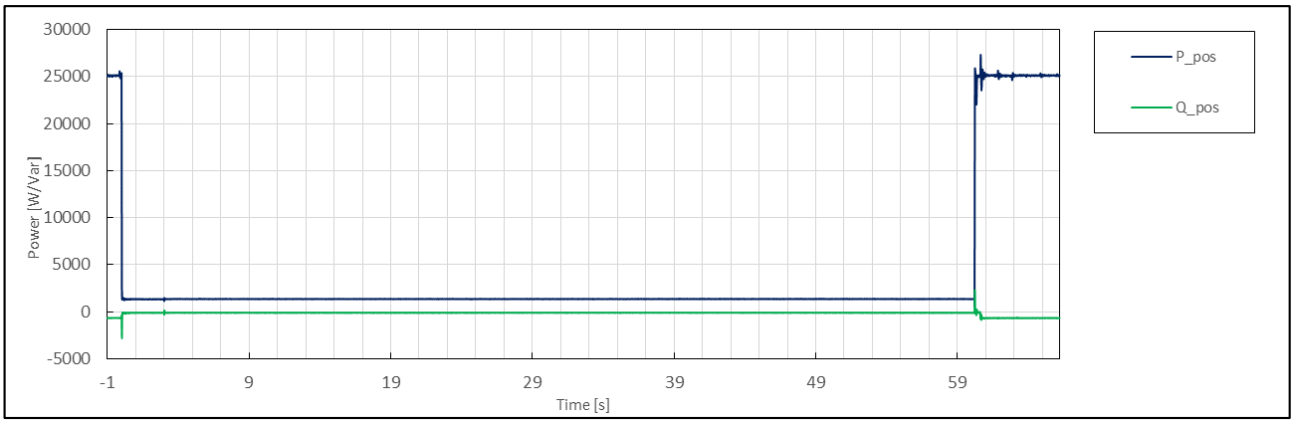


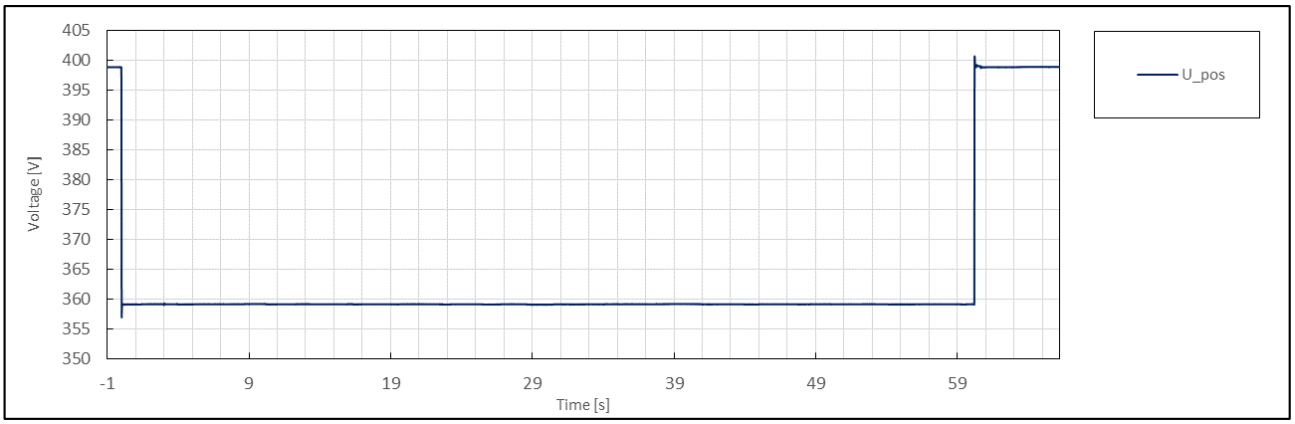

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

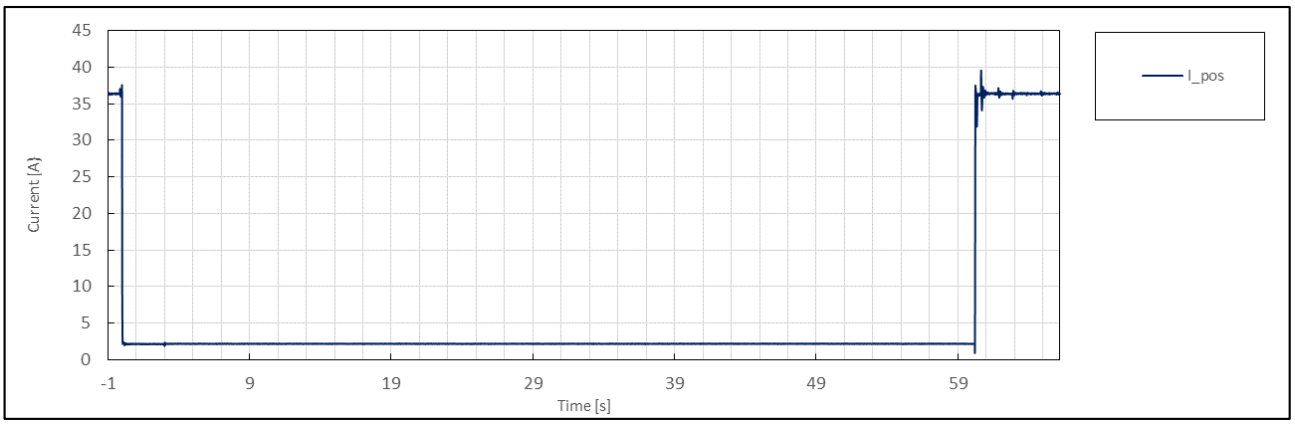

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

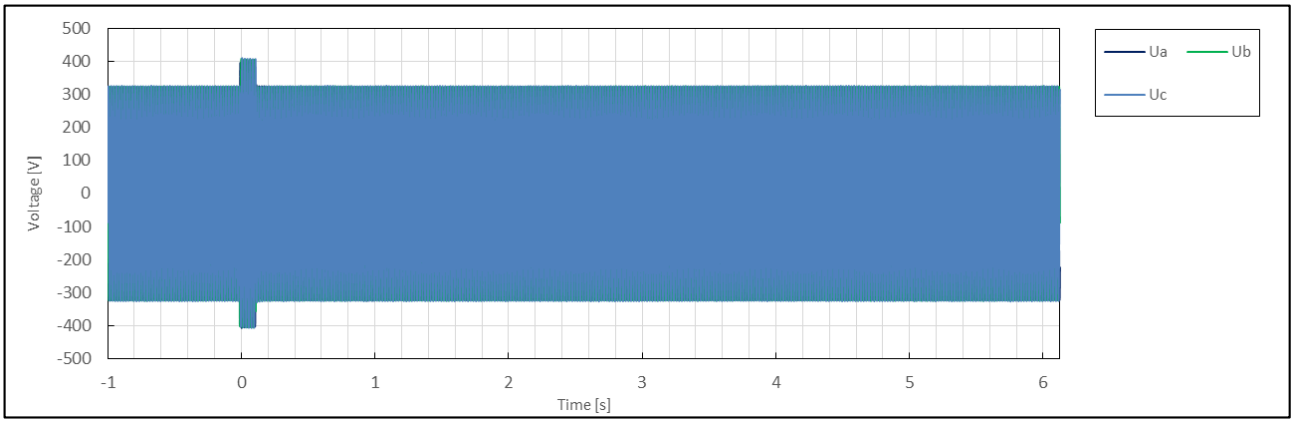

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

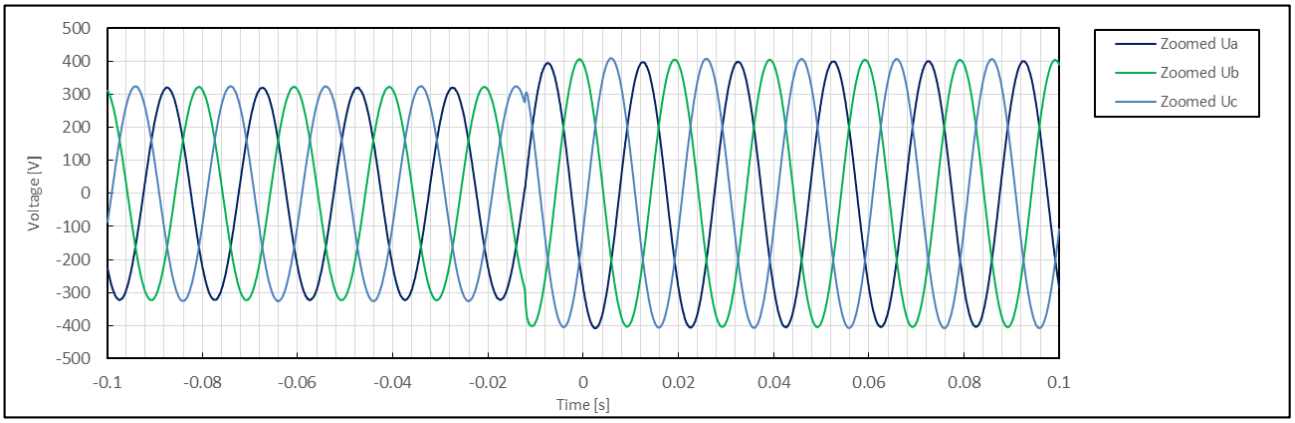

405
400
395
390
385
380
375
370
365
360
355
350
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

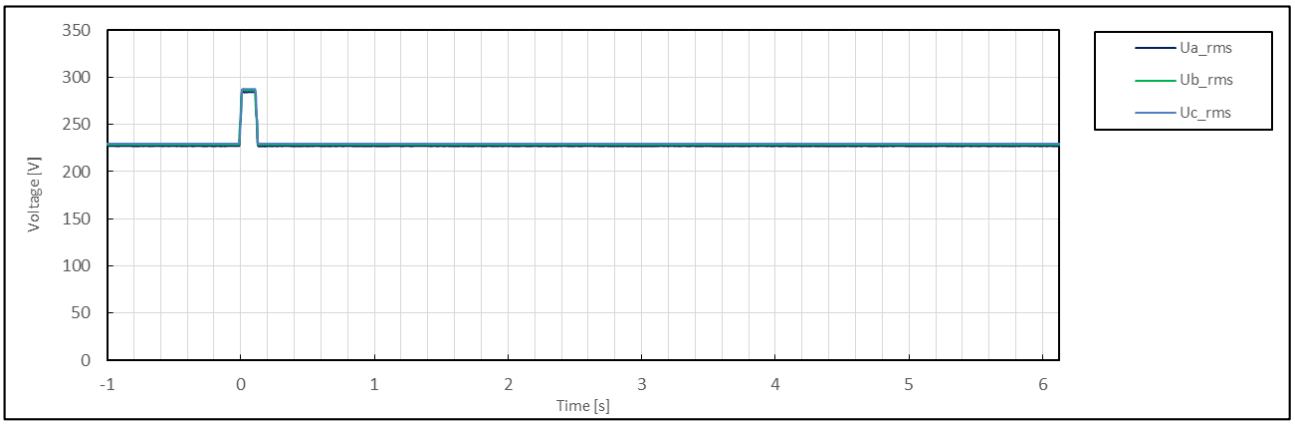

45
40
35
30
25
20
15
10
5
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.1
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:46:08
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.25
	5	Setting dip duration		--		125
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	124
	8	Fault duration in empty load test	Total	--	ms	125
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.25
	10		Pos.		p.u.	1.25
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.25
	19	Line current	Phase 1	t1+60ms	p.u.	0.02
	20		Phase 2			0.02
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.02
	23		Phase 2			0.02
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.080
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

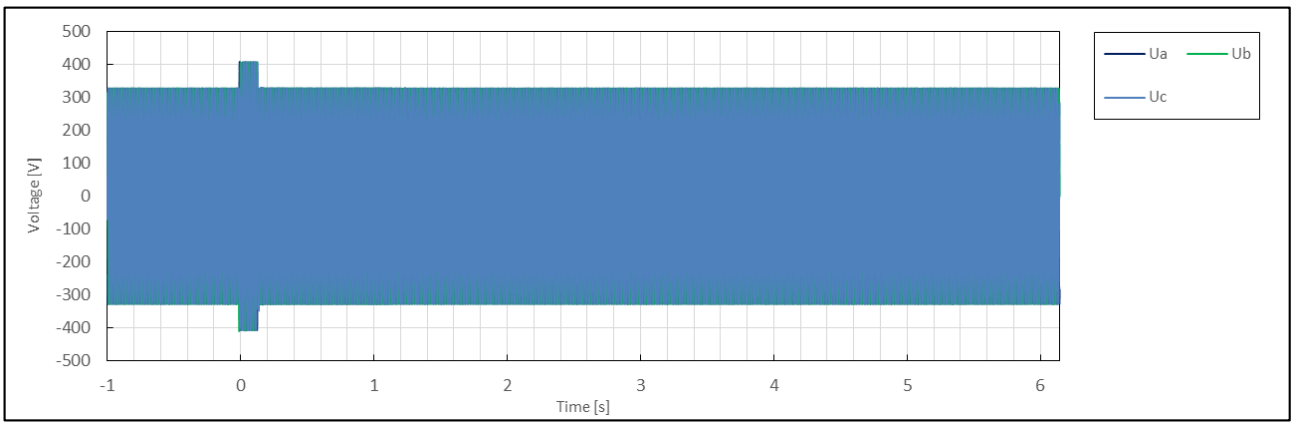
Test No. 5.1 idle test

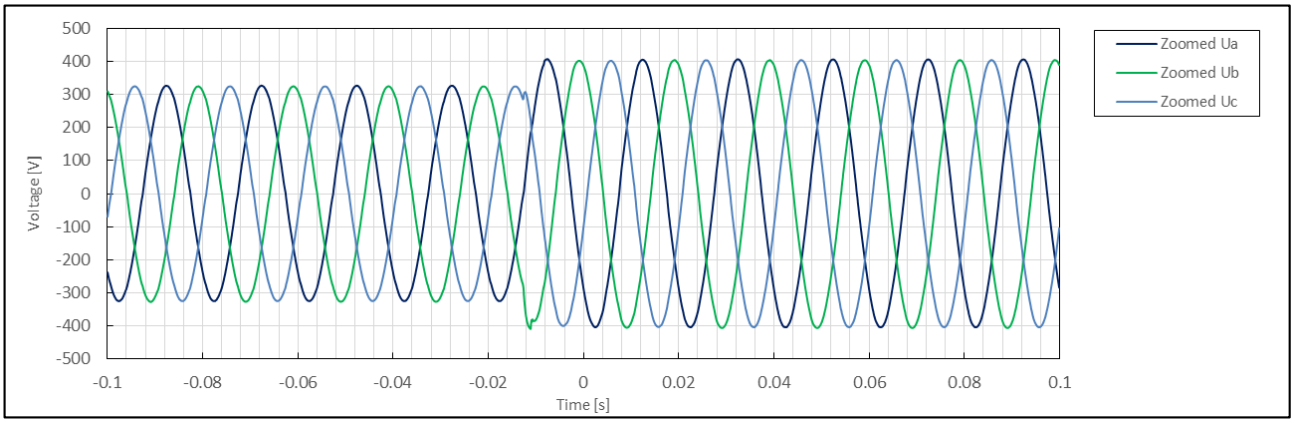


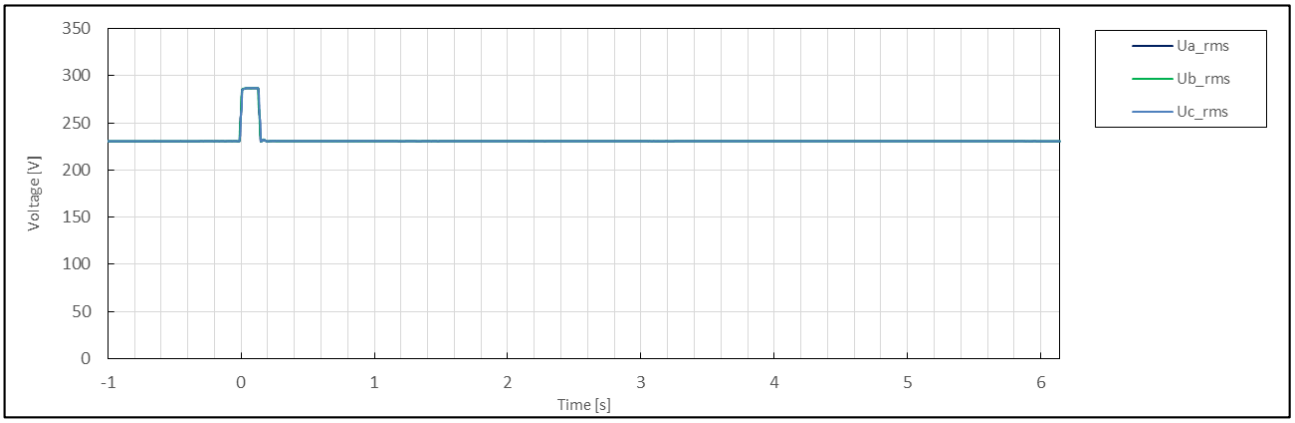


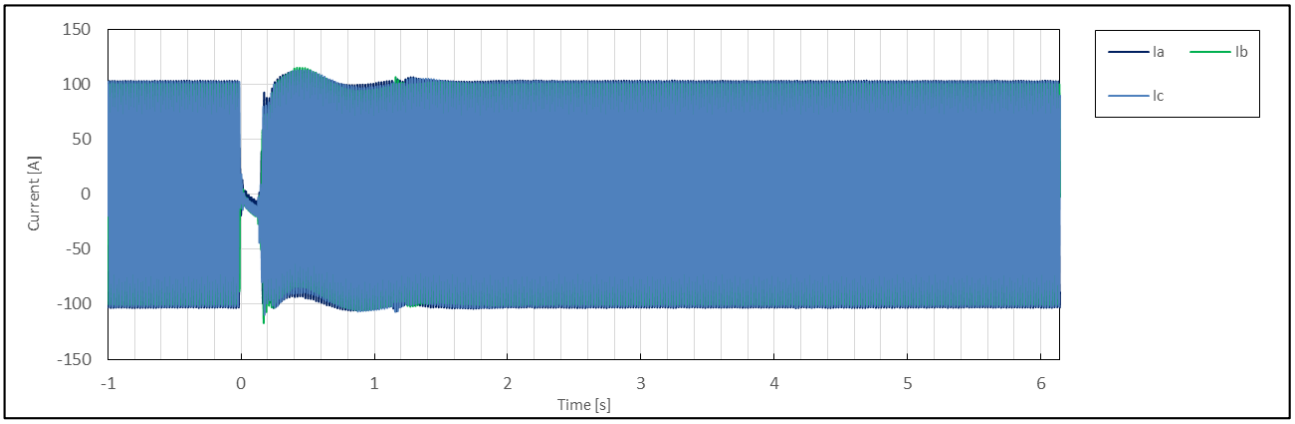


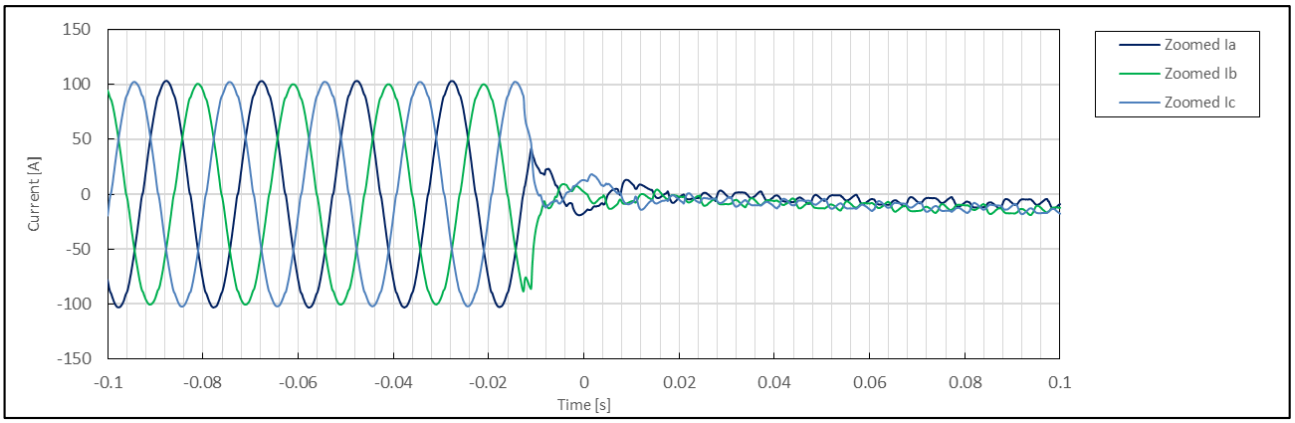
Test No. 5.1 with PGU

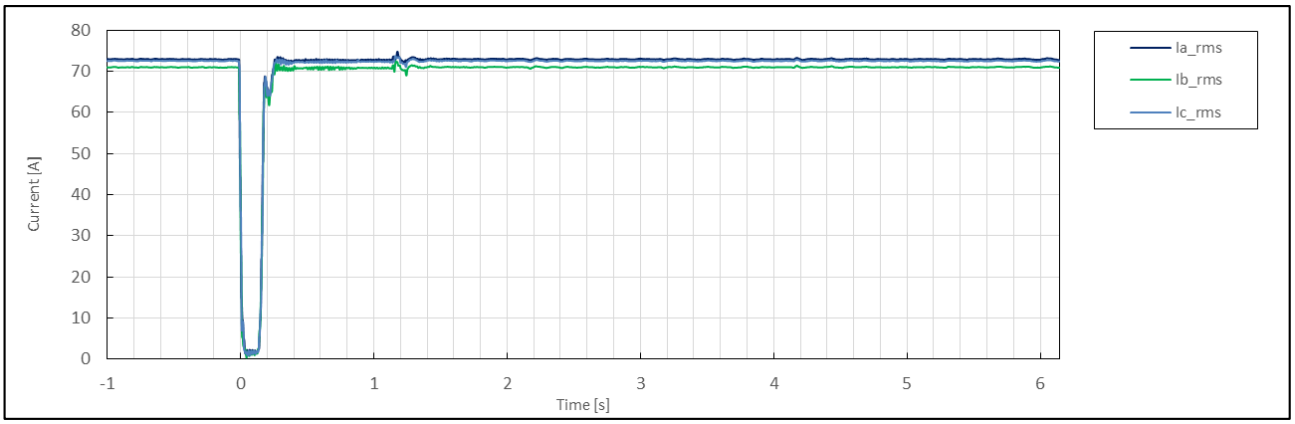


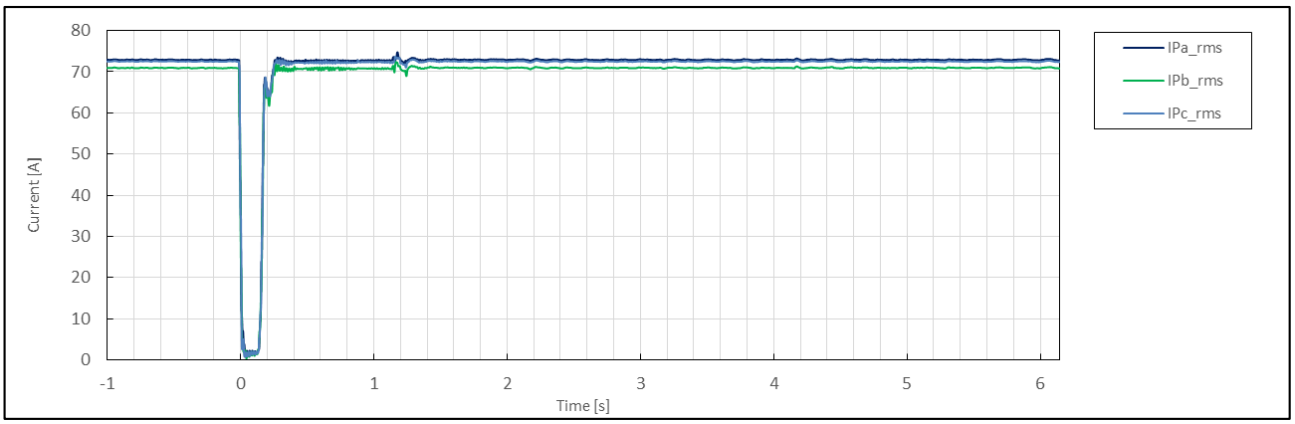


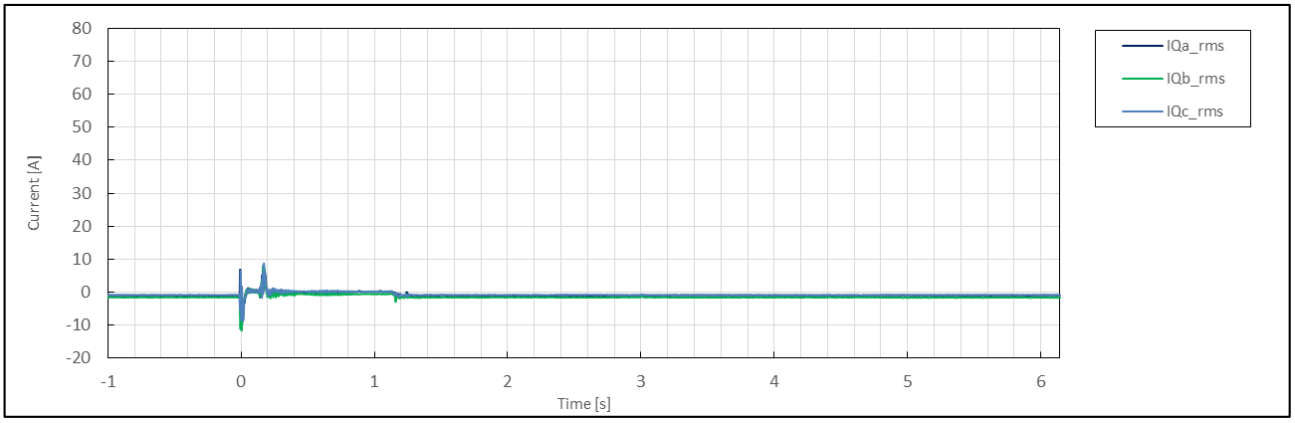


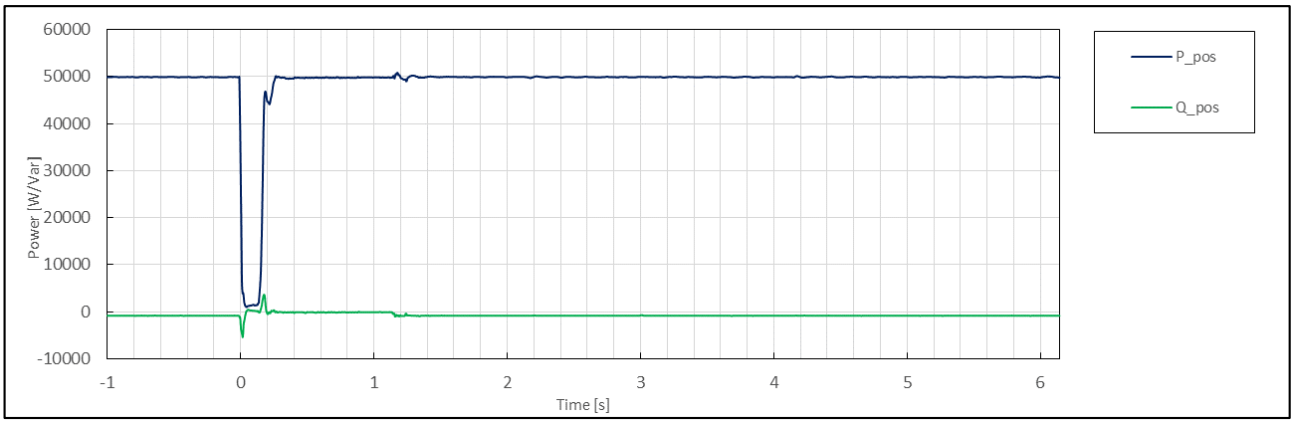


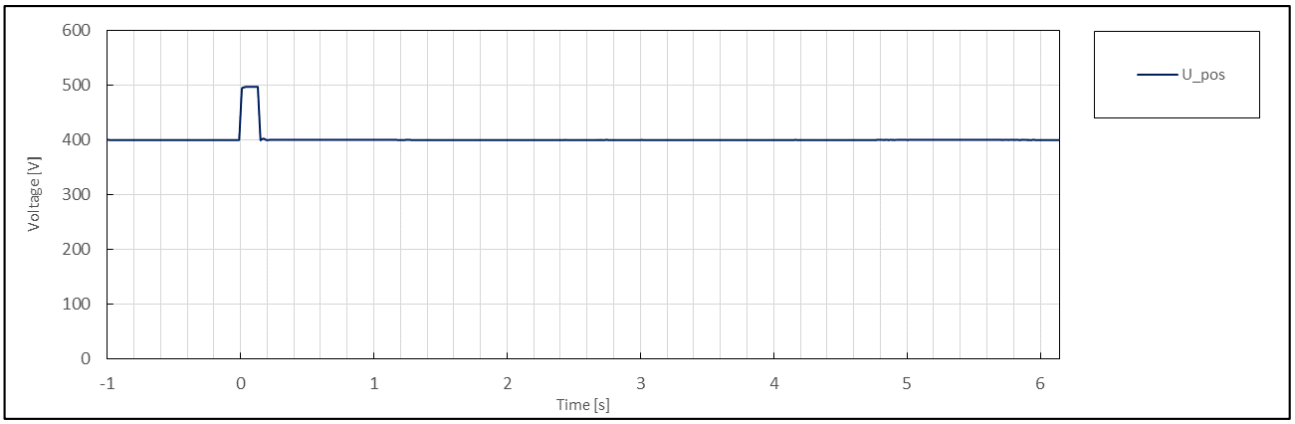

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

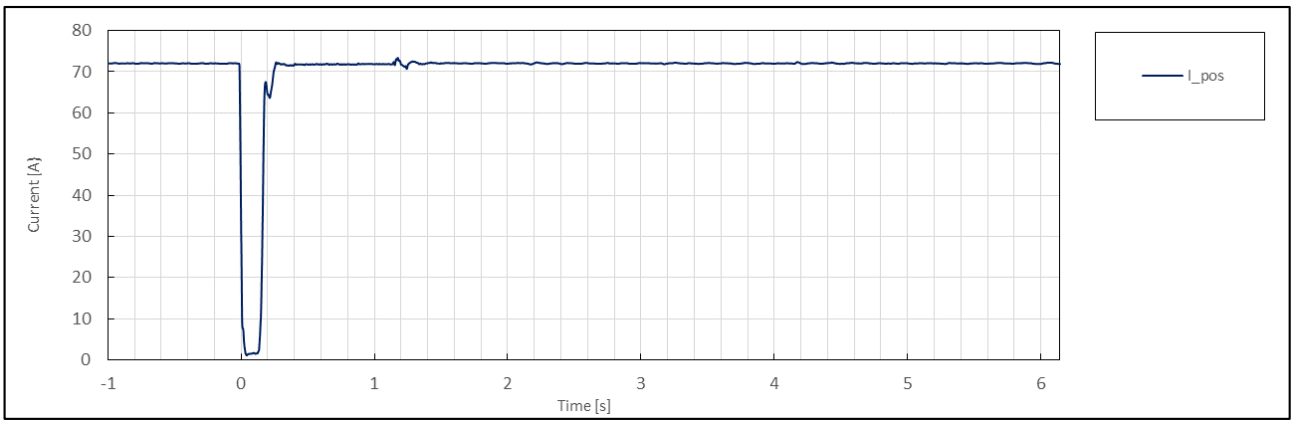

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

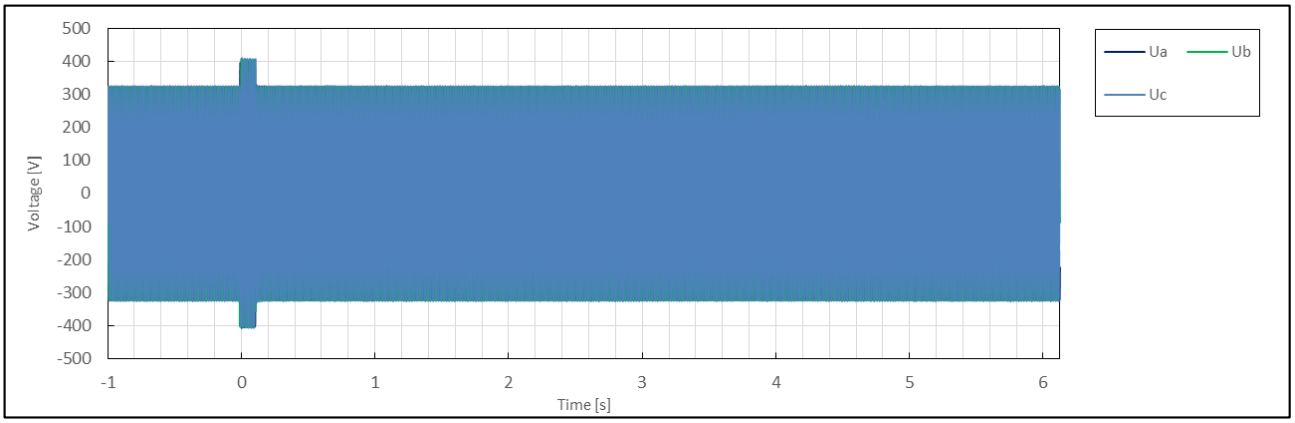

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

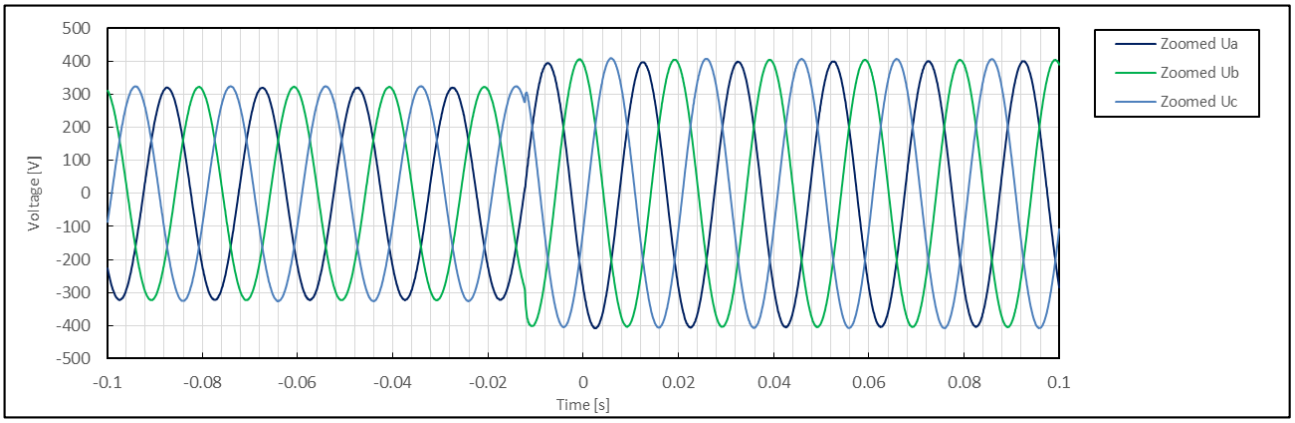

600
500
400
300
200
100
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

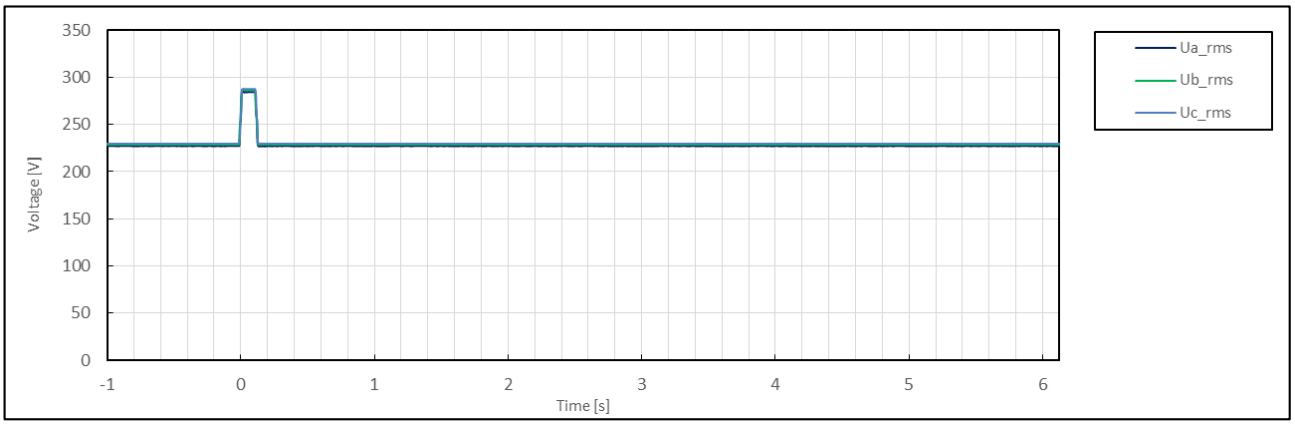

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.2
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:45:50
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.25
	5	Setting dip duration		--		125
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	124
	8	Fault duration in empty load test	Total	--	ms	125
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.25
	10		Pos.		p.u.	1.25
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.	-0.01
	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.	1.25
	19	Line current	Phase 1	t1+60ms	p.u.	0.02
	20		Phase 2			0.02
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.02
	23		Phase 2			0.02
	24		Phase 3			0.02
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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	0.137
	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

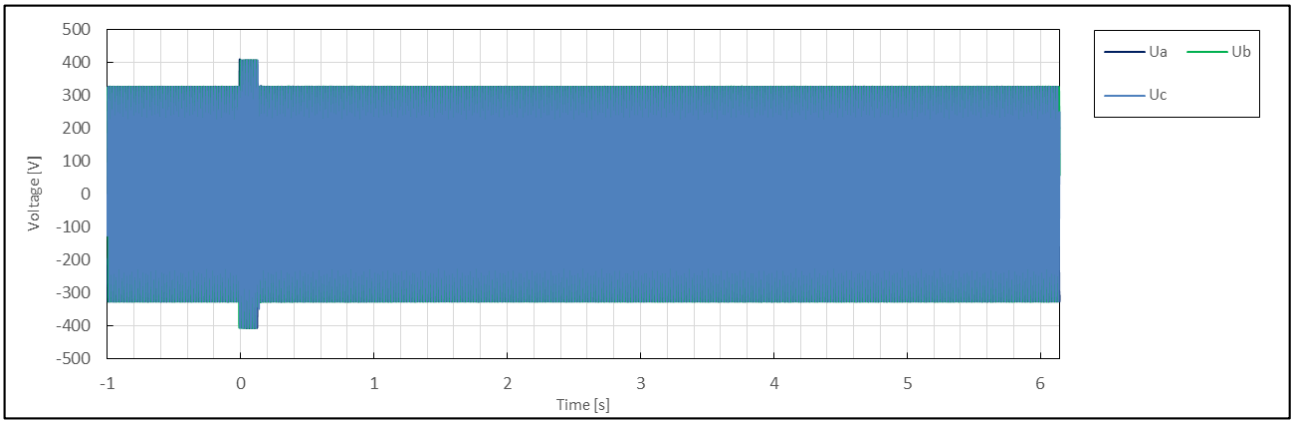
Test No. 5.2 idle test

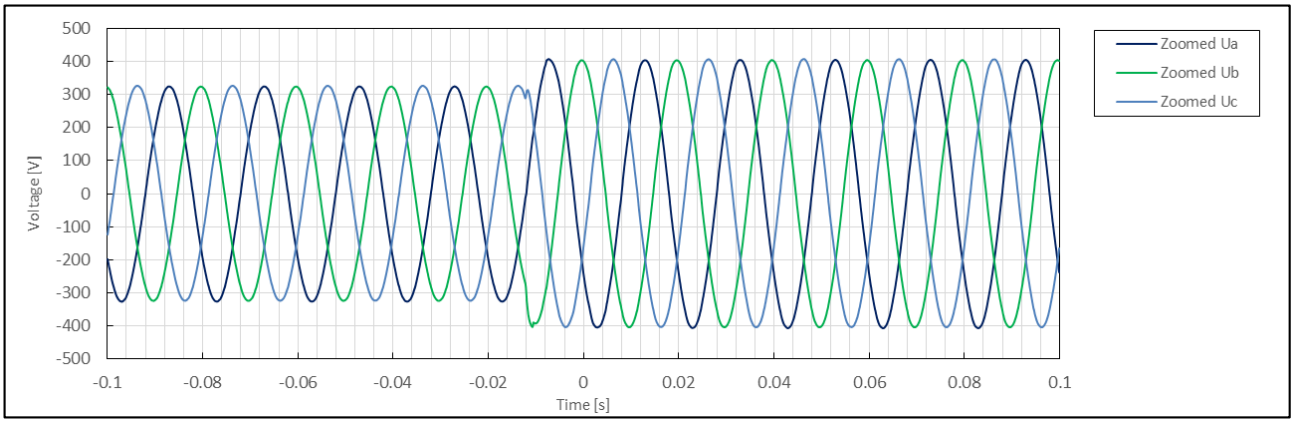


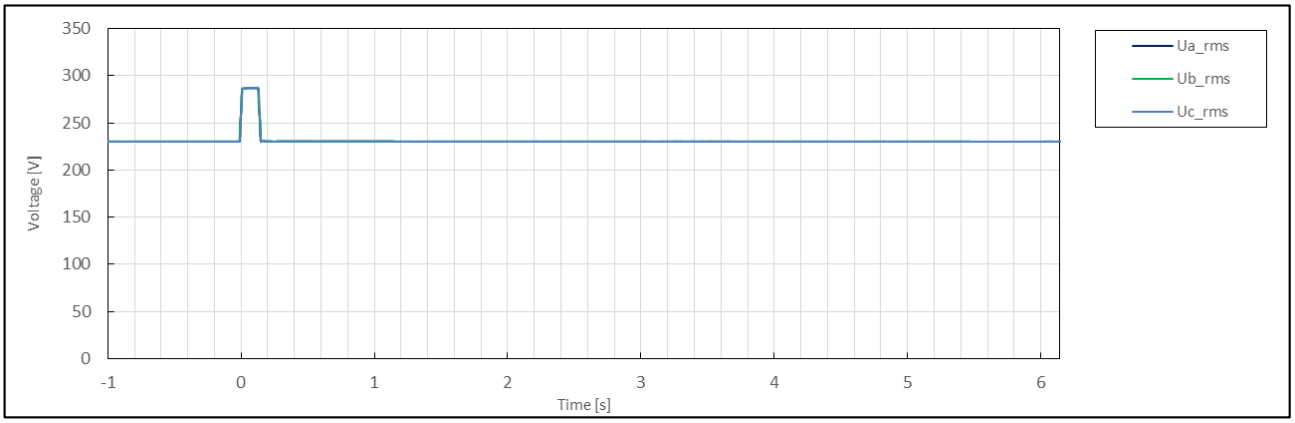


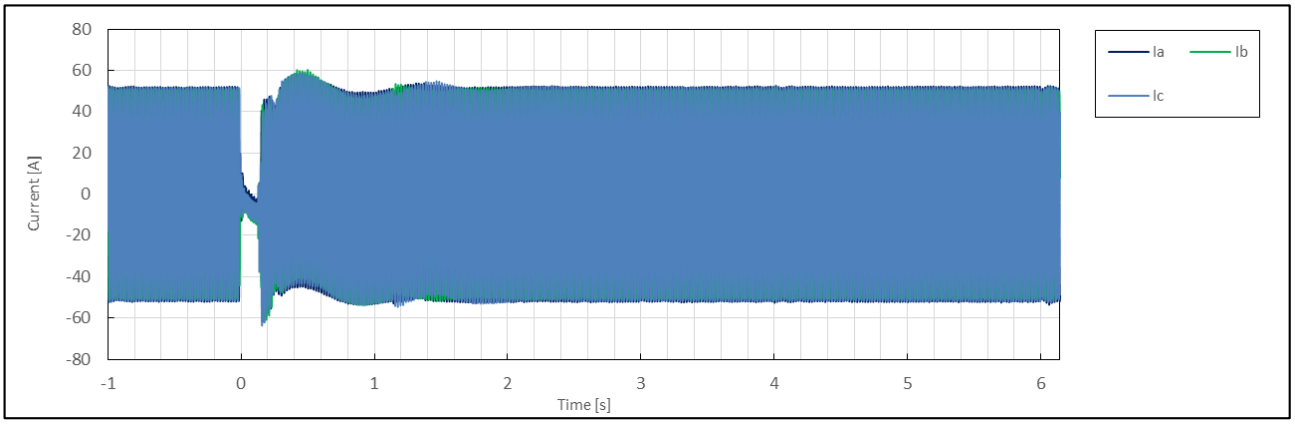


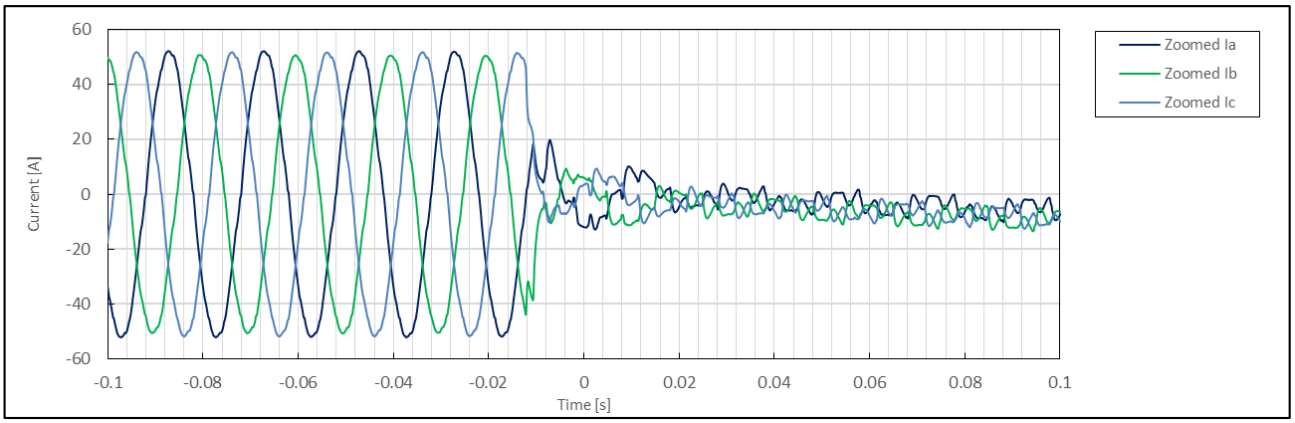
Test No. 5.2 with PGU

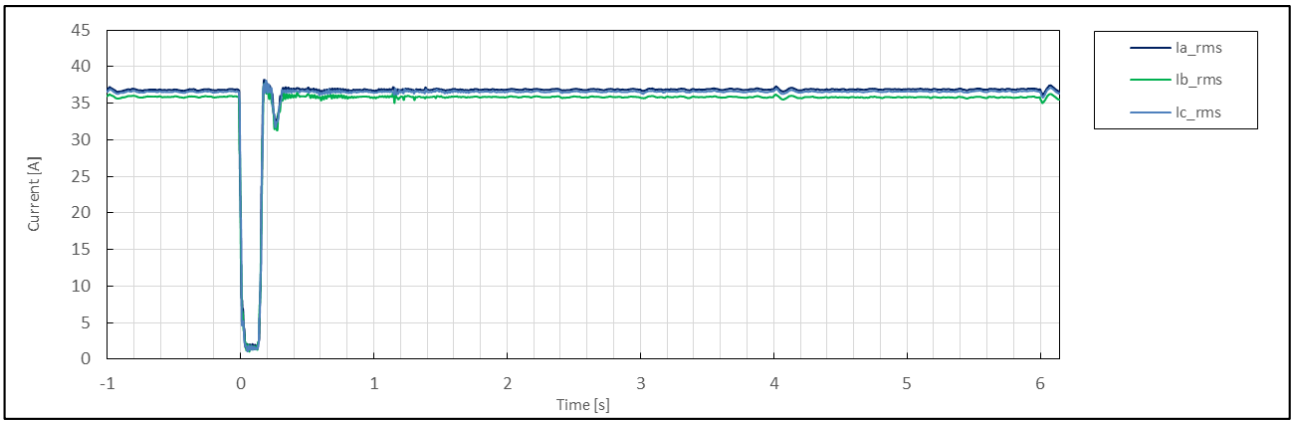


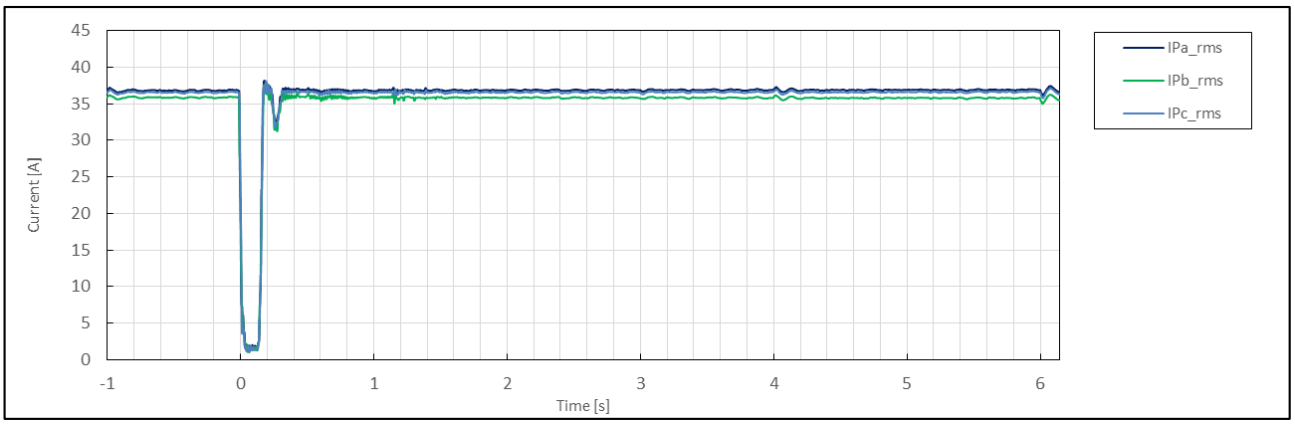


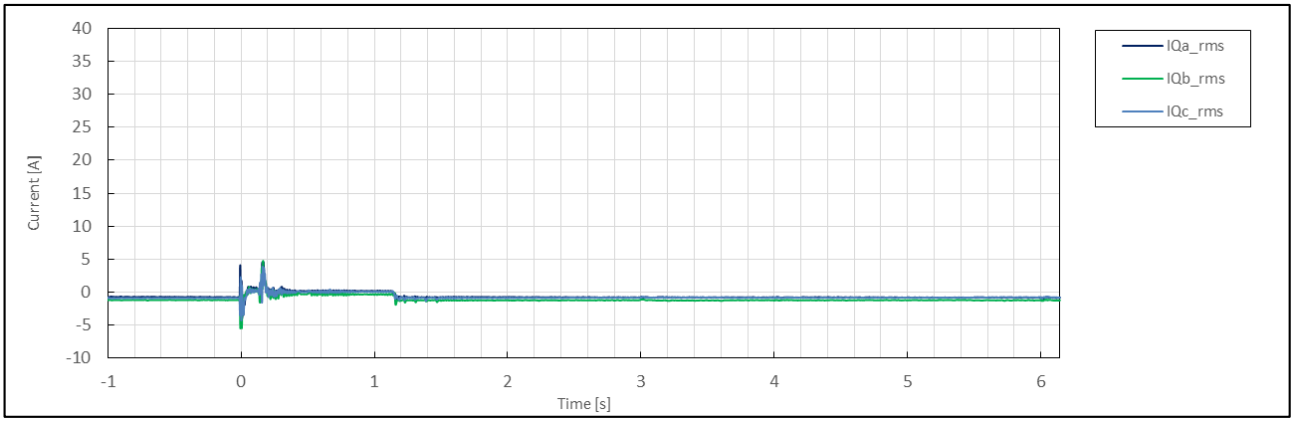


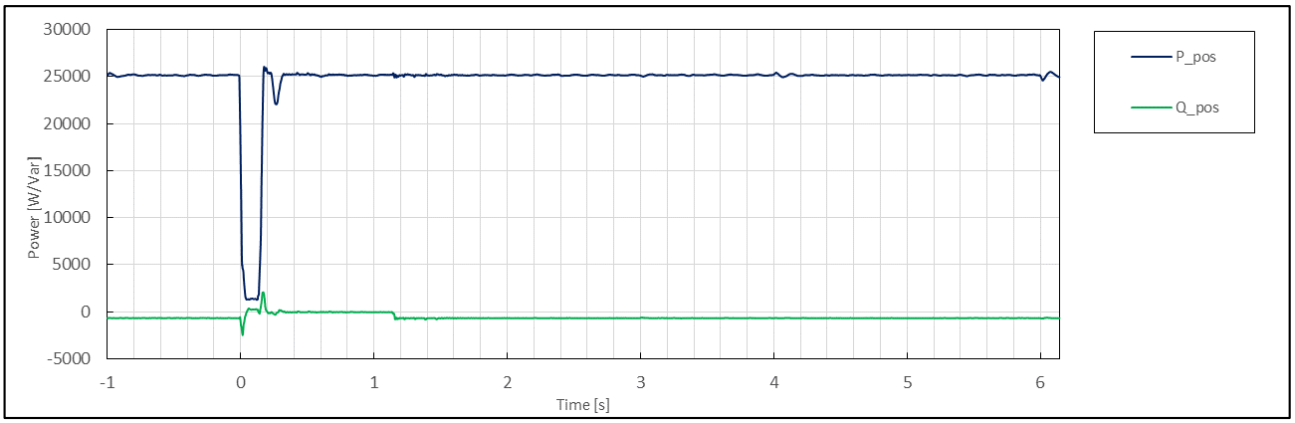


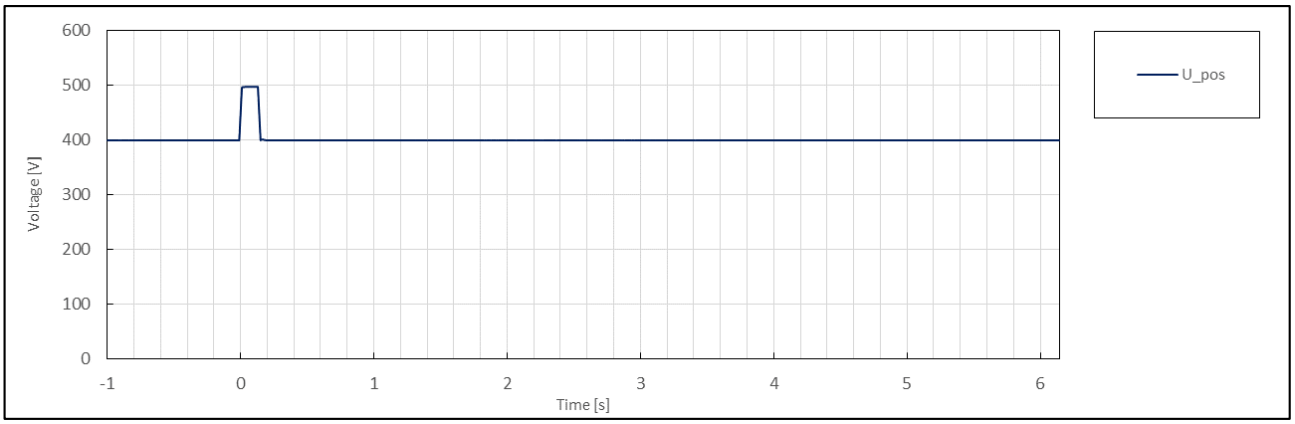

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

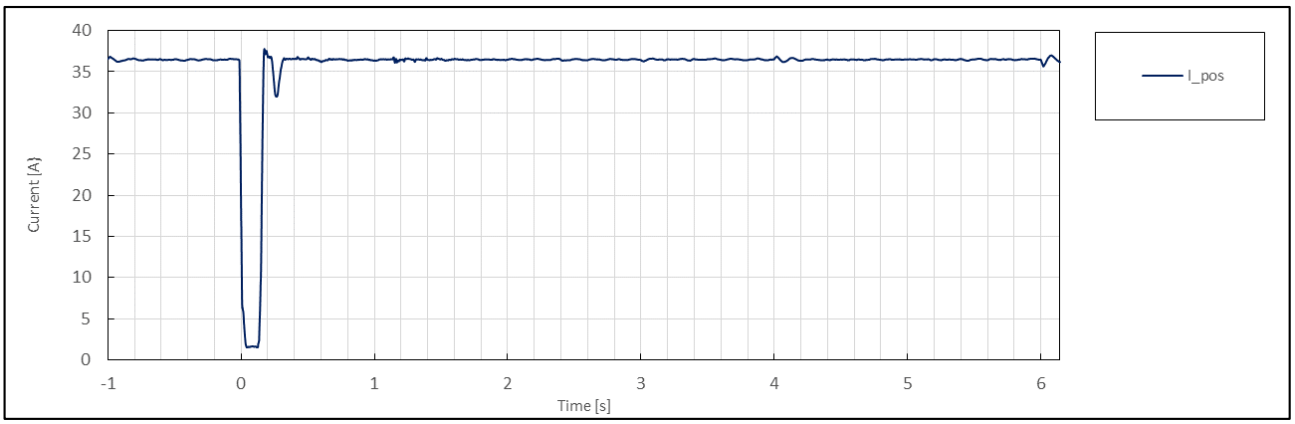

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

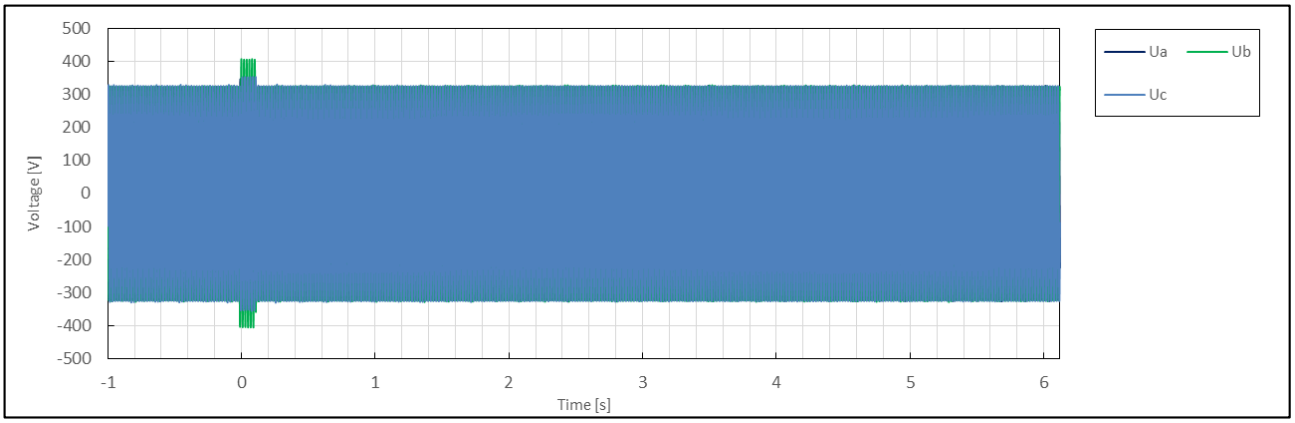

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

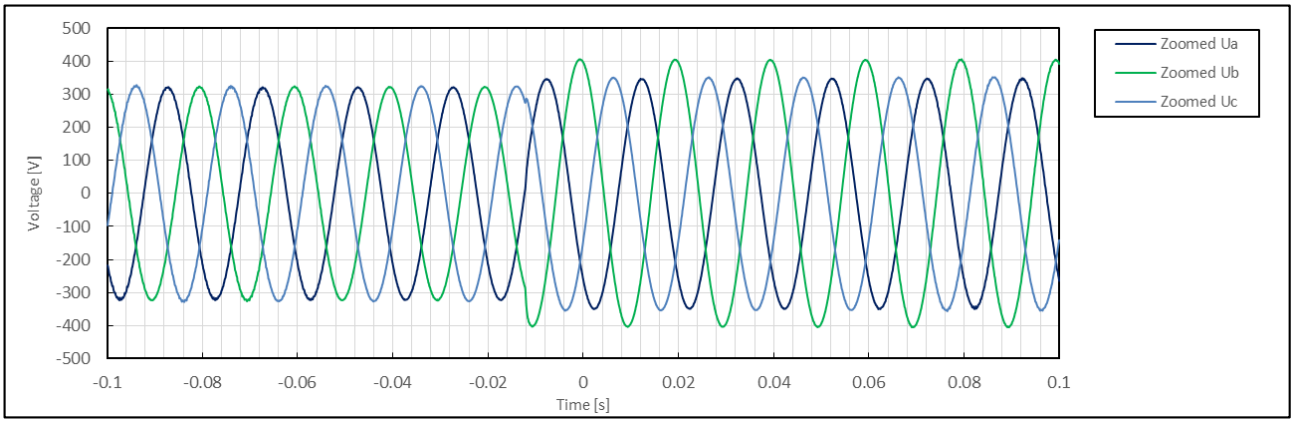

600
500
400
300
200
100
0
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

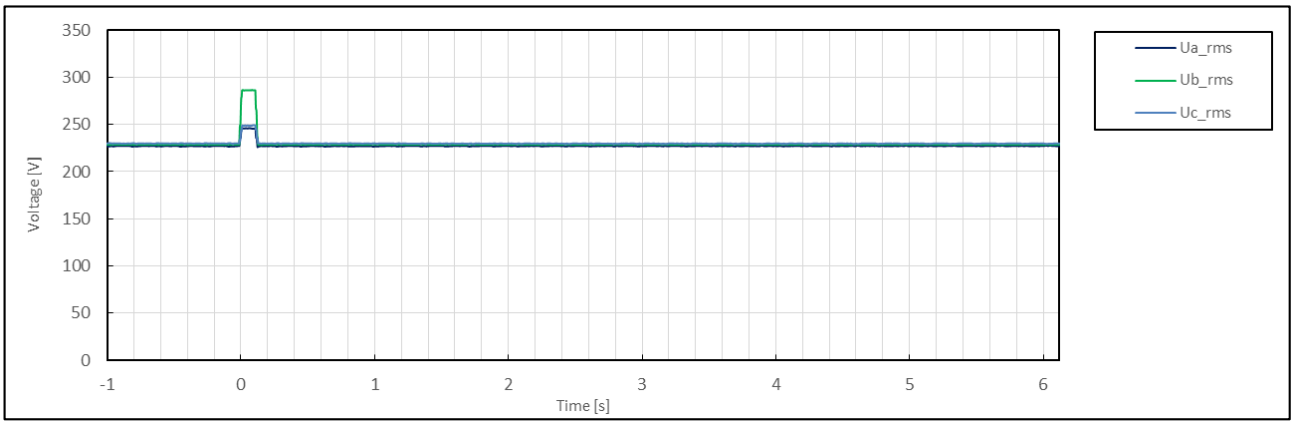

40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.3
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:47:46
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.24
	5	Setting dip duration		--		120
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	119
	8	Fault duration in empty load test	Total	--	ms	120
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.25
	10		Pos.		p.u.	1.13
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.25
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03
	21		Phase 3			0.04
	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.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.081
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

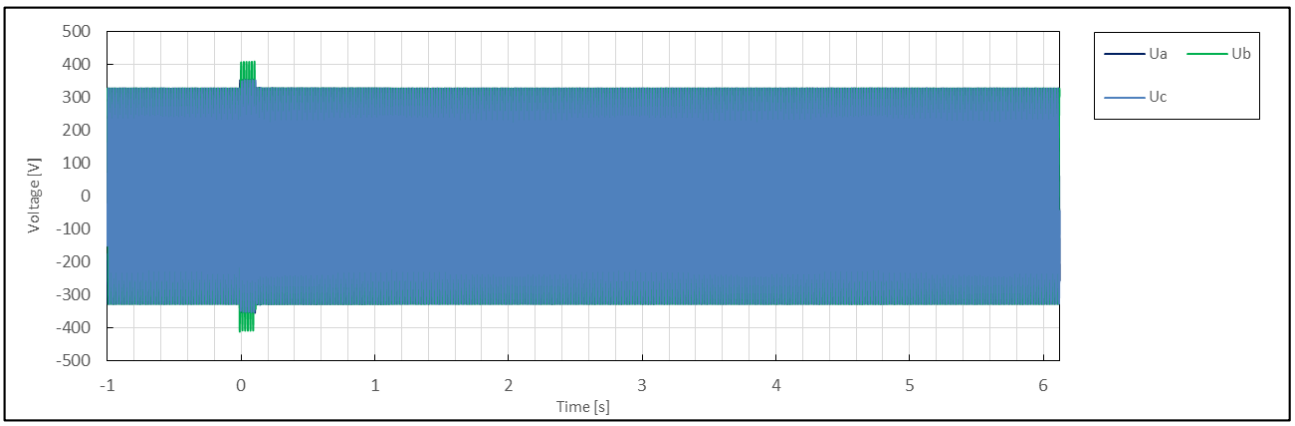
Test No. 5.3 idle test

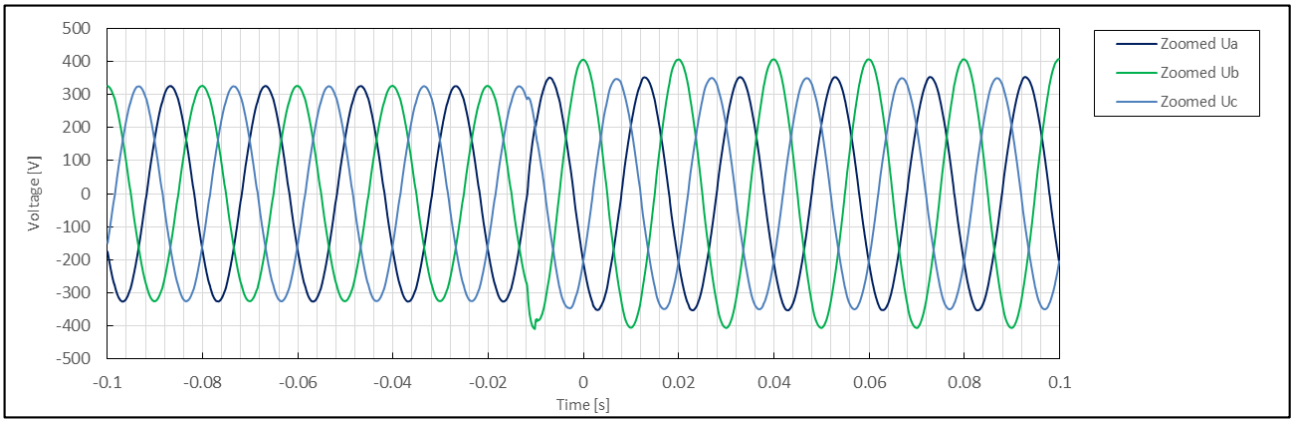


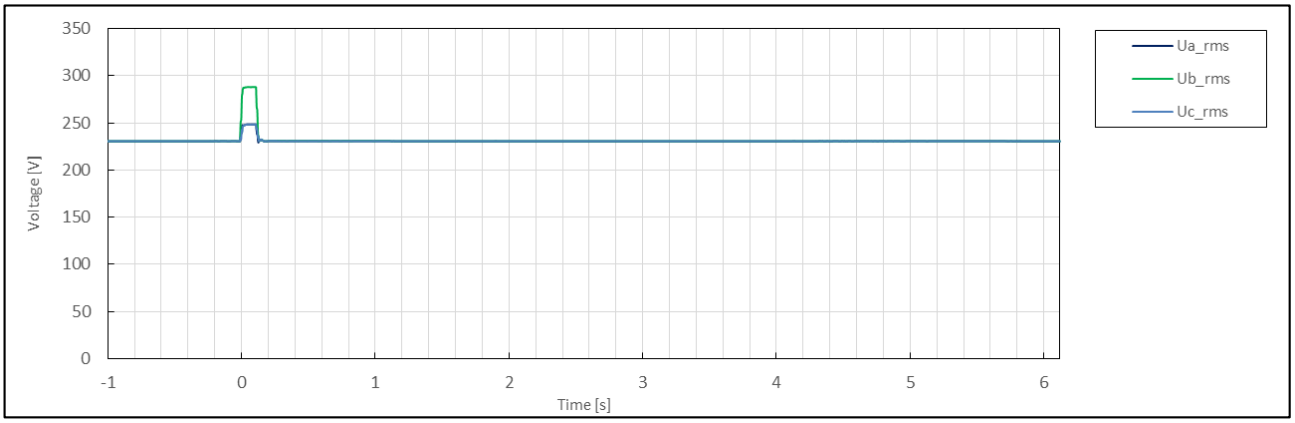


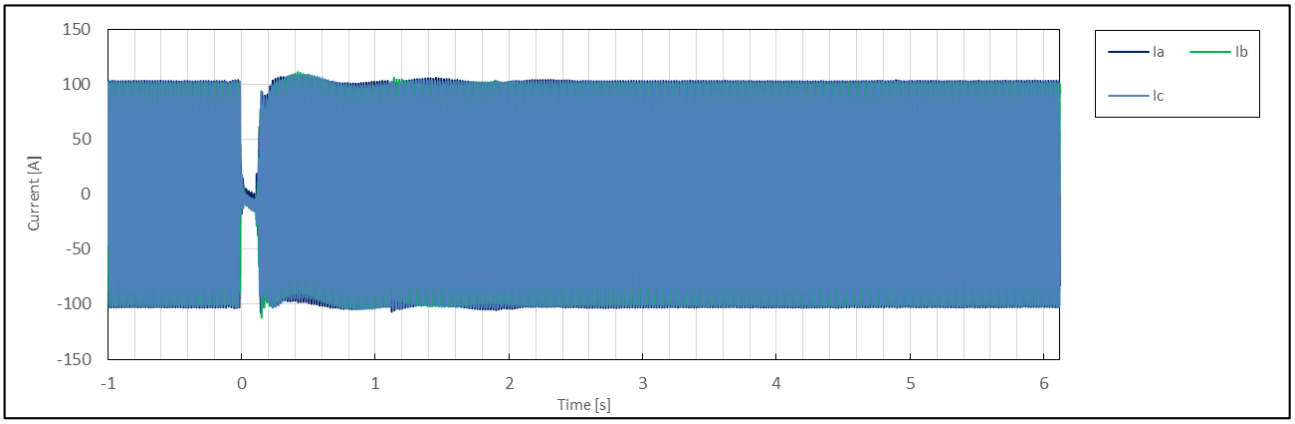


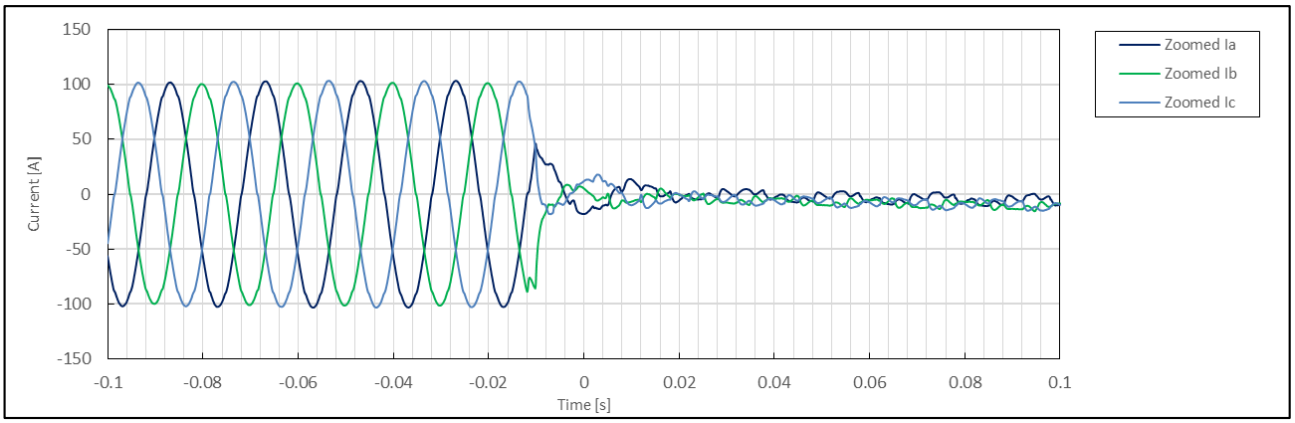
Test No. 5.3 with PGU

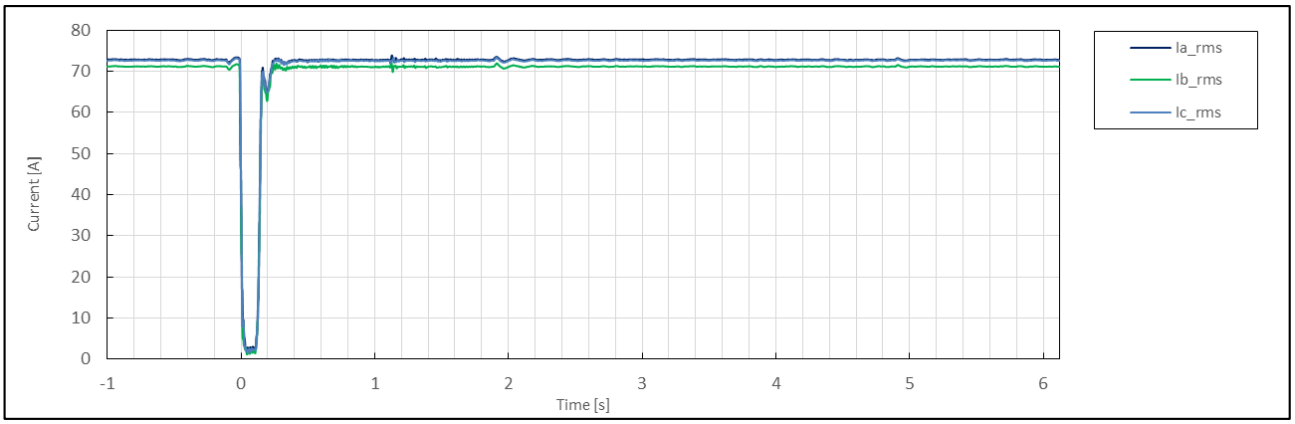


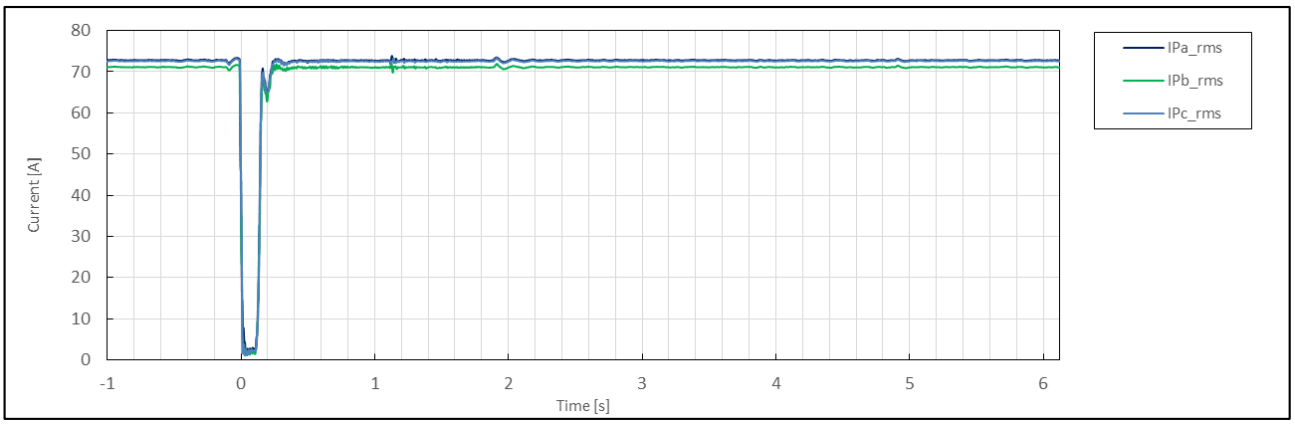


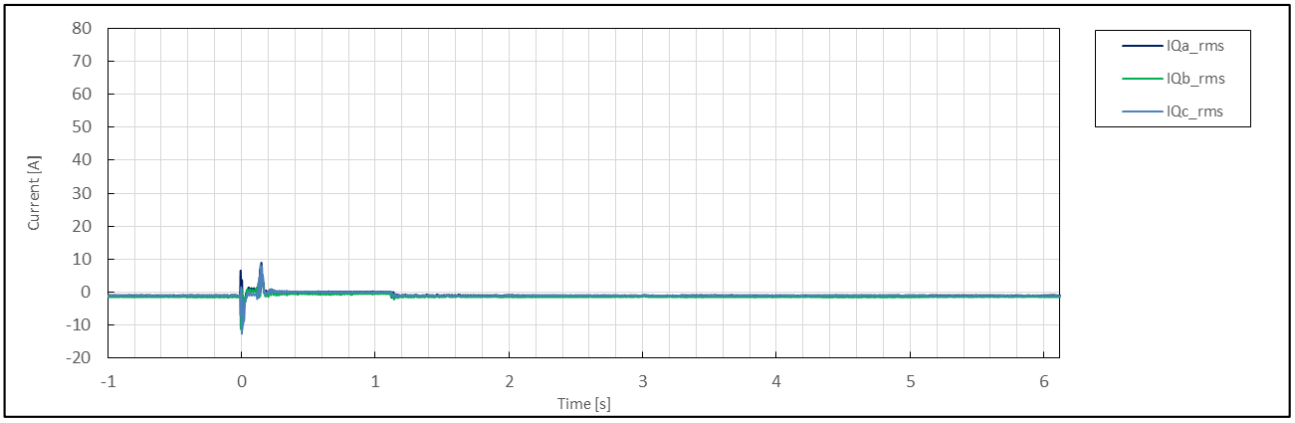


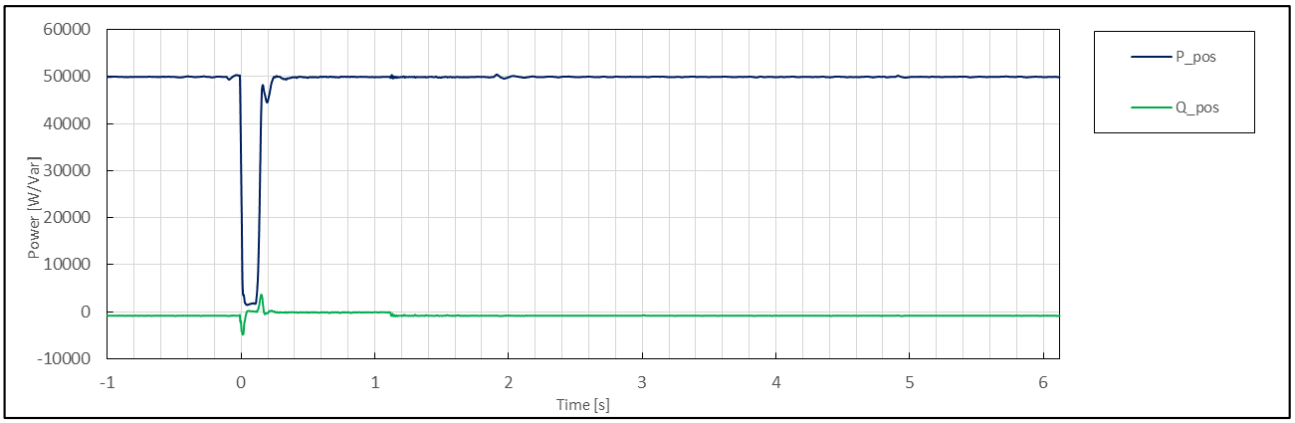


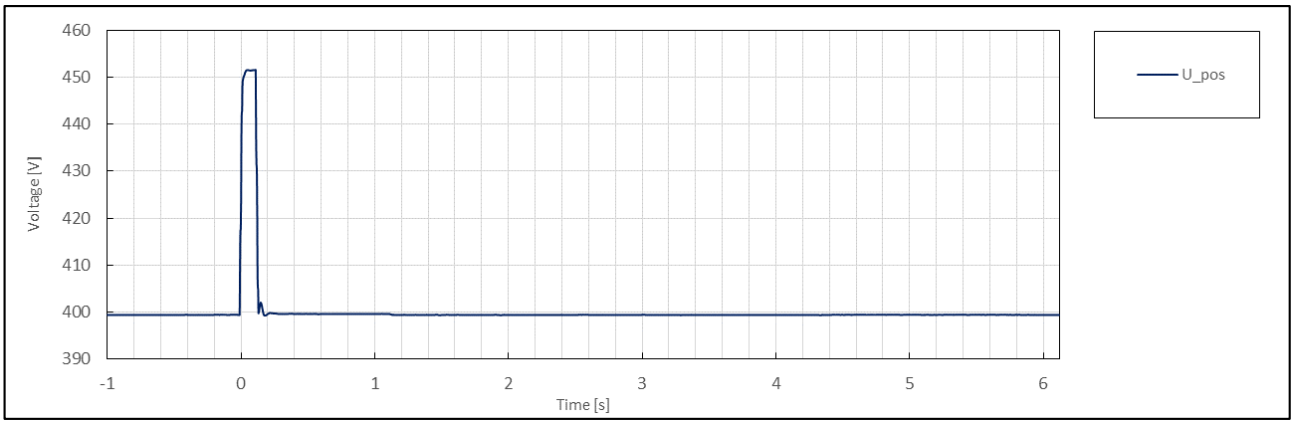

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

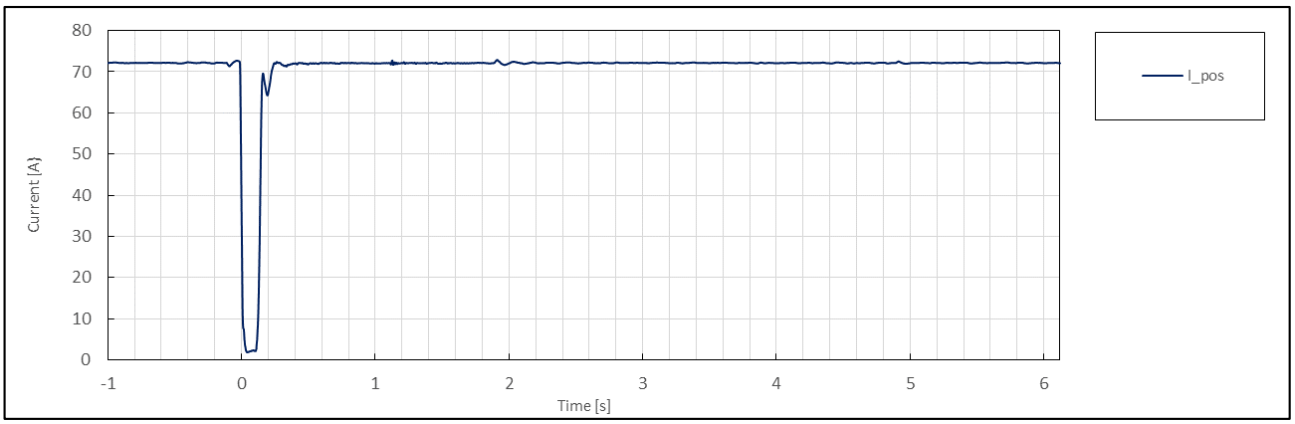

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

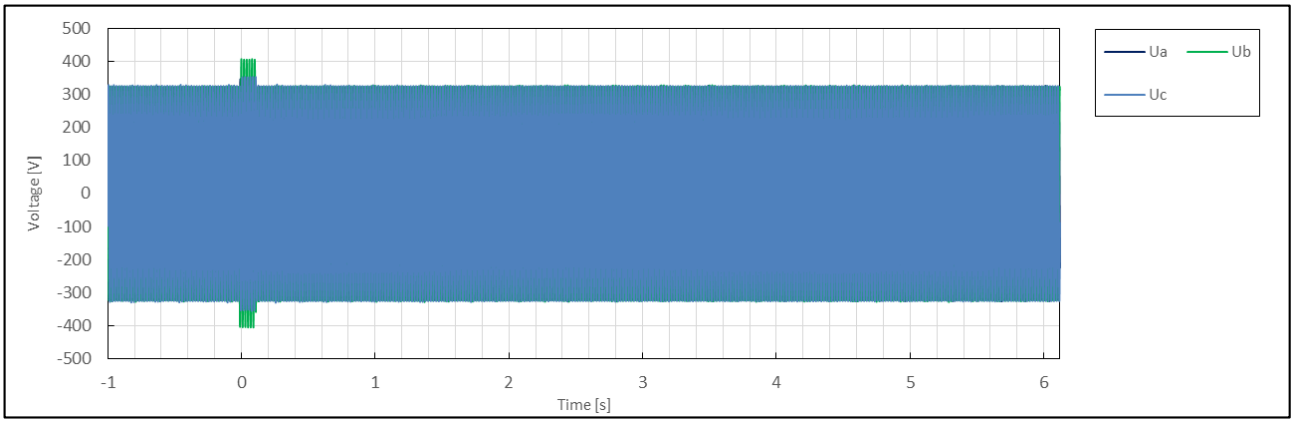

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

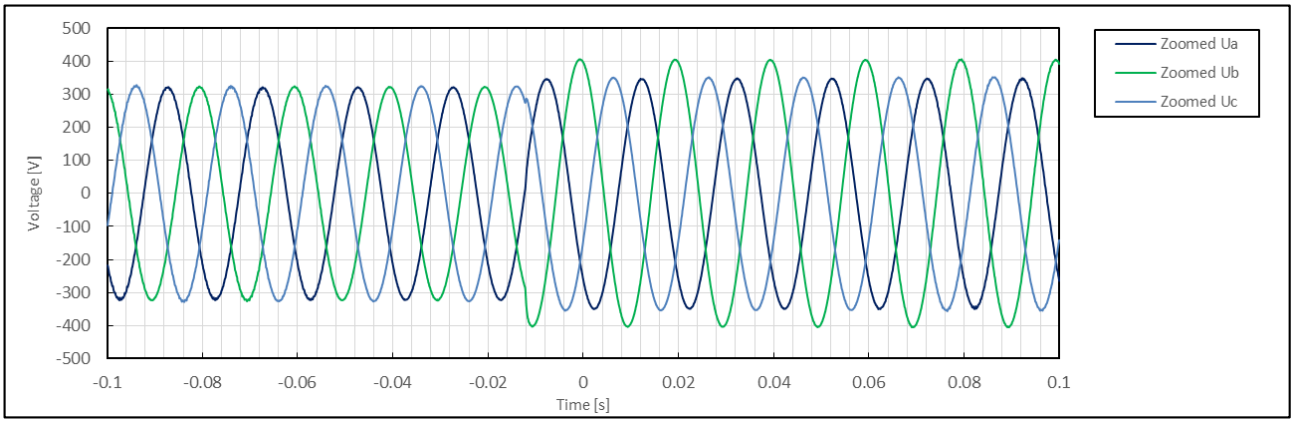

460
450
440
430
420
410
400
390
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

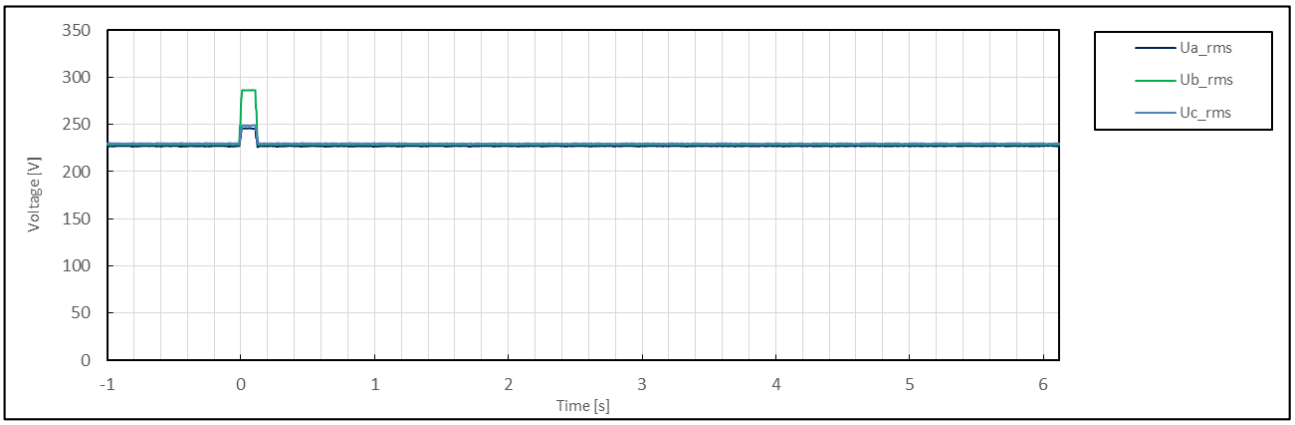

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.3(2)
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:46:32
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.24
	5	Setting dip duration		--		120
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	119
	8	Fault duration in empty load test	Total	--	ms	120
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.24
	10		Pos.		p.u.	1.13
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.24
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.03
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.03
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.085
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

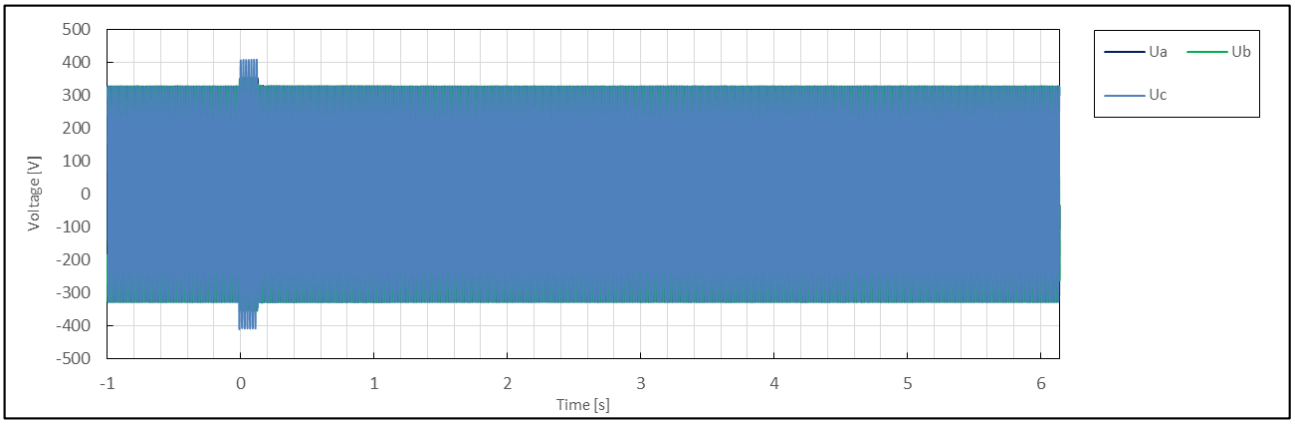
Test No. 5.3(D2) idle test

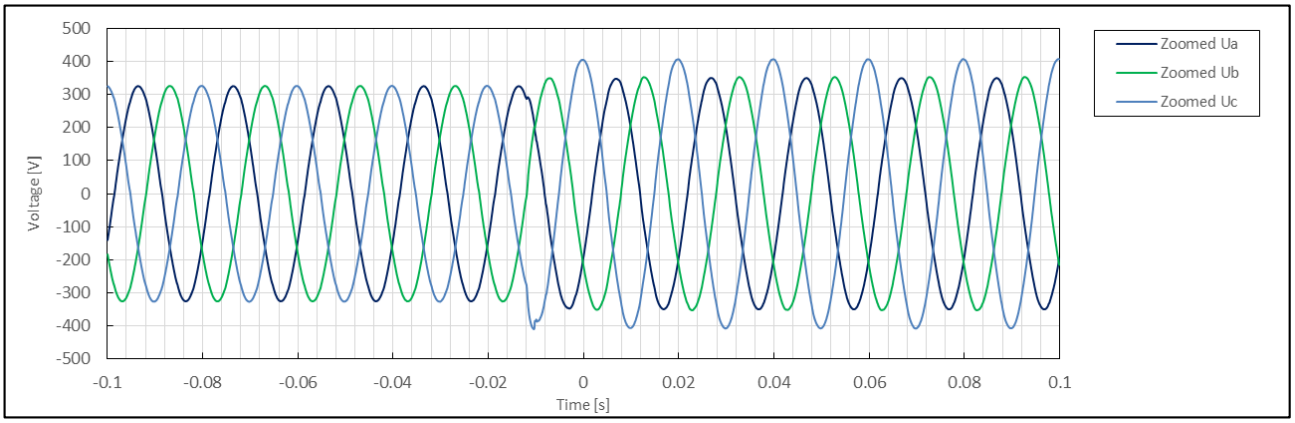


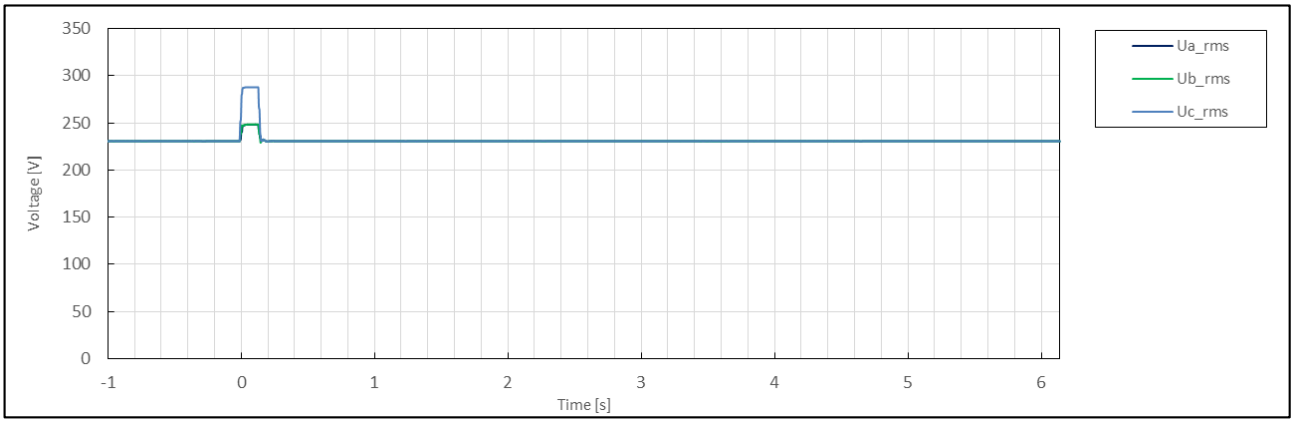


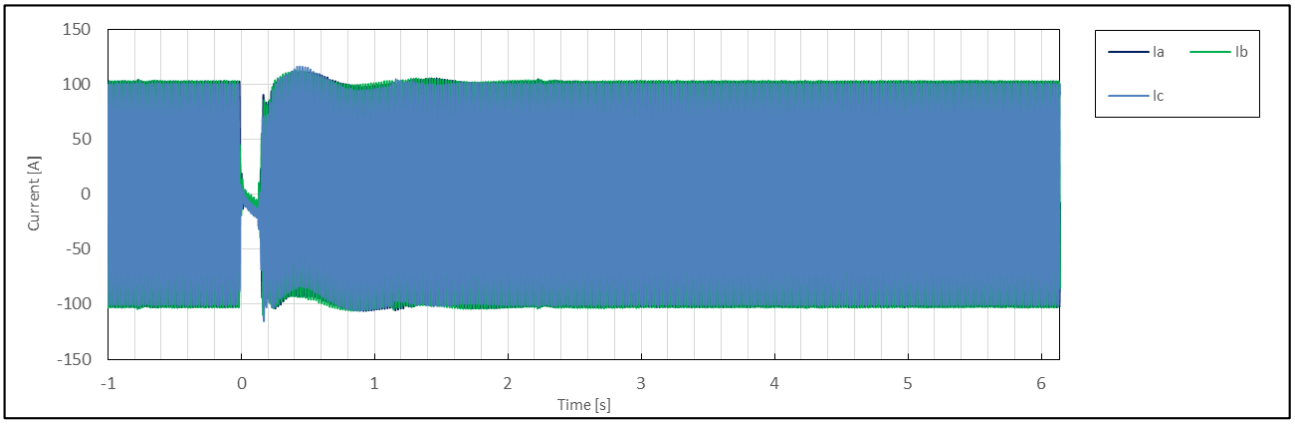


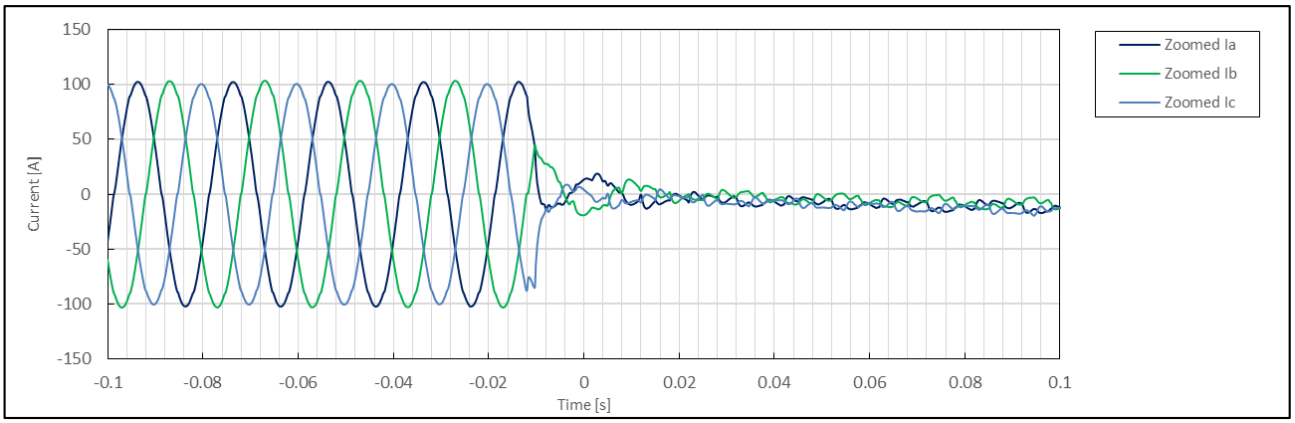
Test No. 5.3(D2) with PGU

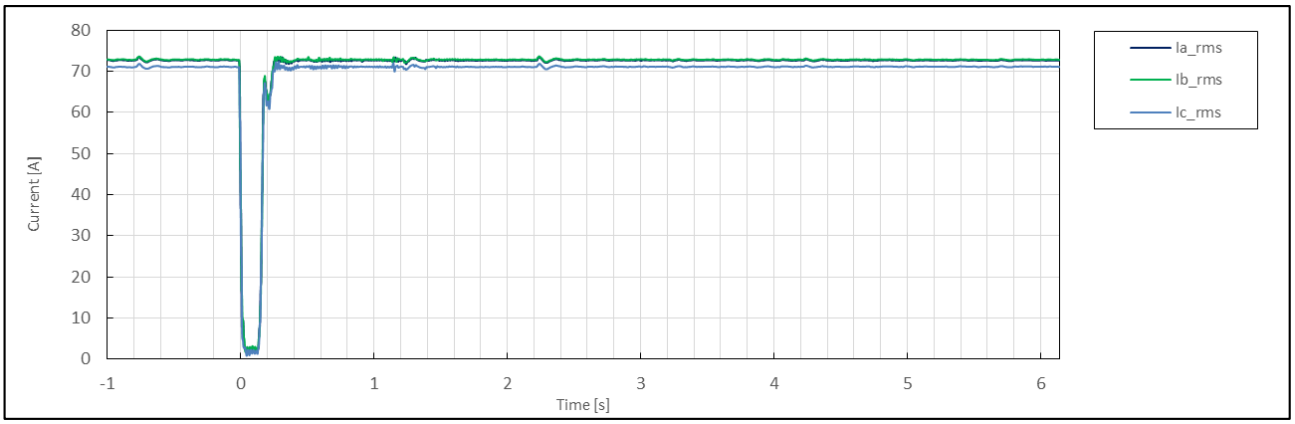


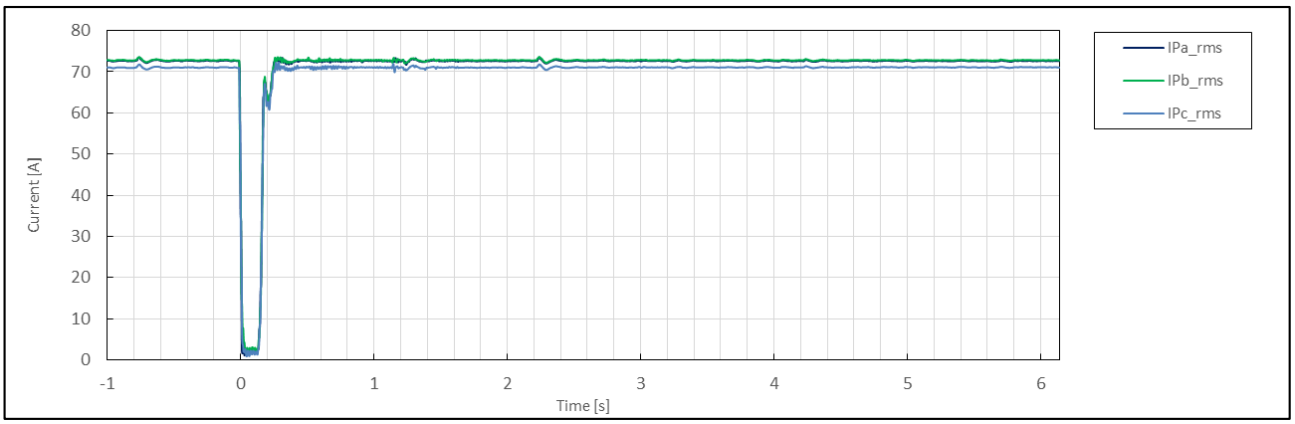


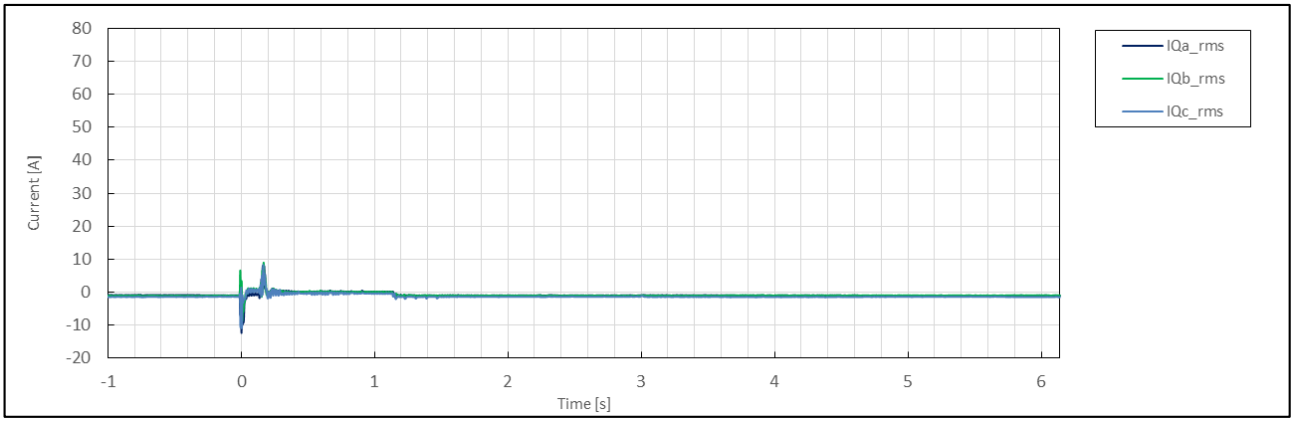


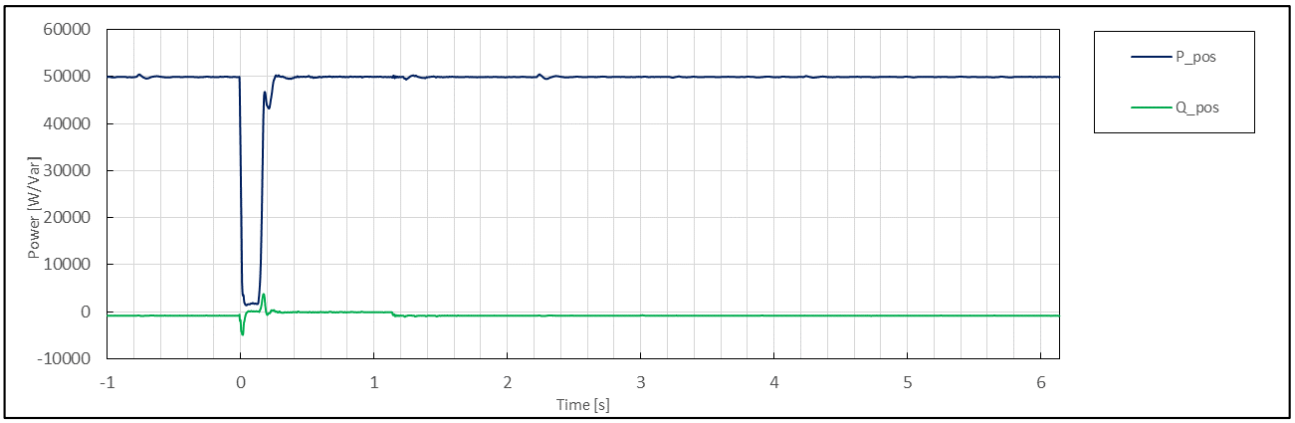


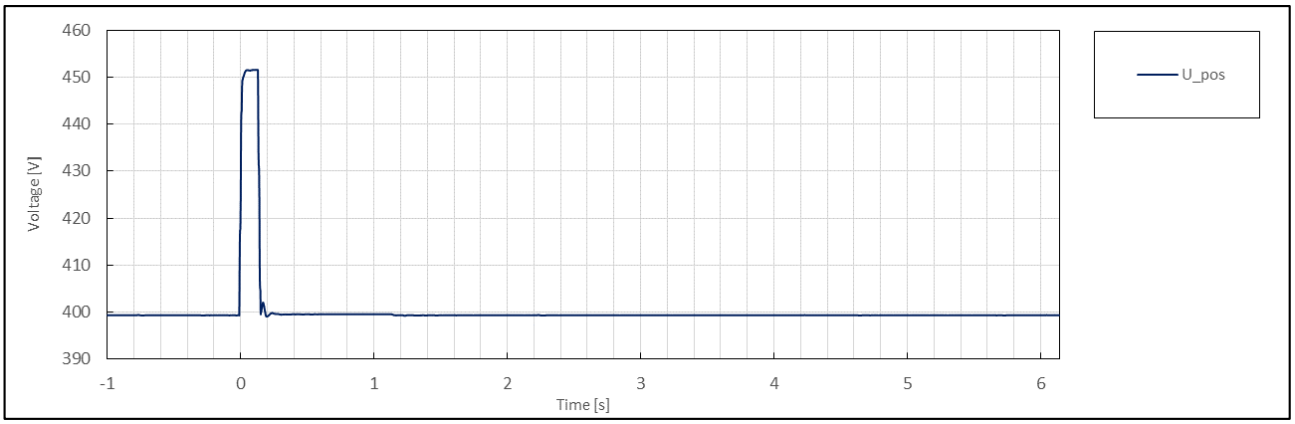

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

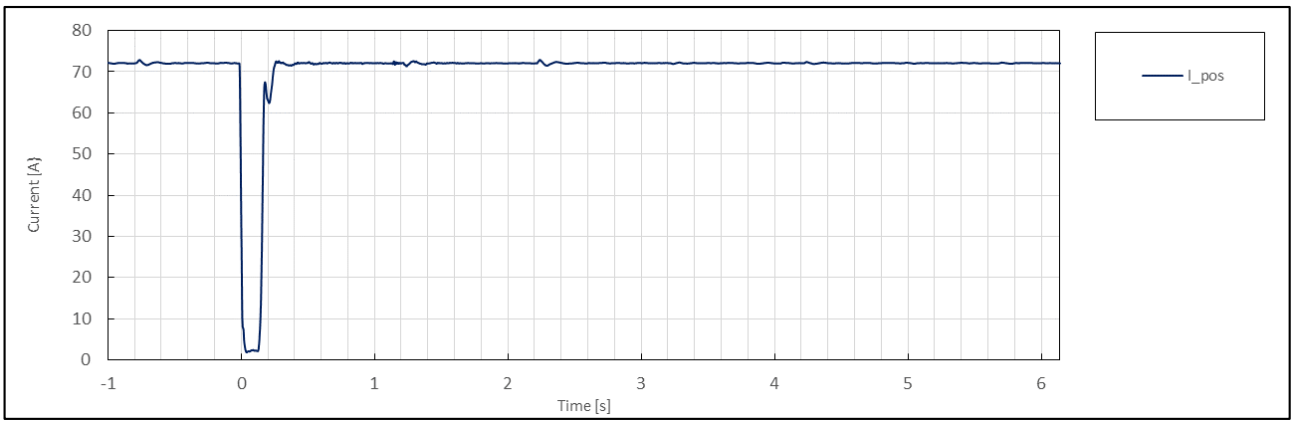

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

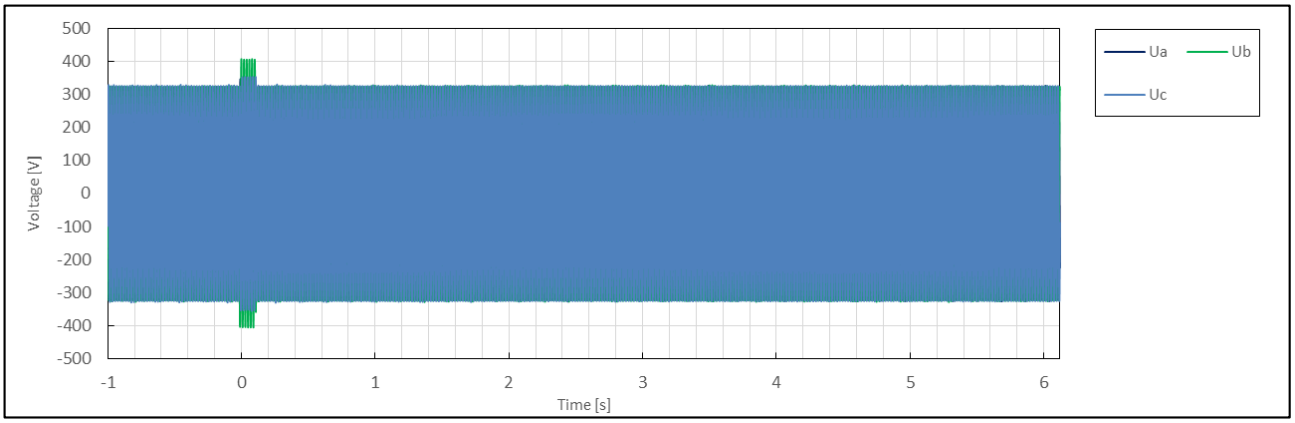

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

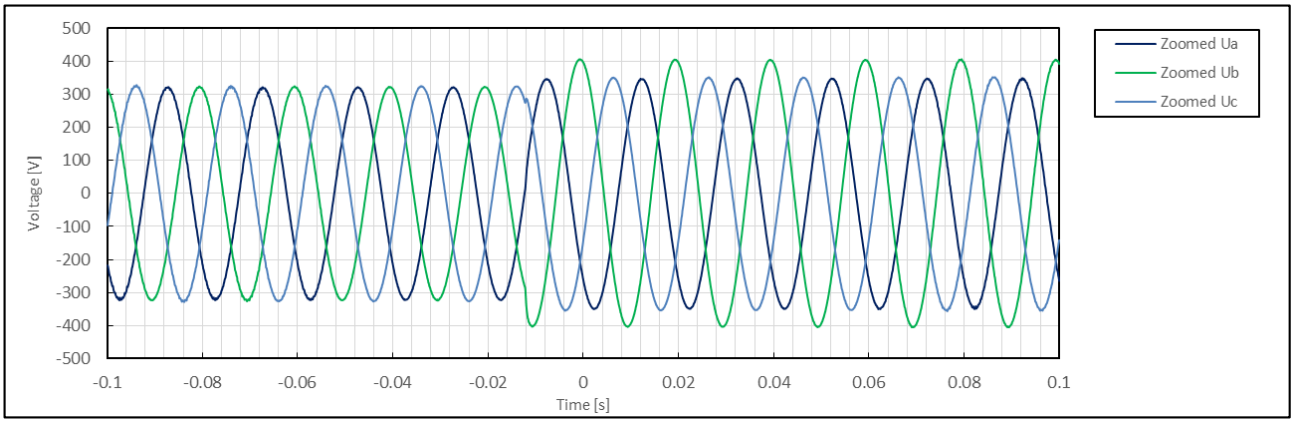

460
450
440
430
420
410
400
390
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

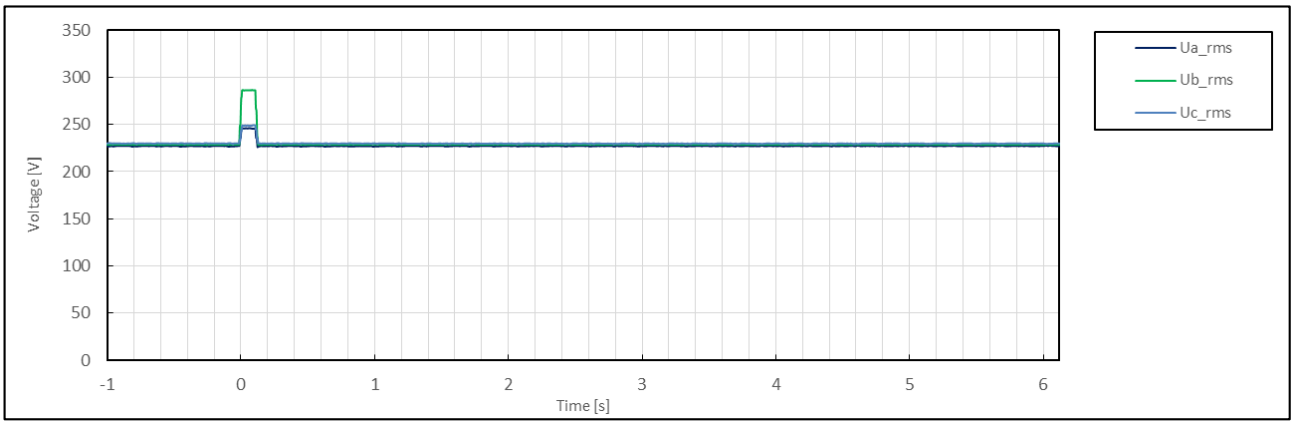

80
70
60
50
40
30
20
10
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.4
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:47:24
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.24
	5	Setting dip duration		--		120
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	119
	8	Fault duration in empty load test	Total	--	ms	120
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.25
	10		Pos.		p.u.	1.13
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.	-0.01
	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.	1.25
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03
	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.02
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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	0.136
	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

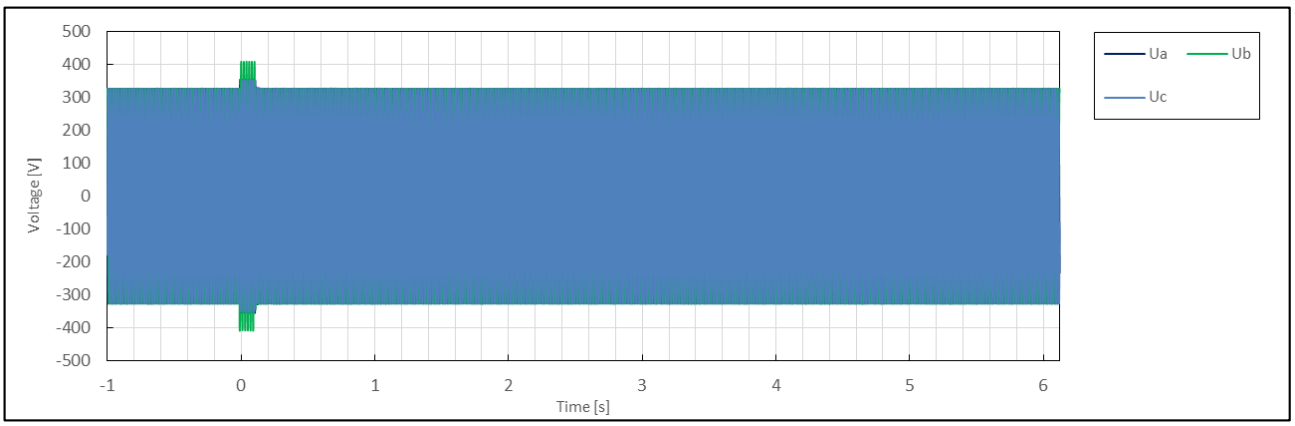
Test No. 5.4 idle test

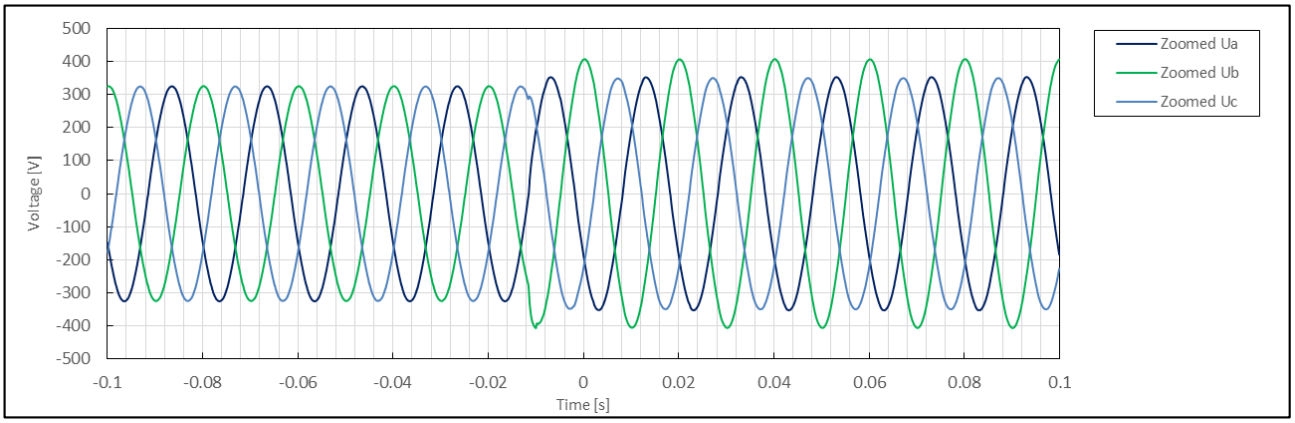


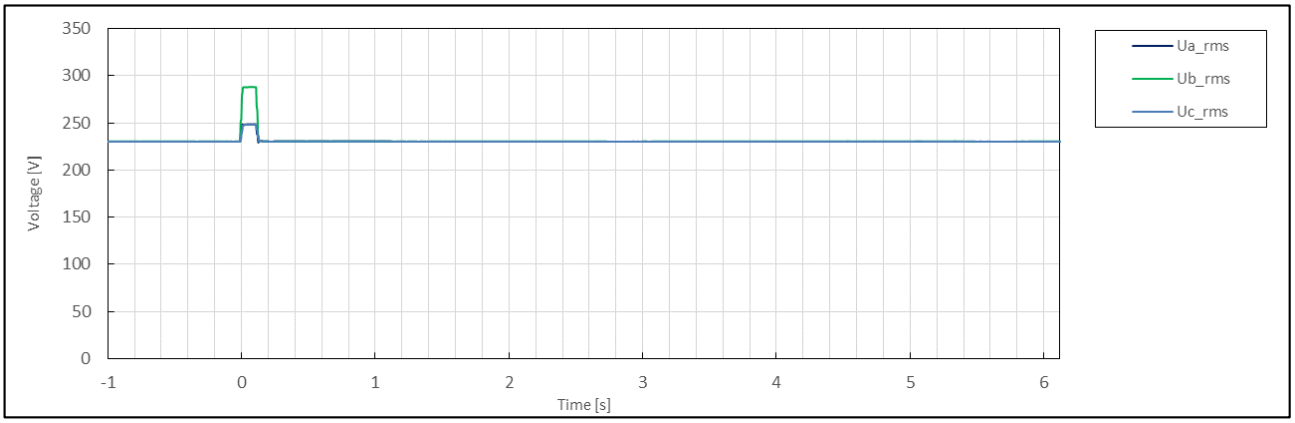


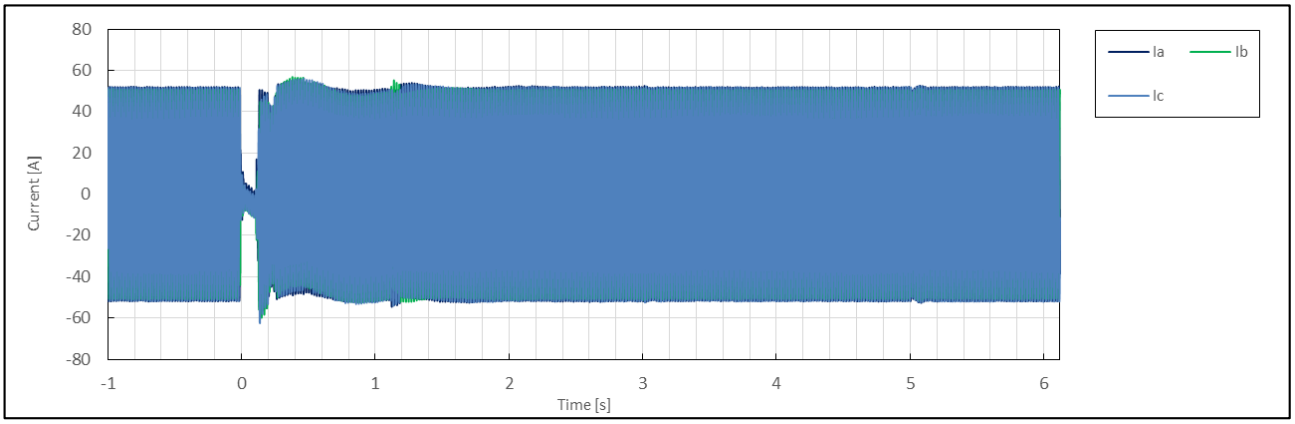


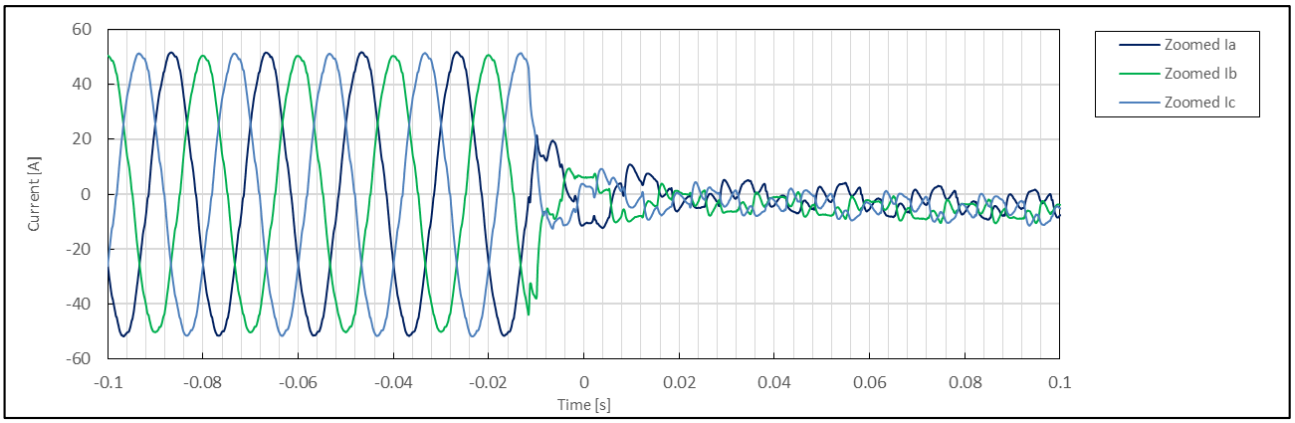
Test No. 5.4 with PGU

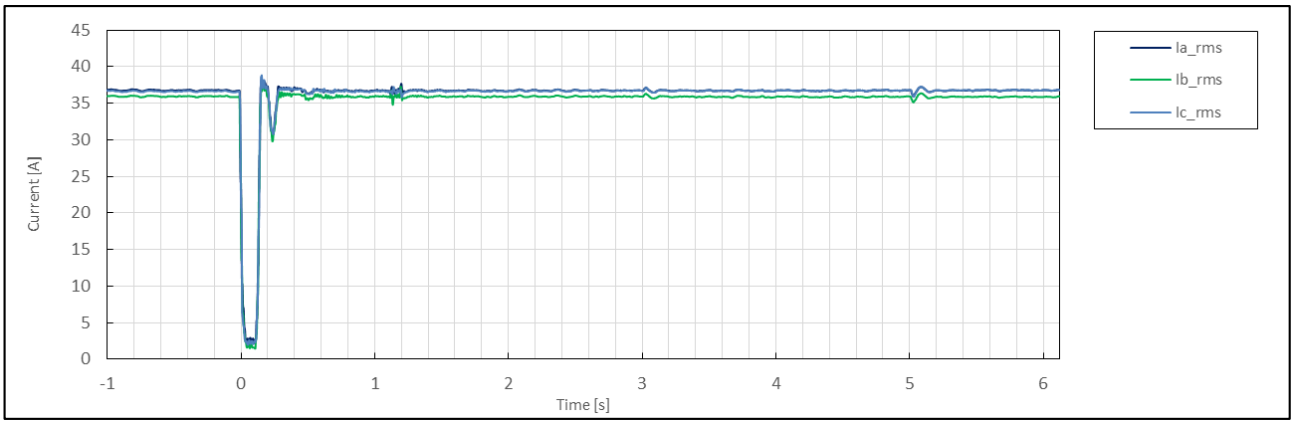


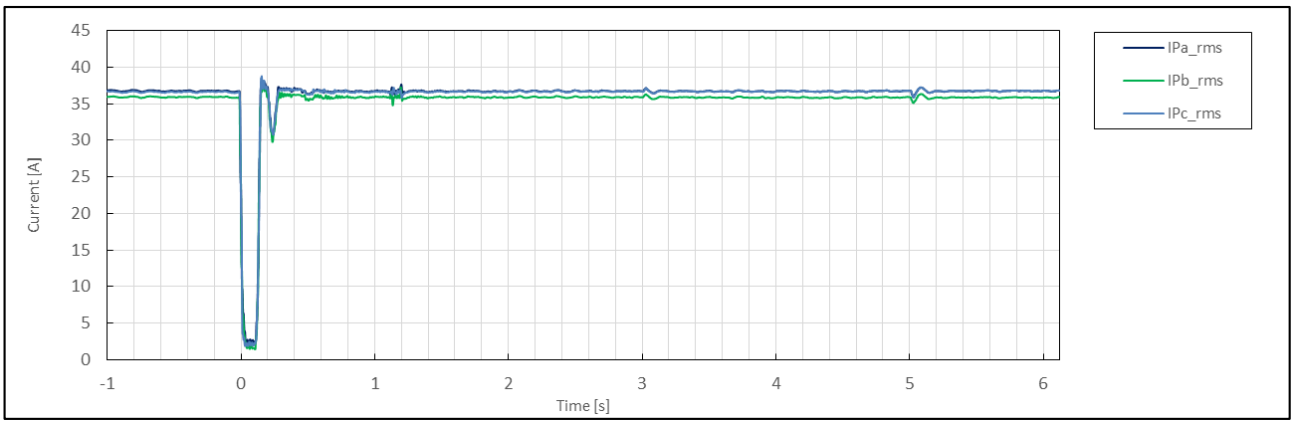


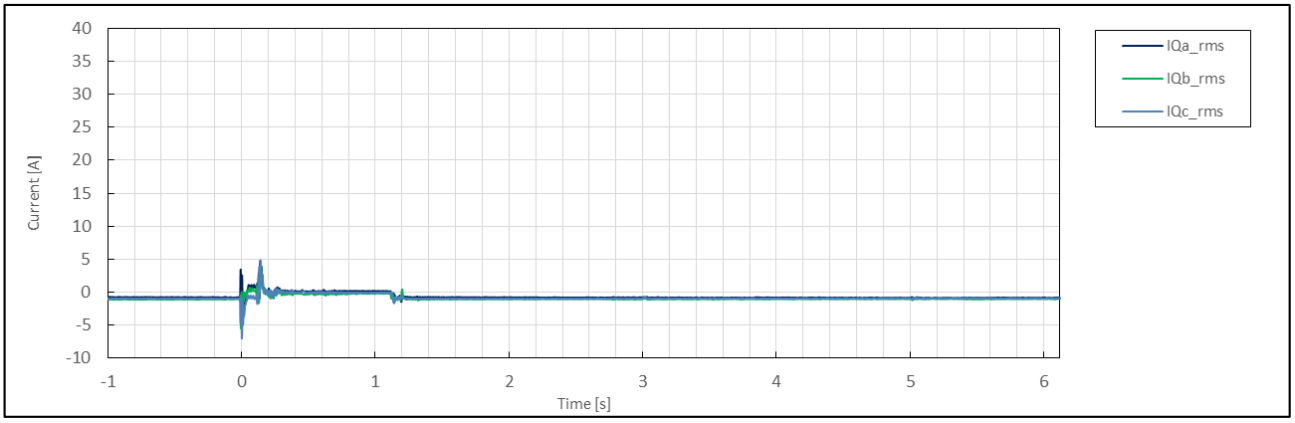


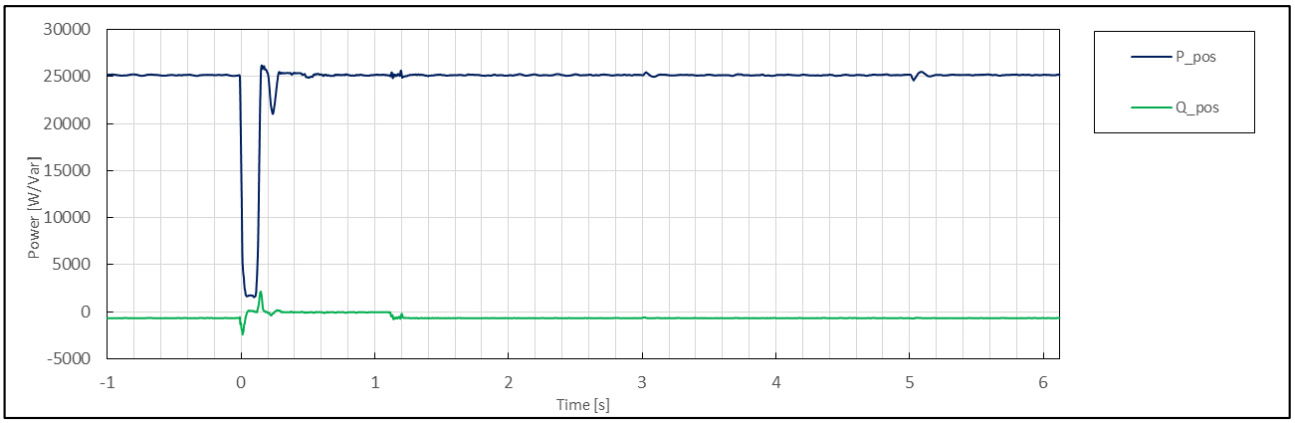


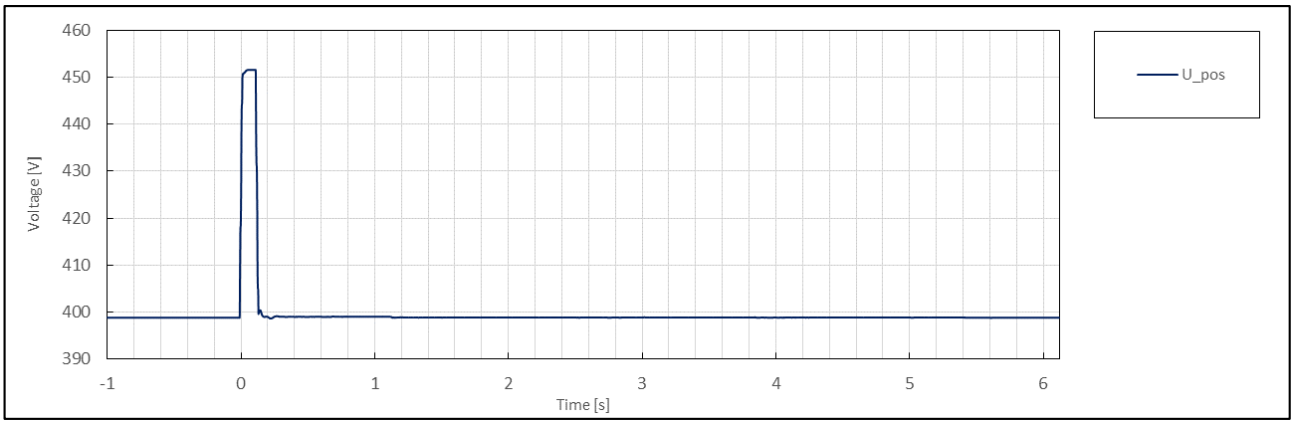

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

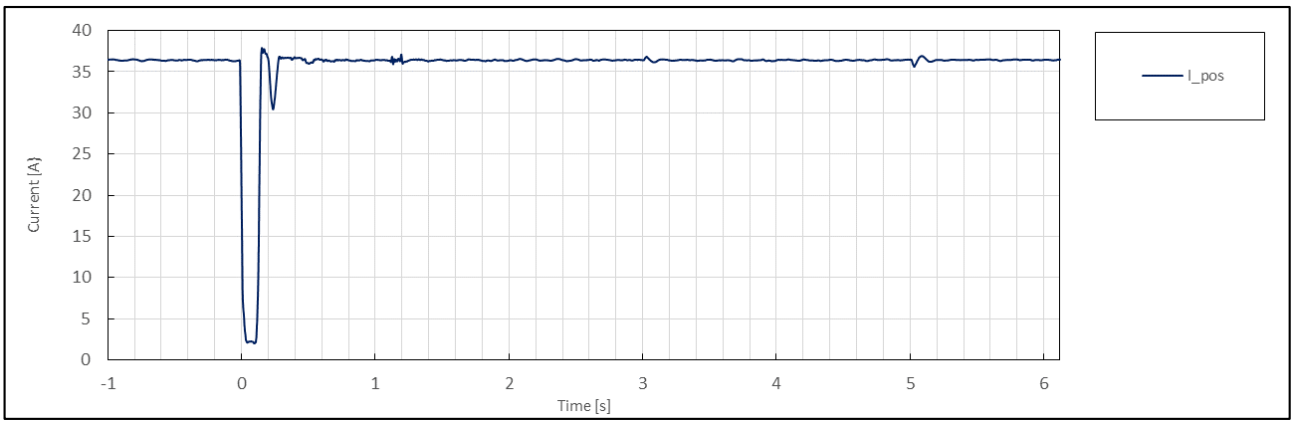

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

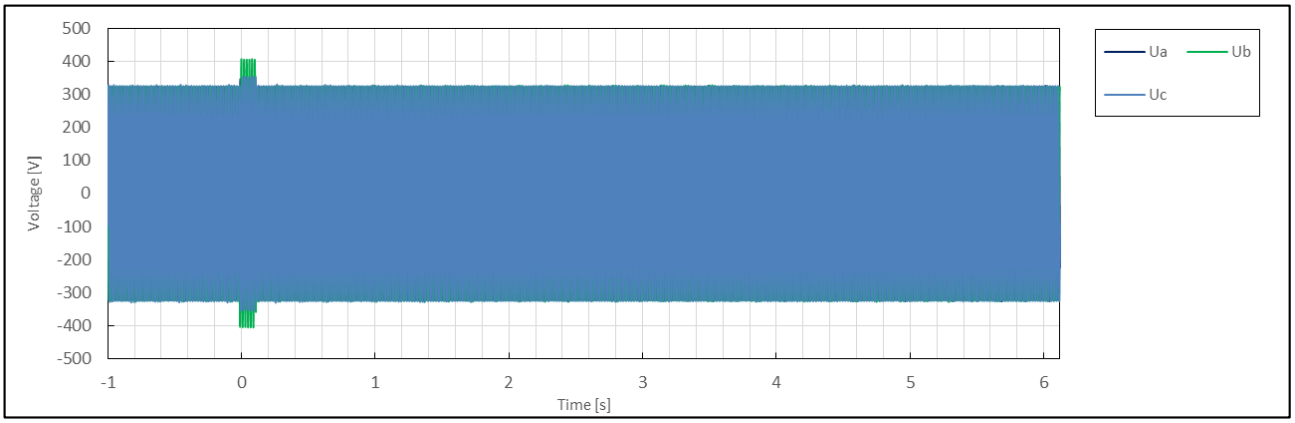

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

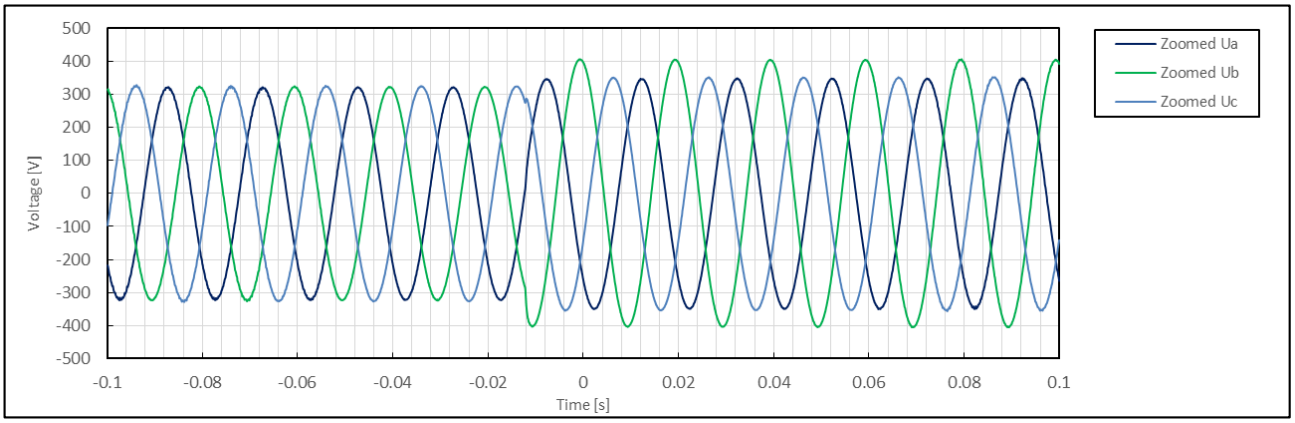

460
450
440
430
420
410
400
390
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

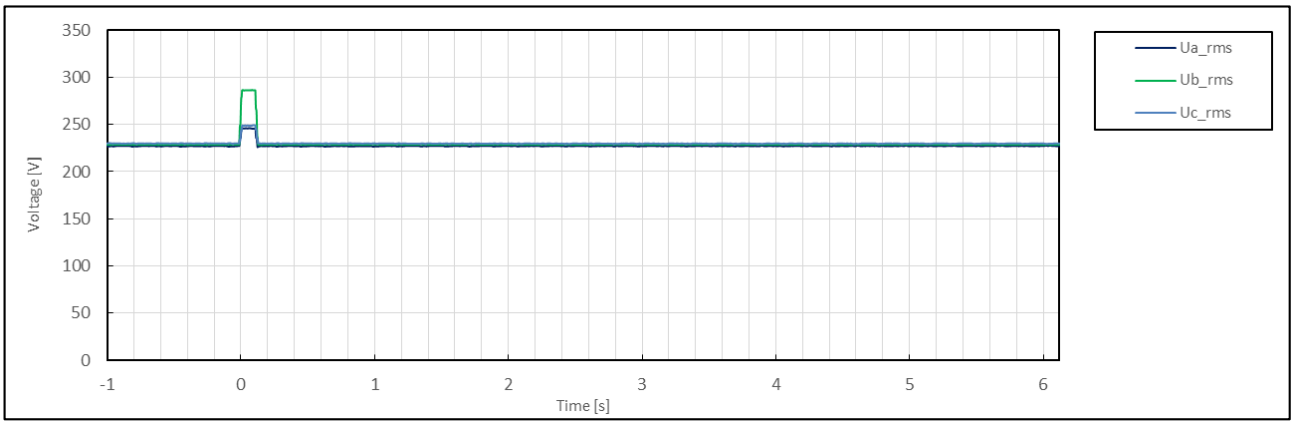

40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	5.4(2)
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:46:54
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.24
	5	Setting dip duration		--		120
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	119
	8	Fault duration in empty load test	Total	--	ms	120
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.24
	10		Pos.		p.u.	1.13
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.	-0.01
	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.	1.24
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03
	21		Phase 3			0.02
	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.	0.04
	26		Pos.			0.04
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	0.132
	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

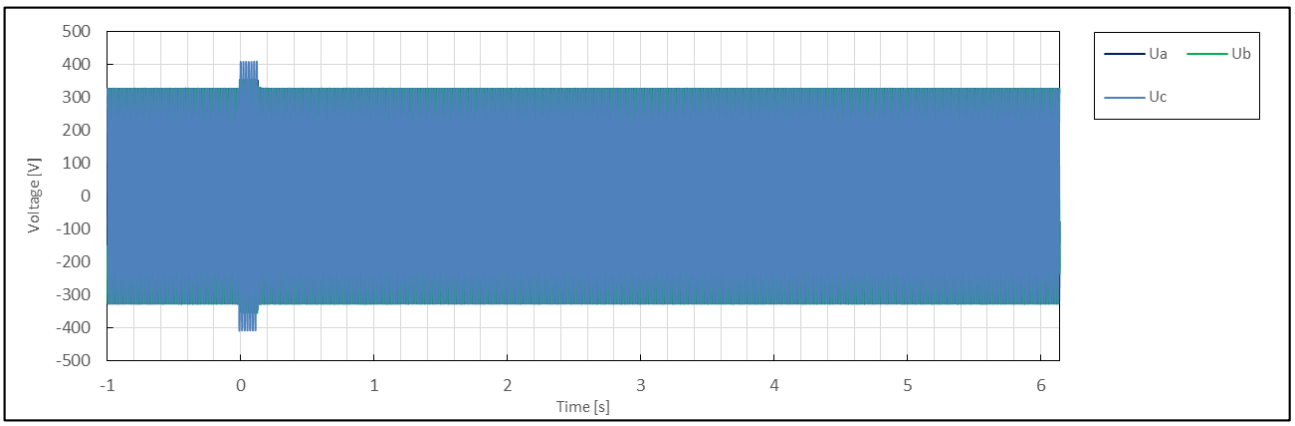
Test No. 5.4(D2) idle test

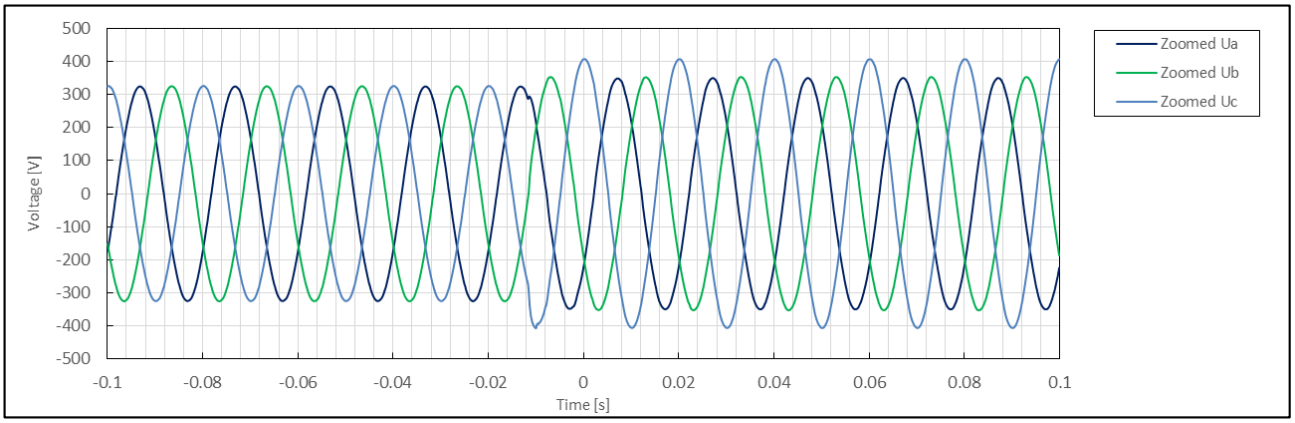


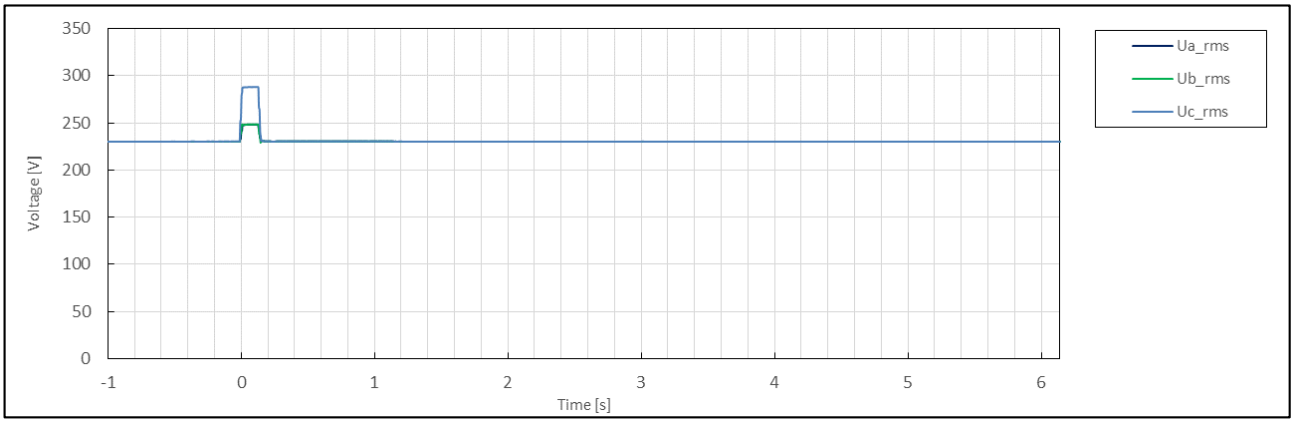


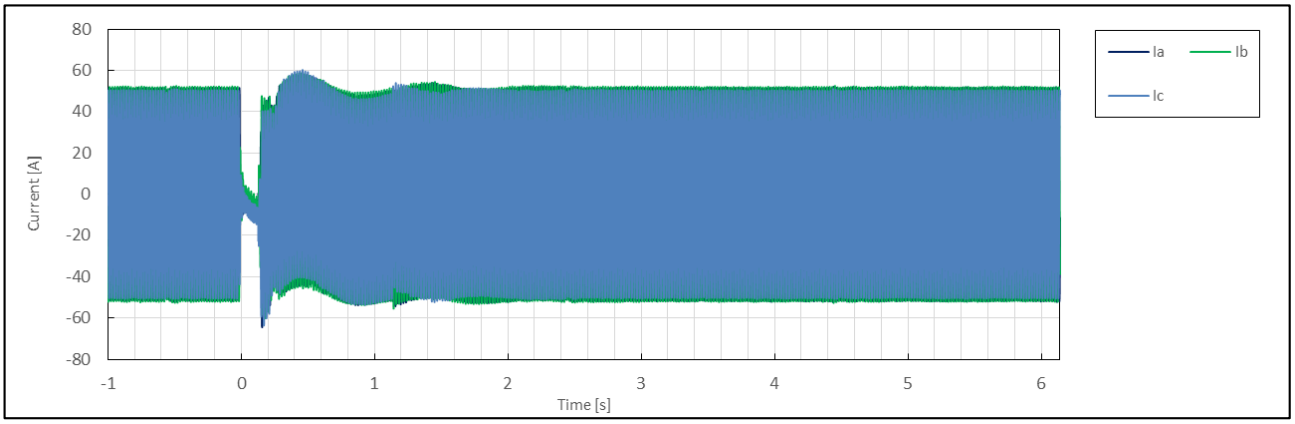


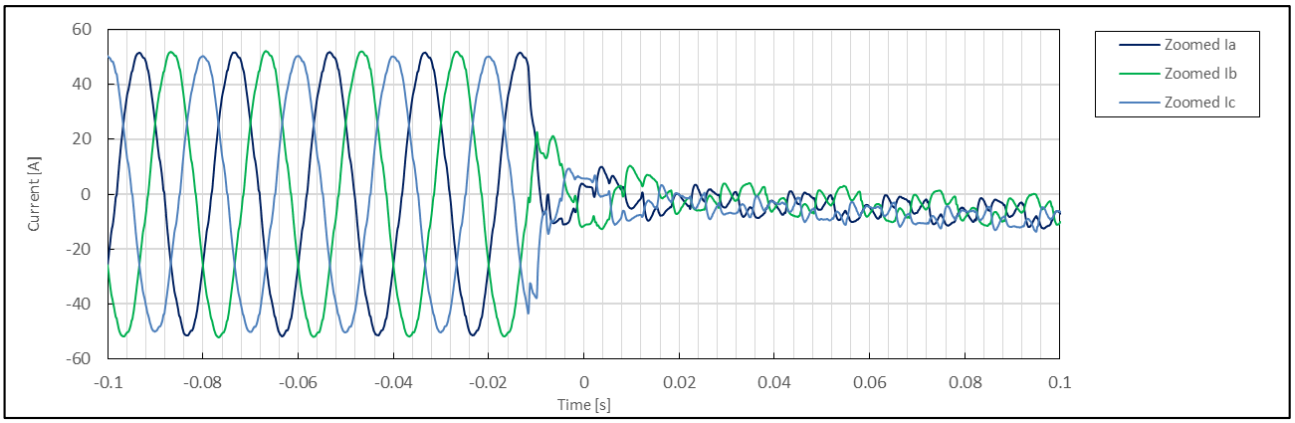
Test No. 5.4(D2) with PGU

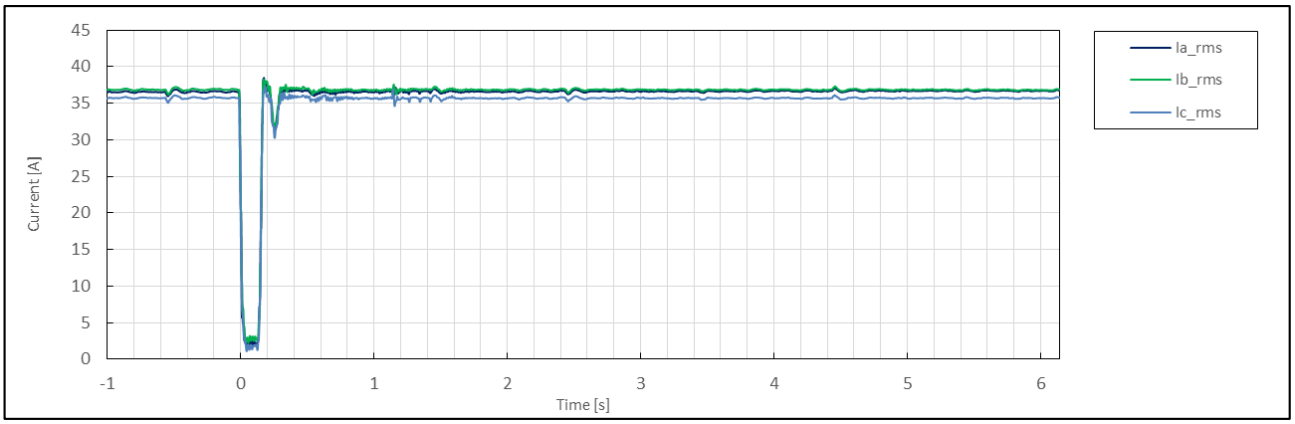


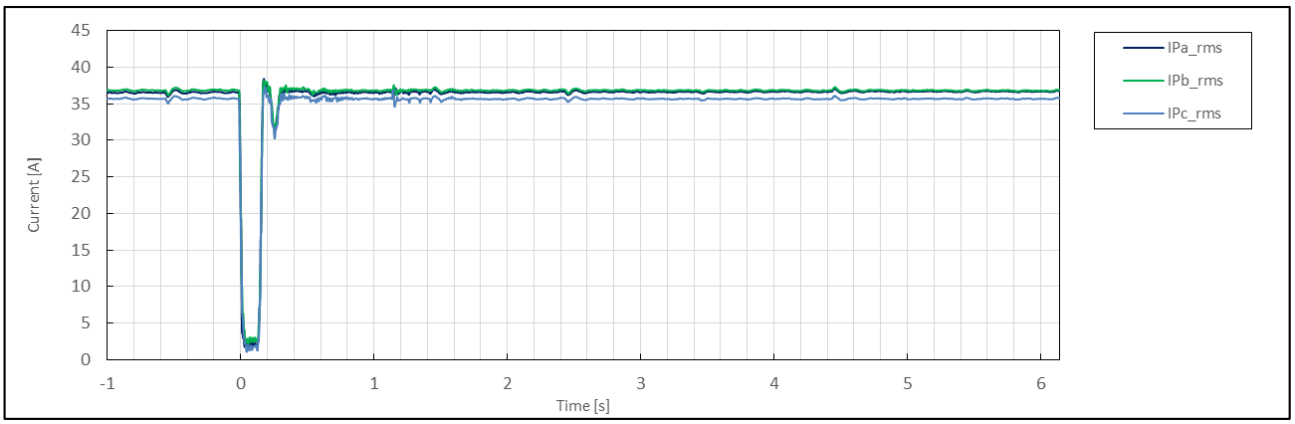


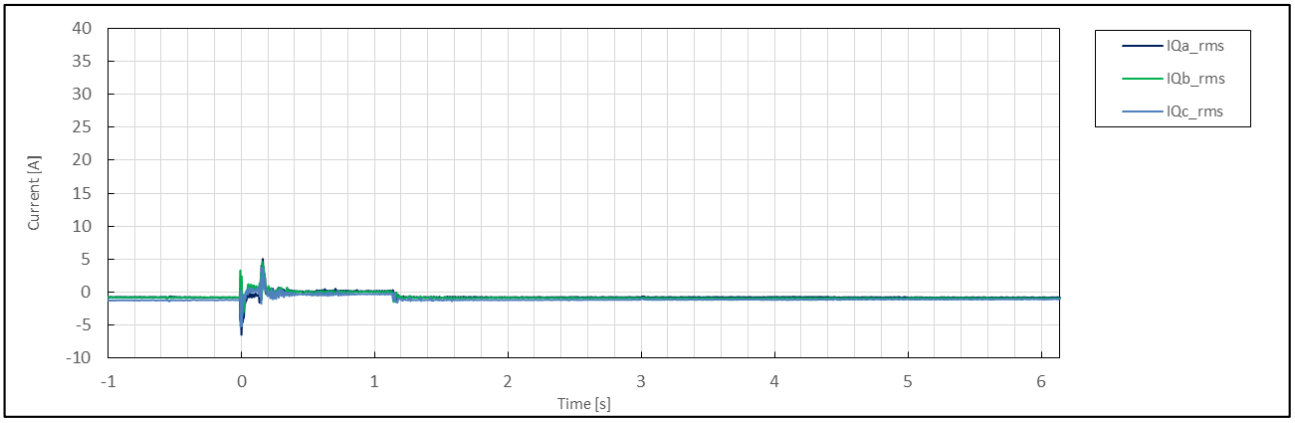


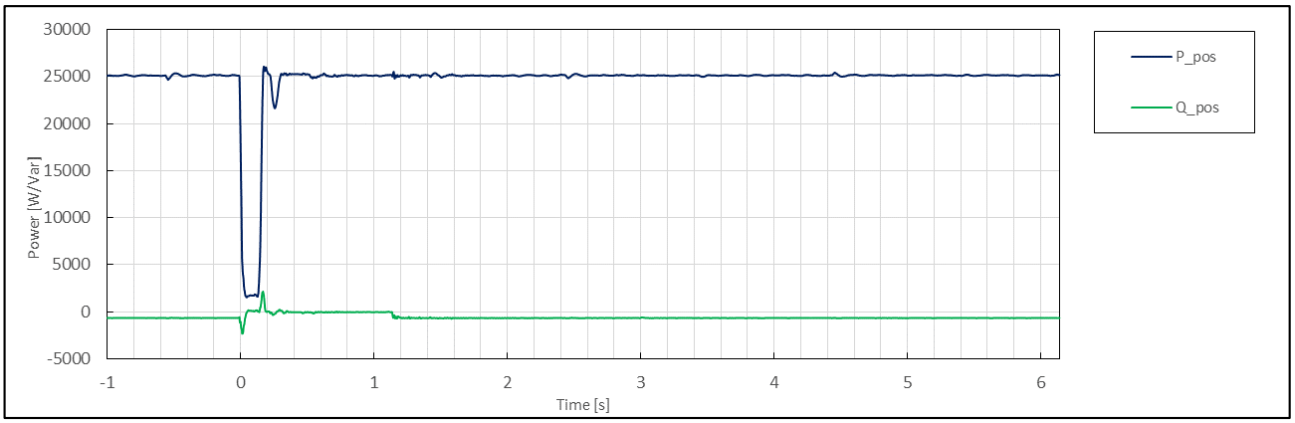


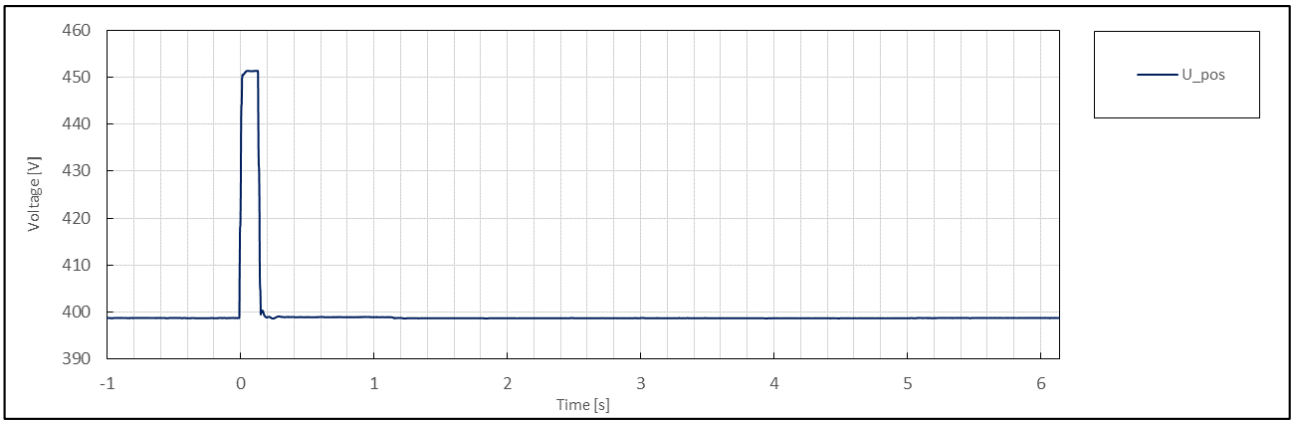

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

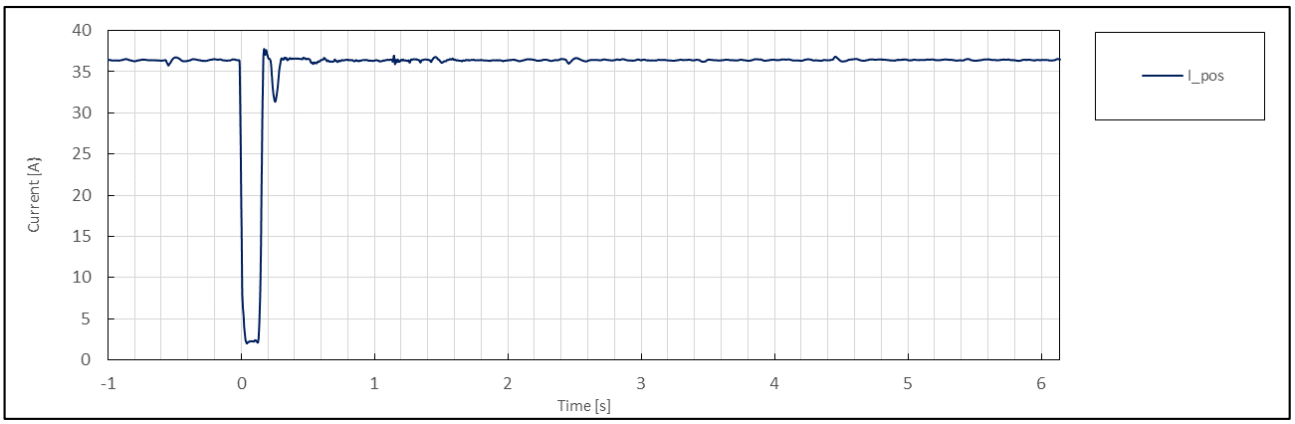

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

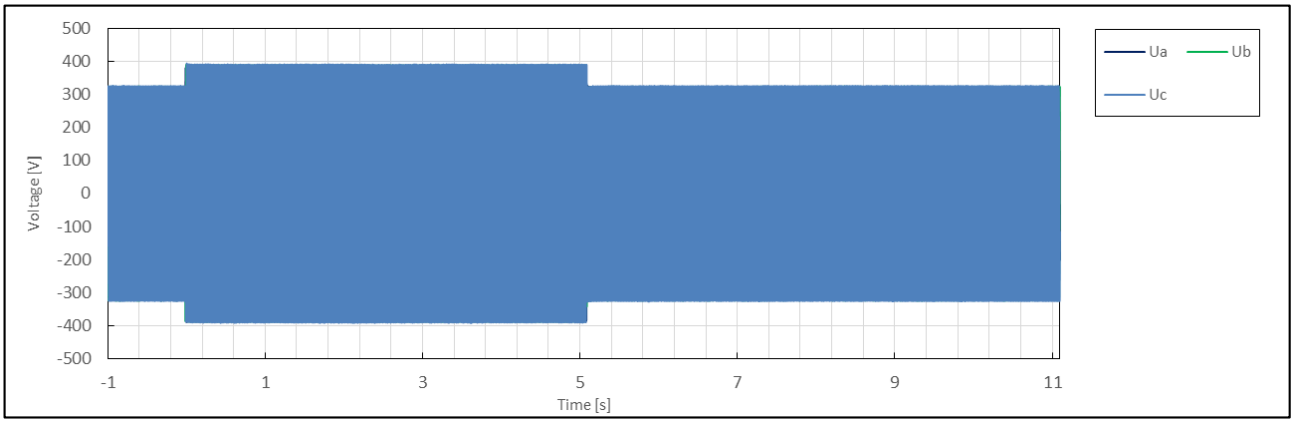

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
0
1
2
3
4
5
6
Time [s]
P_pos
Q_pos

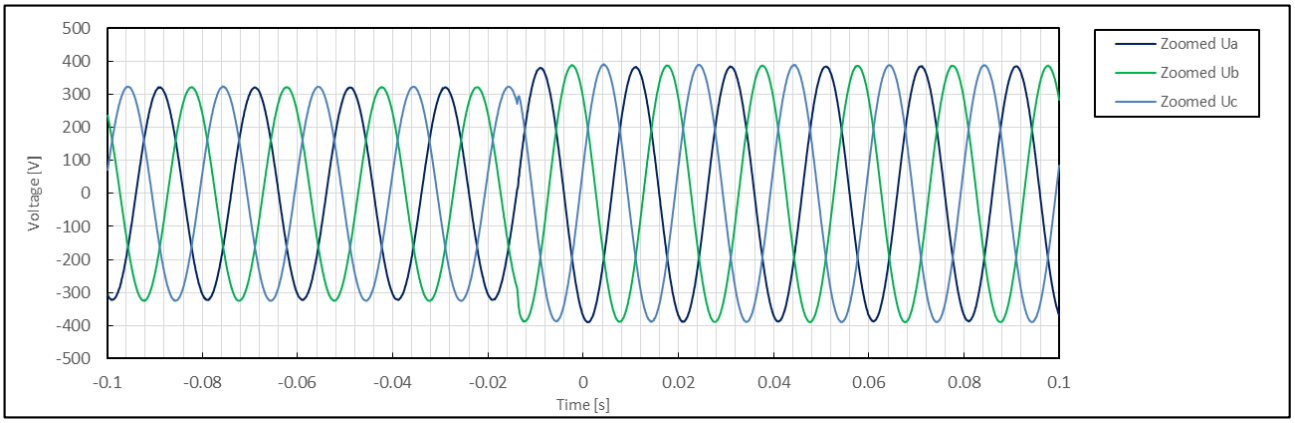

460
450
440
430
420
410
400
390
Voltage [V]
-1
0
1
2
3
4
5
6
Time [s]
U_pos

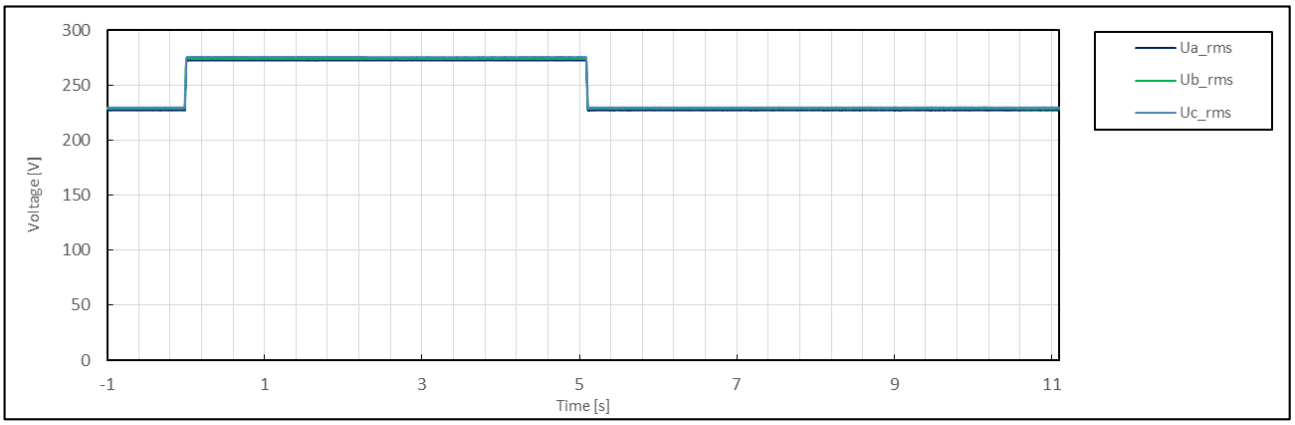

40
35
30
25
20
15
10
5
0
Current [A]
-1
0
1
2
3
4
5
6
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	6.1
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:44:06
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.20
	5	Setting dip duration		--		5098
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	5097
	8	Fault duration in empty load test	Total	--	ms	5098
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.20
	10		Pos.		p.u.	1.20
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.20
	19	Line current	Phase 1	t1+60ms	p.u.	0.02
	20		Phase 2			0.02
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.02
	23		Phase 2			0.02
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.042
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

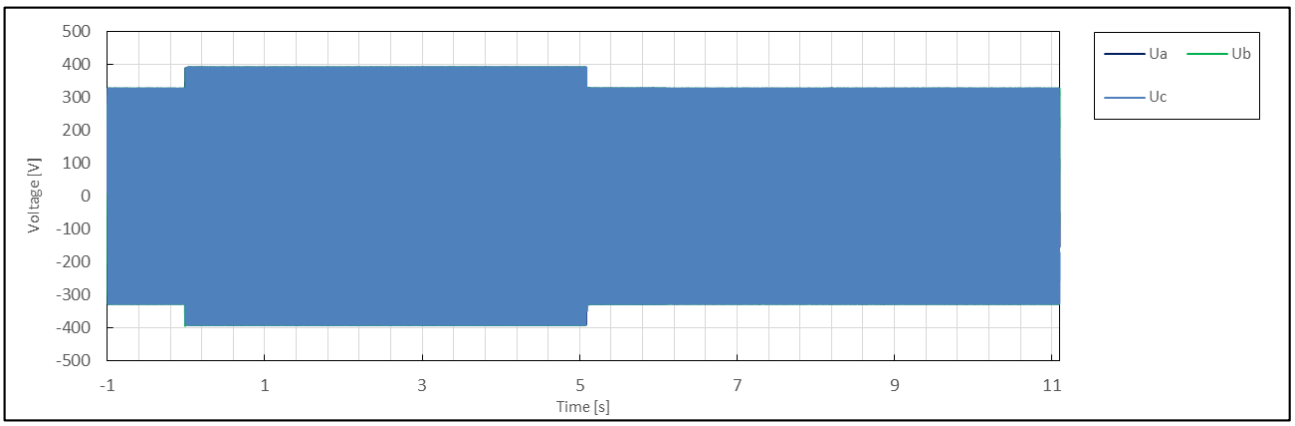
Test No. 6.1 idle test

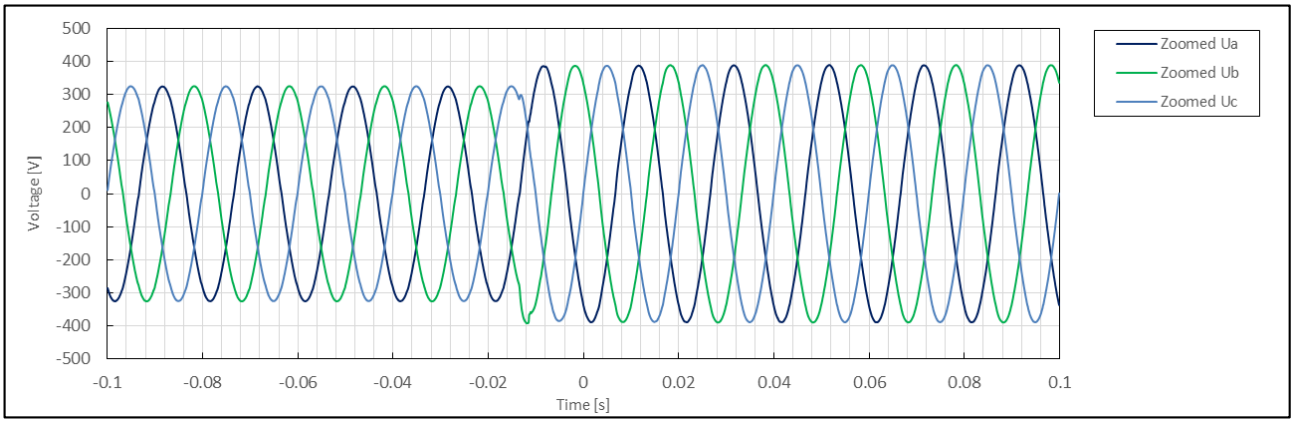


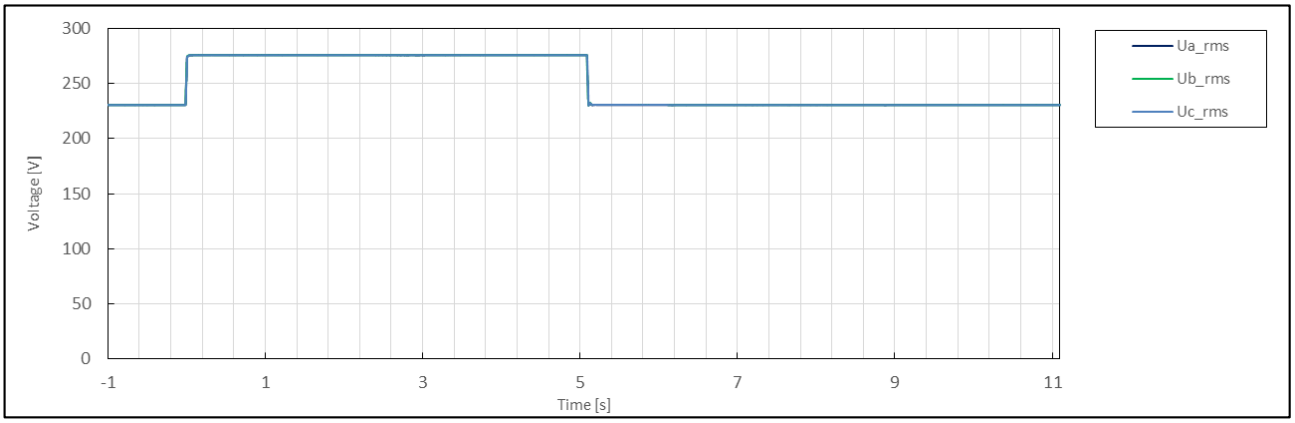


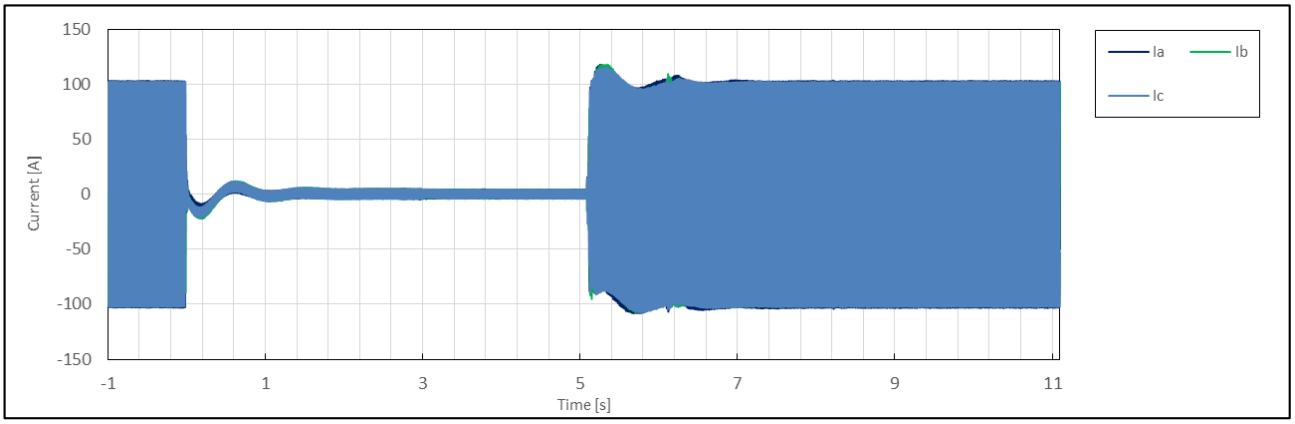


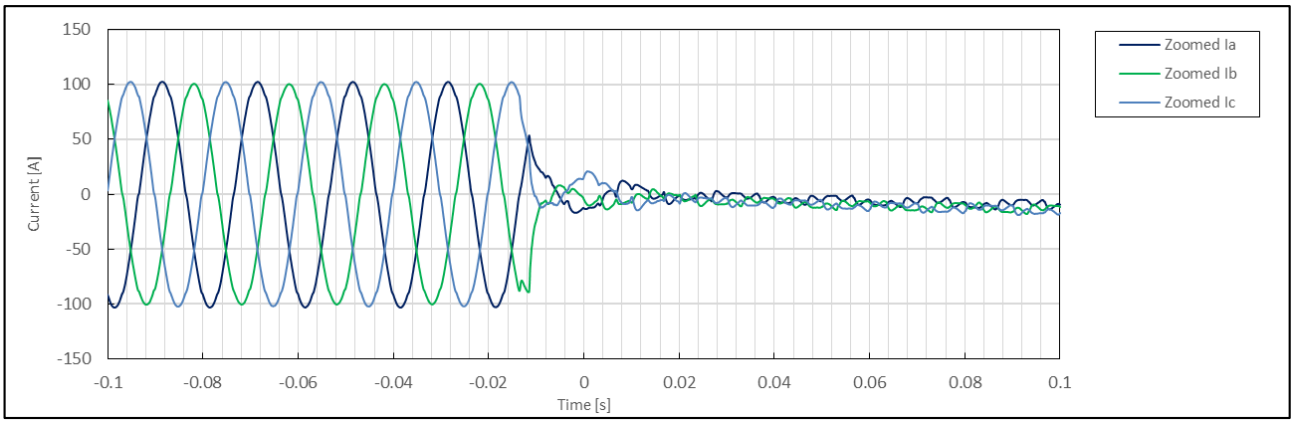
Test No. 6.1 with PGU

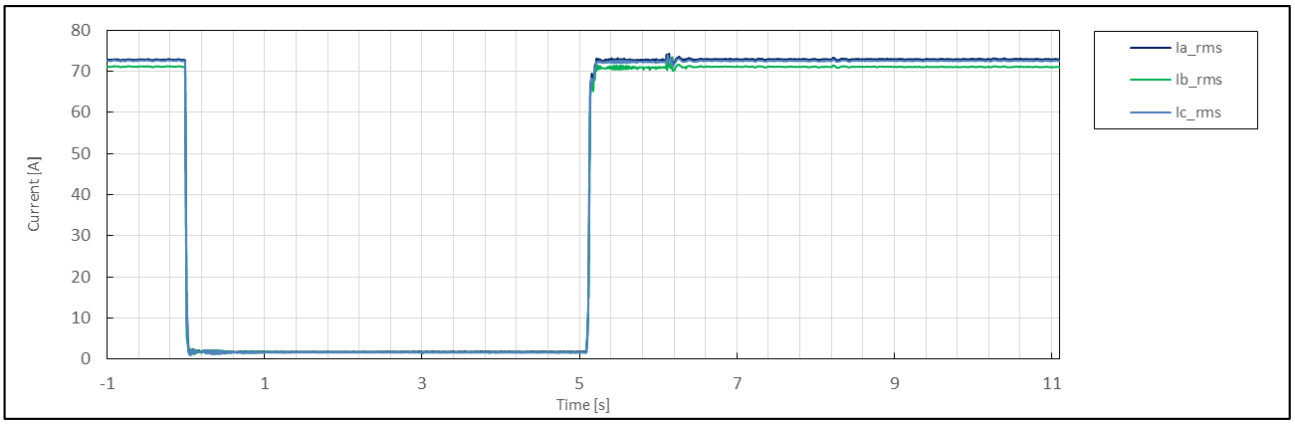


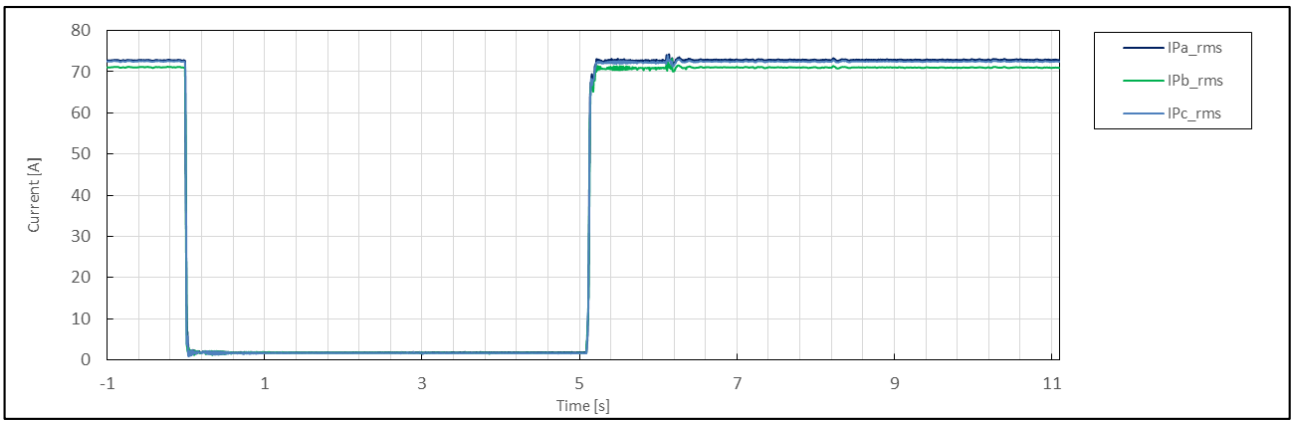


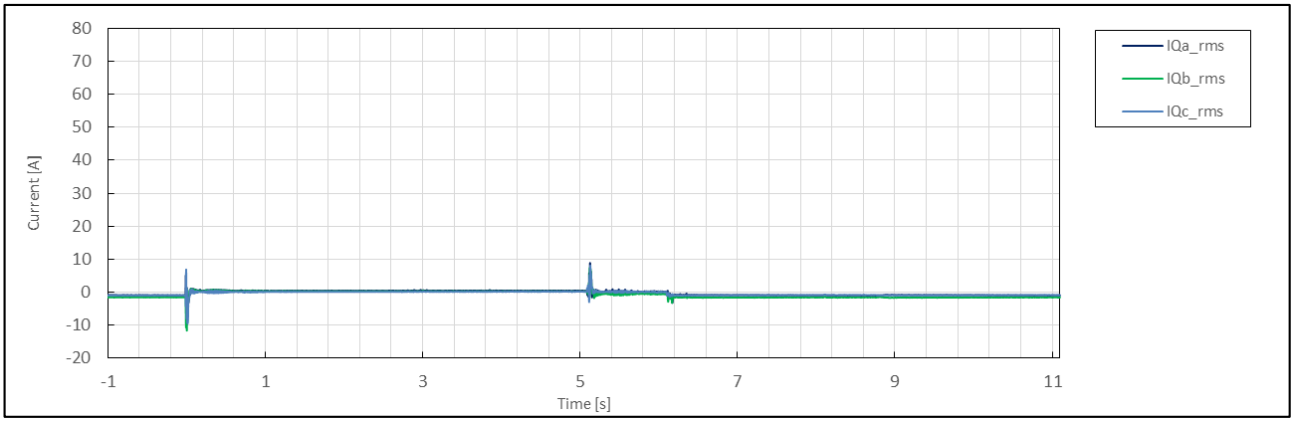


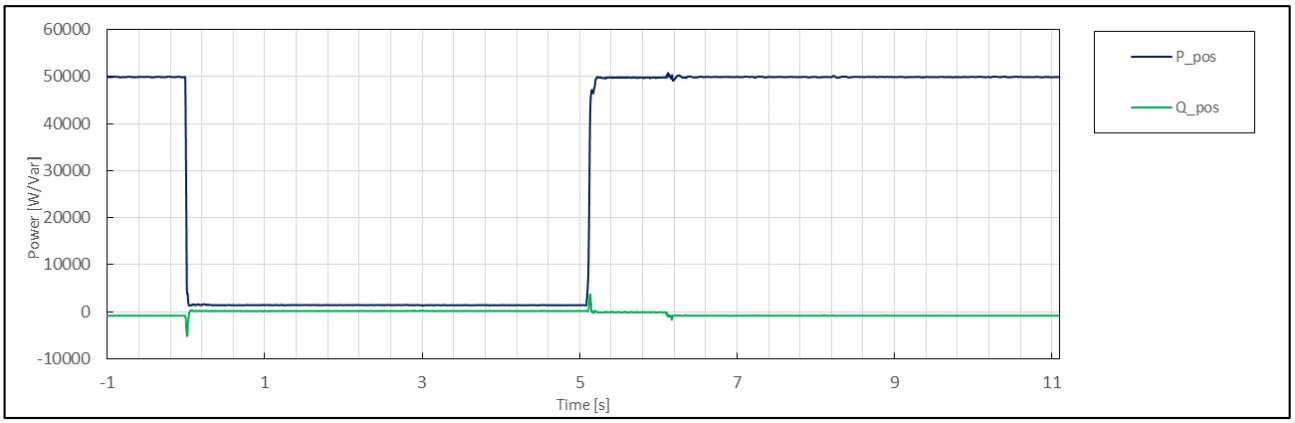


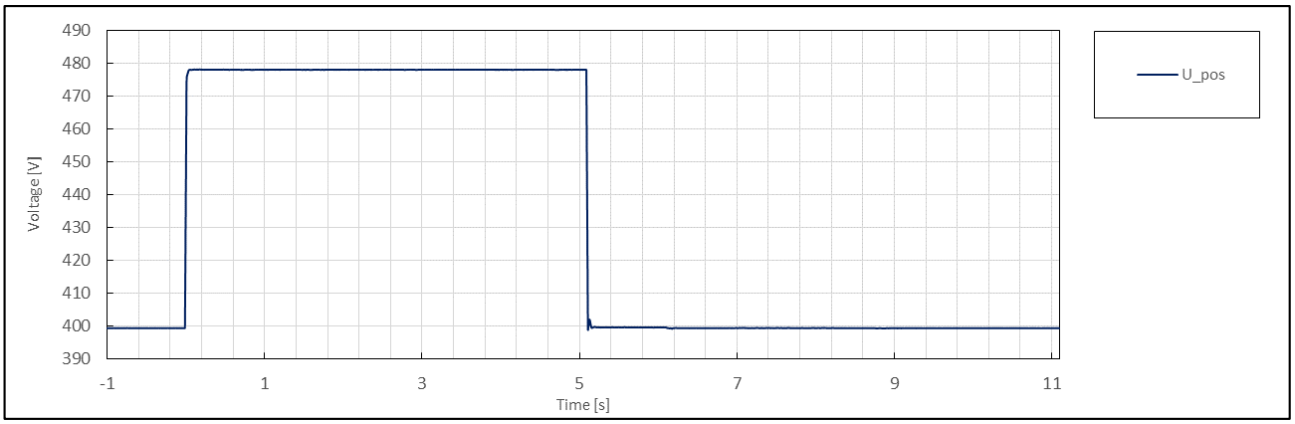

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

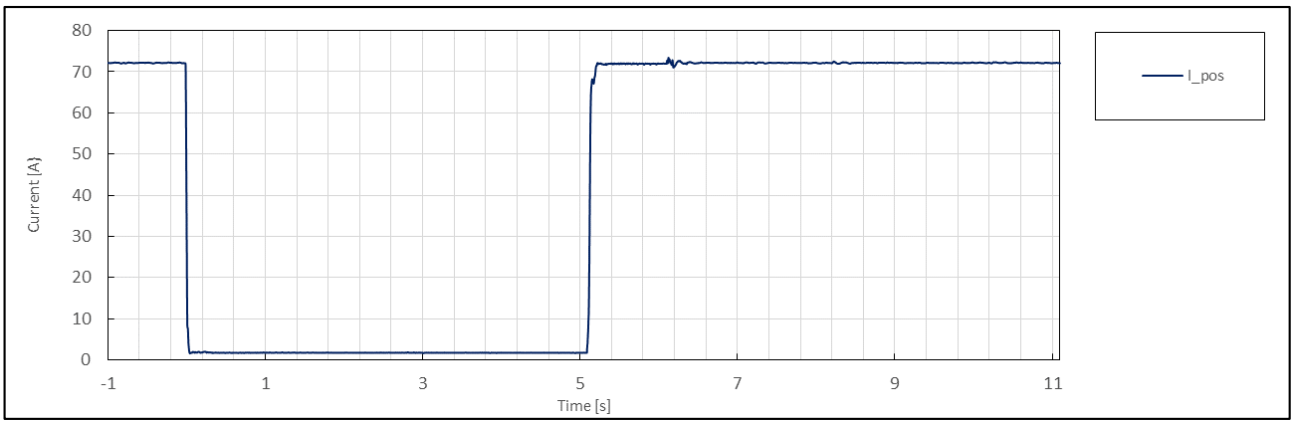

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

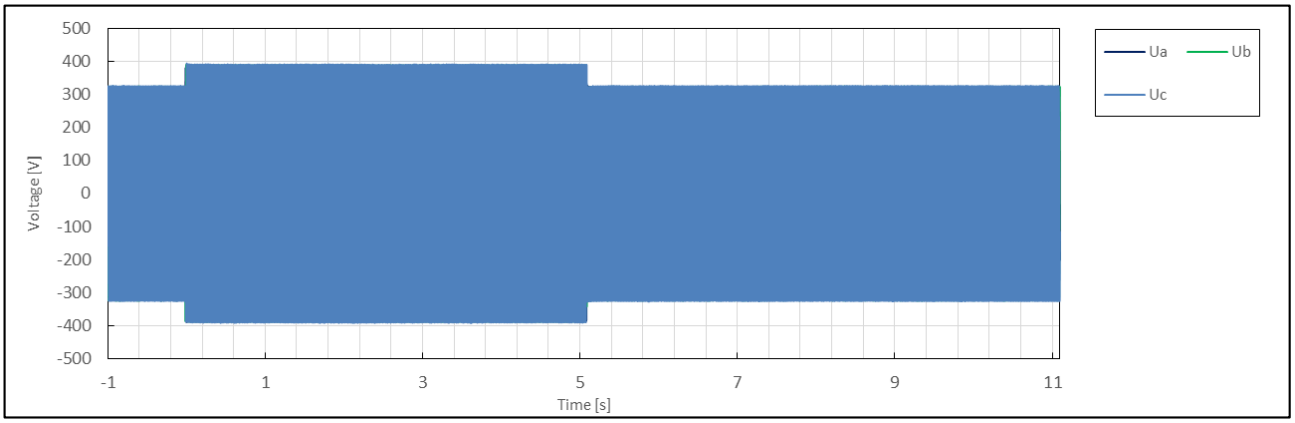

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
1
3
5
7
9
11
Time [s]
P_pos
Q_pos

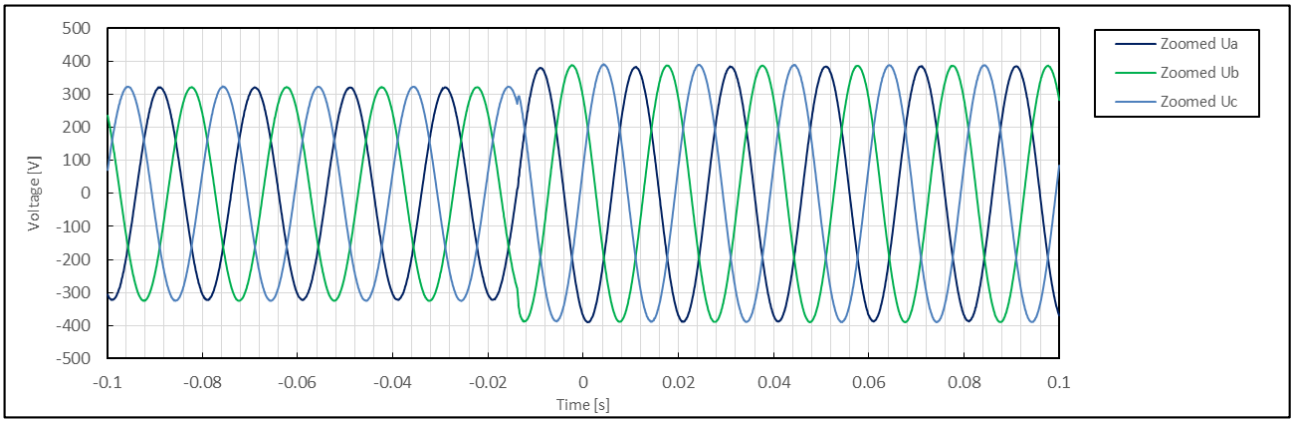

490
480
470
460
450
440
430
420
410
400
390
Voltage [V]
-1
1
3
5
7
9
11
Time [s]
U_pos

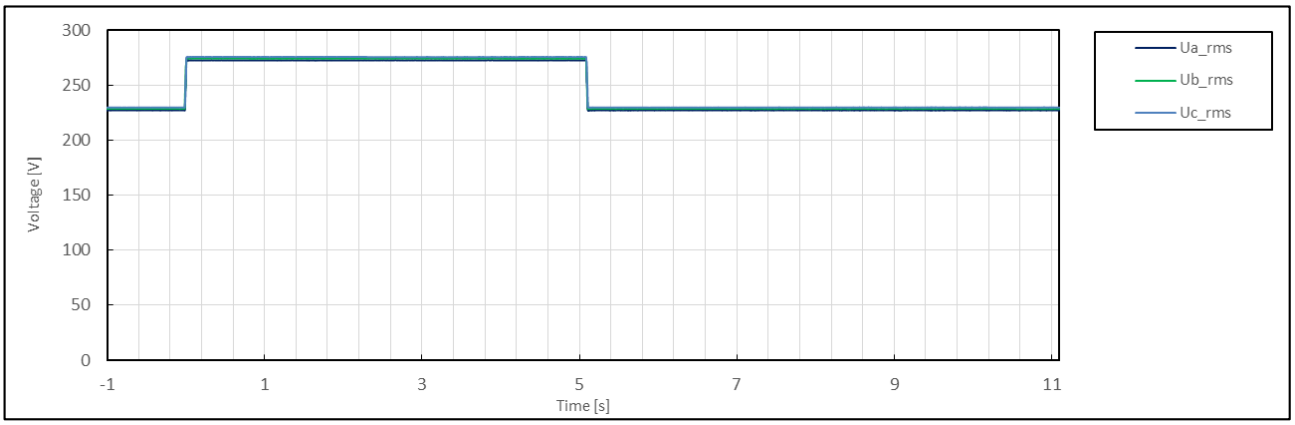

80
70
60
50
40
30
20
10
0
Current [A]
-1
1
3
5
7
9
11
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	6.2
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:44:24
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.20
	5	Setting dip duration		--		5098
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	5097
	8	Fault duration in empty load test	Total	--	ms	5098
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.20
	10		Pos.		p.u.	1.20
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.	-0.01
	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.	1.20
	19	Line current	Phase 1	t1+60ms	p.u.	0.02
	20		Phase 2			0.02
	21		Phase 3			0.03
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.02
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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	0.135
	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

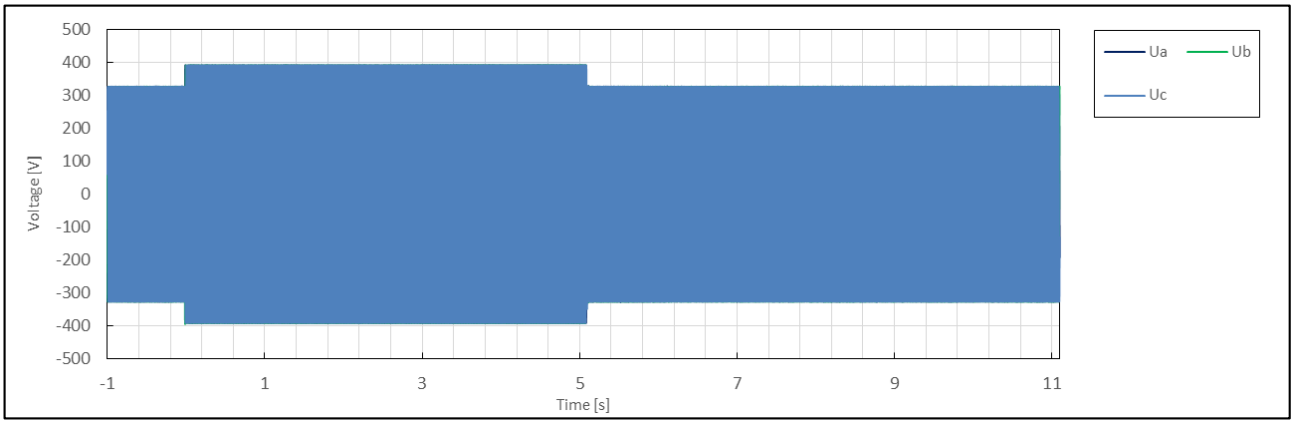
Test No. 6.2 idle test

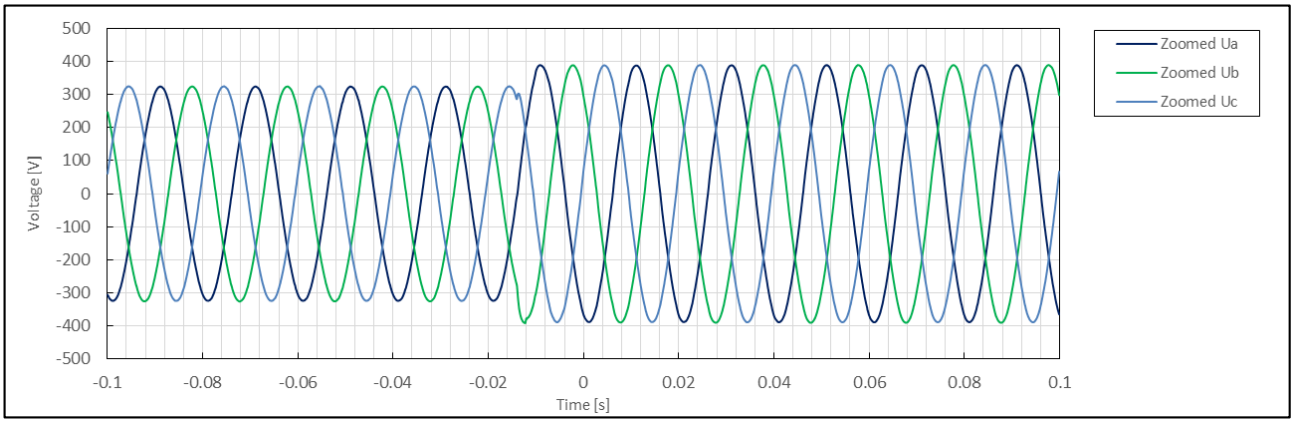


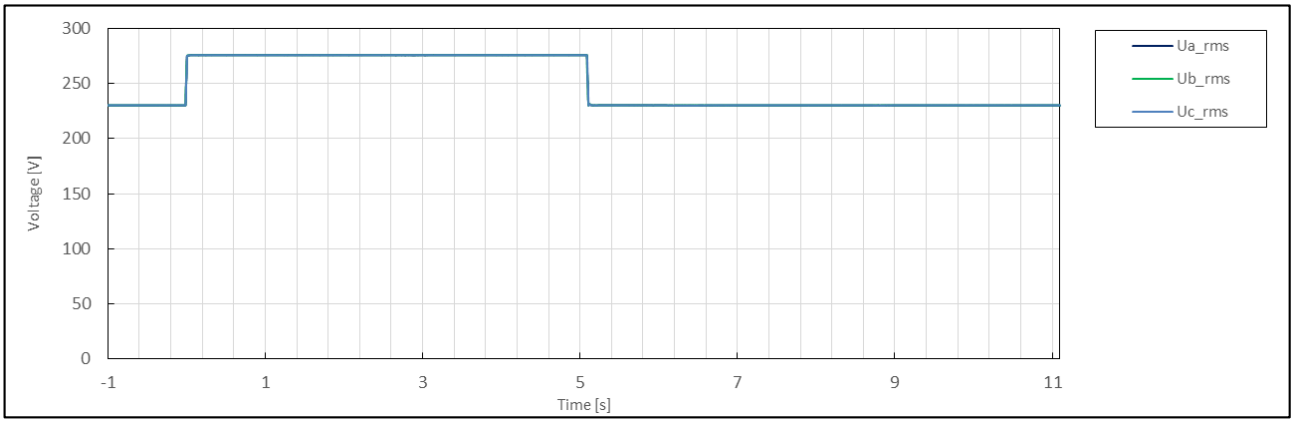


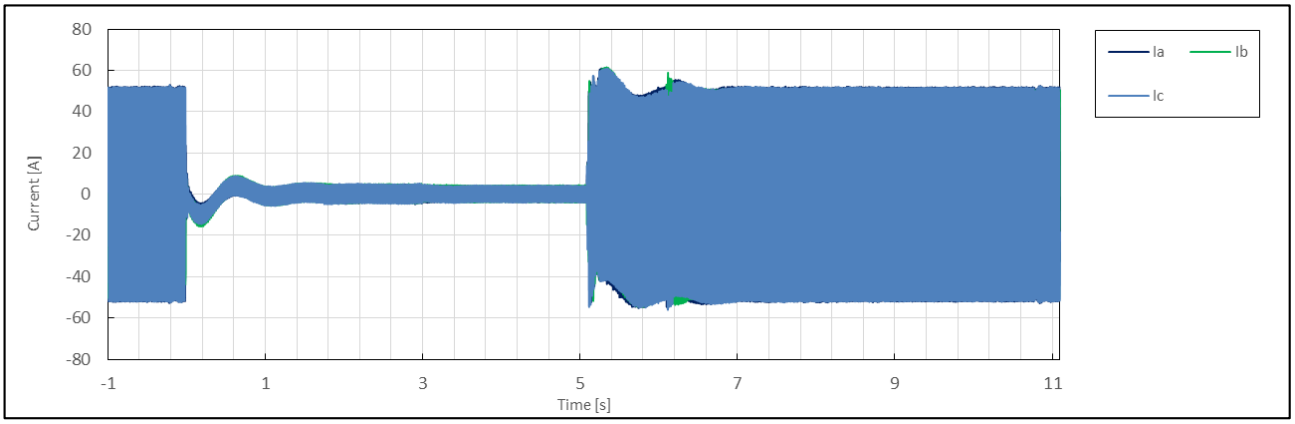


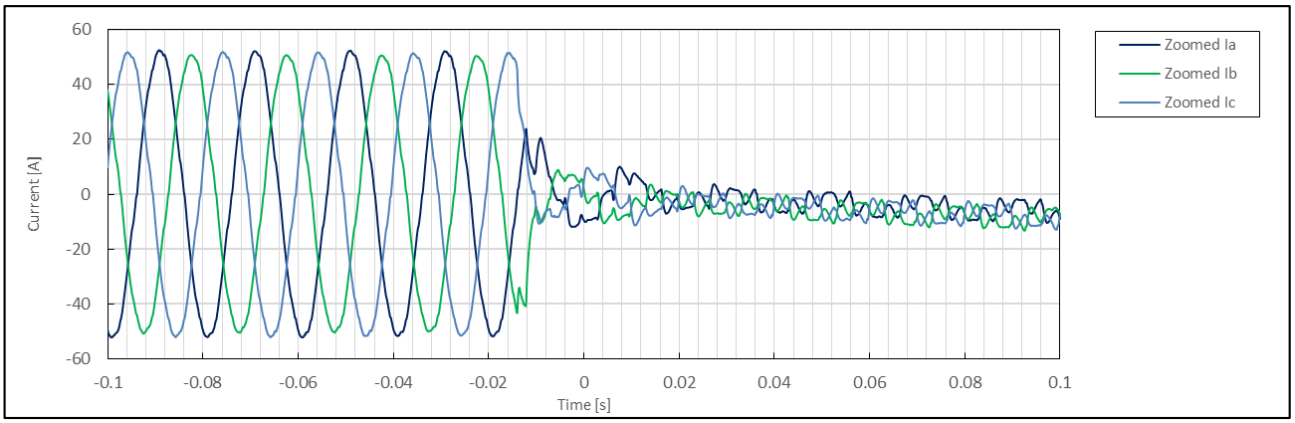
Test No. 6.2 with PGU

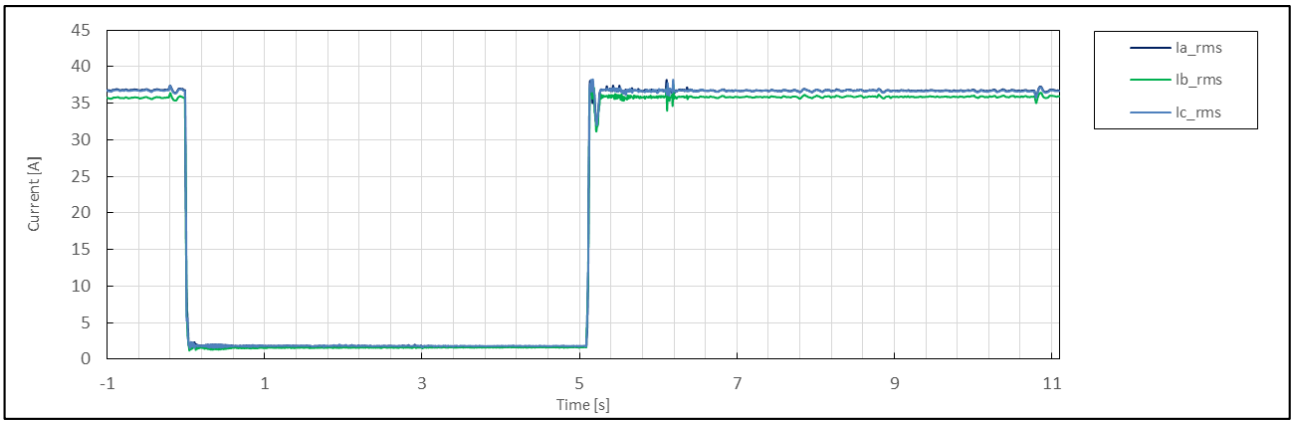


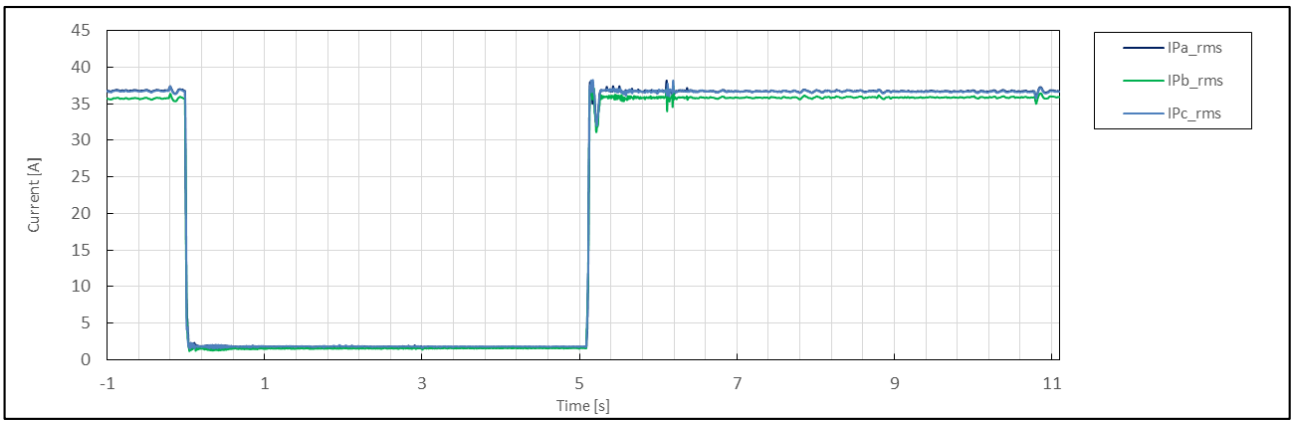


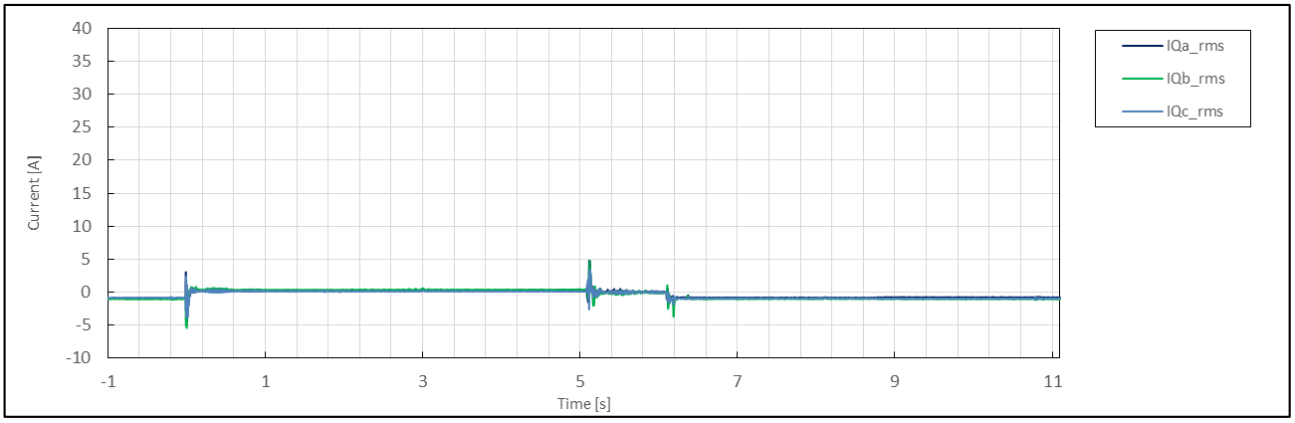


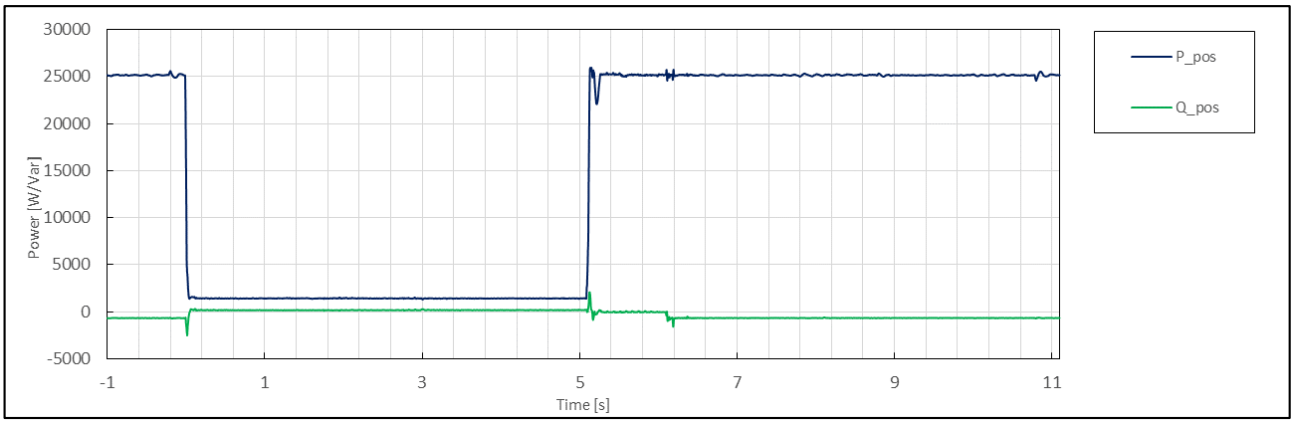


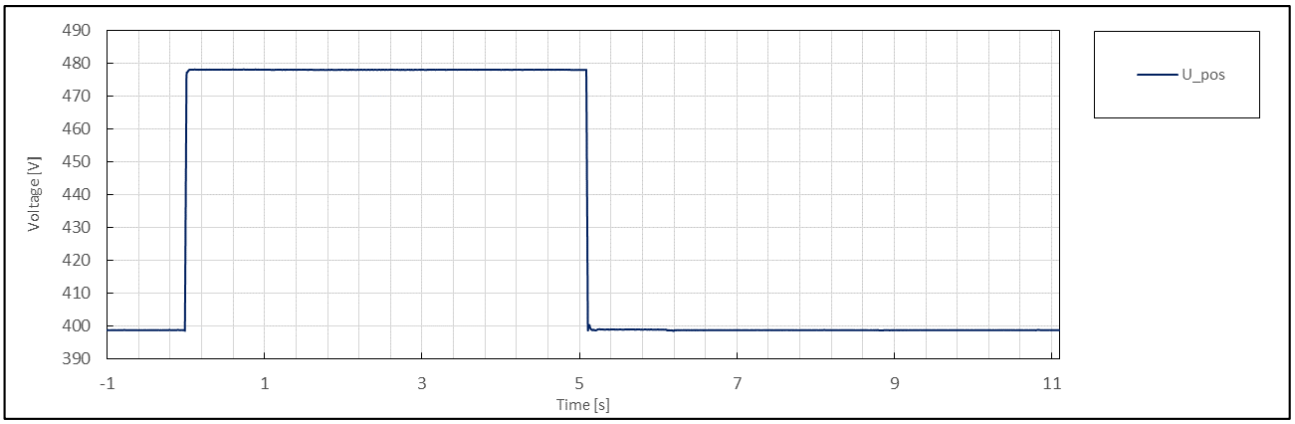

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

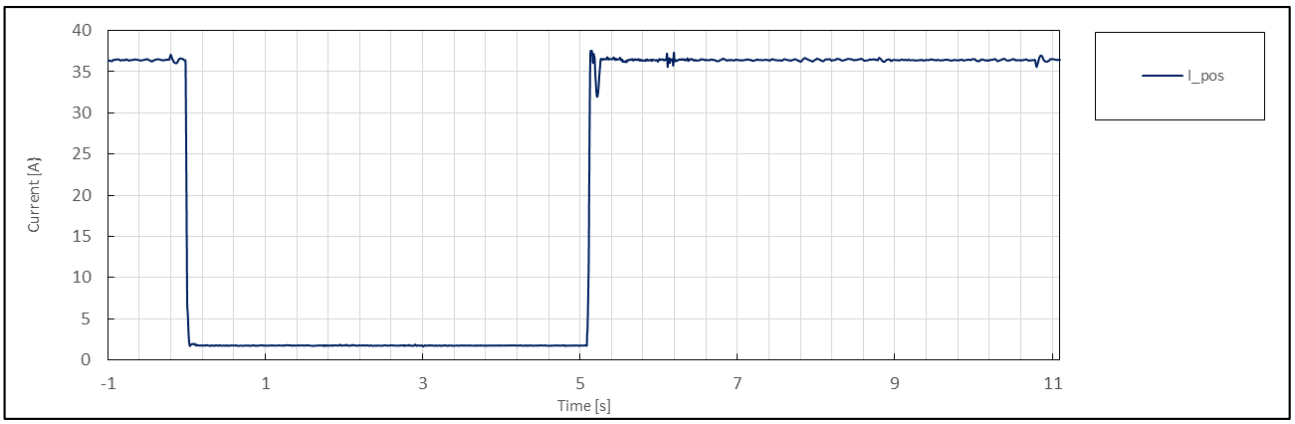

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

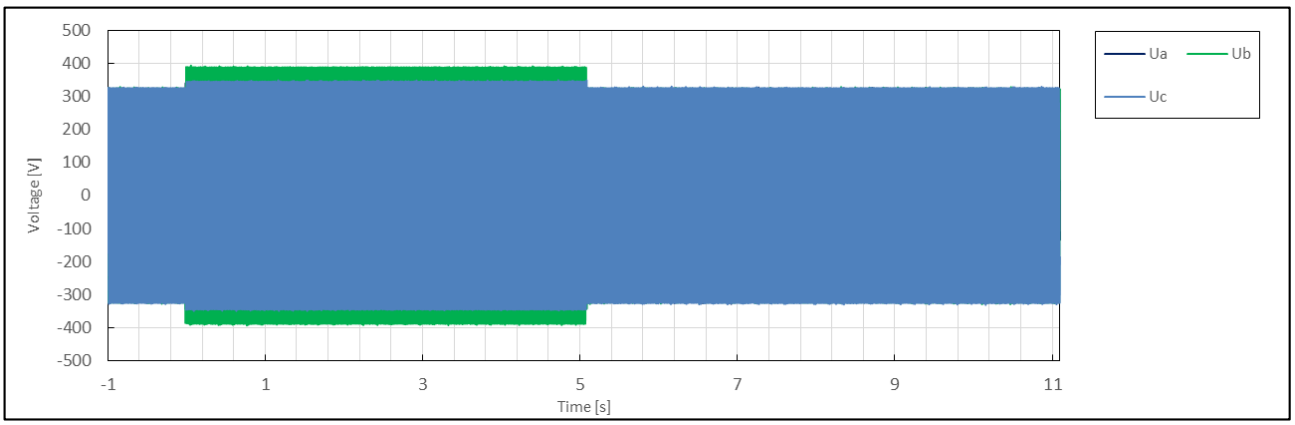

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
1
3
5
7
9
11
Time [s]
P_pos
Q_pos

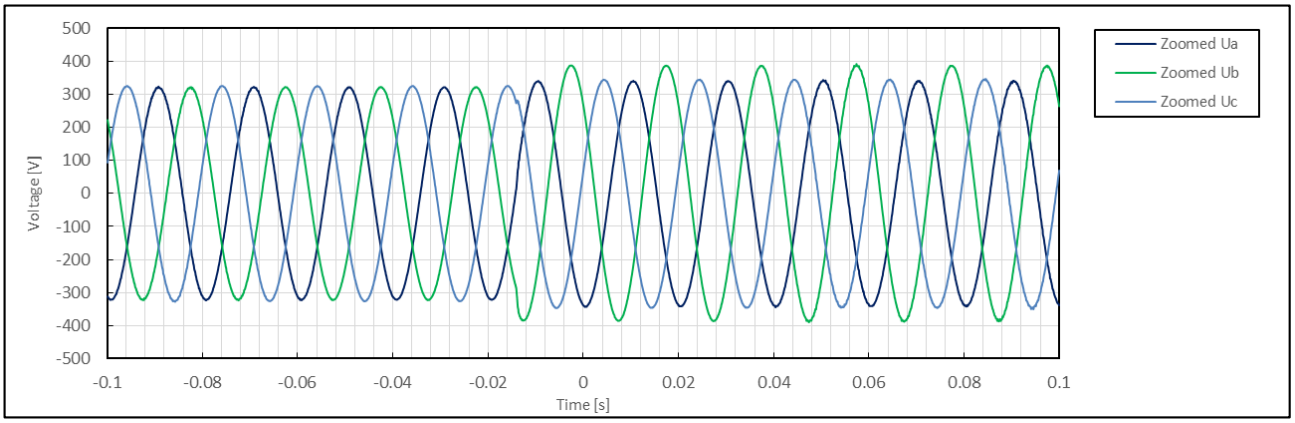

490
480
470
460
450
440
430
420
410
400
390
Voltage [V]
-1
1
3
5
7
9
11
Time [s]
U_pos

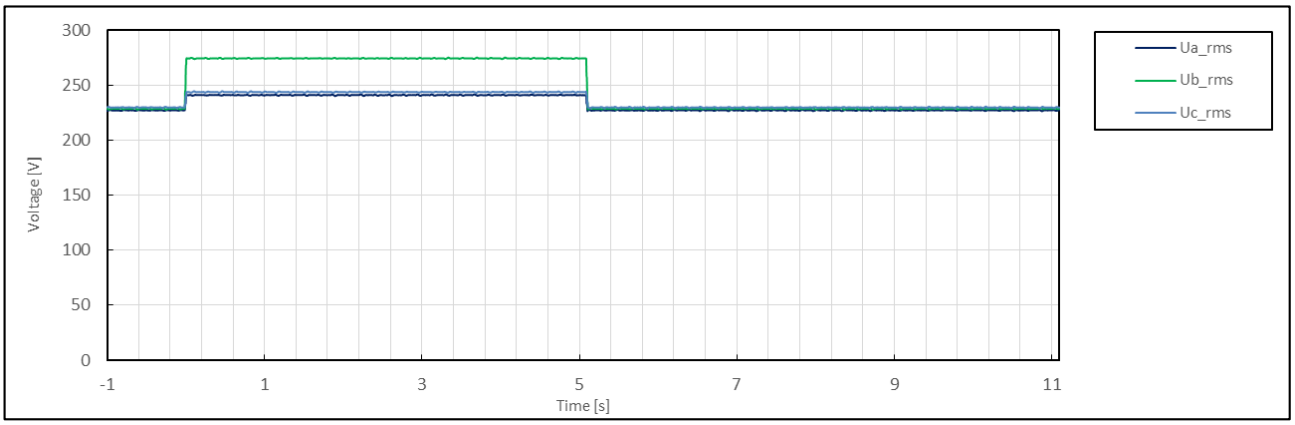

40
35
30
25
20
15
10
5
0
Current [A]
-1
1
3
5
7
9
11
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	6.3
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:44:52
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.19
	5	Setting dip duration		--		5097
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	5096
	8	Fault duration in empty load test	Total	--	ms	5097
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.20
	10		Pos.		p.u.	1.10
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.20
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.02
	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.04
	23		Phase 2			0.02
	24		Phase 3			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.016
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

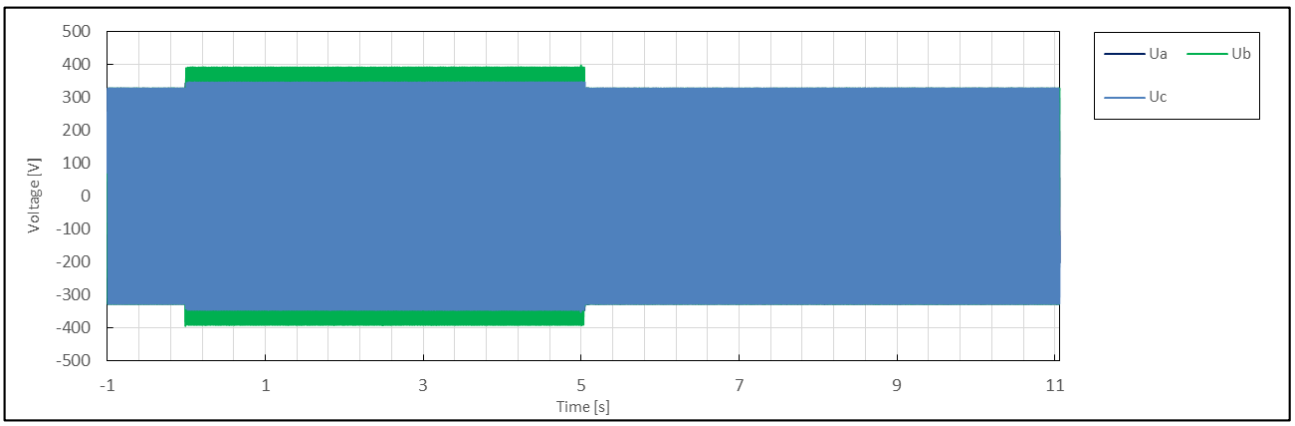
Test No. 6.3 idle test

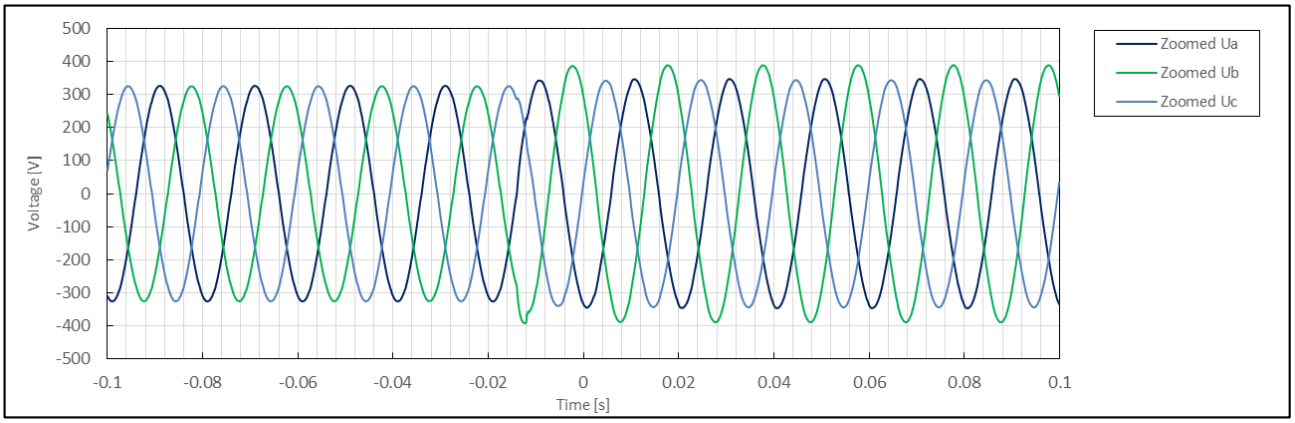


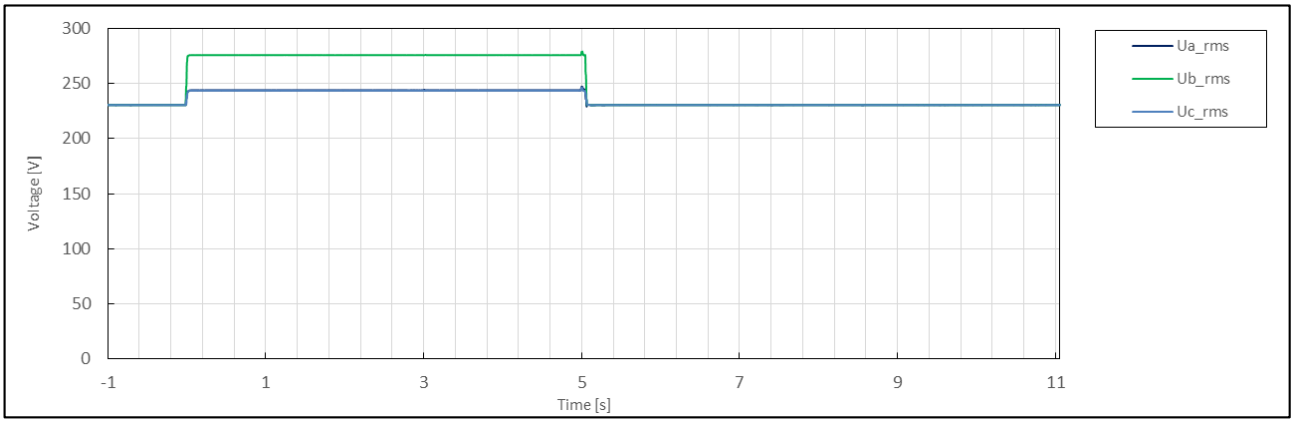


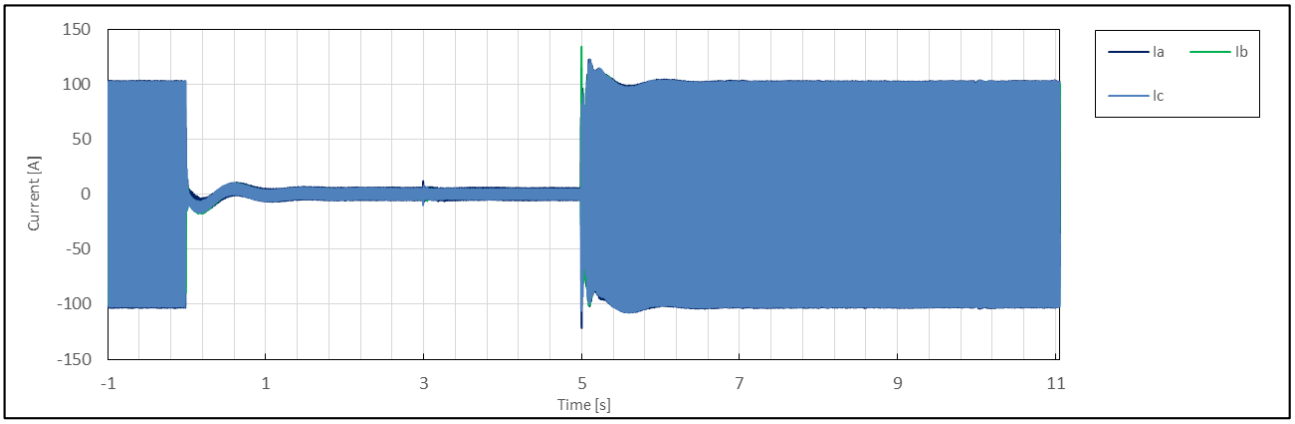


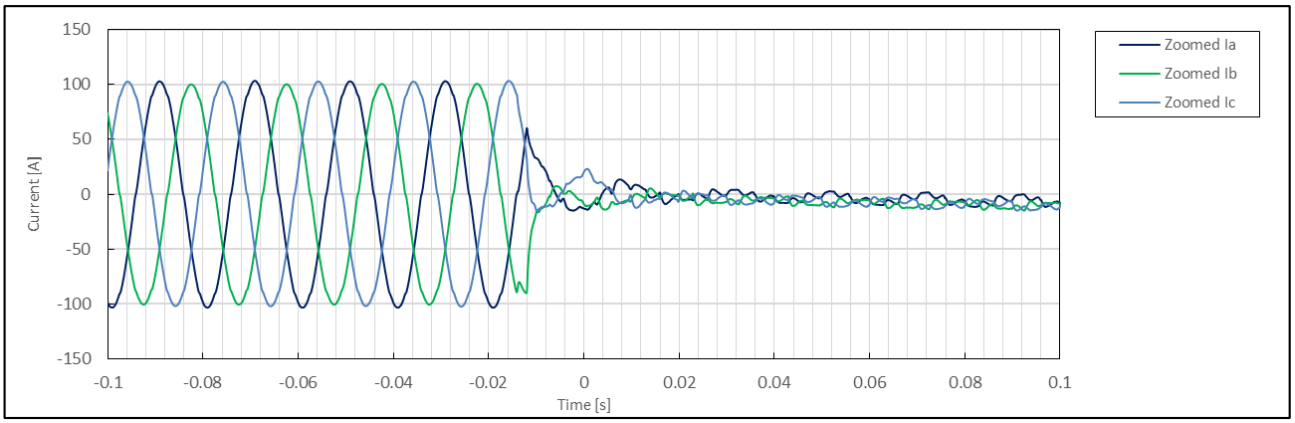
Test No. 6.3 with PGU

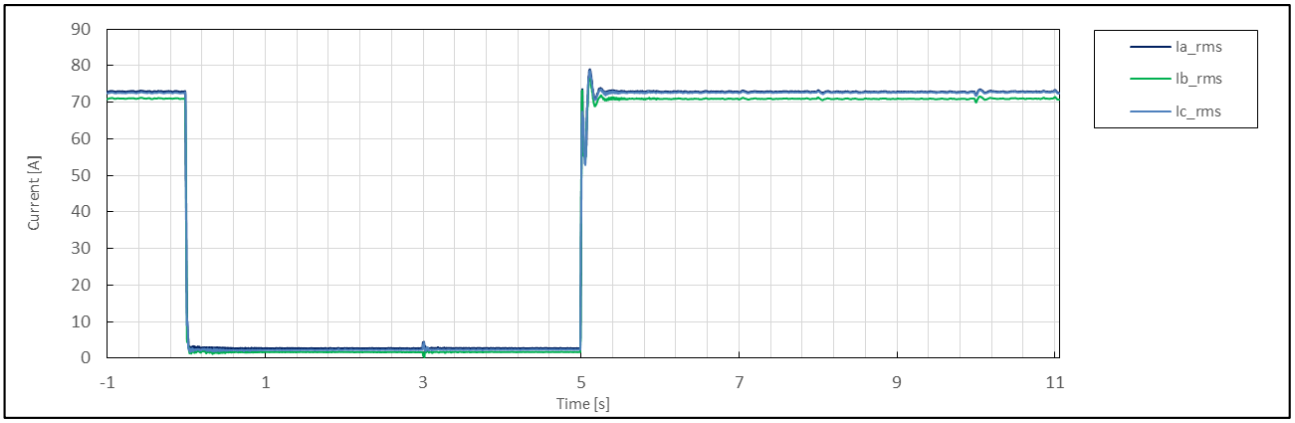


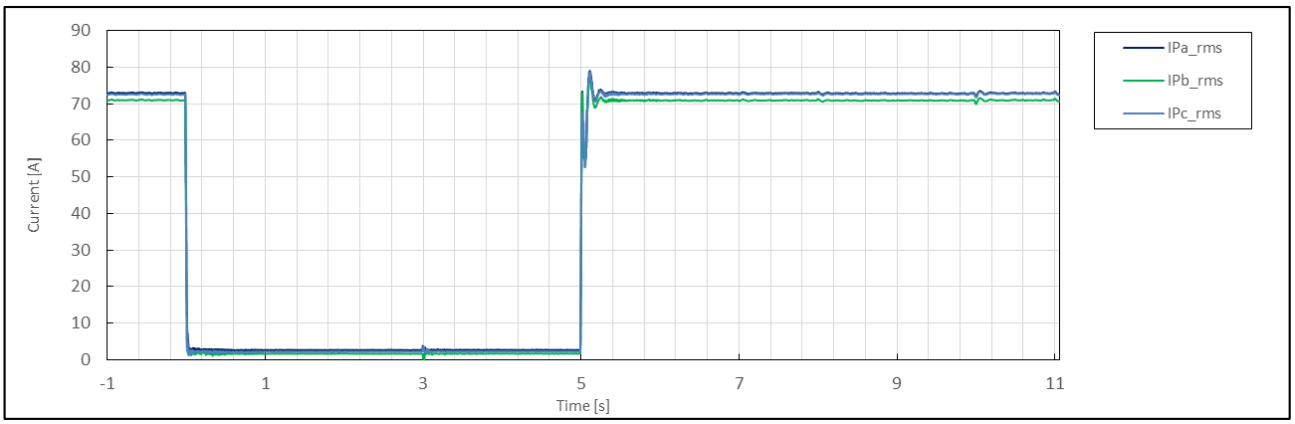


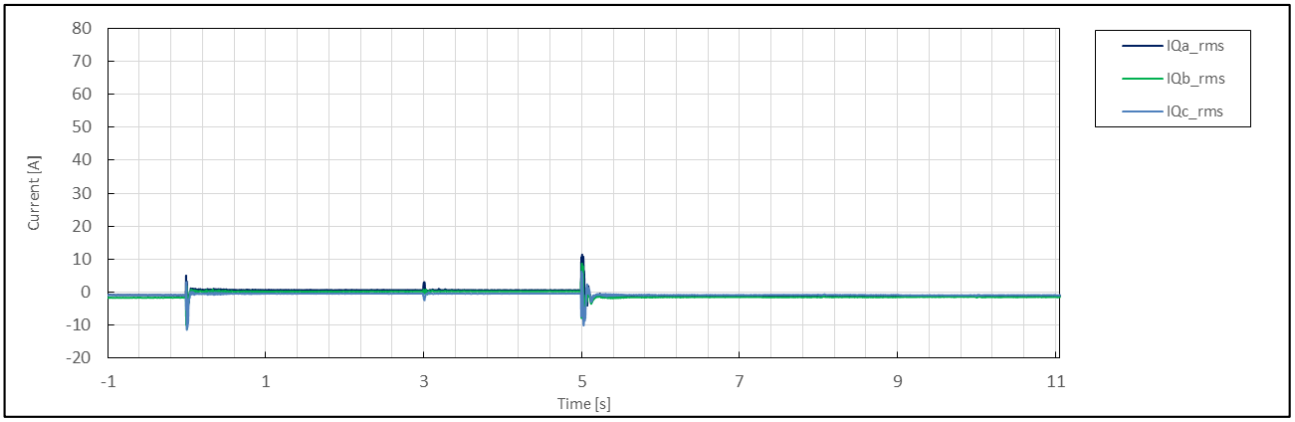


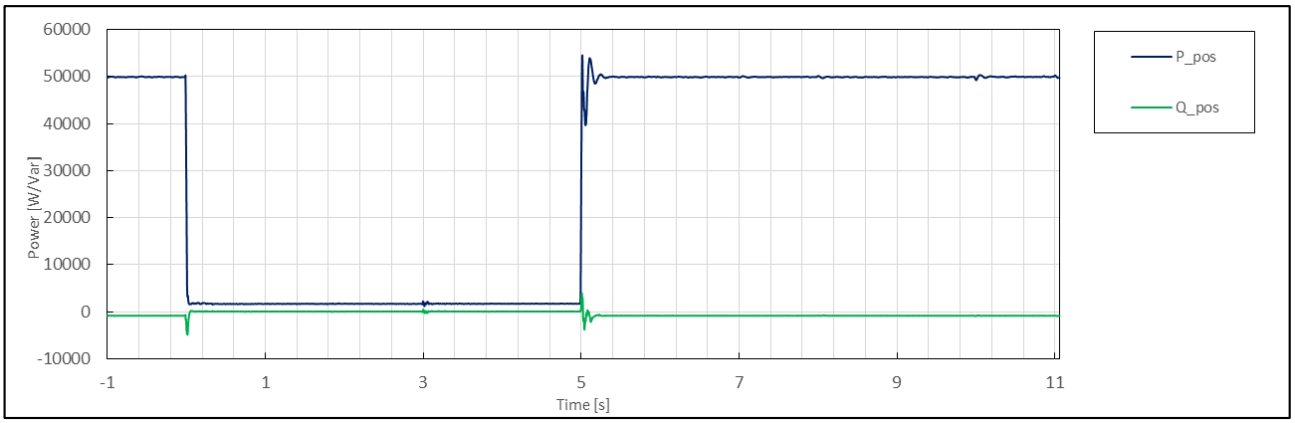


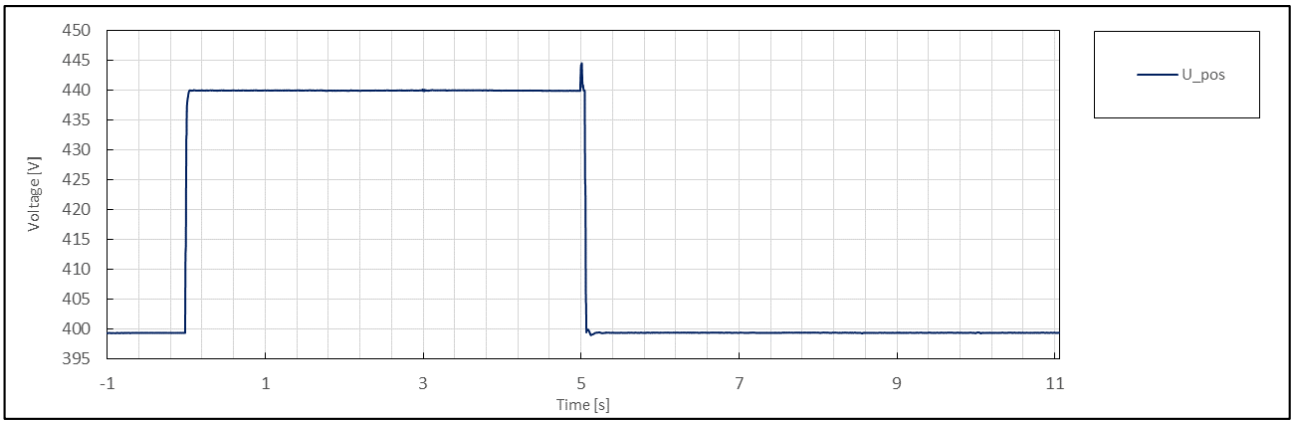

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

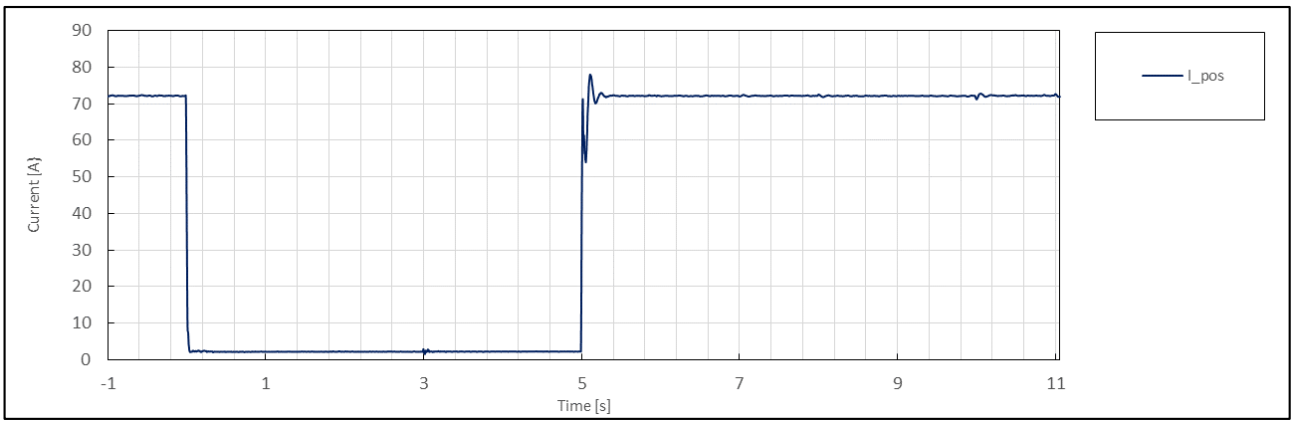

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

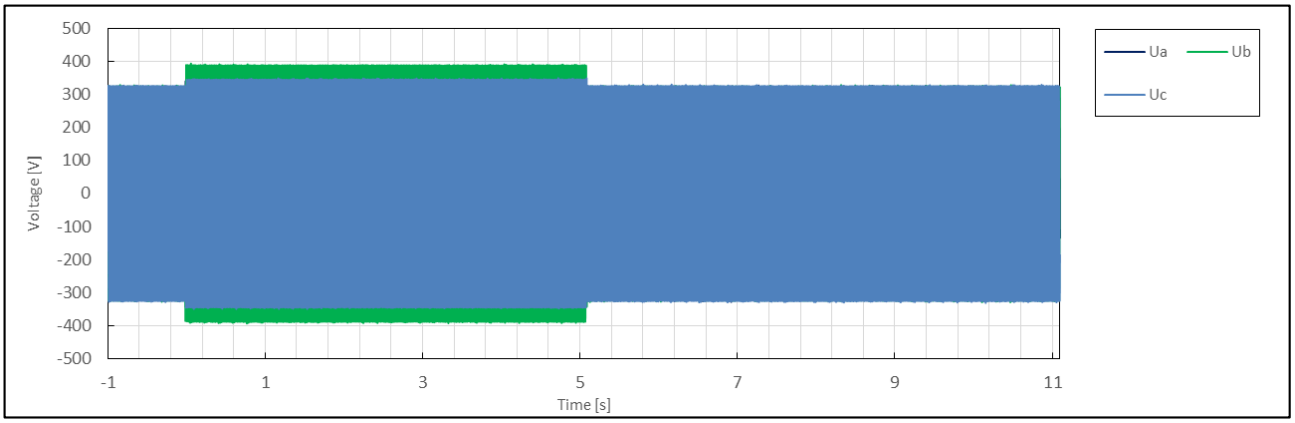

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
1
3
5
7
9
11
Time [s]
P_pos
Q_pos

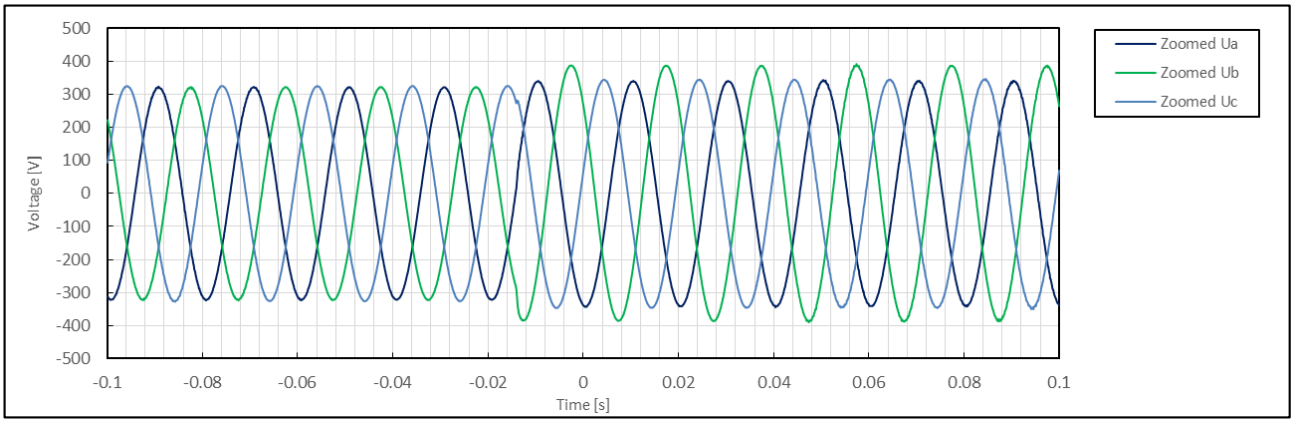

450
445
440
435
430
425
420
415
410
405
400
395
Voltage [V]
-1
1
3
5
7
9
11
Time [s]
U_pos

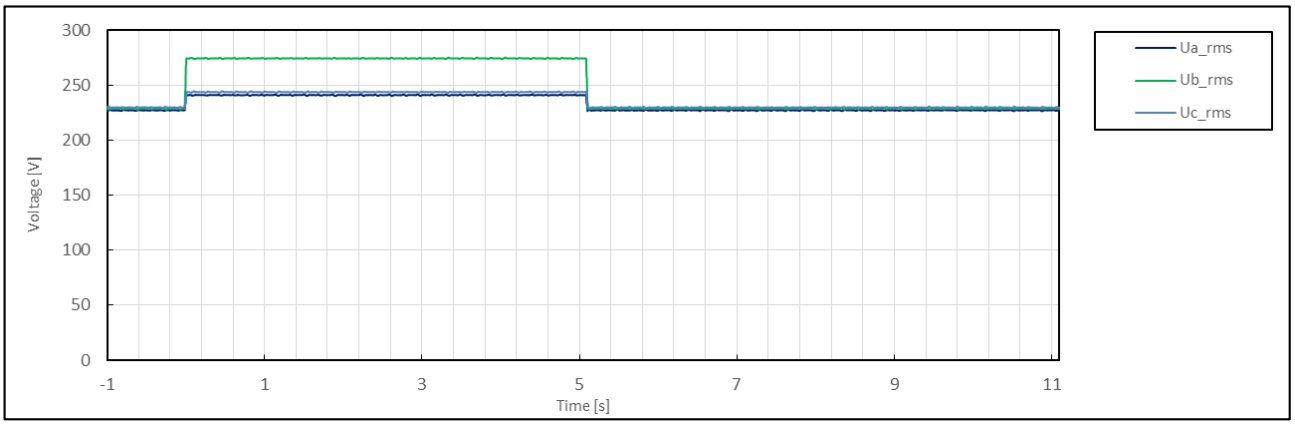

90
80
70
60
50
40
30
20
10
0
Current [A]
-1
1
3
5
7
9
11
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	6.4
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:45:16
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.19
	5	Setting dip duration		--		5097
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	5096
	8	Fault duration in empty load test	Total	--	ms	5097
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.20
	10		Pos.		p.u.	1.10
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.	-0.01
	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.	1.20
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	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			0.03
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.04
	26		Pos.			0.04
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	0.200
	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

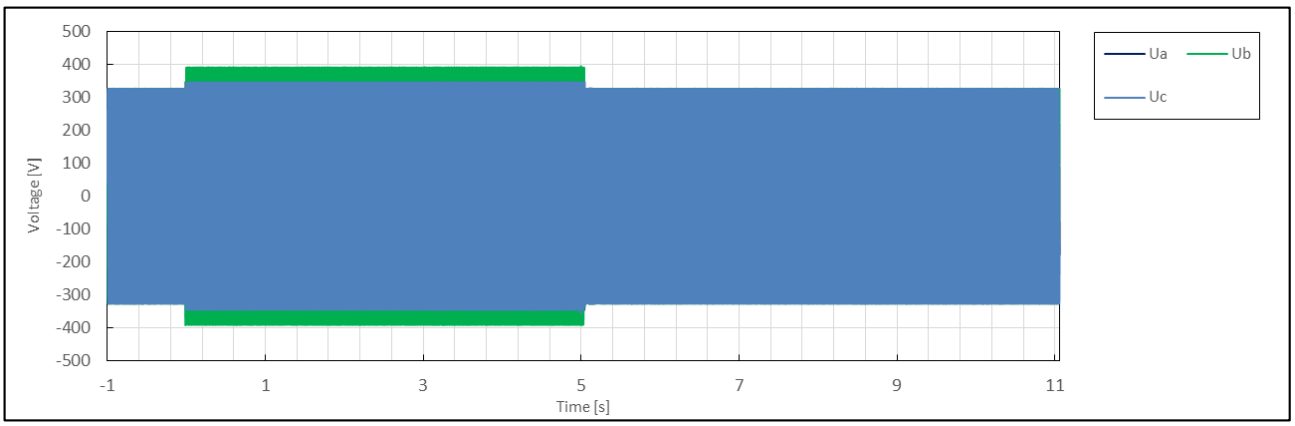
Test No. 6.4 idle test

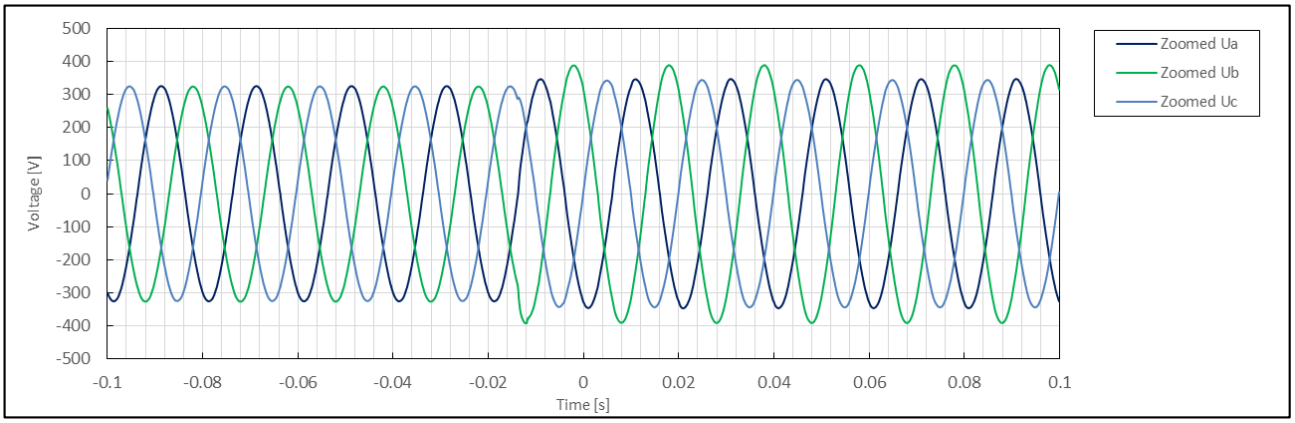


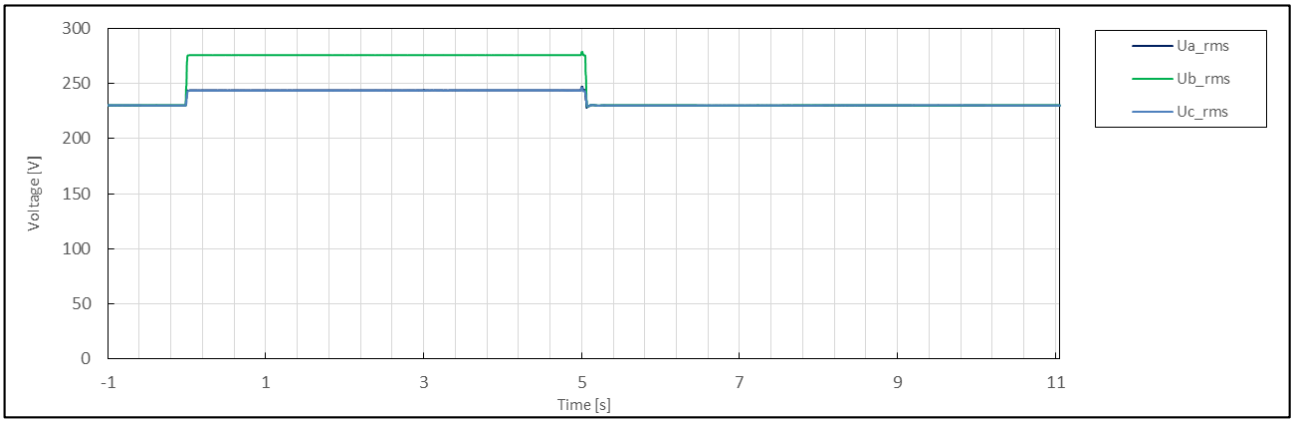


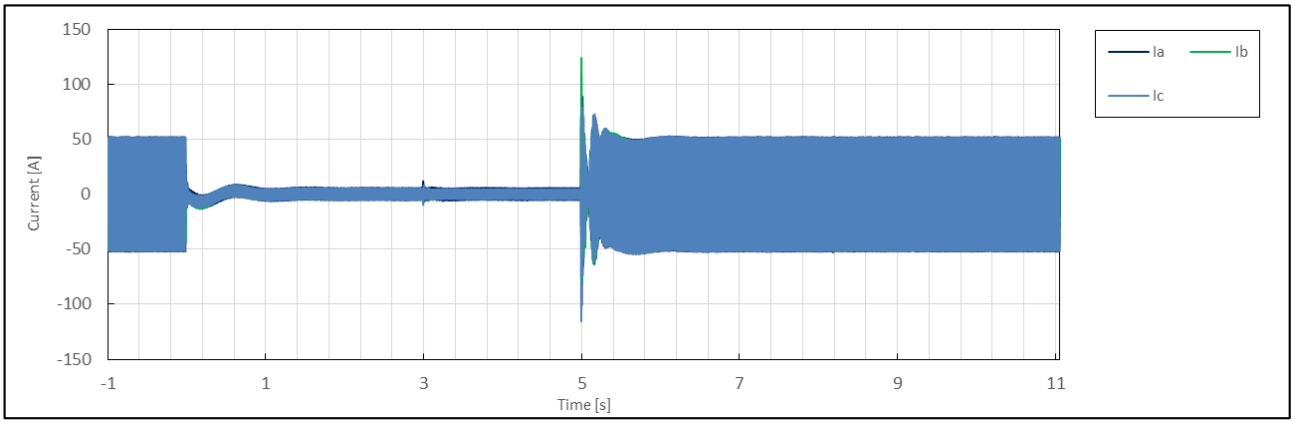


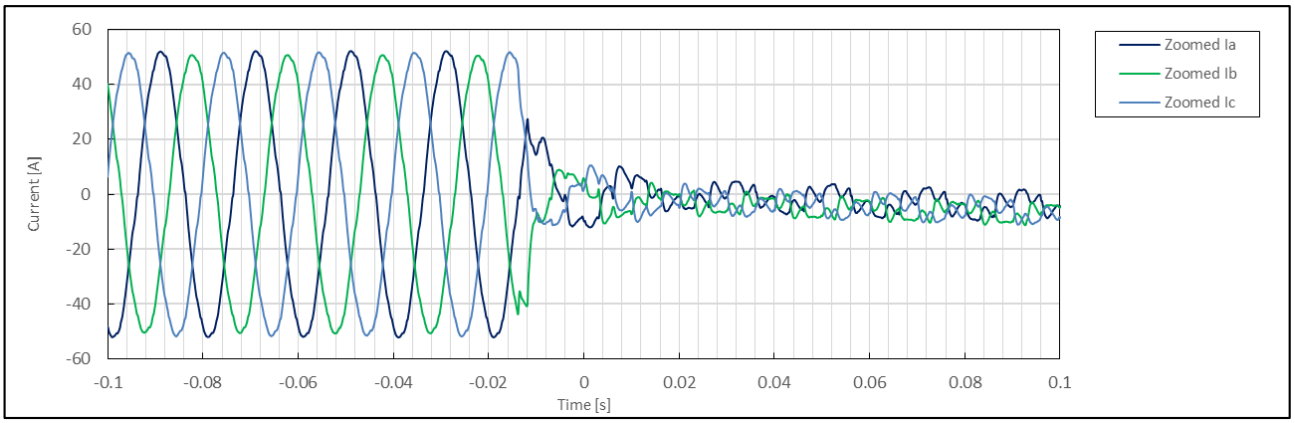
Test No. 6.4 with PGU

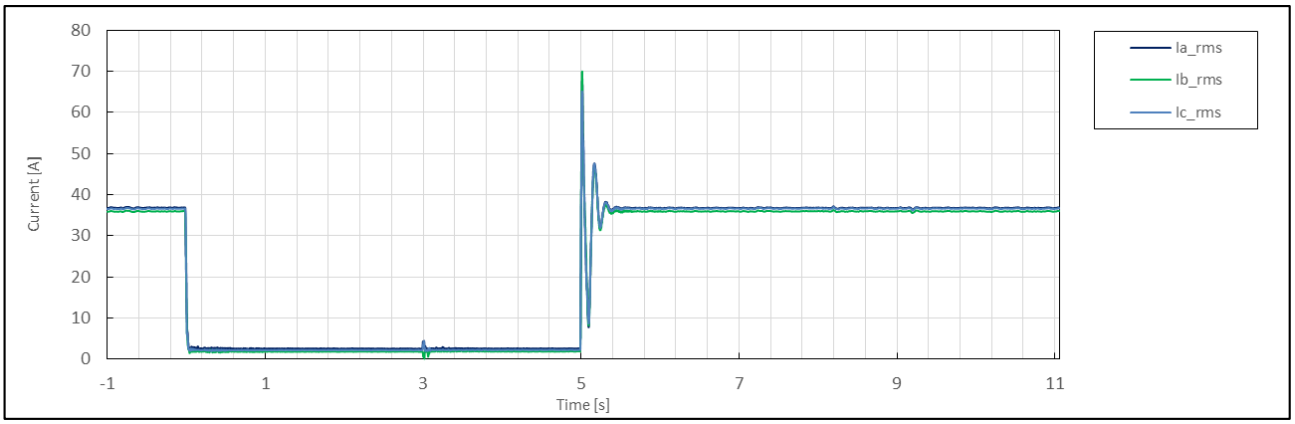


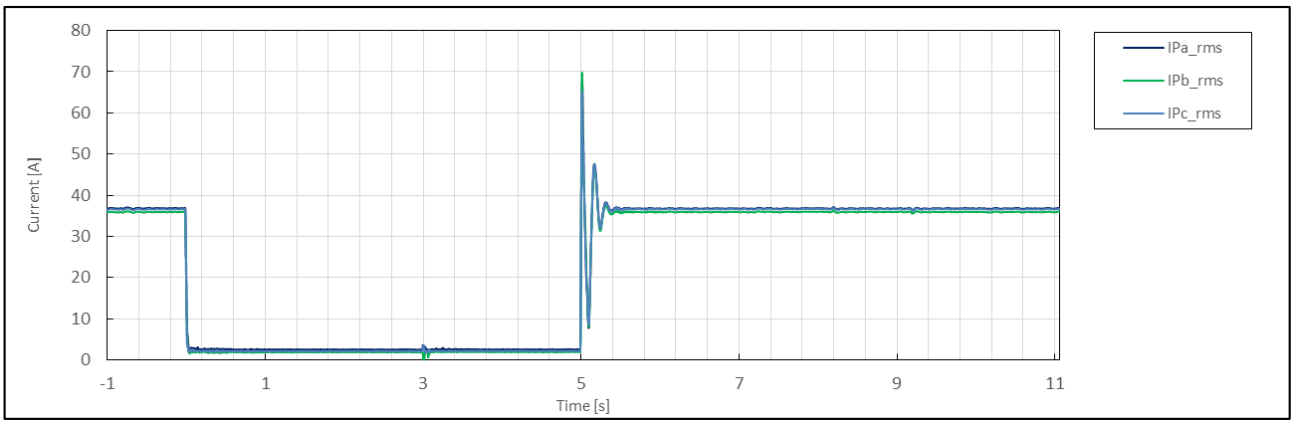


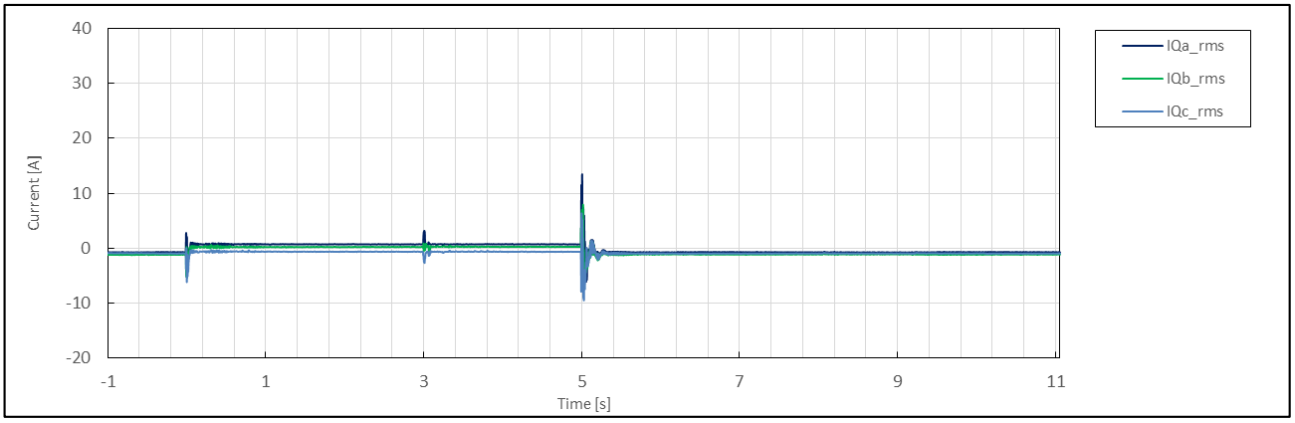


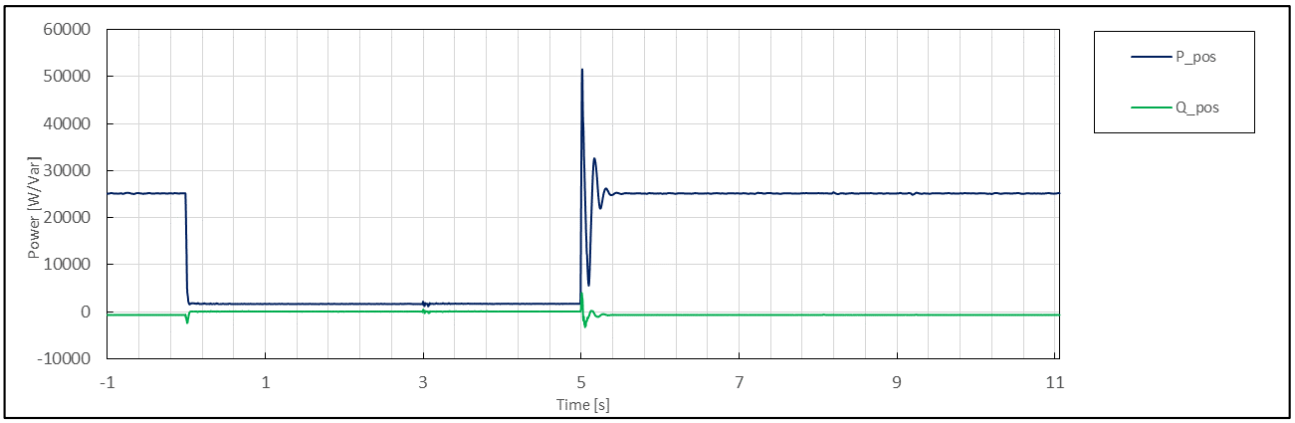


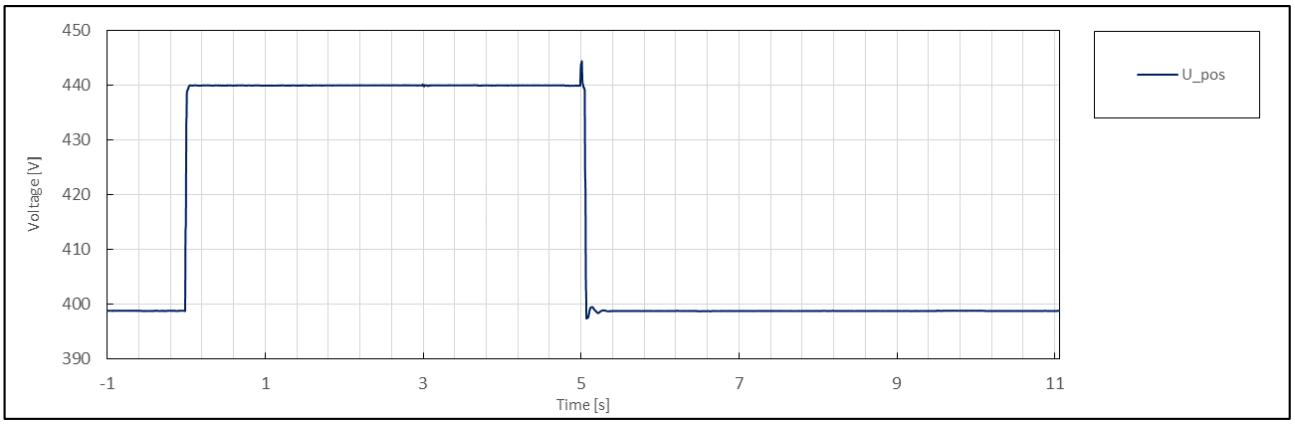

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

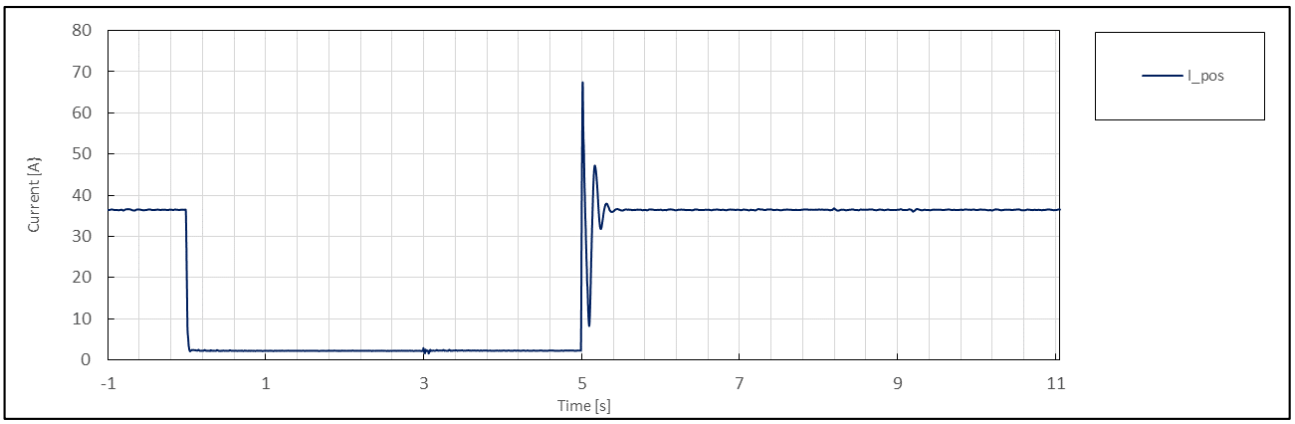

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

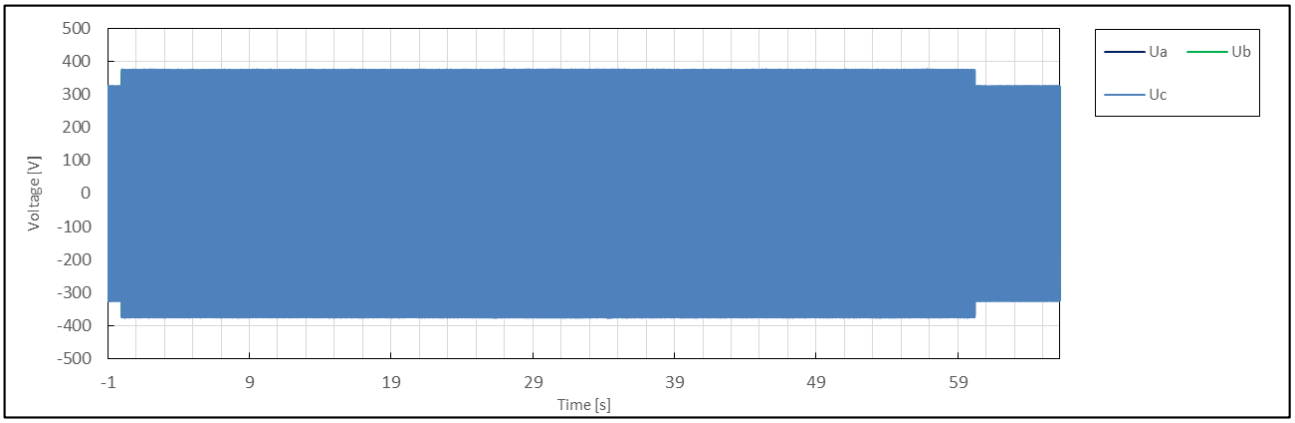

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
1
3
5
7
9
11
Time [s]
P_pos
Q_pos

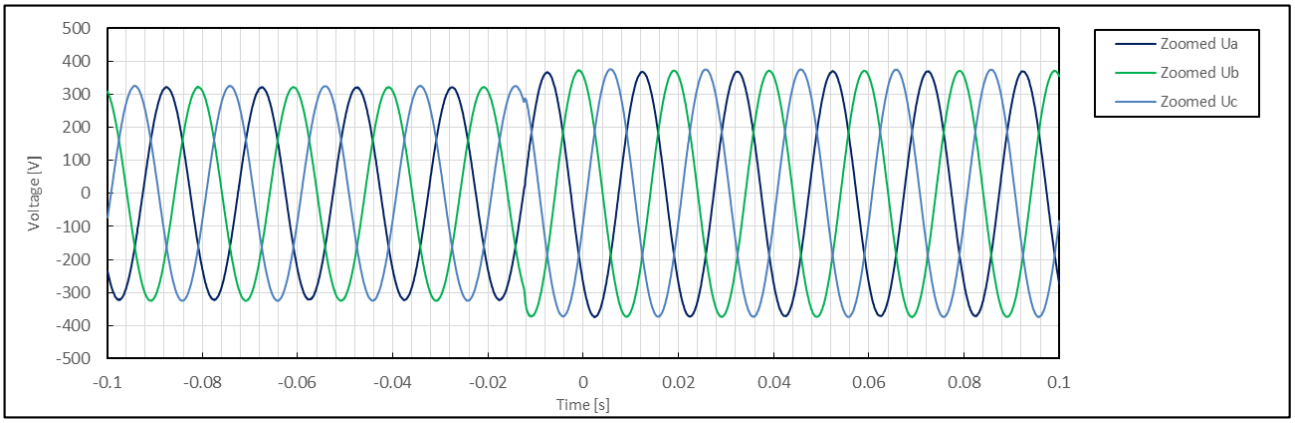

450
440
430
420
410
400
390
Voltage [V]
-1
1
3
5
7
9
11
Time [s]
U_pos

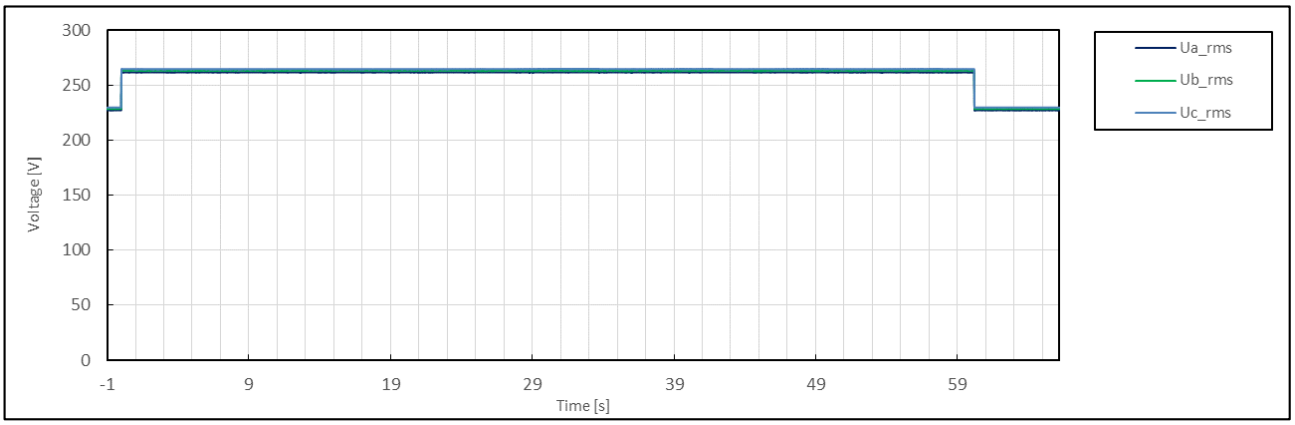

80
70
60
50
40
30
20
10
0
Current [A]
-1
1
3
5
7
9
11
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	7.1
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:40:54
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.15
	5	Setting dip duration		--		60198
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60197
	8	Fault duration in empty load test	Total	--	ms	60198
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.15
	10		Pos.		p.u.	1.15
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.02
	20		Phase 2			0.02
	21		Phase 3			0.04
	22	Line current	Phase 1	t1+100ms	p.u.	0.03
	23		Phase 2			0.03
	24		Phase 3			0.04
	25	Active power	Total	t1+100ms to t2-20ms	p.u.	0.03
	26		Pos.			0.03
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.041
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

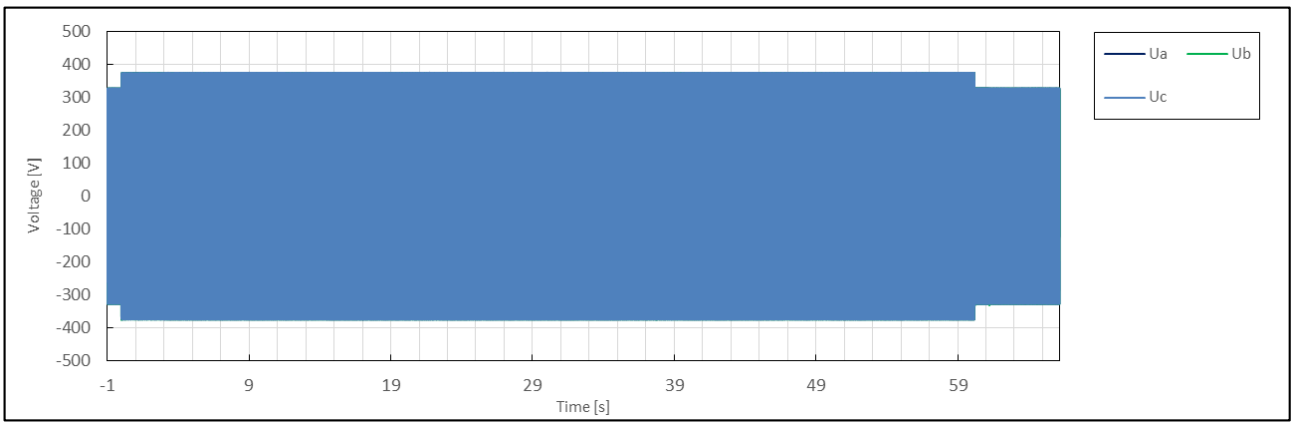
Test No. 7.1 idle test

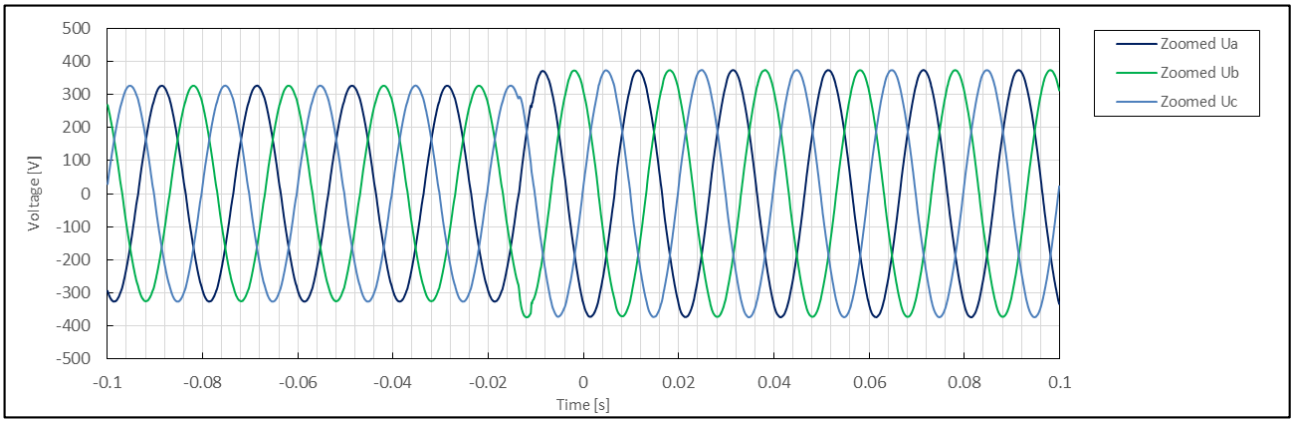


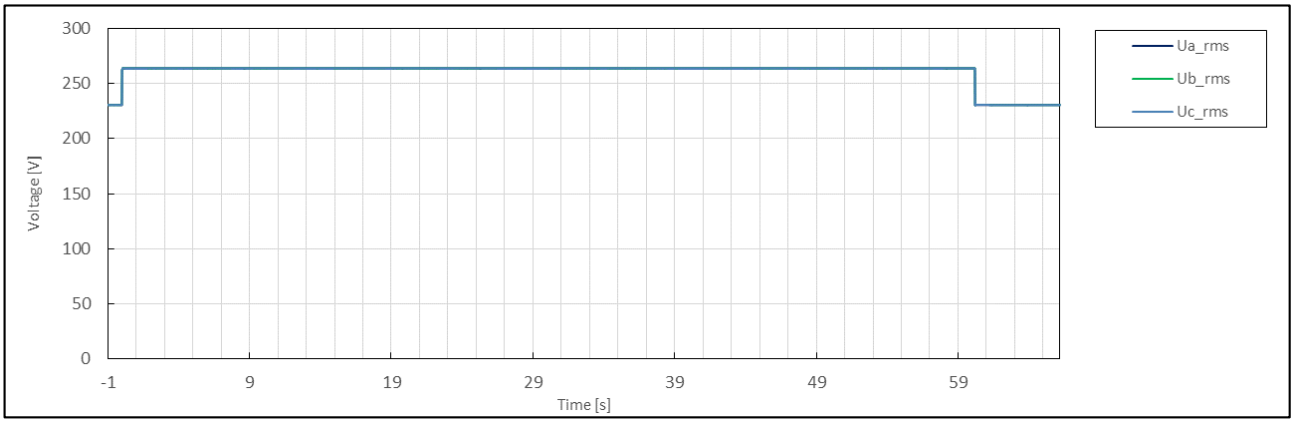


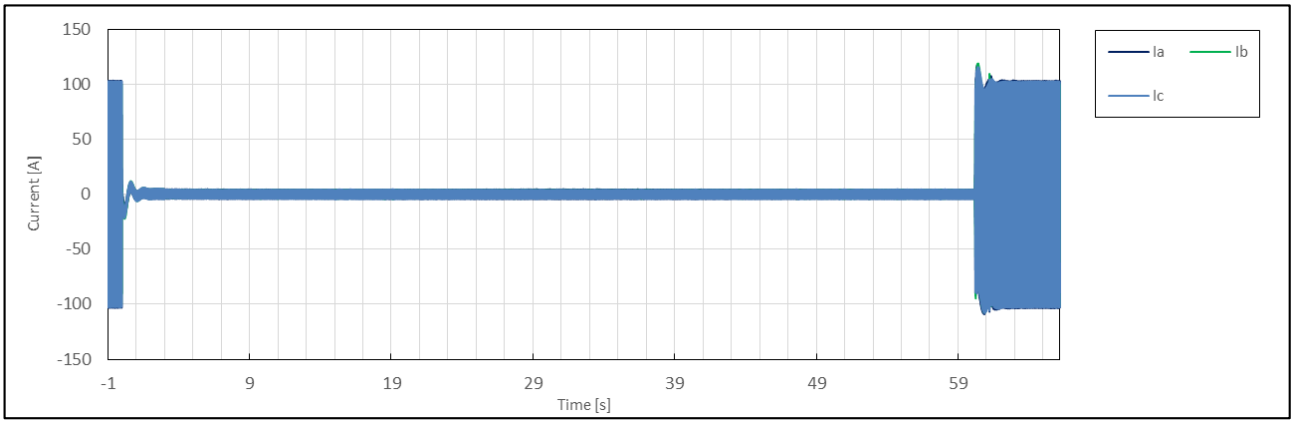


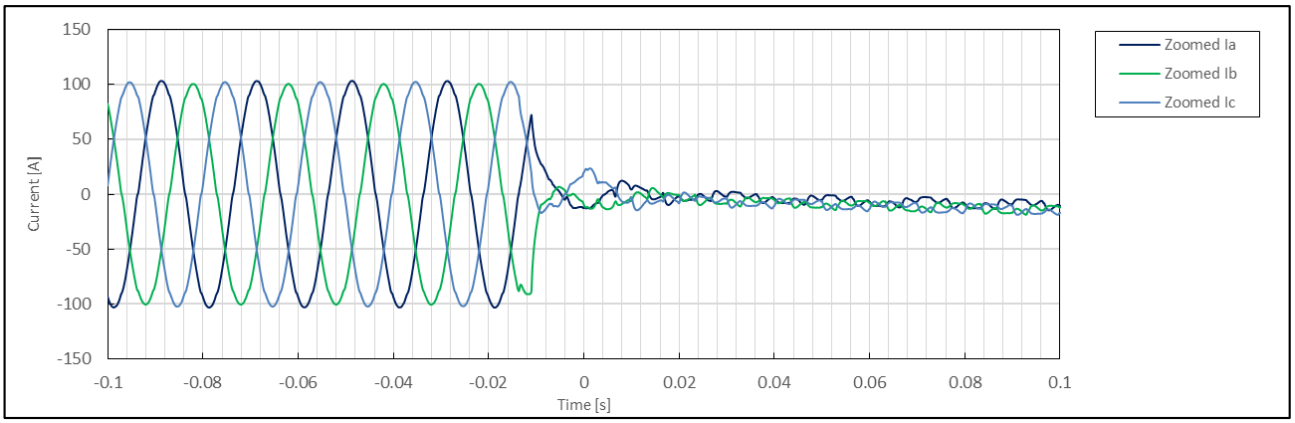
Test No. 7.1 with PGU

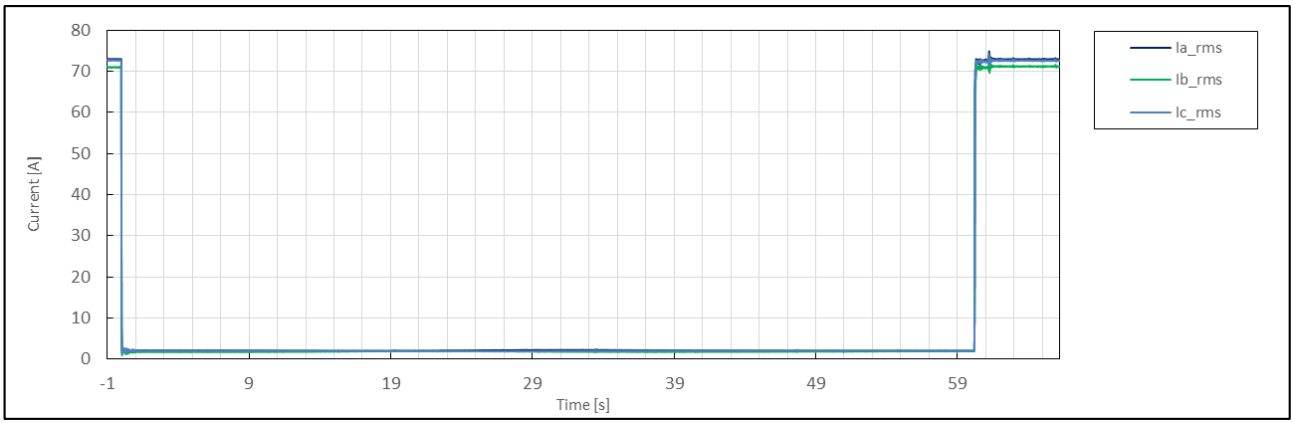


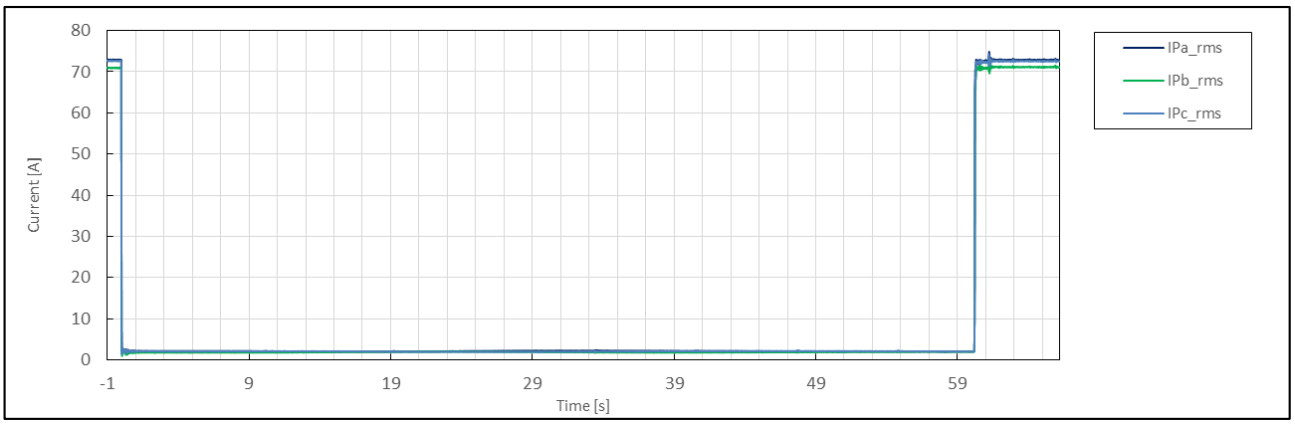


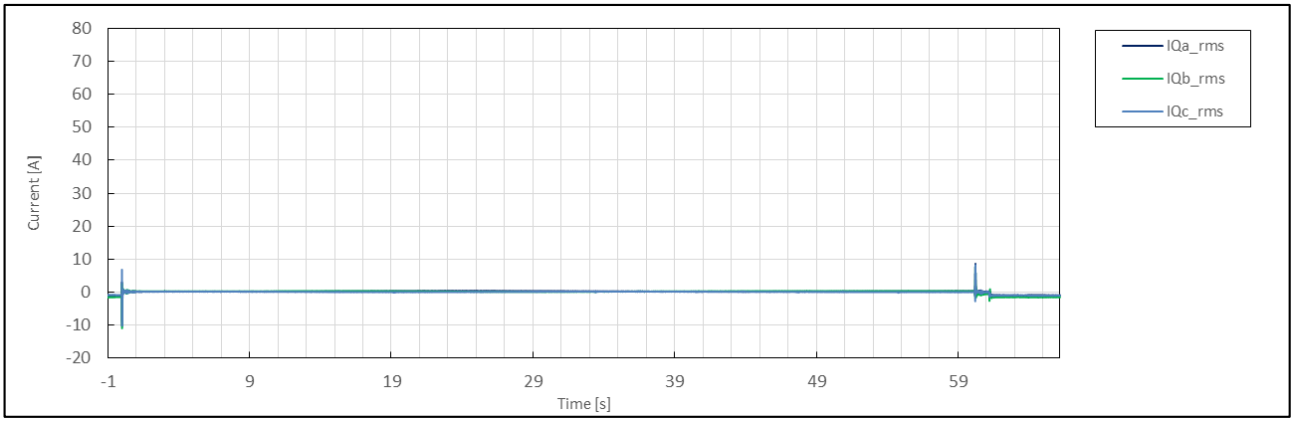


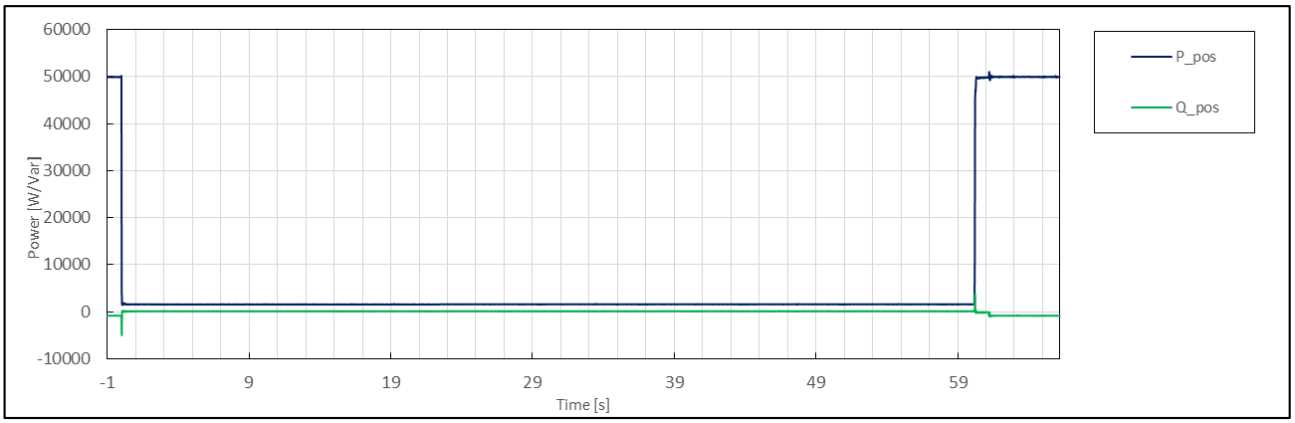


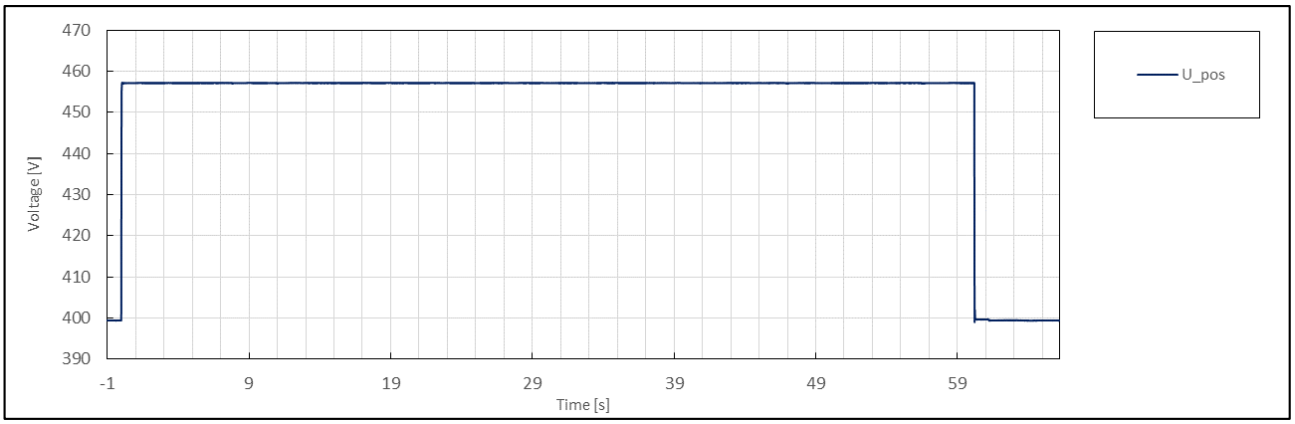

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

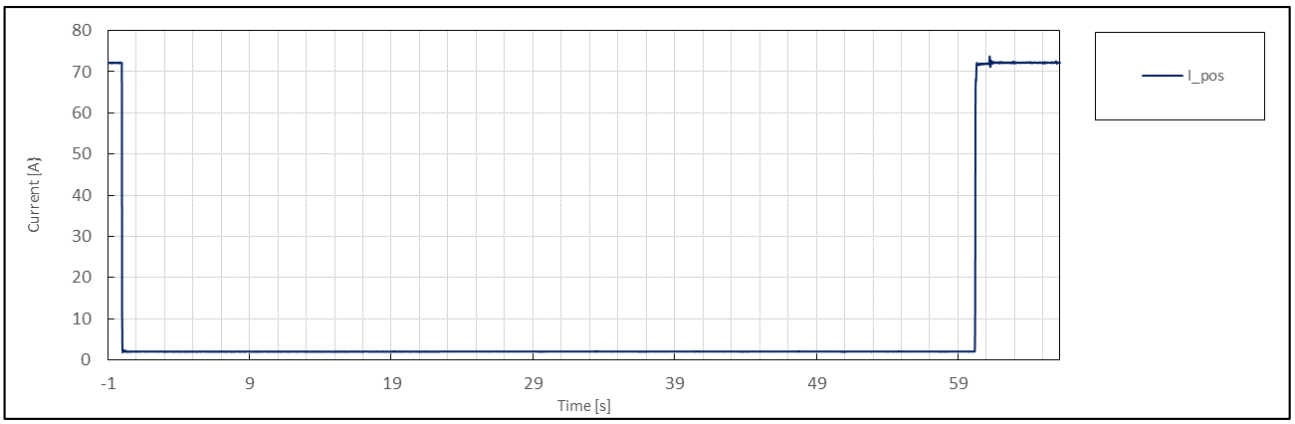

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

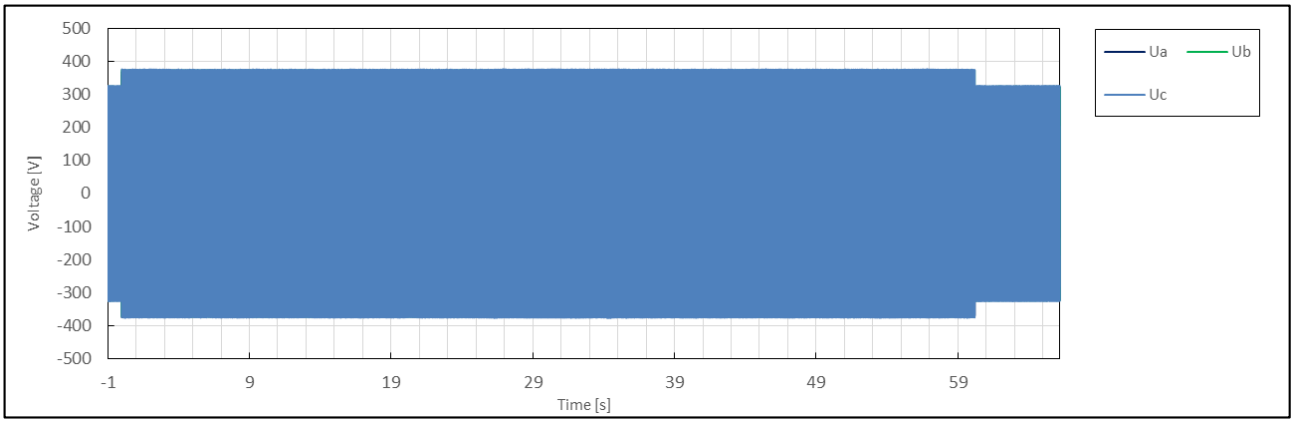

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

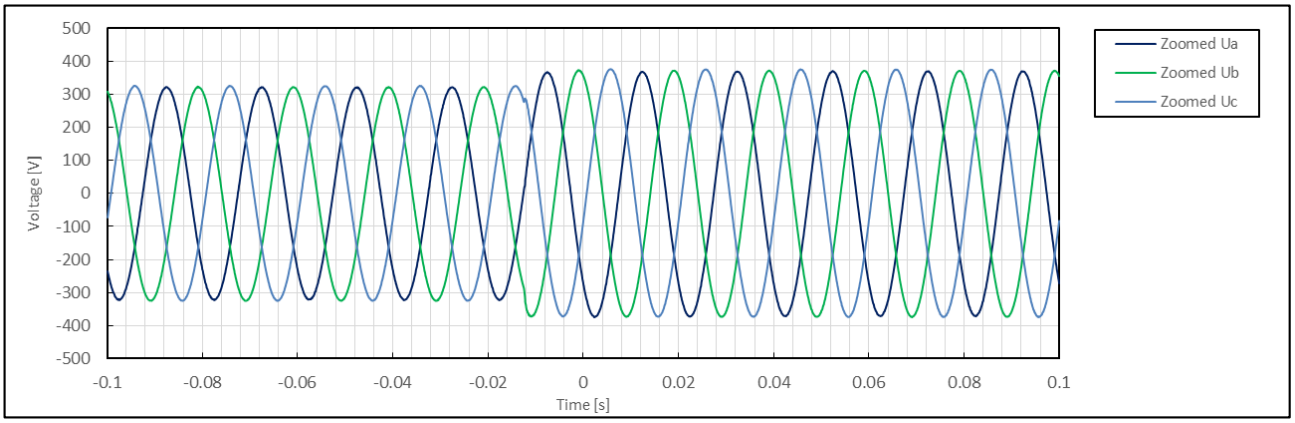

470
460
450
440
430
420
410
400
390
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

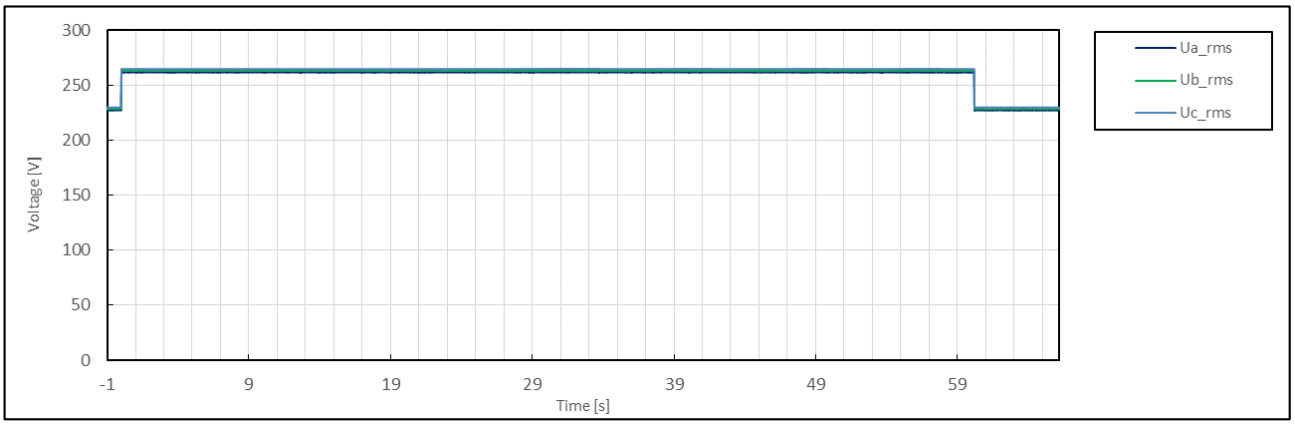

80
70
60
50
40
30
20
10
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	7.2
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:40:22
	3	Fault type (phase)	--	--		3-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.15
	5	Setting dip duration		--		60198
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60197
	8	Fault duration in empty load test	Total	--	ms	60198
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.15
	10		Pos.		p.u.	1.15
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.	-0.01
	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.	1.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.03
	20		Phase 2			0.03
	21		Phase 3			0.04
	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.	0.03
	26		Pos.			0.03
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	0.131
	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

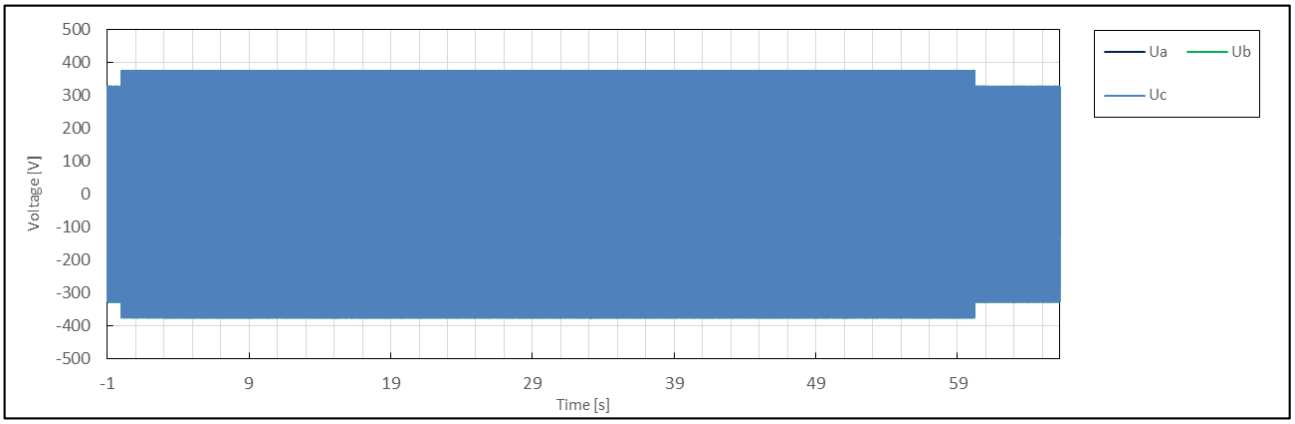
Test No. 7.2 idle test

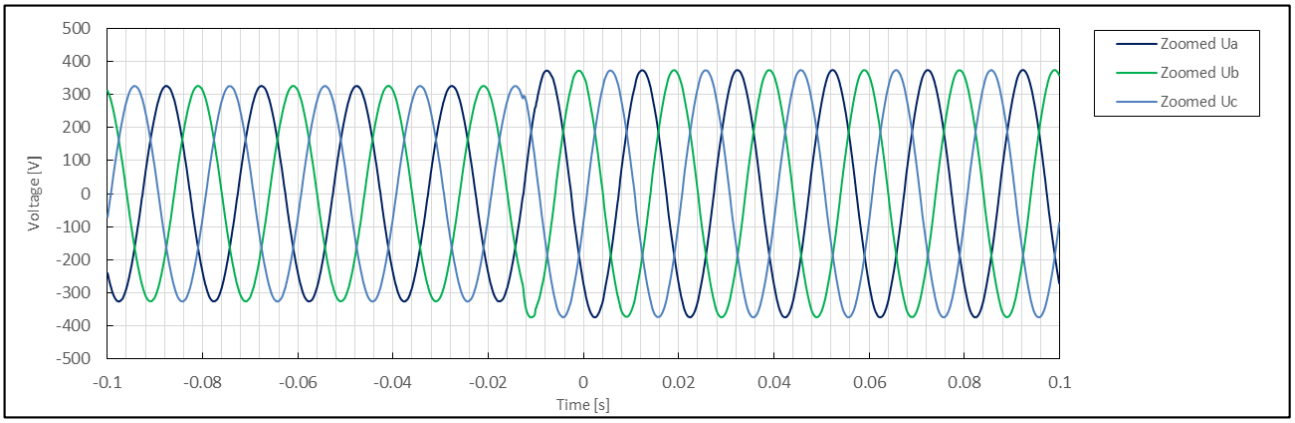


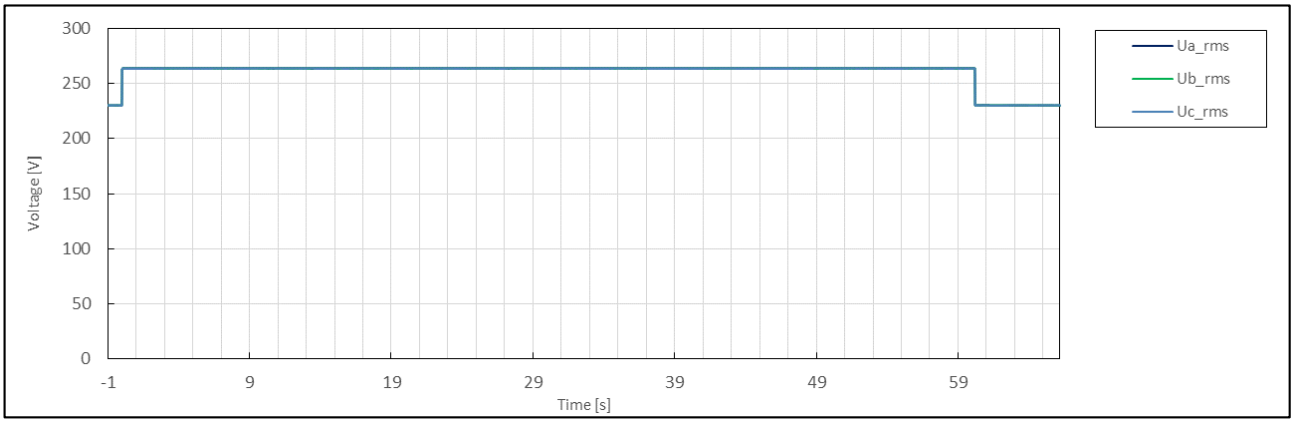


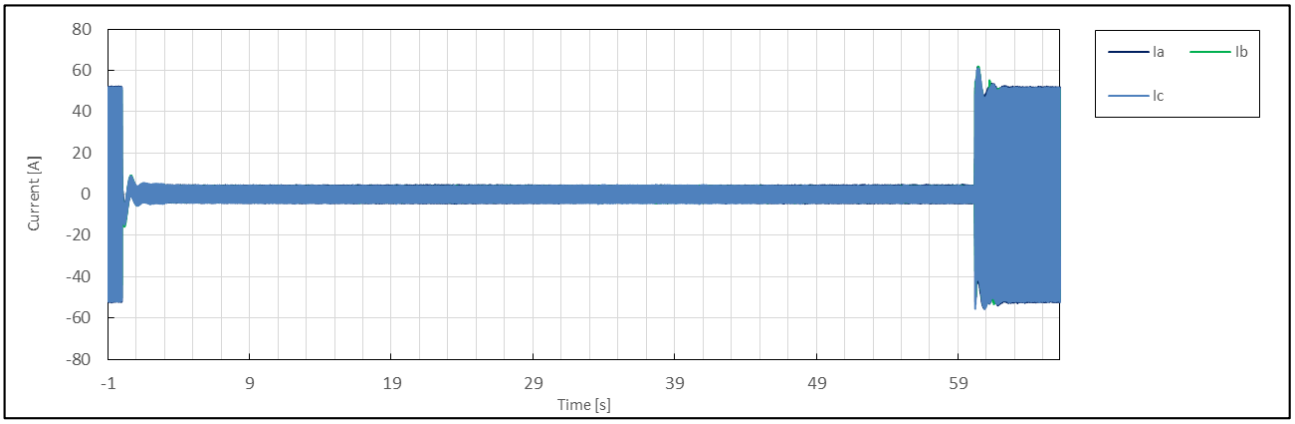


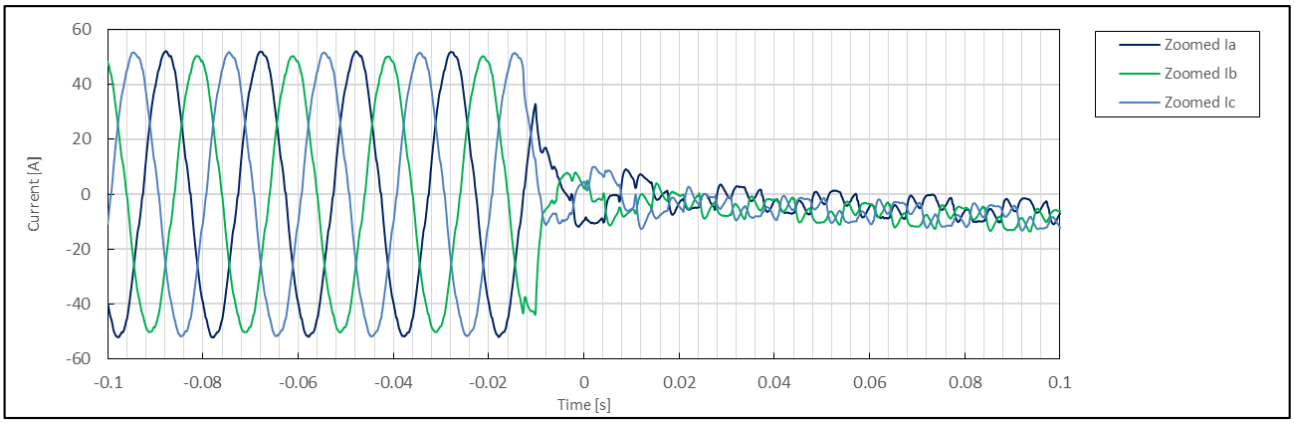
Test No. 7.2 with PGU

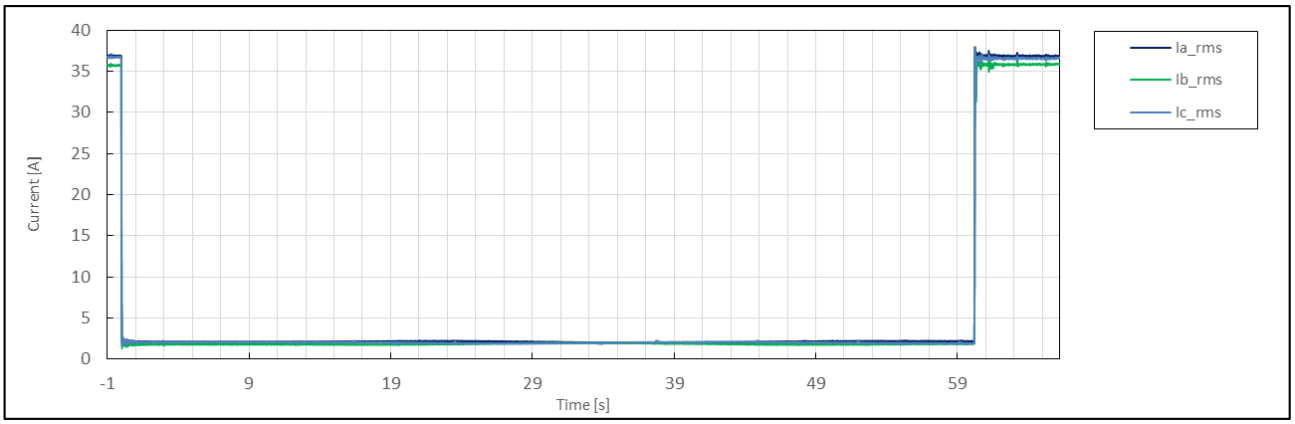


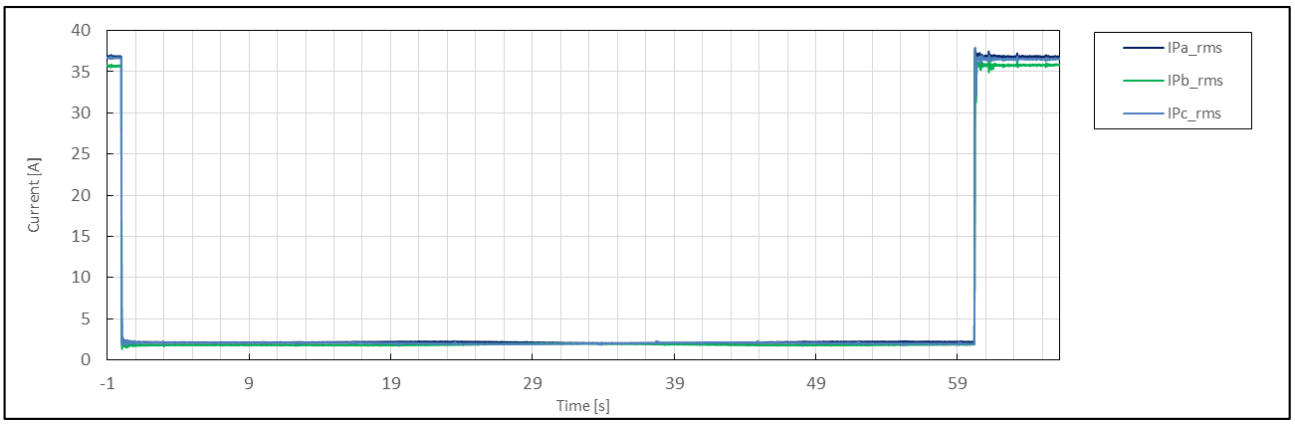


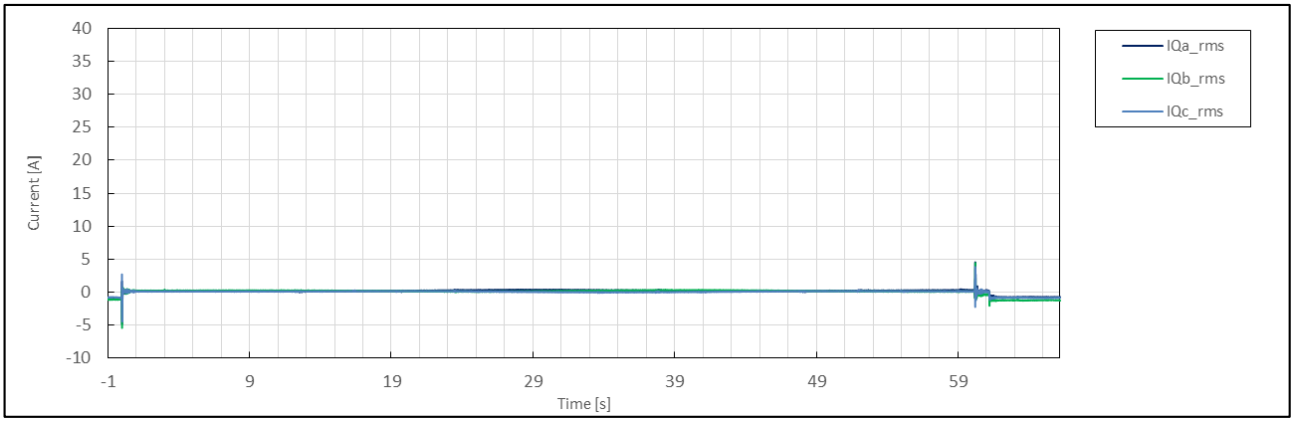


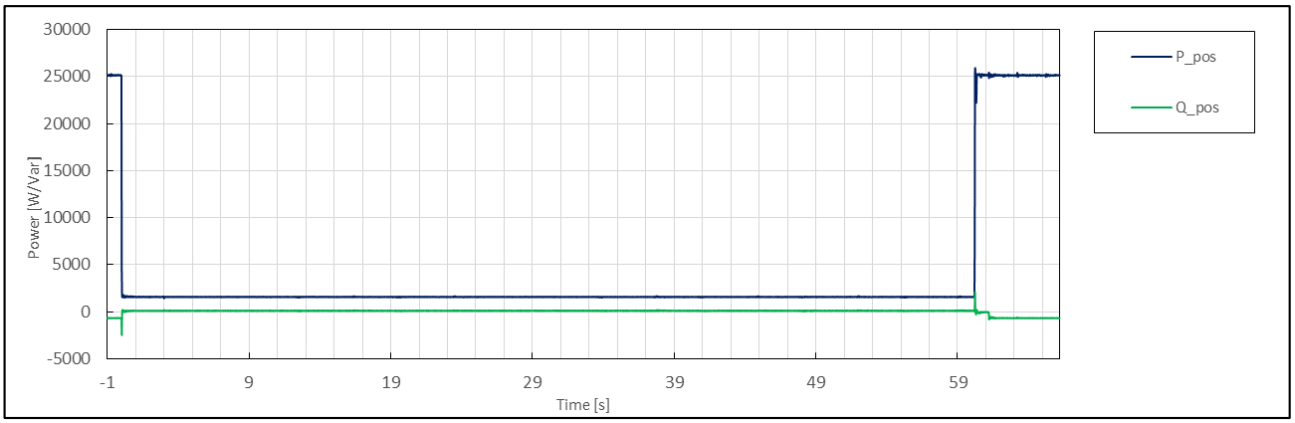


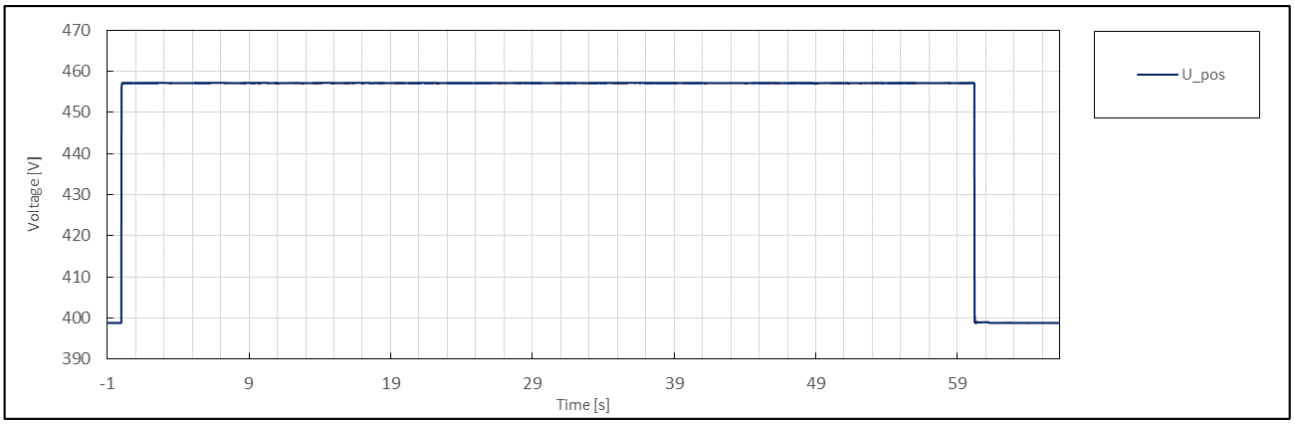

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

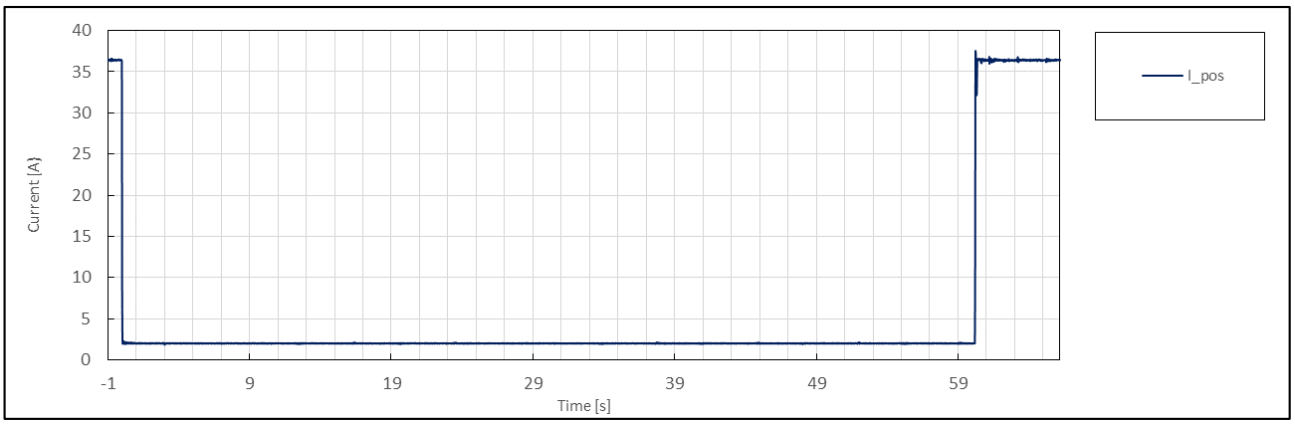

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

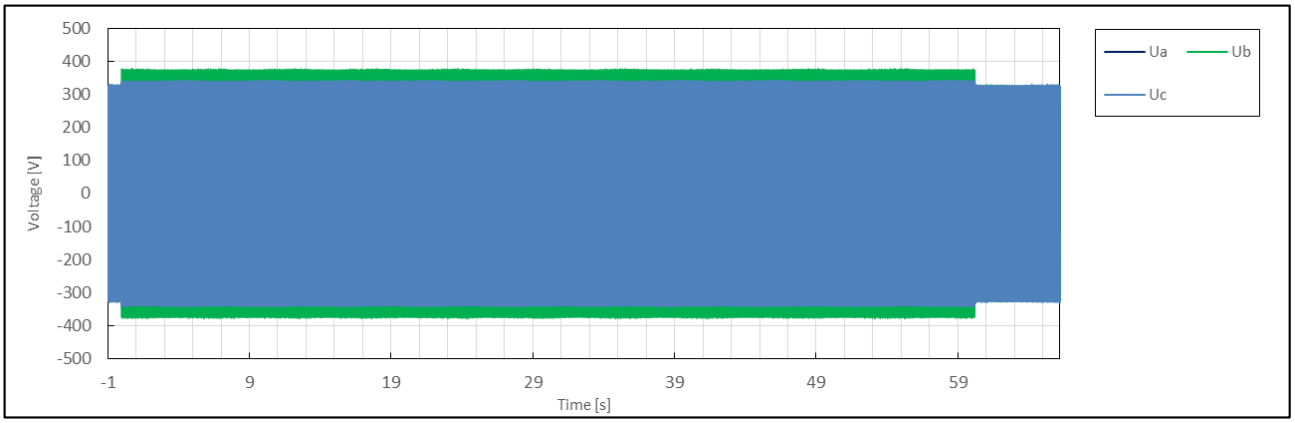

30000
25000
20000
15000
10000
5000
0
-5000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

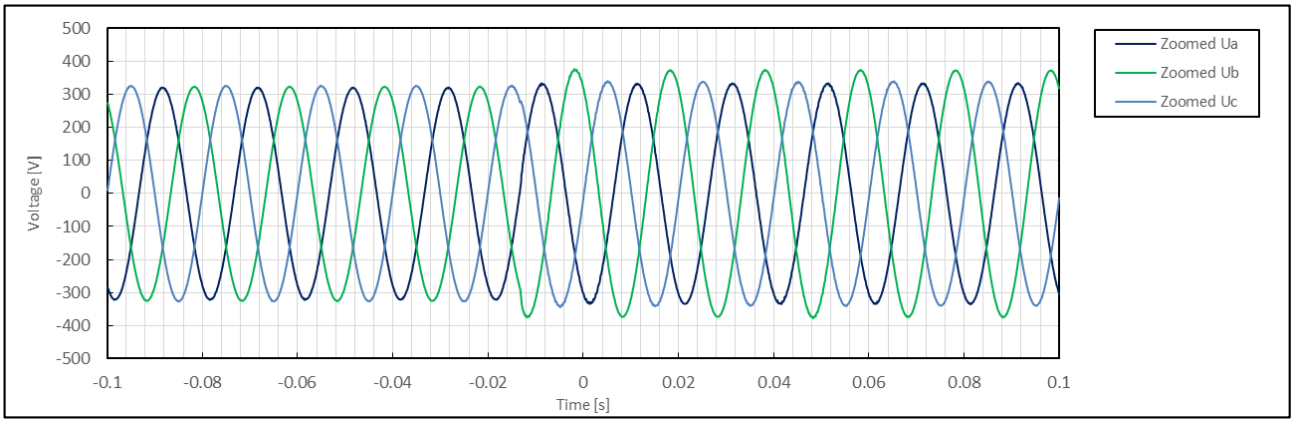

470
460
450
440
430
420
410
400
390
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

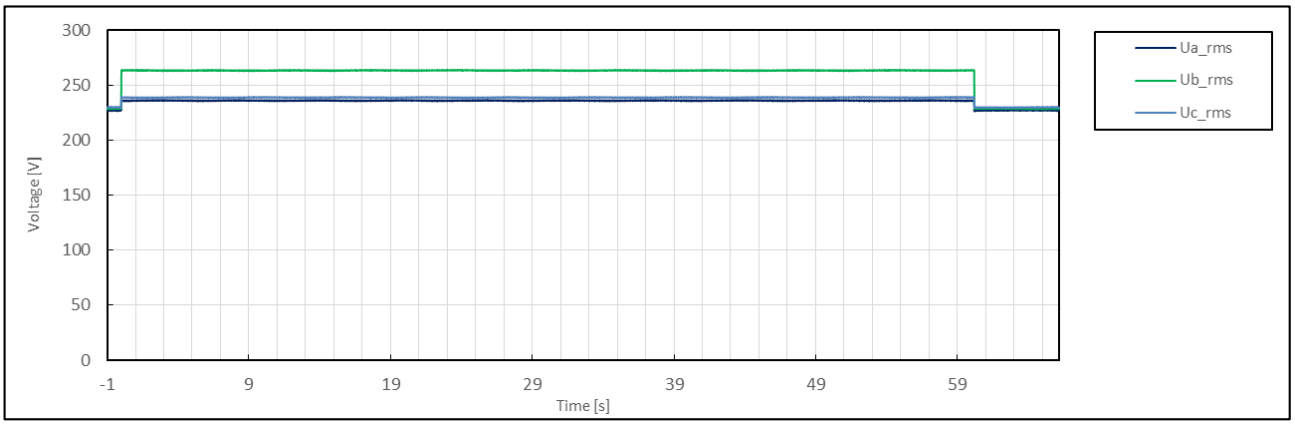

40
35
30
25
20
15
10
5
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	7.3
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:42:44
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.15
	5	Setting dip duration		--		60197
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60196
	8	Fault duration in empty load test	Total	--	ms	60197
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.15
	10		Pos.		p.u.	1.07
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.	1.00
	13	Active power	Total	t1-10s to t1	p.u.	1.00
	14		Pos.			1.00
	15	Reactive power	Total	t1-10s to t1	p.u.	-0.02
	16		Pos.			-0.02
	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.	1.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	20		Phase 2			0.02
	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.	0.03
	26		Pos.			0.04
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.	1.00
	29		Pos.			1.00
	39	Active power rising time	Pos.	--	s	0.037
	31	Reactive power	Total	t2+3s to t2+10s	p.u.	-0.02
	32		Pos.			-0.02
	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

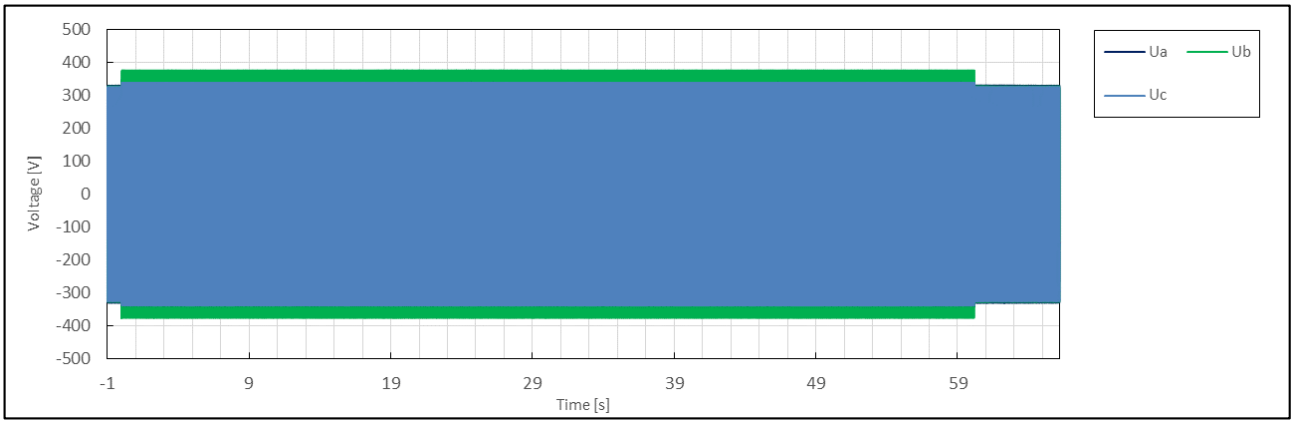
Test No. 7.3 idle test

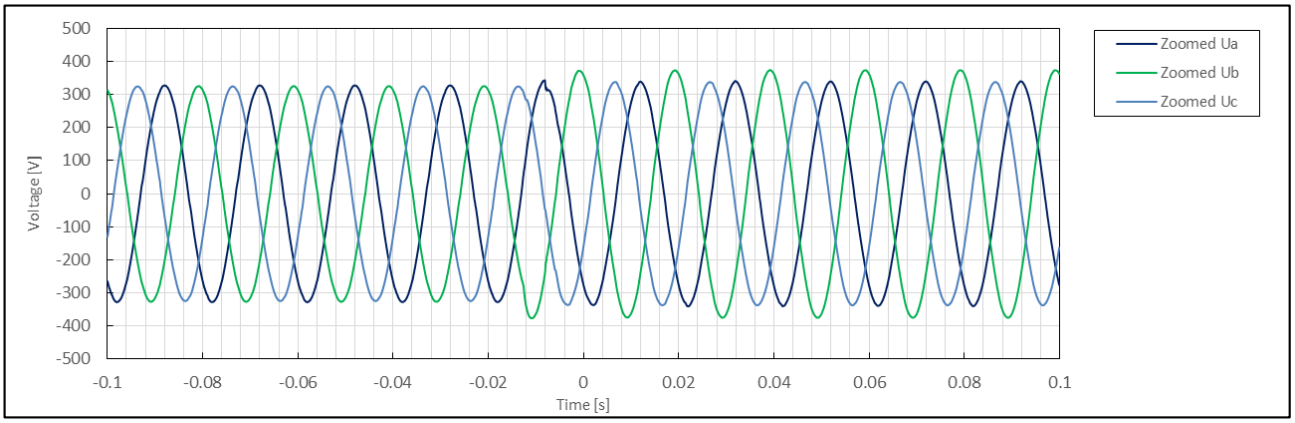


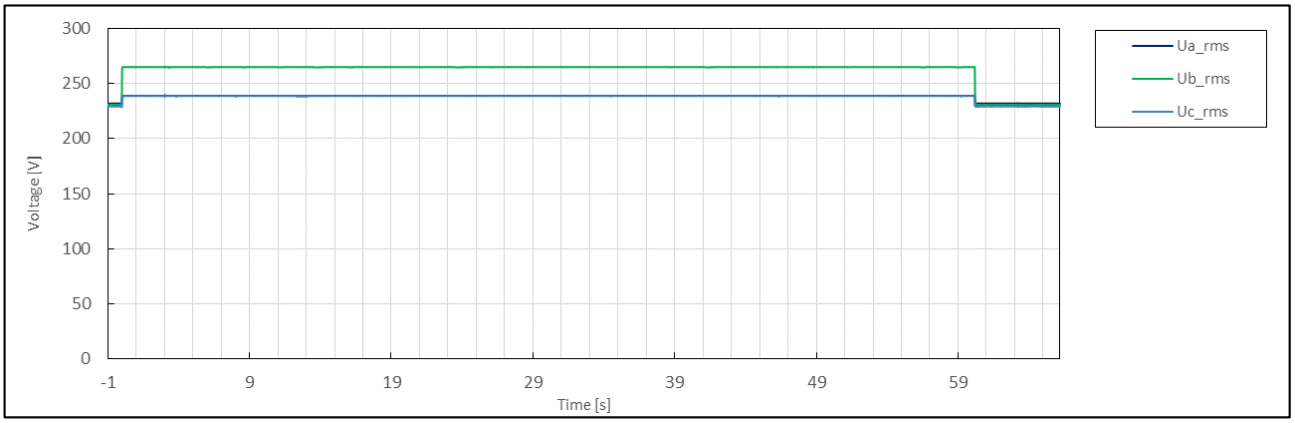


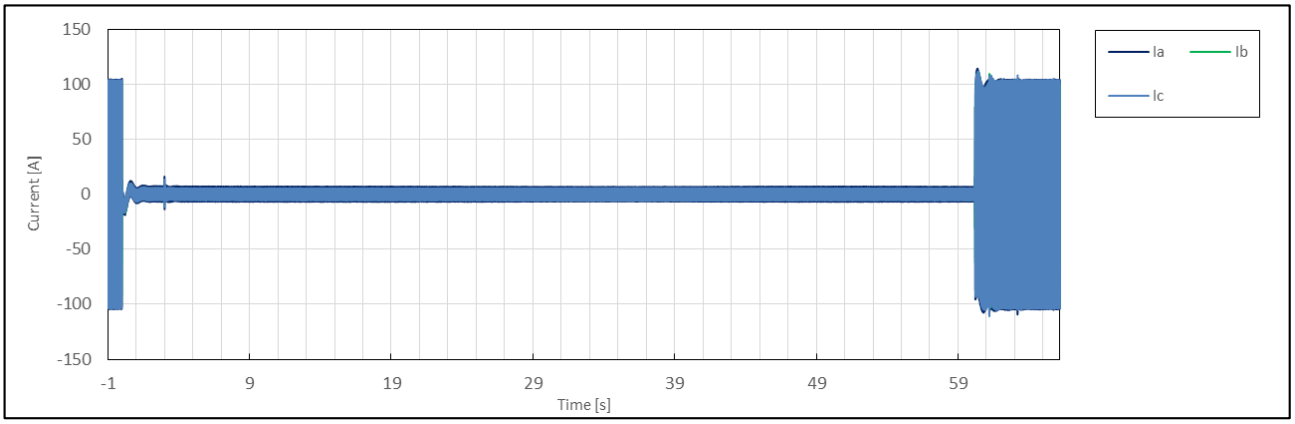


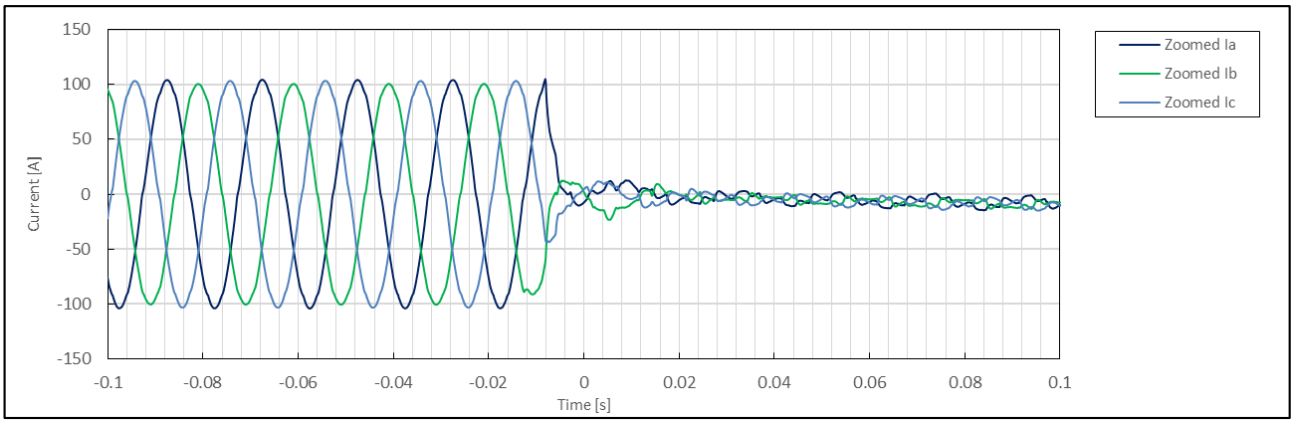
Test No. 7.3 with PGU

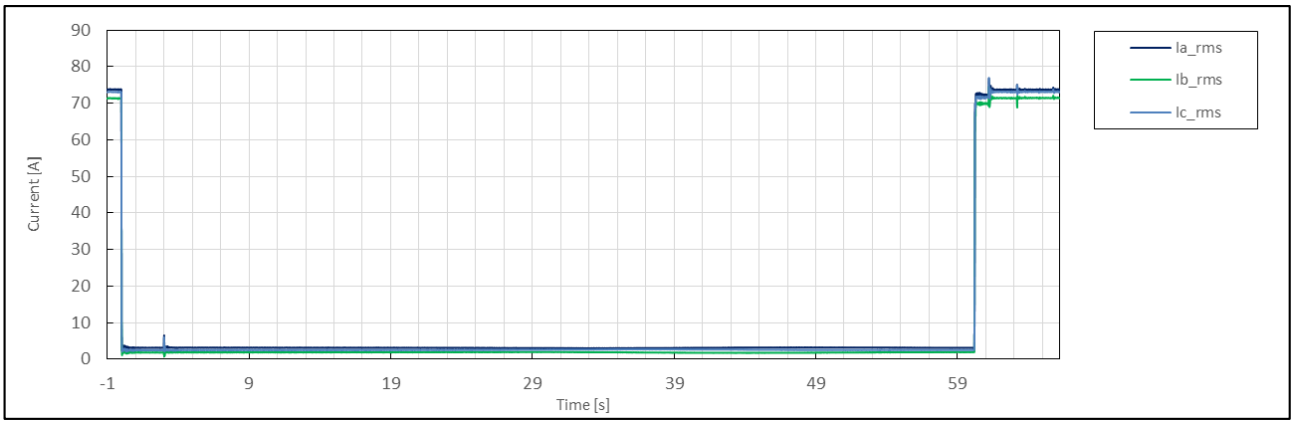


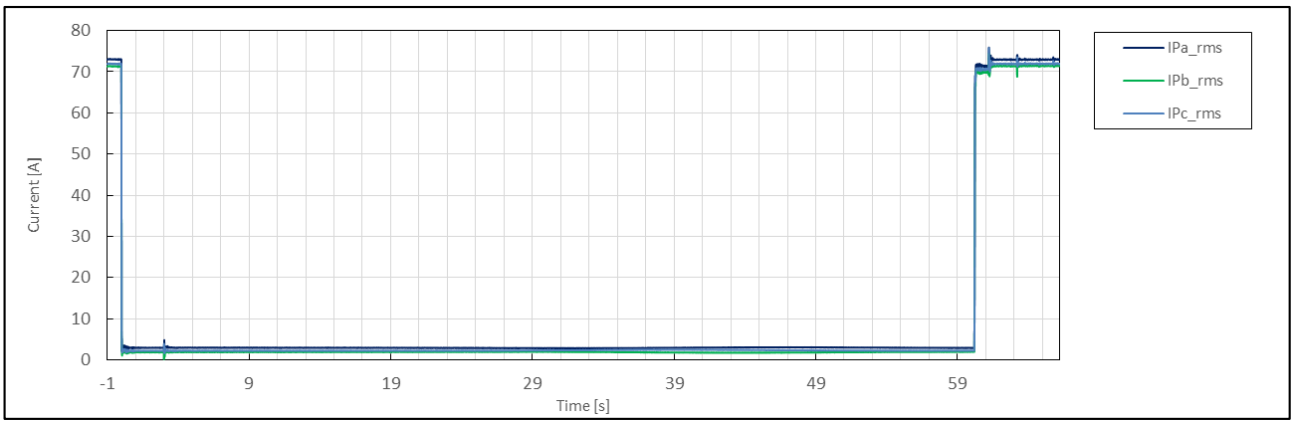


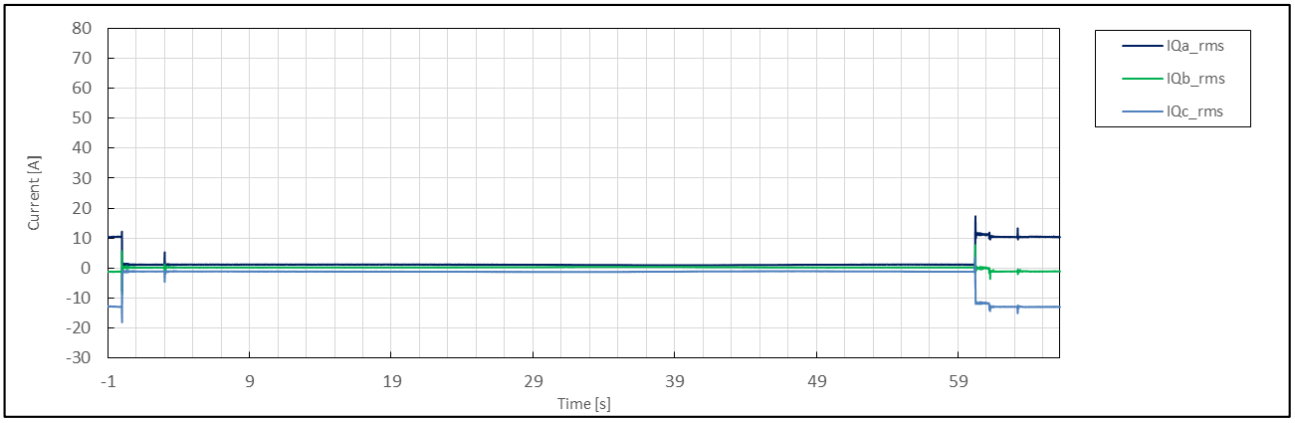


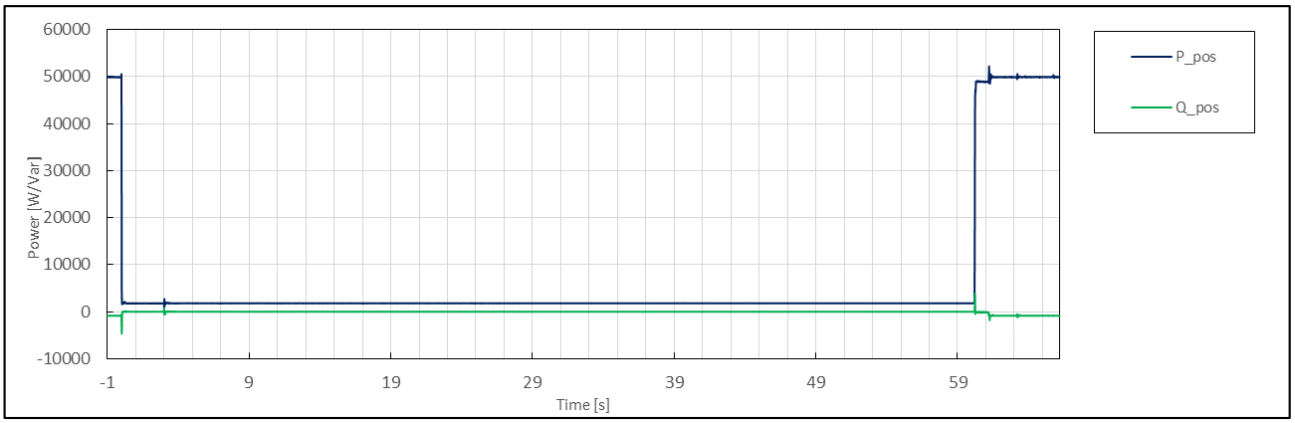


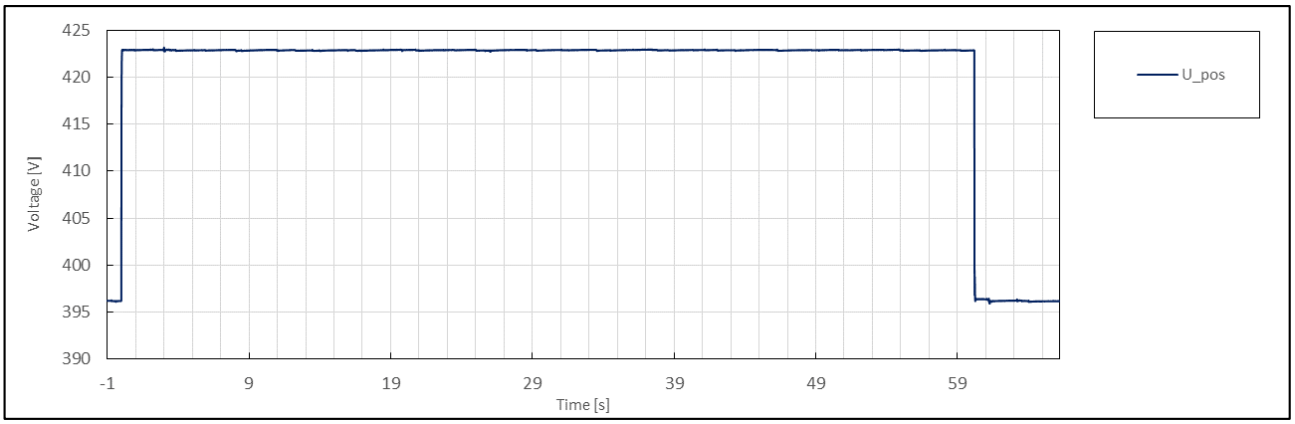

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

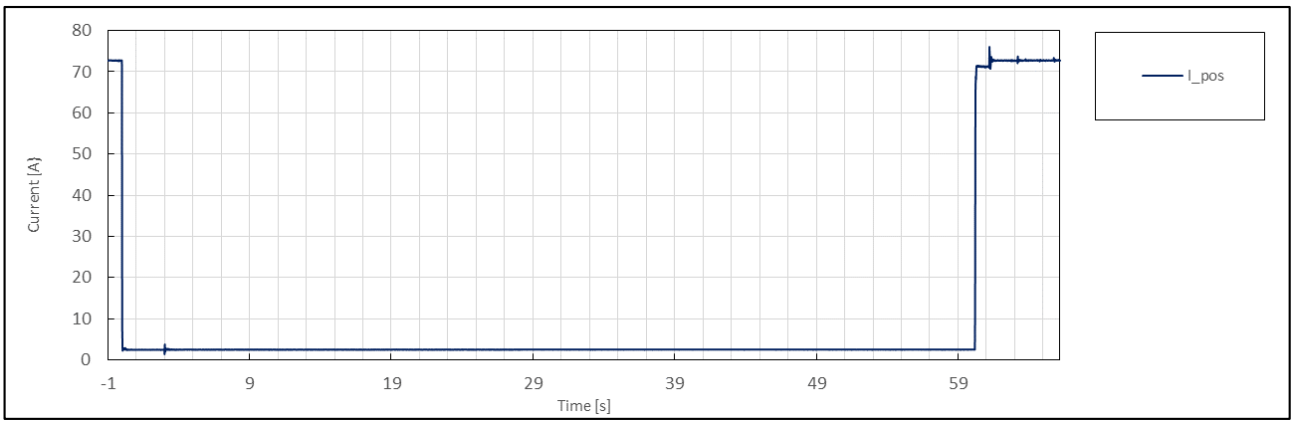

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]

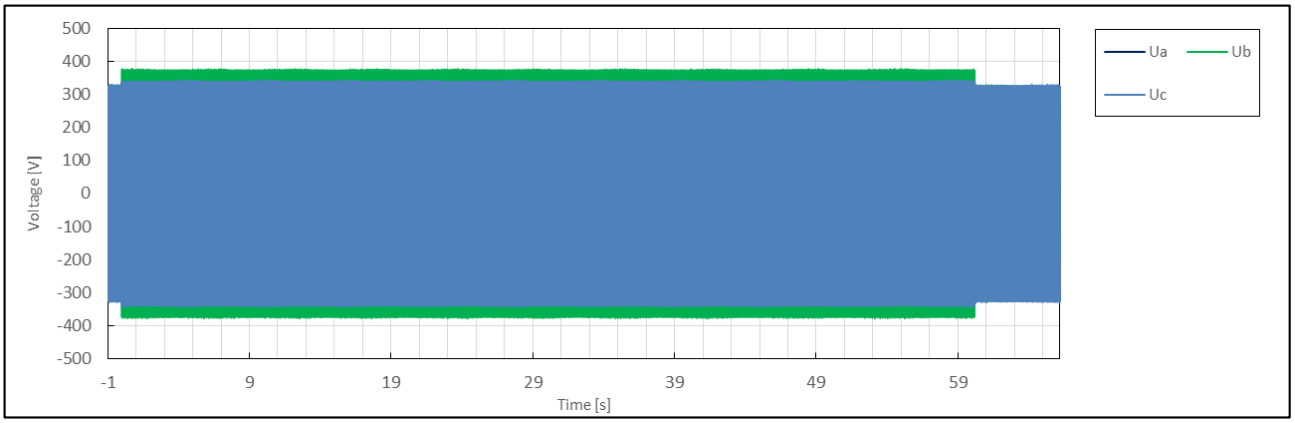

60000
50000
40000
30000
20000
10000
0
-10000
Power [W/Var]
-1
9
19
29
39
49
59
Time [s]
P_pos
Q_pos

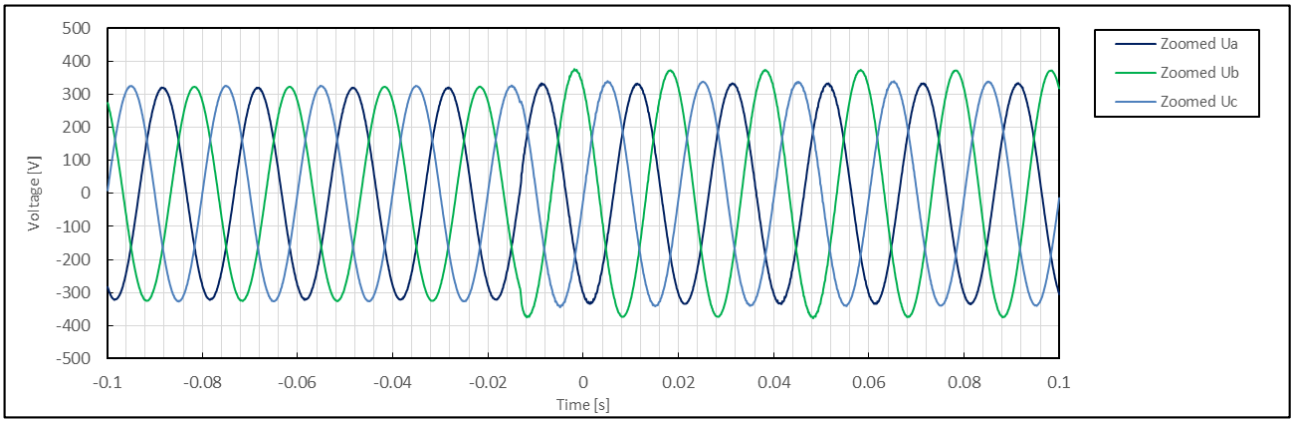

425
420
415
410
405
400
395
390
Voltage [V]
-1
9
19
29
39
49
59
Time [s]
U_pos

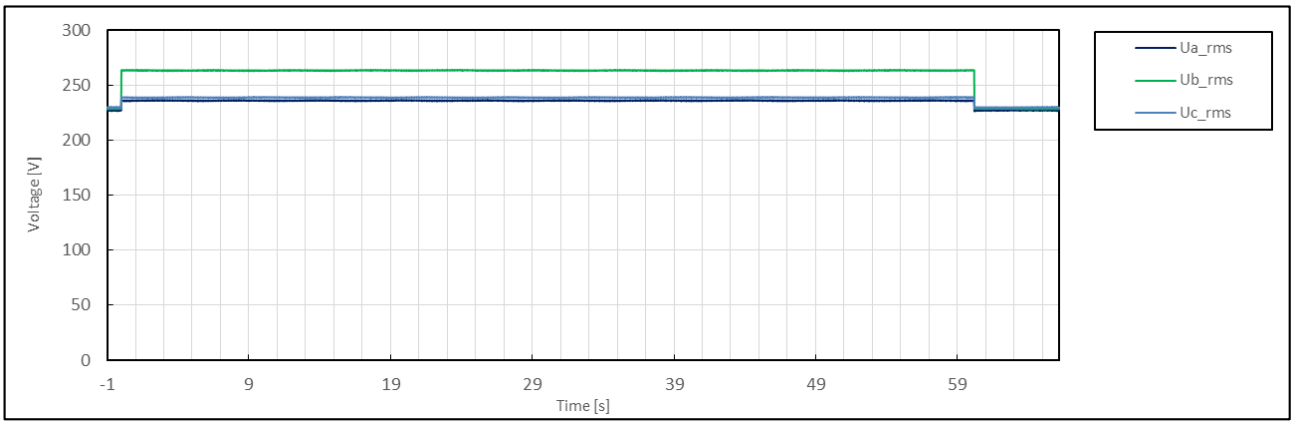

80
70
60
50
40
30
20
10
0
Current [A]
-1
9
19
29
39
49
59
Time [s]
I_pos

	No.	Parameter	Phase ref.	Time ref.	unit	Result
General Info.	0	Test number	--	--	--	7.4
	1	Date	--	--	dd.mm.yyyy	16.2.2020
	2	Time (start of test)	--	--	hh:mm:ss.f	15:42:20
	3	Fault type (phase)	--	--		2-phase fault
	4	Setting voltage depth	Line to line	--	p.u.	1.15
	5	Setting dip duration		--		60197
	6	Point of fault entry	Total	--	ms	0
	7	Point of fault clearance	Total	--	ms	60196
	8	Fault duration in empty load test	Total	--	ms	60197
	9	Voltage depth/height in empty load test	Total	t1+100ms to t2 and t1-10s to t1	p.u.	1.15
	10		Pos.		p.u.	1.07
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.	0.51
	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.	-0.01
	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.	1.15
	19	Line current	Phase 1	t1+60ms	p.u.	0.04
	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.	0.03
	26		Pos.			0.04
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	0.125
	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

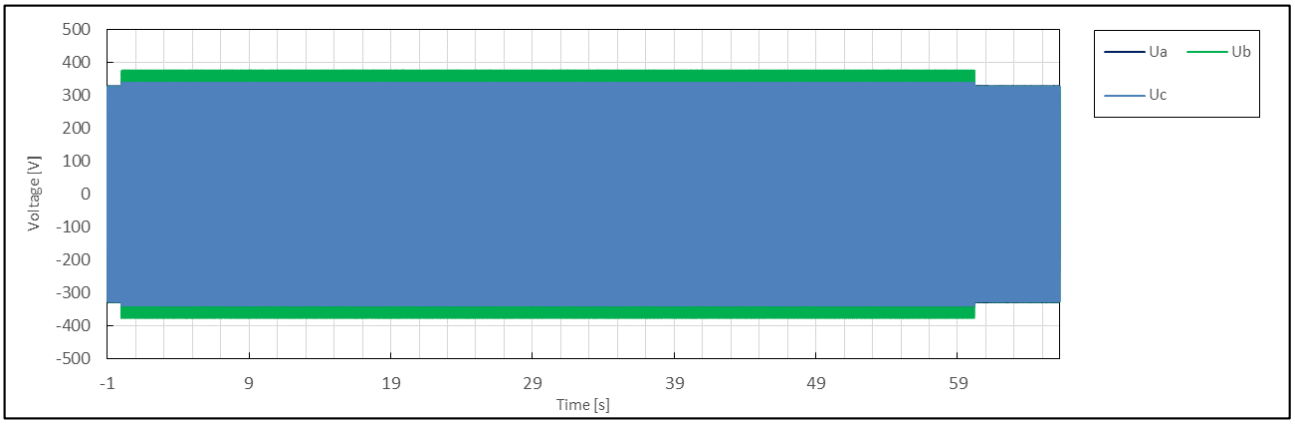
Test No. 7.4 idle test

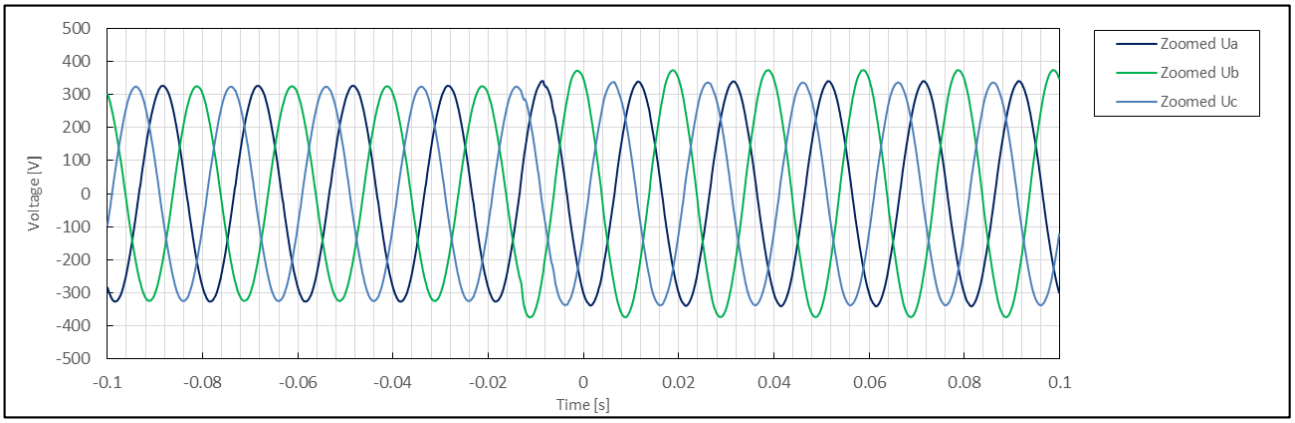


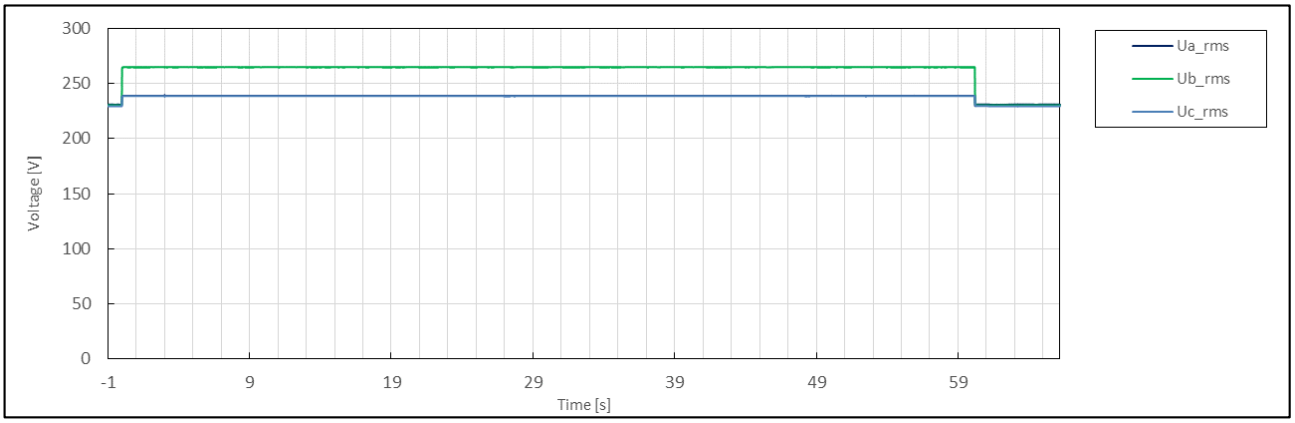


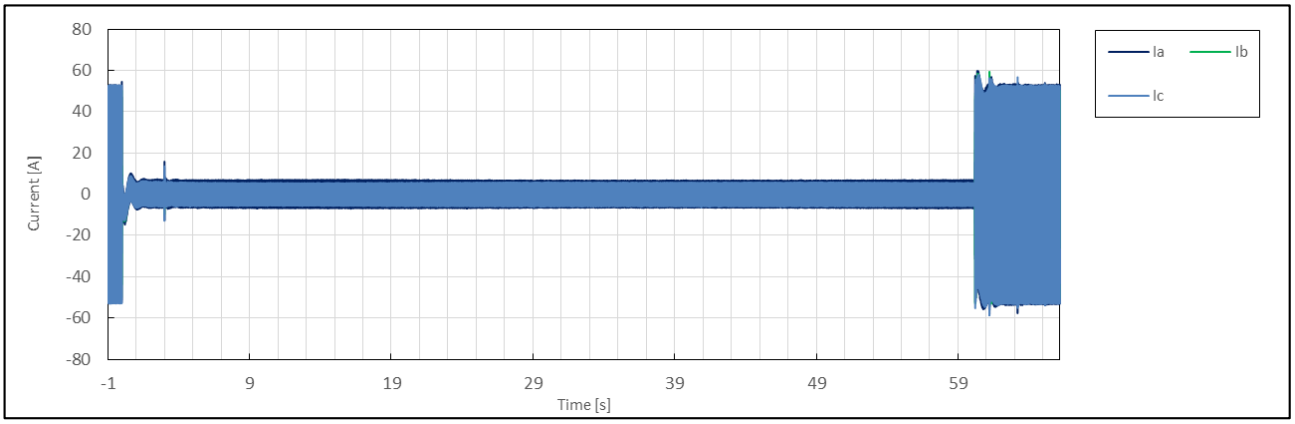


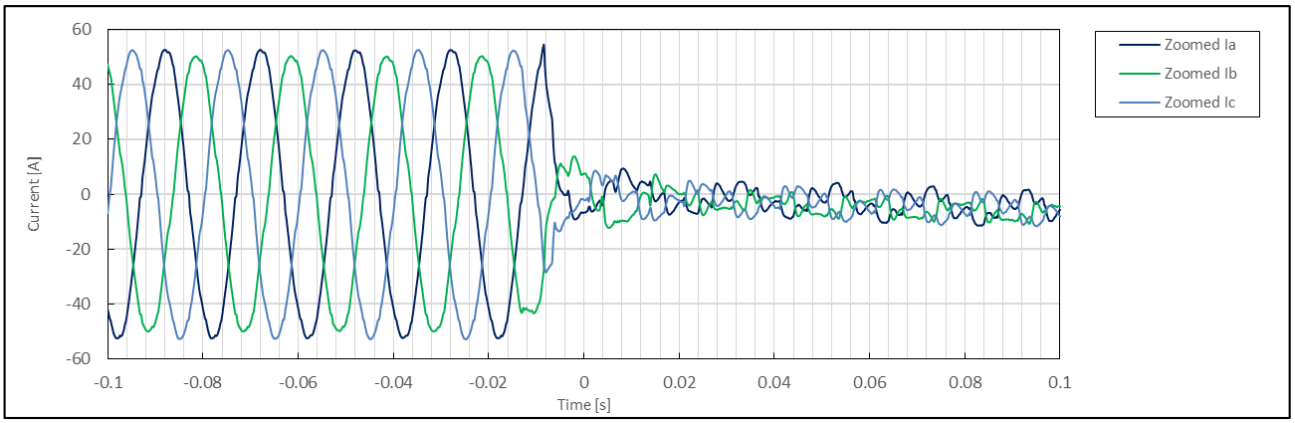
Test No. 7.4 with PGU

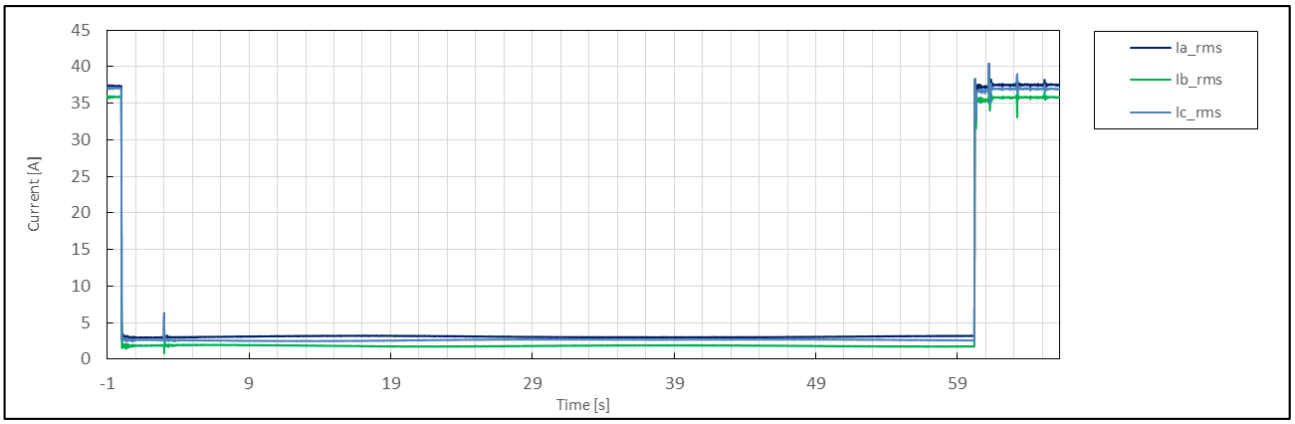


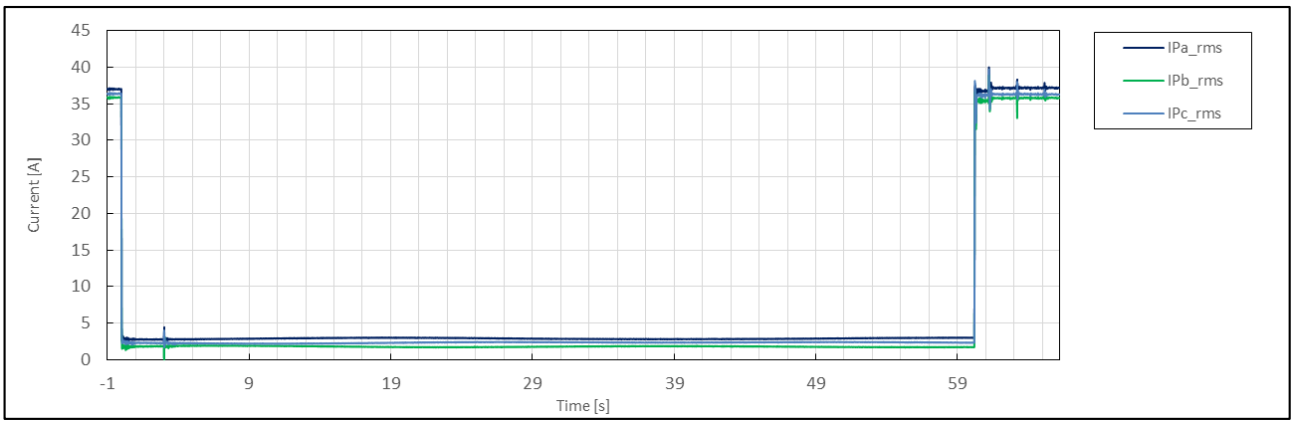


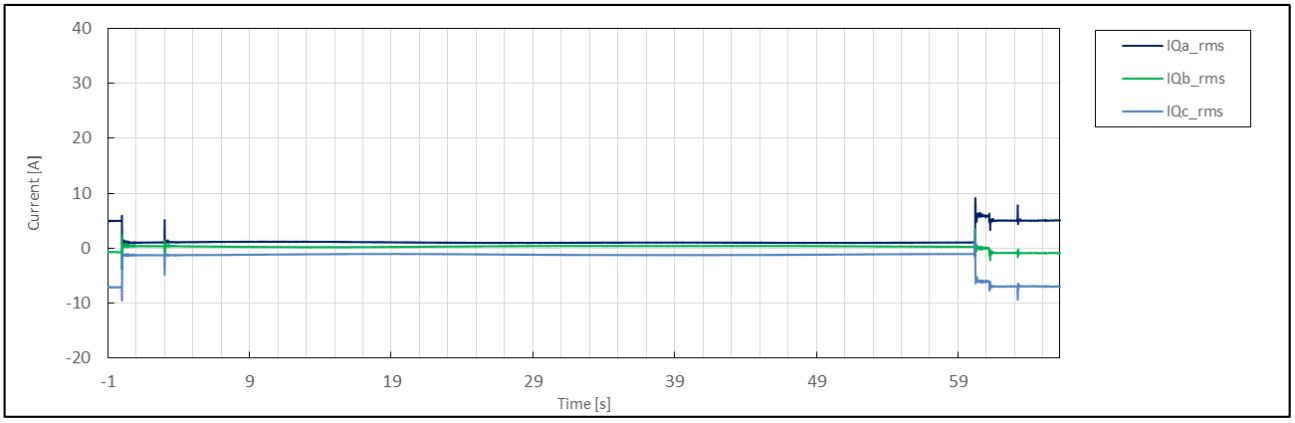


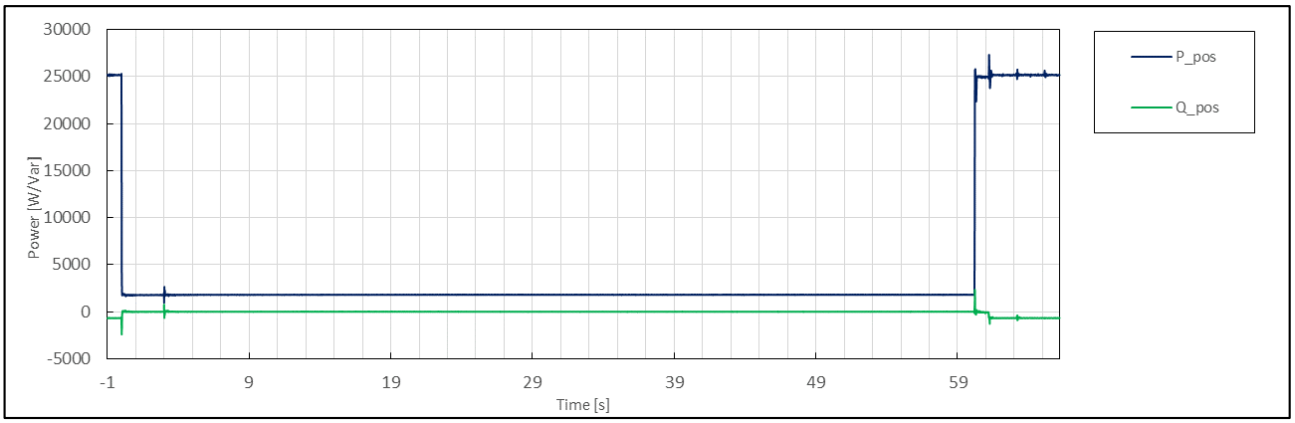


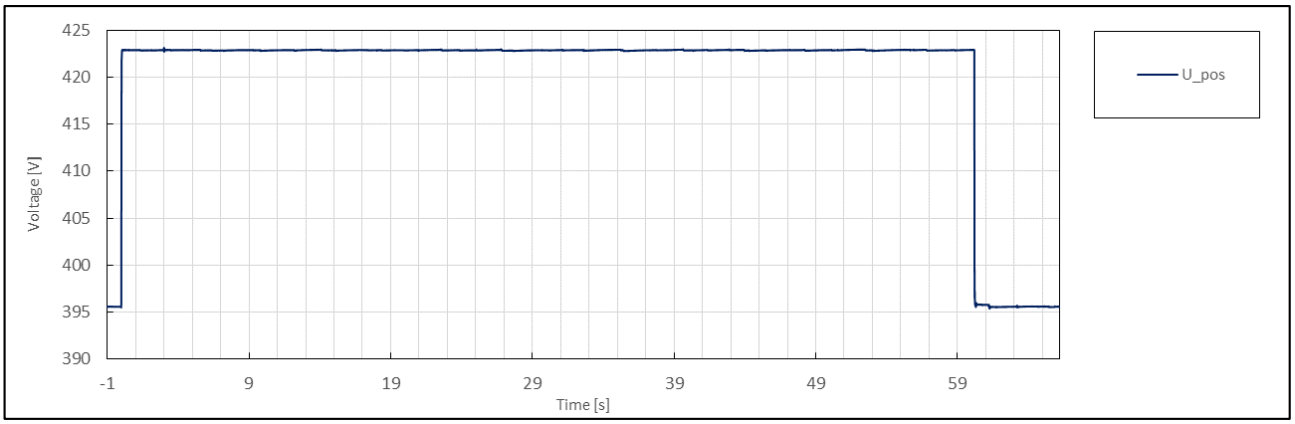

Zoomed Ia
Zoomed Ib
Zoomed Ic
Current [A]
Time [s]

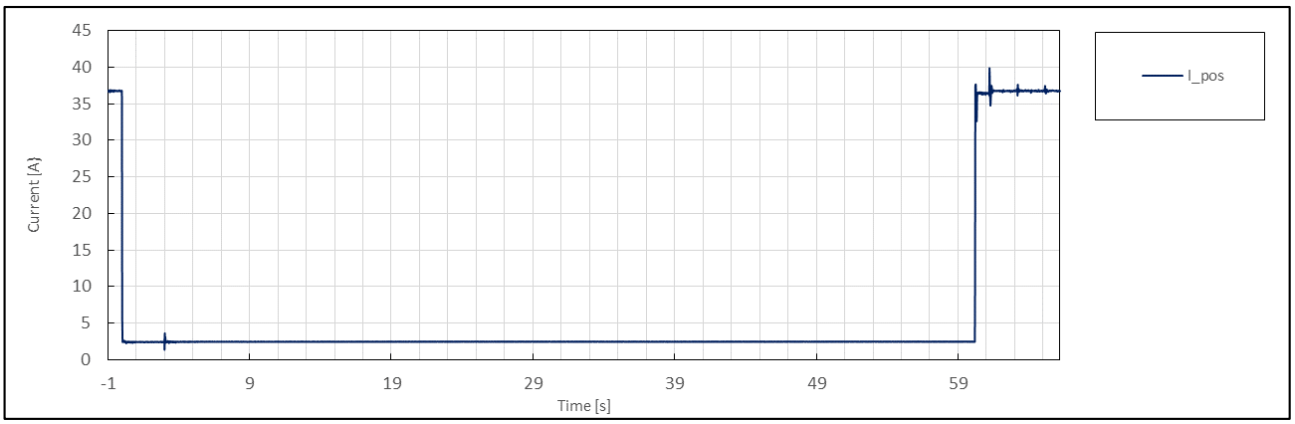

Ia_rms
Ib_rms
Ic_rms
Current [A]
Time [s]


IPa_rms
IPb_rms
IPc_rms
Current [A]
Time [s]


IQa_rms
IQb_rms
IQc_rms
Current [A]
Time [s]







End of test report

TÜVRheinland®

PHOTO DOCUMENTATION

50350516 001

for

Grid-Connected PV Inverter

SG33CX, SG40CX, SG50CX

Sungrow Power Supply Co., Ltd.

This documentation consists of 11 pages (excluding this cover page)

Figure 1. Overview

Figure 2. Right side view

Figure 3. Left side view (without dc switch)

Figure 4. Top side view

Figure 5. Bottom side view

Figure 6. Rear view

Figure 7. Internal view without cover

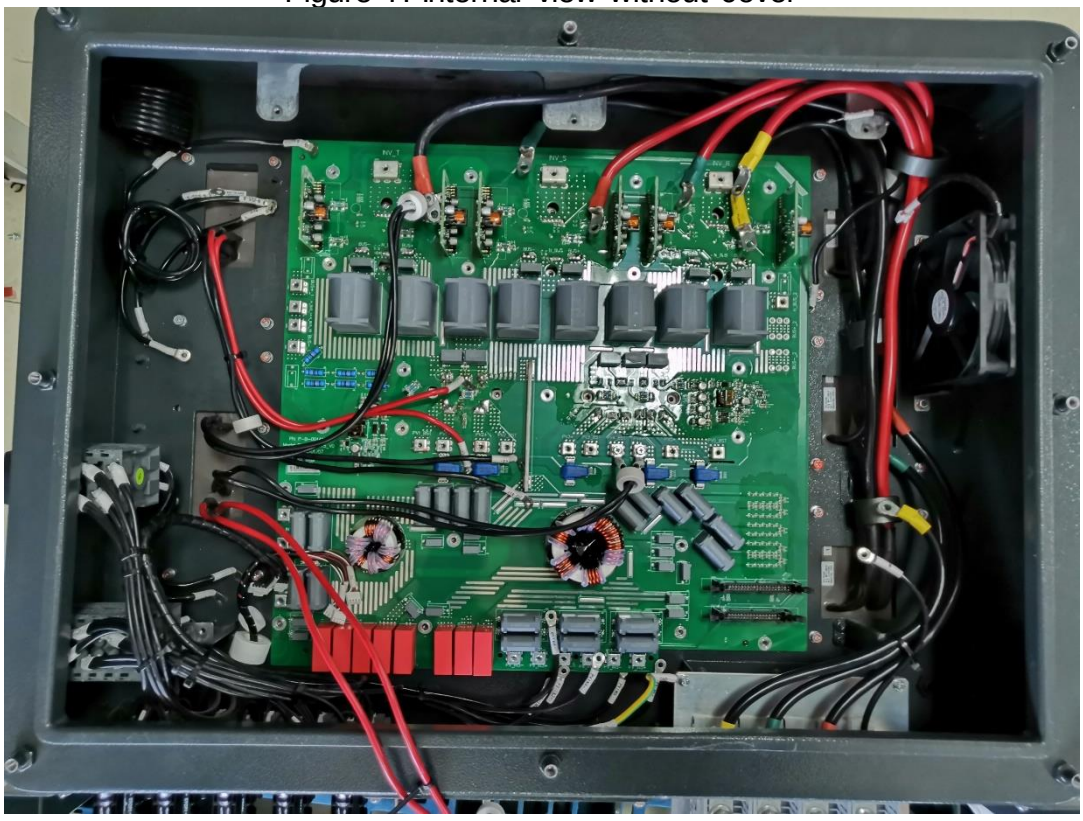


Figure 8. Internal view with main power board

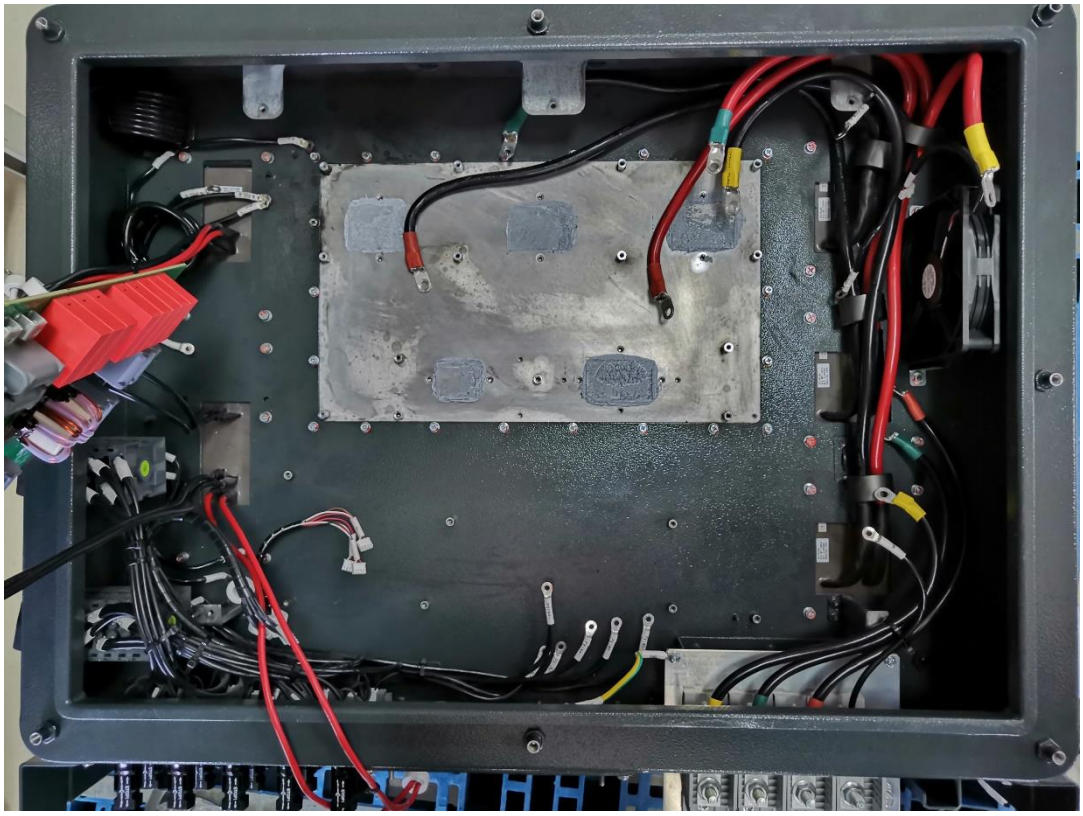


Figure 9. Internal view without PCB

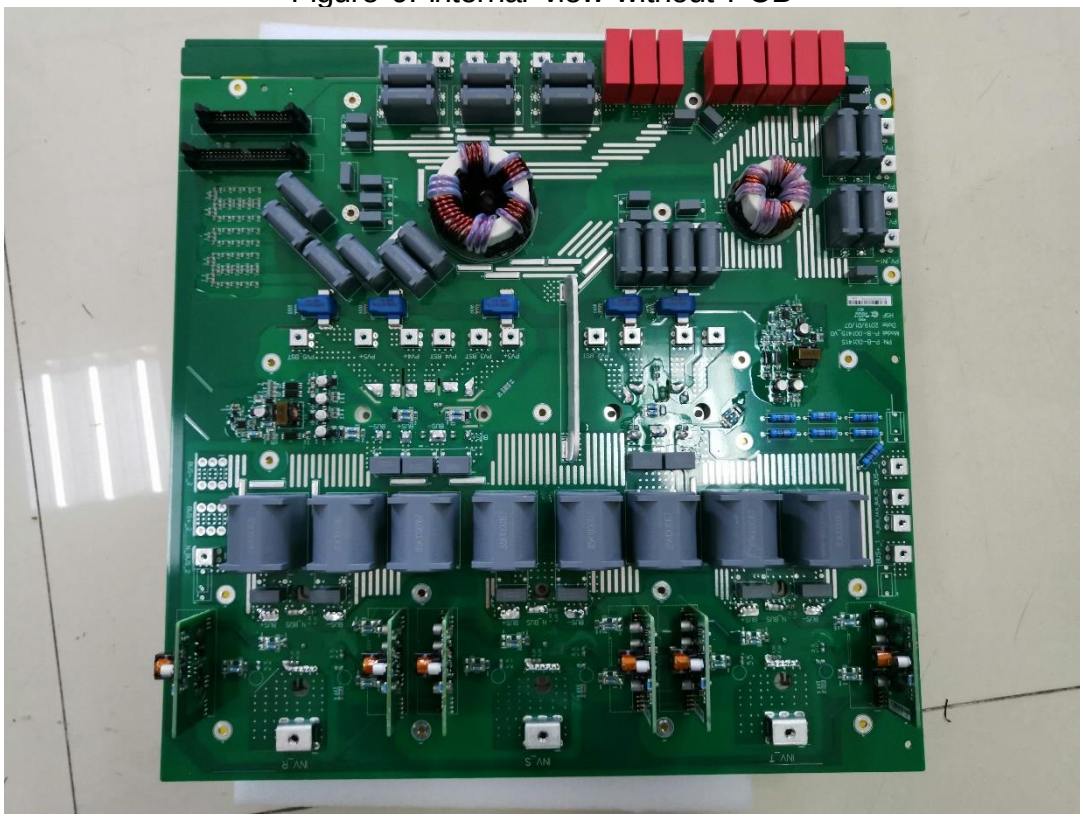


Figure 10. Component side of main power board

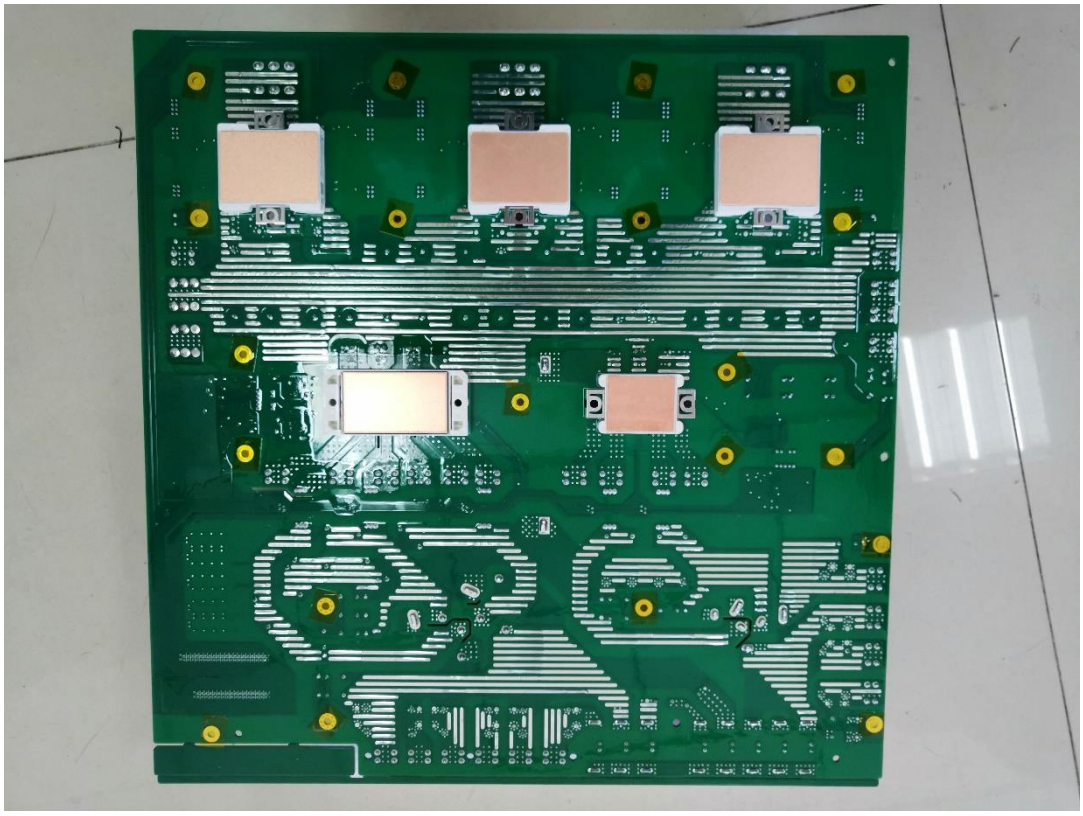


Figure 11. Trace side of main power board

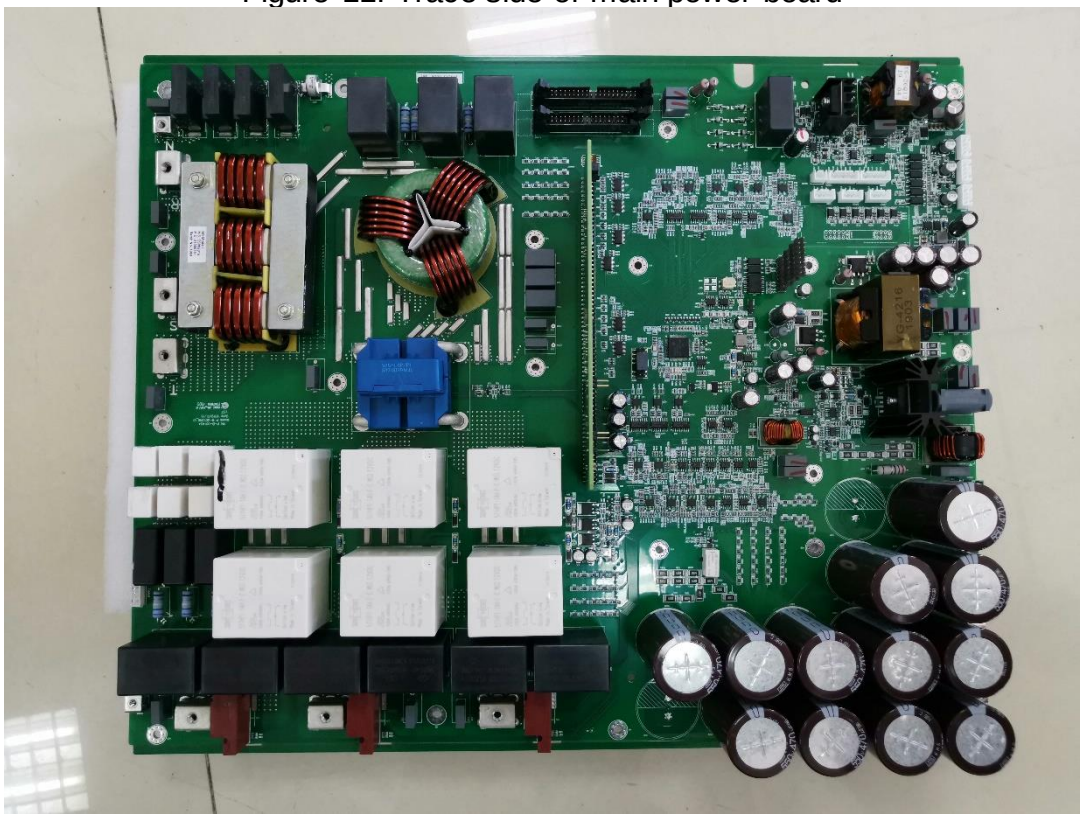


Figure 12. Component side of AC output power board

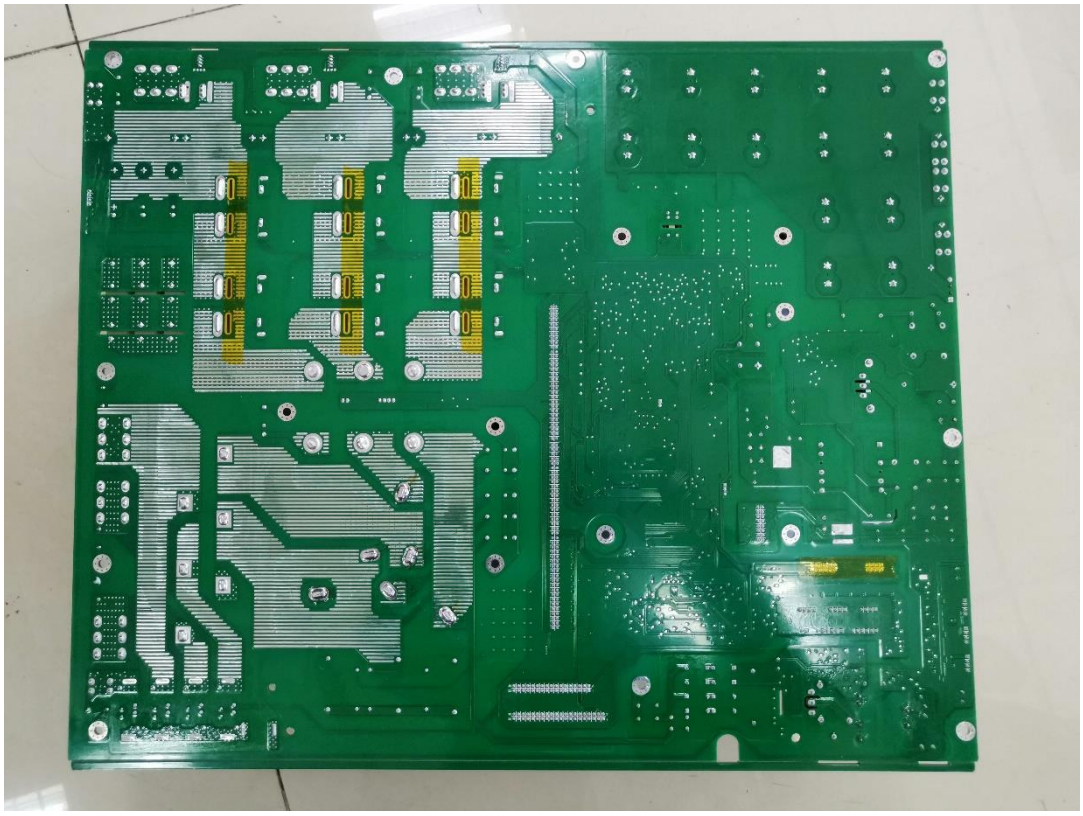


Figure 13. Trace side of AC output power board

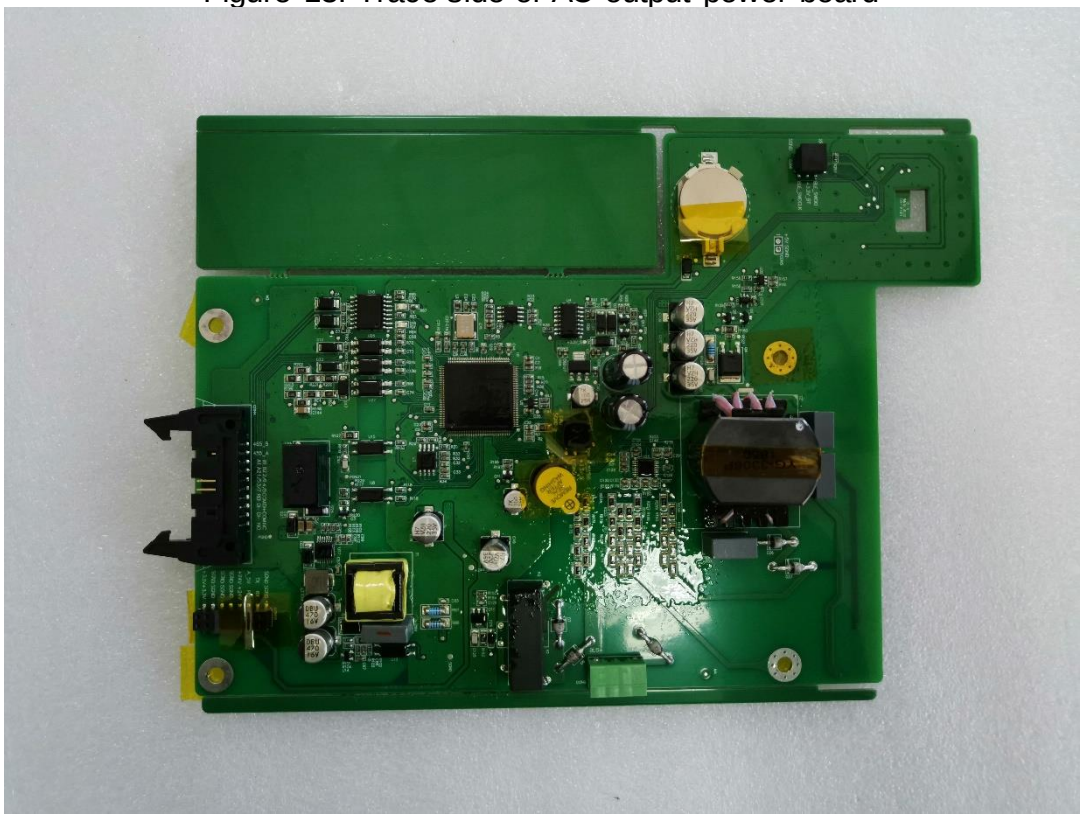


Figure 14. Component side of communication board

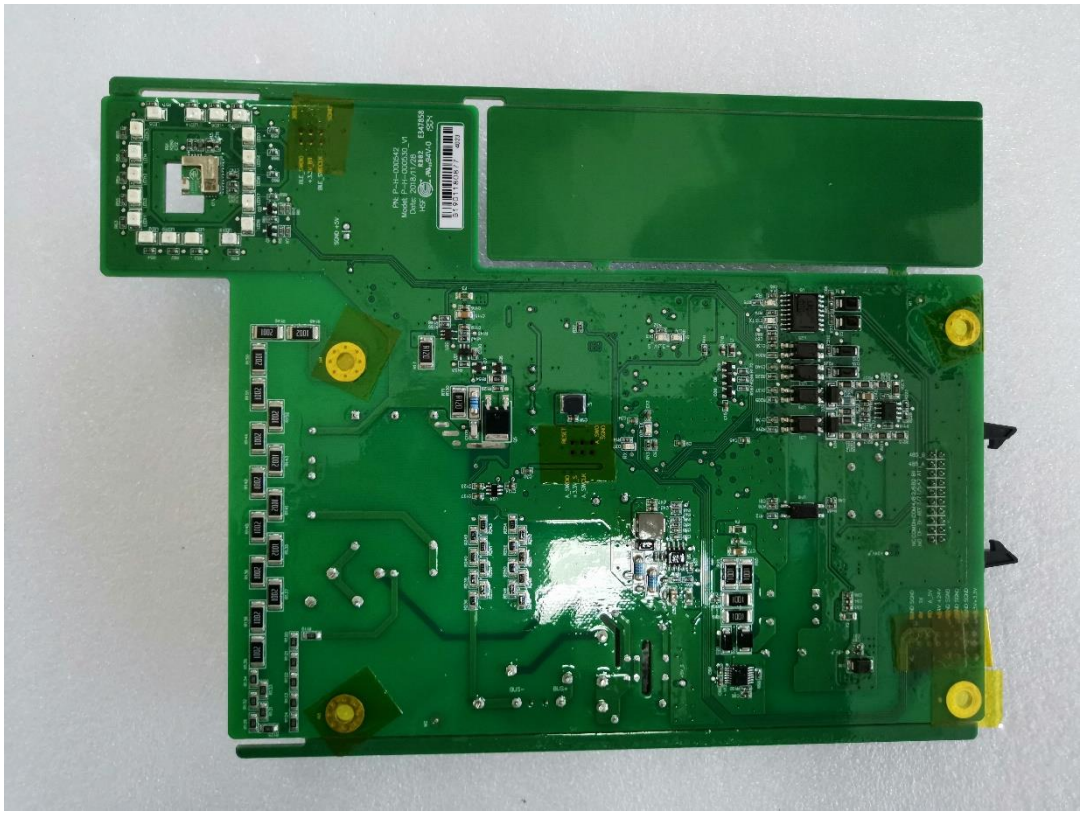


Figure 15. Trace side of communication board

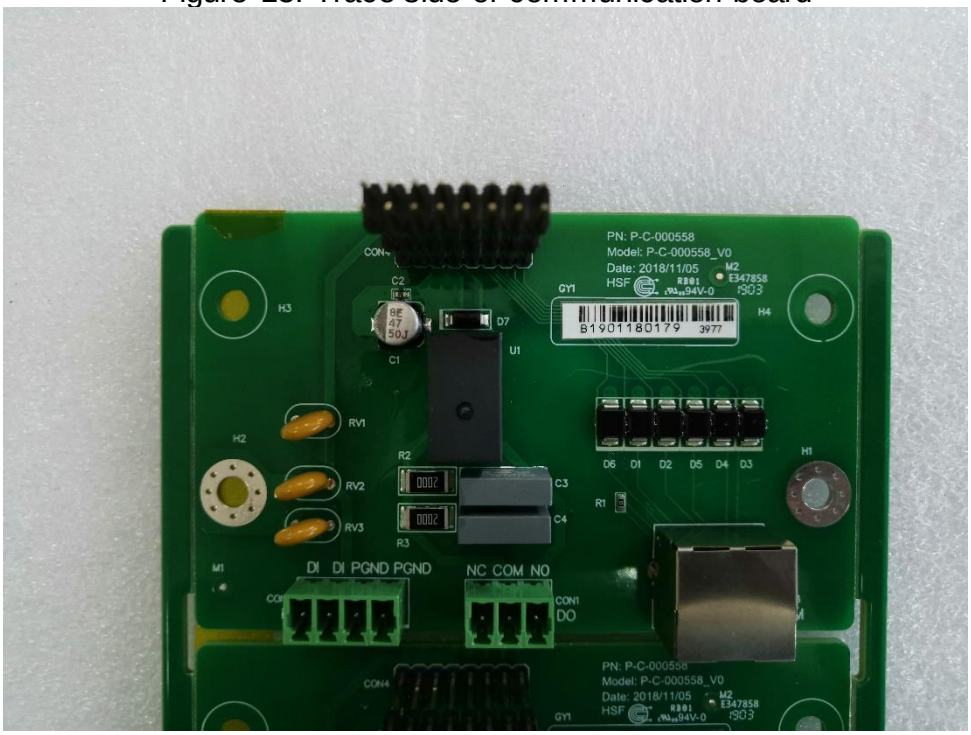


Figure 16. Component side of DIDO Interface board

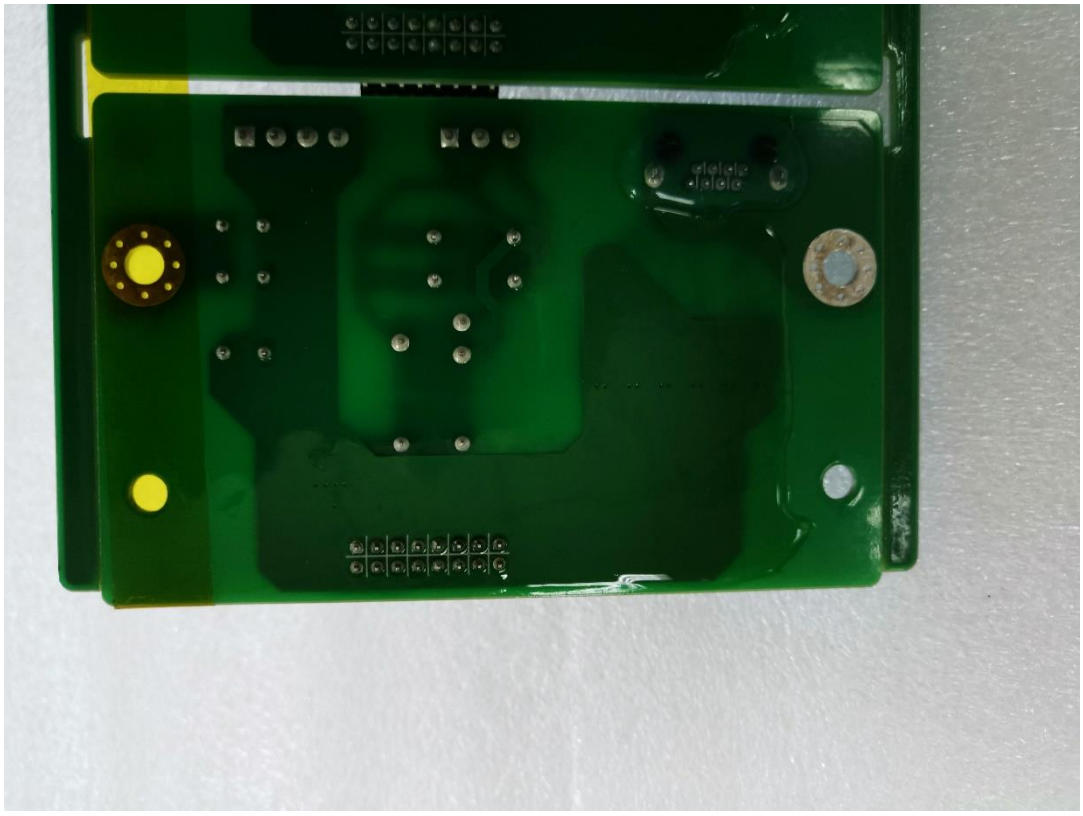


Figure 17. Trace side of DIDO Interface board

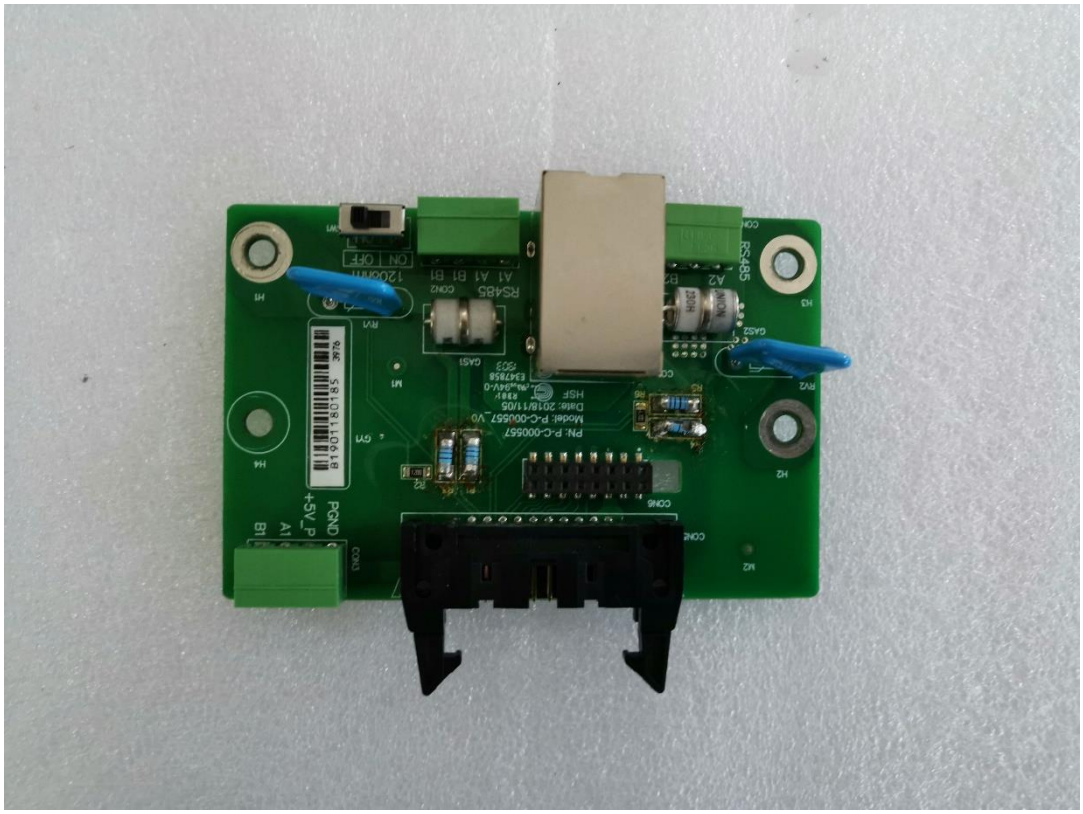


Figure 18. Component side of RS 485 Interface board

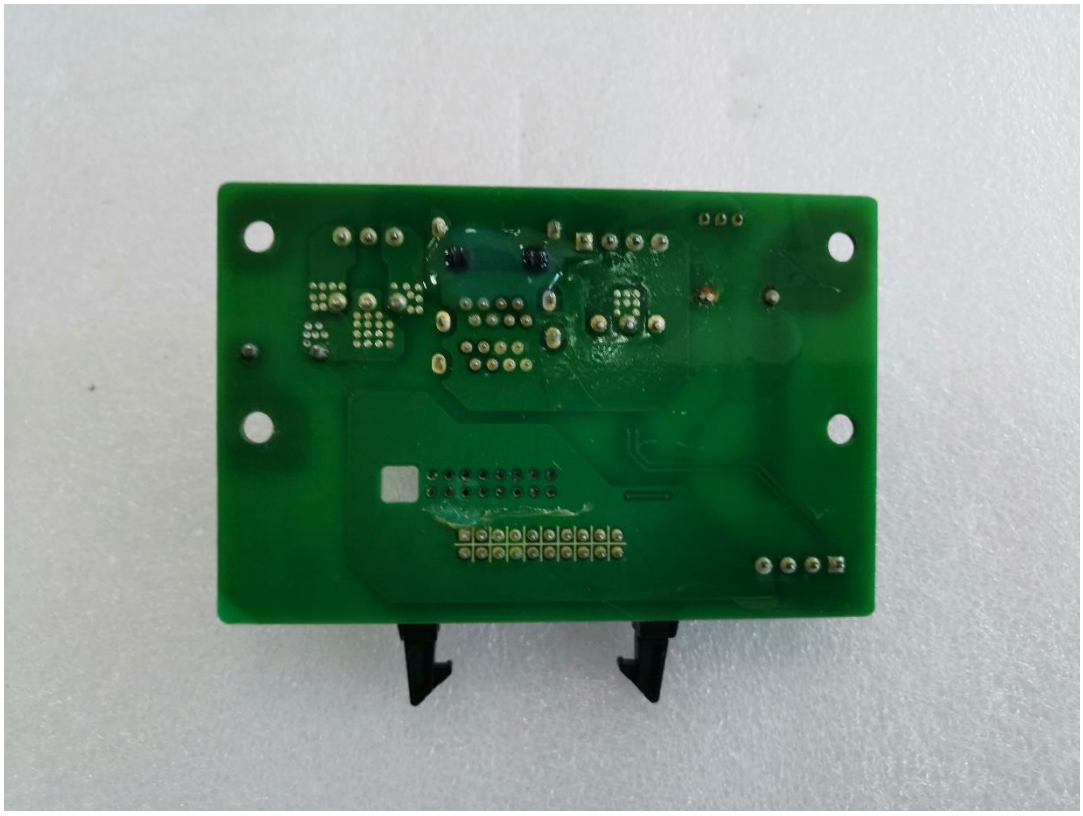


Figure 19. Trace side of RS485 Interface board

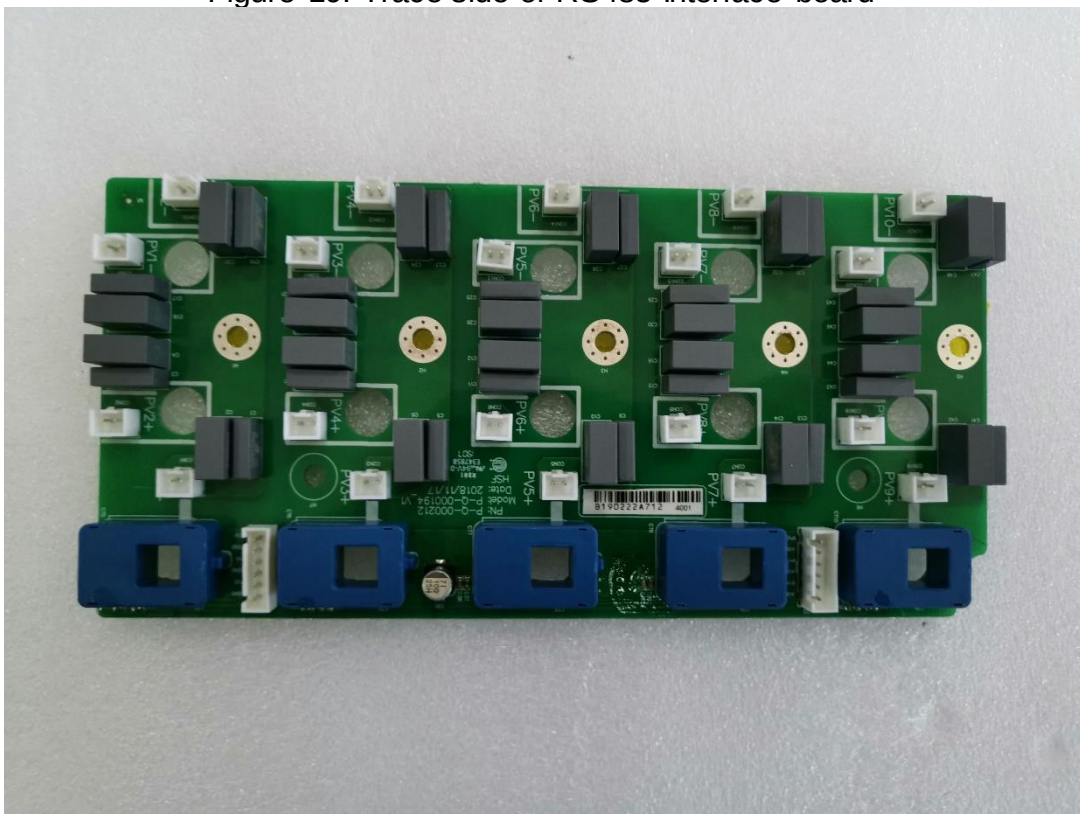


Figure 20. Component side of String Detective board

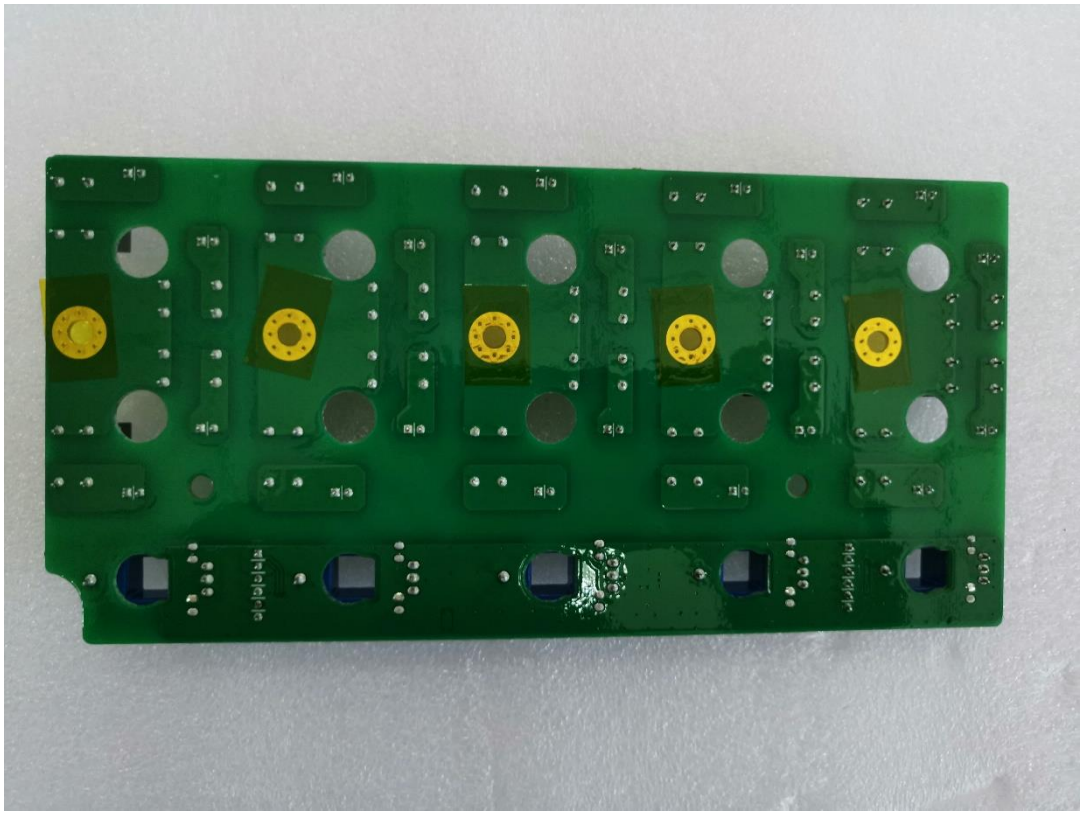


Figure 21. Trace side of String Detective board