Type Certificate

Applicant:	**Huawei Technologies Co., Ltd.**	
Address:	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129 P.R. China	
Type of power generating unit:	**Grid-Tied Solar Inverter**	**SUN2000-168 - 215KTL (Inverter Family)** (for details see *Supplement of Certificate* on p.2)
Technical data:	Max. apparent power:	215 kVA
	Nominal output AC voltage:	800 V (3P + PE)
	Nominal frequency:	50 Hz
Technical data determined by measurements:	Max. active power P_{Emax} / Max. active power peak P_{600}:	(for details see *Supplement of Certificate* on p.2)
Firmware version:	**V300R001** or higher	
Software version:	**V300R001C00SPC107** or higher	

Validated type model:	Model file:	Huawei_19-0650_1_TR4_SUN2000-168-215KTL_V2.zip
	Identification number (MD5):	922c8ff5d481200bc7140ea28cedfef2

Grid connection regulation:

VDE-AR-N 4110:2018-11 – Technical requirements for the connection and operation of customer installations to the medium voltage network (TCR medium voltage) [1]

VDE-AR-N 4120:2018-11 – Technical requirements for the connection and operation of customer installations to the high voltage network (TCR high voltage) [2]

Pertinent standards / Guidelines:

Technical guidelines:
FGW TR 3 Rev. 25 [3], FGW TR 4 Rev. 09 [4], FGW TR 8 Rev. 09 [5]

The power generating units, stated in the certificate, were tested and certified according to the technical guidelines referenced to the grid connection regulation. The electrical characteristics fulfil the requirements of the grid connection regulation:

- Quasi-steady-state operation
- Dynamic network stability (reactive current characteristic according to TCR medium voltage)
- Active power output and network security management
- Active power adjustment as a function of the grid frequency
- Protection technology and protection settings on generating unit level
- Power quality

The manufacturer has provided proof of certification of the quality management system of his production facility in accordance with ISO 9001

Restrictions, deviations or notes on usage: see *Supplement of Certificate* on p.2.

The certificate includes the following information:

- technical data of the power generating unit, the auxiliary equipment used and the software version used;
- schematic structure of the power generating units;
- summarized information on the properties of the power generating unit.

The certificate is comprised of 107 pages (including Annex of 105 pages).

BV project number : **19TH0240**
Certificate no. : **19-0650_1**
Issued : **2021-08-31**
Certification scheme : **NSOP-0032-DEU-ZE-V01**
Valid until : **2024-12-22**

Certification body

Holger Schaffer

DAkkS Deutsche Akkreditierungsstelle D-ZE-12024-01-00

BUREAU VERITAS
Consumer Products Services Germany GmbH
Oehleckerring 40, 22419 Hamburg, Germany
Tel: +49 40 74041-0
cps-hamburg@de.bureauveritas.com
www.bureauveritas.de/cps

Supplement of Certificate (19-0650_1)

Type of power generating unit:	**Grid-tied photovoltaic inverter**	**SUN2000-168KTL-H1**	**SUN2000-185KTL-H1**	**SUN2000-215KTL-H0 SUN2000-215KTL-H3**
Technical data:	Nominal active output power [1]	150 kW	175 kW	200 kW
	Max. apparent / active output power:	168 kVA / KW	185 kVA / KW	215 kVA / KW
	Nominal voltage:	800 V (3P + PE)		
	Nominal frequency:	50 Hz		
Technical data determined by measurements:	Max. active power P_{Emax} / Max. active power peak P_{600} [2), 3)]:	167,87 kW	185,61 kW	214,91 kW

Firmware version:	**V300R001** or higher
Software version:	**V300R001C00SPC107** or higher

Note:

[1] The nominal active output power P_n is just a nominal value defined by manufacturer, for details see p.51.

[2] The P_{Emax} is *the highest 10-min mean of the active power of a power generating unit* defined according to VDE-AR-N 4110:2018 [1]. The P_{600} is *the maximum active power peak of the overall system (averaging period 10 min)* defined according to FGW TR 3 Rev. 25 [3].

[3] The stated measurement results were determined according to test 4.1.1, FGW TR 3 Rev. 25 [3].

Restrictions, deviations or notes on usage:

- The PGUs in the series do not provide test terminals for on-site testing. For necessary on-site testing, a separate test terminal must be installed additionally.
- The PGUs in the series do not provide display for checking the protection setting. Settings of the integrated protection relay can only be checked per remote via WebUI or via SUN2000 app using a mobile phone. Authentic identification is ensured via the serial number of the device, which is displayed on the Web-UI or SUN2000 app.
- Only one Interface for specifying active power implemented on the PGU. Separate specifying active power by grid operator and direct seller is not possible. For prioritization of different setpoints must be carried out on the plant level e.g. in the superimposed PGS controller.
- The on the PGU level implemented reactive power set point changes (parameter No. 30 in provided parameter list, see Annex 5) does not provide PT1 filtering effect.
  The on the PGU level implemented Q(U) control function deviates from requirements according to VDE-AR-N 4110:2018-11 [1].
  The PGUs in the series provide only one kind of Q(U) control function. The on the PGU level implanted Q(U) control function can be used as *reactive power with voltage limitation function* by suitable setting of the characteristic curve. But this also deviates from requirements according to VDE-AR-N 4110:2018-11 [1].
  These need to be considered for project planning. If needed, these have to be implemented on the plant level e.g. in the superimposed PGS controller.
- The default configuration of the units may not meet the reactive power requirement at the grid connection point. A permanent active power reduction may be needed (see p.50 to 51). This needs to be considered for project planning.

BV project number : **19TH0240**
Certificate no. : **19-0650_1** **Certification scheme** : **NSOP-0032-DEU-ZE-V01**
Issued : **2021-08-31** **Valid until** : **2024-12-22**

Certification body

Holger Schaffer

DAkkS Deutsche Akkreditierungsstelle D-ZE-12024-01-00

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Description of the revisions of certificate 19-0650_1	
Rev. 0	First issue
Rev. 1	**General changes:** • Model types of *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* added. • *Software version* added. • Simulation model updated. • *Technical data determined by measurements* added. • *Restrictions, deviations or notes on usage* added. **Changes in the certificate annexes:** • *Annex 1 – Guidelines, test reports and documents* o Reference [7], [8], [9], [10], [11], [12], [13], [14] and [15] updated. o Reference [16] and [17] added. • *Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)* updated. • *Annex 3 – Extract from the test report* updated. • *Annex 4 – Validated simulation model* updated. • *Annex 5 – Certification-relevant parameters* updated.

Annexes included in certificate 19-0650_1

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1. Annex 1 – Guidelines, test reports and documents

This certificate is based on following guidelines, test reports and documents:

Reference	Guidelines
[1]	Technische Regeln für den Anschluss von Kundenanlagen an das Mittelspannungsnetz und deren Betrieb (TAR Mittelspannung), VDE-AR-N 4110:2018-11 / *Technical requirements for the connection and operation of customer installations to the medium voltage network (TCR medium voltage), VDE-AR-N 4110:2018-11*
[2]	Technische Regeln für den Anschluss von Kundenanlagen an das Hochspannungsnetz und deren Betrieb (TAR Hochspannung), VDE-AR-N 4120:2018-11 / *Technical requirements for the connection and operation of customer installations to the high voltage network (TCR high voltage), VDE-AR-N 4120:2018-11*
[3]	Technische Richtlinien für Erzeugungseinheiten und –anlagen TEIL 3 (TR3), Bestimmung der elektrischen Eigenschaften von Erzeugungseinheiten und -anlagen, Speicher sowie für deren Komponenten am Mittel-, Hoch- und Höchstspannungsnetz, Revision 25, Stand 01.09.2018 / *Technical Guidelines for Power Generating Units and Systems PART 3 (TG3), Determination of the Electrical Characteristics of Power Generating Units and Systems, Storage Systems as well for their Components in Medium-, High- and Extra-High Voltage Grids, Revision 25, Dated 01/09/2018*
[4]	Technische Richtlinien für Erzeugungseinheiten und –anlagen TEIL 4 (TR4), Anforderungen an Modellierung und Validierung von Simulationsmodellen der elektrischen Eigenschaften von Erzeugungseinheiten und -anlagen, Speicher sowie deren Komponenten, Revision 09, Stand 01.02.2019 / *Technical Guidelines for Power Generating Units and Systems PART 4 (TG4), Demands on Modelling and Validating Simulation Models of the Electrical Characteristics of Power Generating Units and Systems, Storage Systems as well as their Components, Revision 09, Dated 01/02/2019*
[5]	Technische Richtlinien für Erzeugungseinheiten, -anlagen und Speicher sowie für deren Komponenten TEIL 8 (TR8), Zertifizierung der elektrischen Eigenschaften von Erzeugungseinheiten und -anlagen, Speicher sowie für deren Komponenten am Stromnetz, Revision 09, Stand 01.02.2019 / *Technical Guidelines for for Power Generating Units, Systems and Storage Systems as well as for their Components PART 8 (TG8), Determination of the Electrical Characteristics of Power Generating Units and Systems, Storage Systems as well for their Components in Medium-, High- and Extra-High Voltage Grids, Revision 09, Dated 01/02/2019*
[6]	Kurzschlussströme in Drehstromnetzen Teil 0: Berechnung der Ströme, DIN EN 60909-0 (VDE 0102):2016-12 / *Short-circuit currents in three-phase a.c. systems Part 0: Calculation of currents (IEC 60909-0:2016)*

Reference	Test reports
[7]	19TH0240_TR3_1 TG3 test report according to FGW TG3 Rev.25, issued by Bureau Veritas Consumer Products Services Germany GmbH on 30.Jul.2021
[8]	19TH0240_TR4_1 TG4 test report according to FGW TG4 Rev.09, issued by Bureau Veritas Consumer Products Services Germany GmbH on 30.Aug.2021
[9]	19TH0240_TR8_1 TG8 evaluation report according to FGW TG8 Rev.09, issued by Bureau Veritas Consumer Products Services Germany GmbH on 31. Aug. 2021
[10]	19TH0240_TR3_1_excerpt-part_1_0 Extract from the TG3 test report, issued by Bureau Veritas Consumer Products Services Germany GmbH on 30.Aug.2021

1. Annex 1 – Guidelines, test reports and documents	
[11]	19TH0240_TR3_1_excerpt-part_2_0 Extract from the TG3 test report, issued by Bureau Veritas Consumer Products Services Germany GmbH on 30.Aug.2021
[12]	19TH0240_TR3_1_excerpt-part_3_0 Extract from the TG3 test report, issued by Bureau Veritas Consumer Products Services Germany GmbH on 30.Aug.2021

The compliance to the grid connection regulation of the power generating units is shown by the results in the test report (*19TH0240_TR3_1*) which includes all type tests stated in the certificate. The type tests were conducted by Bureau Veritas Consumer Products Services Germany GmbH.

The compliance to the grid connection regulation of the simulation models is verified by the validation report (*19TH0240_TR4_1*). The simulations were conducted by Bureau Veritas Consumer Products Services Germany GmbH.

The summary of the grid connection regulation compliant certification of the units

- SUN2000-168KTL-H1
- SUN2000-185KTL-H1
- SUN2000-215KTL-H0
- SUN2000-215KTL-H3

is stated in the certification report (*19TH0240_TR8_1*).

Reference	Certification-relevant documents provided by manufacturer
[13]	Manufacturer's certificate on specific data of a Photovoltaic Converter, dated 18.Dec.2019: F.0_Huawei_SUN2000-168KTL_Manufacturer certificate_V01 F.0_Huawei_SUN2000-185KTL_Manufacturer certificate_V01 Manufacturer's certificate on specific data of a Photovoltaic Converter, dated 16.Jun.2021: F.0_Huawei_SUN2000-215KTL-H0_Manufacturer certificate_V01 F.0_Huawei_SUN2000-215KTL-H3_Manufacturer certificate_V01
[14]	Parameter list, V2.0, dated 30.Apr.2021: F.2_Huawei_SUN2000-215KTL Series_Parameter list_V2
[15]	Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11, dated 19.May.2021: F.4_Huawei_SUN2000-215KTL Series_Declaration of manufacturer_V2
[16]	*SmartLogger3000 User Manual*, issued by Huawei Technologies Co., Ltd., Issue 05, Date: 2020-09-30 SmartLogger3000 User Manual.pdf
[17]	*SmartLogger ModBus Interface Definitions*, issued by Huawei Technologies Co., Ltd., Issue 38, Date: 2020-11-25 SmartLogger ModBus Interface Definitions.pdf

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

2.1. Technical data of the power generating unit (Manufacturer's data)

Herstellerbescheinigung zu spezifischen Daten eines Photovoltaik-Wechselrichters vom Typ SUN2000-168KTL-H1

Manufacturer's certificate on specific data of a Photovoltaic Converter of the type SUN2000-168KTL-H1

Datum / Date: 2019-12-18 **Seite/Page 1/1**

1	**Allgemeines und Ausgangsgrößen**			**General and Output values**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-168KTL-H1		type name
3	Einspeisung (einphasig/dreiphasig)	three-phase		no. of phases (single-phase/three-phase)
4	Nennscheinleistung	150	kVA	rated apparent power
5	Nennwirkleistung	150	kW	rated active power
6	AC-Nennspannung	800	V	rated AC-voltage
7	AC-Nennfrequenz	50	Hz	rated frequency
8	Beitrag zum Stoßkurzschlussstrom (i_p nach IEC 60909-0)	0.1225	kA	contribution to initial short circuit current (i_p according to IEC 60909-0)
2	**DC Eingangsgrößen**			**DC Input**
1	Min. MPP-Spannung	500	V	min. MPP voltage
2	Max. MPP-Spannung	1500	V	max. MPP voltage
3	Max. PV-Eingangsspannung	1500	V	max. DC input voltage
4	Max. PV-Eingangsstrom	234	A	max. DC input current
5	Max. Modulleistung	171.5	kWp	max. peak power
3	**Wechselrichter-Leistungsteil**			**Converter-Power section**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-168KTL-H1		type name
3	Nennscheinleistung	150	kVA	rated apparent power
4	Art (HF/NF-Trafo, trafolos)	Without		generic type (HF/LF-transformer, without)
5	Taktfrequenz	18	kHz	pulse rate of inverter
6	Art der Leistungsregelung (MPPT)	Advanced Climb		generic type of power control (MPPT)
7	Software-Version	V300R001		software version
4	**Sonstige elektrische Komponenten**			**Other electric components**
1	Art der Netzkopplung	3 ~ + PE		generic type of interconnection
2	- Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		- manufacturer
3	- Typenbezeichnung	SUN2000-168KTL-H1		- type
4	Netzschutz integriert (Ja/Nein)	Yes		integrated grid protection (Yes/No)
5	Netzschutzhersteller	HUAWEI		grid protection manufacturer
5	- Typenbezeichnung	SUN2000-168KTL-H1		- type
7	Typenbezeichnung der Abschalteinheit (angesteuert vom Netzschutz)	Hongfa Electroacoustic HF167F-140/12-H3F		circuit breaker type controlled by the grid protection
8	Oberschwingungsfilter (ja/nein)	Yes		harmonic filter (yes/no)
5	**Typenprüfung**			**Type test**
1	Prüfbehörde	Bureau Veritas CPS		testing authority
2	Aktenzeichen	19TH0240		reference
3	Seriennummer des Wechselrichters	6T1979057521		serial number of converter

Anschrift des Herstellers
Address of manufacturer

Administration Building, Headquarters of Huawei Technologies Co.,Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

Stempel, Datum, Unterschrift
stamp, date, signature

18.12.2019 Xu Bin

Der Hersteller des PV-Wechselrichters bestätigt, dass der PV-Wechselrichter, dessen elektrischen Eigenschaften in den Prüfberichten abgebildet sind, hinsichtlich seiner technischen Daten mit den o.g. Positionen identisch ist.

The manufacturer of the PV-Converter confirms that the PV-Converter whose power quality is measured and depicted in the test reports, is identical with the above entries with regard to its technical data

F.0 BUREAU VERITAS CPS Germany – Manufacturer's declaration / V01 09/19

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

Herstellerbescheinigung zu spezifischen Daten eines Photovoltaik-Wechselrichters vom Typ SUN2000-185KTL-H1 Manufacturer's certificate on specific data of a Photovoltaic Converter of the type SUN2000-185KTL-H1				
Datum / Date: 2019-12-18				Seite/Page 1/1
1	**Allgemeines und Ausgangsgrößen**			**General and Output values**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-185KTL-H1		type name
3	Einspeisung (einphasig/dreiphasig)	three-phase		no. of phases (single-phase/three-phase)
4	Nennscheinleistung	175	kVA	rated apparent power
5	Nennwirkleistung	175	kW	rated active power
6	AC-Nennspannung	800	V	rated AC-voltage
7	AC-Nennfrequenz	50	Hz	rated frequency
8	Beitrag zum Stoßkurzschlussstrom (i_p nach IEC 60909-0)	0.1349	kA	contribution to initial short circuit current (i_p according to IEC 60909-0)
2	**DC Eingangsgrößen**			**DC Input**
1	Min. MPP-Spannung	500	V	min. MPP voltage
2	Max. MPP-Spannung	1500	V	max. MPP voltage
3	Max. PV-Eingangsspannung	1500	V	max. DC input voltage
4	Max. PV-Eingangsstrom	234	A	max. DC input current
5	Max. Modulleistung	188.8	kW_p	max. peak power
3	**Wechselrichter-Leistungsteil**			**Converter-Power section**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-185KTL-H1		type name
3	Nennscheinleistung	175	kVA	rated apparent power
4	Art (HF/NF-Trafo, trafolos)	Without		generic type (HF/LF-transformer, without)
5	Taktfrequenz	18	kHz	pulse rate of inverter
6	Art der Leistungsregelung (MPPT)	Advanced Climb		generic type of power control (MPPT)
7	Software-Version	V300R001		software version
4	**Sonstige elektrische Komponenten**			**Other electric components**
1	Art der Netzkopplung	3 ~ + PE		generic type of interconnection
2	- Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		- manufacturer
3	- Typenbezeichnung	SUN2000-185KTL-H1		- type
4	Netzschutz integriert (Ja/Nein)	Yes		integrated grid protection (Yes/No)
5	Netzschutzhersteller	HUAWEI		grid protection manufacturer
5	- Typenbezeichnung	SUN2000-185KTL-H1		- type
7	Typenbezeichnung der Abschalteinheit (angesteuert vom Netzschutz)	Hongfa Electroacoustic HF167F-140/12-H3F		circuit breaker type controlled by the grid protection
8	Oberschwingungsfilter (ja/nein)	Yes		harmonic filter (yes/no)
5	**Typenprüfung**			**Type test**
1	Prüfbehörde	Bureau Veritas CPS		testing authority
2	Aktenzeichen	19TH0240		reference
3	Seriennummer des Wechselrichters	6T1979057521		serial number of converter

Anschrift des Herstellers
Address of manufacturer

Administration Building, Headquarters of Huawei Technologies Co.,Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

Stempel, Datum, Unterschrift
stamp, date, signature

18.12.2019 Xu Bin

Der Hersteller des PV-Wechselrichters bestätigt, dass der PV-Wechselrichter, dessen elektrischen Eigenschaften in den Prüfberichten abgebildet sind, hinsichtlich seiner technischen Daten mit den o.g. Positionen identisch ist.

The manufacturer of the PV-Converter confirms that the PV-Converter whose power quality is measured and depicted in the test reports, is identical with the above entries with regard to its technical data

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

Herstellerbescheinigung zu spezifischen Daten eines Photovoltaik-Wechselrichters vom Typ *SUN2000-215KTL-H0*				
Manufacturer's certificate on specific data of a Photovoltaic Converter of the type *SUN2000-215KTL-H0*				
Datum / Date: 2021-06-16				**Seite/Page 1/1**
1	**Allgemeines und Ausgangsgrößen**			**General and Output values**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-215KTL-H0		type name
3	Einspeisung (einphasig/dreiphasig)	three-phase		no. of phases (single-phase/three-phase)
4	Nennscheinleistung	200	kVA	rated apparent power
5	Nennwirkleistung	200	kW	rated active power
6	AC-Nennspannung	800	V	rated AC-voltage
7	AC-Nennfrequenz	50	Hz	rated frequency
8	Beitrag zum Stoßkurzschlussstrom (i_p nach IEC 60909-0)	0.233	kA	contribution to initial short circuit current (i_p according to IEC 60909-0)
2	**DC Eingangsgrößen**			**DC Input**
1	Min. MPP-Spannung	500	V	min. MPP voltage
2	Max. MPP-Spannung	1500	V	max. MPP voltage
3	Max. PV-Eingangsspannung	1500	V	max. DC input voltage
4	Max. PV-Eingangsstrom	9*30	A	max. DC input current
5	Max. Modulleistung	219.4	kW_p	max. peak power
3	**Wechselrichter-Leistungsteil**			**Converter-Power section**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-215KTL-H0		type name
3	Nennscheinleistung	200	kVA	rated apparent power
4	Art (HF/NF-Trafo, trafolos)	without		generic type (HF/LF-transformer, without)
5	Taktfrequenz	18	kHz	pulse rate of inverter
6	Art der Leistungsregelung (MPPT)	Advanced Climb		generic type of power control (MPPT)
7	Software-Version	V300R001		software version
4	**Sonstige elektrische Komponenten**			**Other electric components**
1	Art der Netzkopplung	3W+PE		generic type of interconnection
2	- Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		- manufacturer
3	- Typenbezeichnung	SUN2000-215KTL-H0		- type
4	Netzschutz integriert (Ja/Nein)	Yes		integrated grid protection (Yes/No)
5	Netzschutzhersteller	HUAWEI TECHNOLOGIES CO.,LTD.		grid protection manufacturer
6	- Typenbezeichnung	SUN2000-215TL-H0		- type
7	Typenbezeichnung der Abschalteinheit (angesteuert vom Netzschutz)	HF167F-200/12-H3F		circuit breaker type controlled by the grid protection
8	Oberschwingungsfilter (ja/nein)	Yes		harmonic filter (yes/no)
5	**Typenprüfung**			**Type test**
1	Prüfbehörde	Bureau Veritas CPS		testing authority
2	Aktenzeichen	20TH0373		reference
3	Seriennummer des Wechselrichters	ES20C0082042		serial number of converter

Anschrift des Herstellers
Address of manufacturer

ZHAO YAZHU

Stempel, Datum, Unterschrift
stamp, date, signature

Der Hersteller des PV-Wechselrichters bestätigt, dass der PV-Wechselrichter, dessen elektrischen Eigenschaften in den Prüfberichten abgebildet sind, hinsichtlich seiner technischen Daten mit den o.g. Positionen identisch ist.

The manufacturer of the PV-Converter confirms that the PV-Converter whose power quality is measured and depicted in the test repoits, is identical with the above entries with regard lo its technical data

F.0 BUREAU VERITAS CPS Germany – Manufacturer's declaration / V01 09/19

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

Herstellerbescheinigung zu spezifischen Daten eines Photovoltaik-Wechselrichters vom Typ *SUN2000-215KTL-H3*

Manufacturer's certificate on specific data of a Photovoltaic Converter of the type *SUN2000-215KTL-H3*

Datum / Date: 2021-06-16 **Seite/Page 1/1**

1	**Allgemeines und Ausgangsgrößen**			**General and Output values**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-215KTL-H3		type name
3	Einspeisung (einphasig/dreiphasig)	three-phase		no. of phases (single-phase/three-phase)
4	Nennscheinleistung	200	kVA	rated apparent power
5	Nennwirkleistung	200	kW	rated active power
6	AC-Nennspannung	800	V	rated AC-voltage
7	AC-Nennfrequenz	50	Hz	rated frequency
8	Beitrag zum Stoßkurzschlussstrom (i_p nach IEC 60909-0)	0.233	kA	contribution to initial short circuit current (i_p according to IEC 60909-0)
2	**DC Eingangsgrößen**			**DC Input**
1	Min. MPP-Spannung	500	V	min. MPP voltage
2	Max. MPP-Spannung	1500	V	max. MPP voltage
3	Max. PV-Eingangsspannung	1500	V	max. DC input voltage
4	Max. PV-Eingangsstrom	3*100	A	max. DC input current
5	Max. Modulleistung	219.4	kW_p	max. peak power
3	**Wechselrichter-Leistungsteil**			**Converter-Power section**
1	Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		manufacturer
2	Typenbezeichnung	SUN2000-215KTL-H3		type name
3	Nennscheinleistung	200	kVA	rated apparent power
4	Art (HF/NF-Trafo, trafolos)	without		generic type (HF/LF-transformer, without)
5	Taktfrequenz	18	kHz	pulse rate of inverter
6	Art der Leistungsregelung (MPPT)	Advanced Climb		generic type of power control (MPPT)
7	Software-Version	V300R001		software version
4	**Sonstige elektrische Komponenten**			**Other electric components**
1	Art der Netzkopplung	3W+PE		generic type of interconnection
2	- Hersteller	HUAWEI TECHNOLOGIES CO.,LTD.		- manufacturer
3	- Typenbezeichnung	SUN2000-215KTL-H3		- type
4	Netzschutz integriert (Ja/Nein)	Yes		integrated grid protection (Yes/No)
5	Netzschutzhersteller	HUAWEI TECHNOLOGIES CO.,LTD.		grid protection manufacturer
6	- Typenbezeichnung	SUN2000-215TL-H3		- type
7	Typenbezeichnung der Abschalteinheit (angesteuert vom Netzschutz)	HF167F-200/12-H3F		circuit breaker type controlled by the grid protection
8	Oberschwingungsfilter (ja/nein)	Yes		harmonic filter (yes/no)
5	**Typenprüfung**			**Type test**
1	Prüfbehörde	Bureau Veritas CPS		testing authority
2	Aktenzeichen	20TH0373		reference
3	Seriennummer des Wechselrichters	ES20B0063004		serial number of converter

Anschrift des Herstellers
Address of manufacturer

ZHAO YAZHU

Stempel, Datum, Unterschrift
stamp, date, signature

Der Hersteller des PV-Wechselrichters bestätigt, dass der PV-Wechselrichter, dessen elektrischen Eigenschaften in den Prüfberichten abgebildet sind, hinsichtlich seiner technischen Daten mit den o.g. Positionen identisch ist.

The manufacturer of the PV-Converter confirms that the PV-Converter whose power quality is measured and depicted in the test reports, is identical with the above entries with regard to its technical data

F.0 BUREAU VERITAS CPS Germany – Manufacturer's declaration / V01 09/19

Figure 1 – Manufacturer's certificate on specific data from [13]

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

2.2. Description of the power generating unit

Description of the power circuit (Figure 2, Figure 3 & Figure 4)

The photovoltaic converter converts DC voltage, generated by photovoltaic modules, into AC voltage.

The units are three-phase.

The input and output are protected by SPDs to Earth. The unit is providing EMI filtering at the PV input and output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high-power switching bridge and two relays. This assures that the opening of the output circuit can operate in case of one error.

The internal control is redundant built. It consists of Microcontroller master ARM (U101) and slave ARM (U100).

The master ARM (U101) which can control the relays by switching signals; measures the voltage, frequency, AC current, DC-injection current, insulation resistance and residual current. In addition, it tests the array isolation impedance and the RCMU circuit before each start up.

The slave ARM (U100) is user for detecting grid voltage, grid frequency and residual current, also can open the relay, and communicate with Main ARM (U101) each other.

The unit provides two relays in series on each phase. When single-fault applied to one relay, an error code will appear on display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before start up. Both ARM can open the relays.

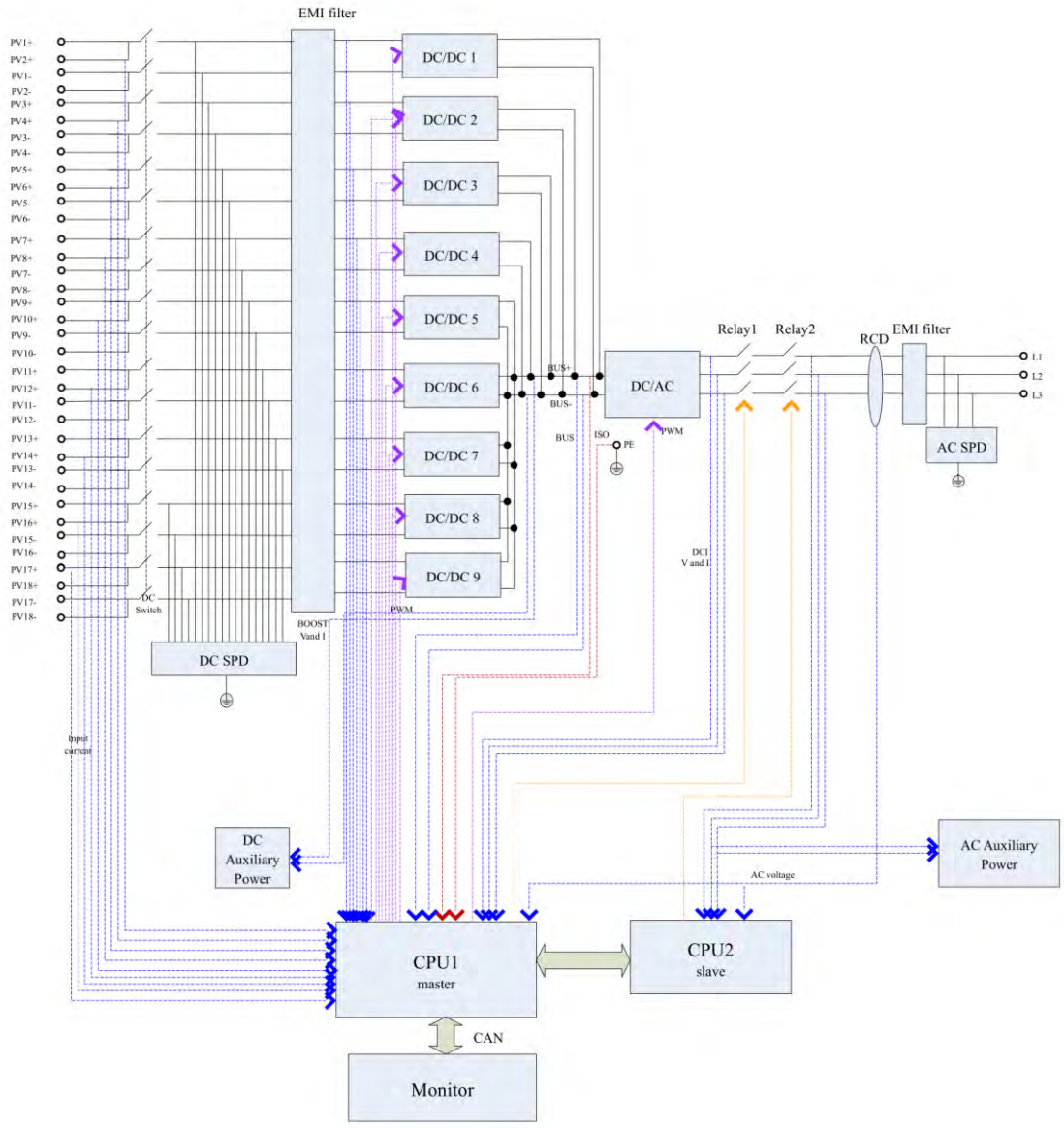


Figure 2 – Block diagram of the power circuit (*SUN2000-168KTL-H1* / *SUN2000-185KTL-H1*)

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

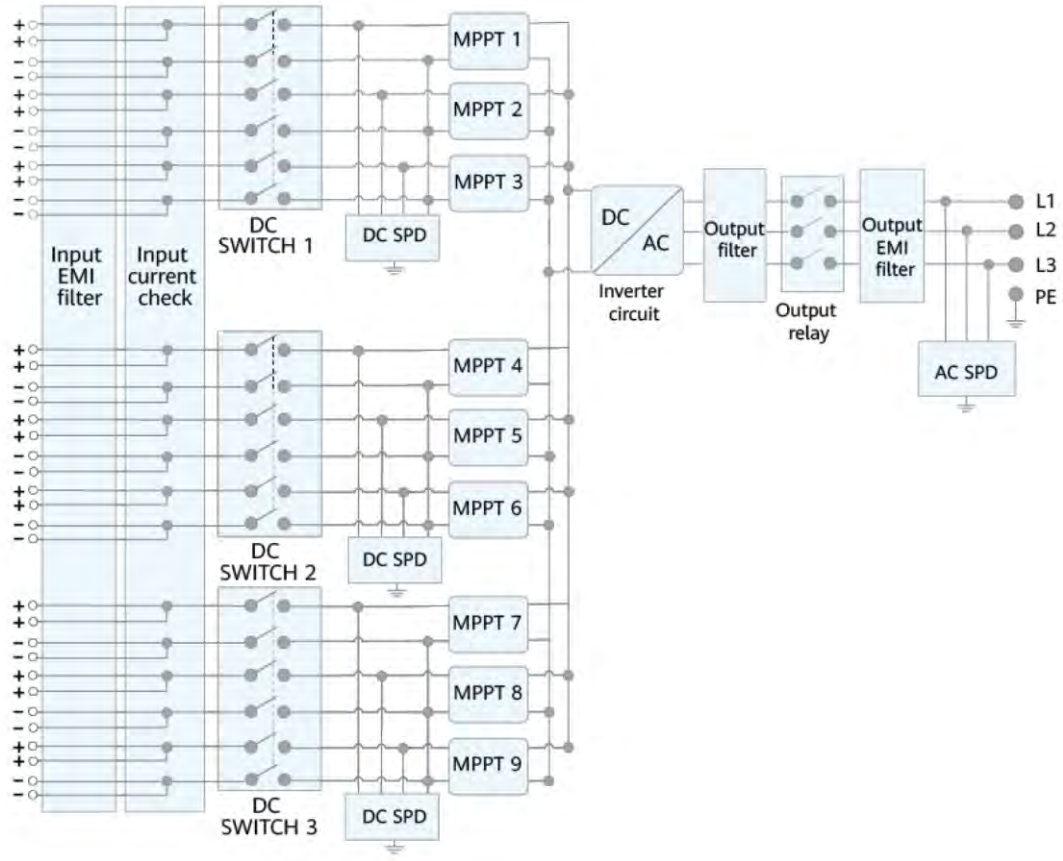


Figure 3 – Block diagram of the power circuit (*SUN2000-215KTL-H0*)

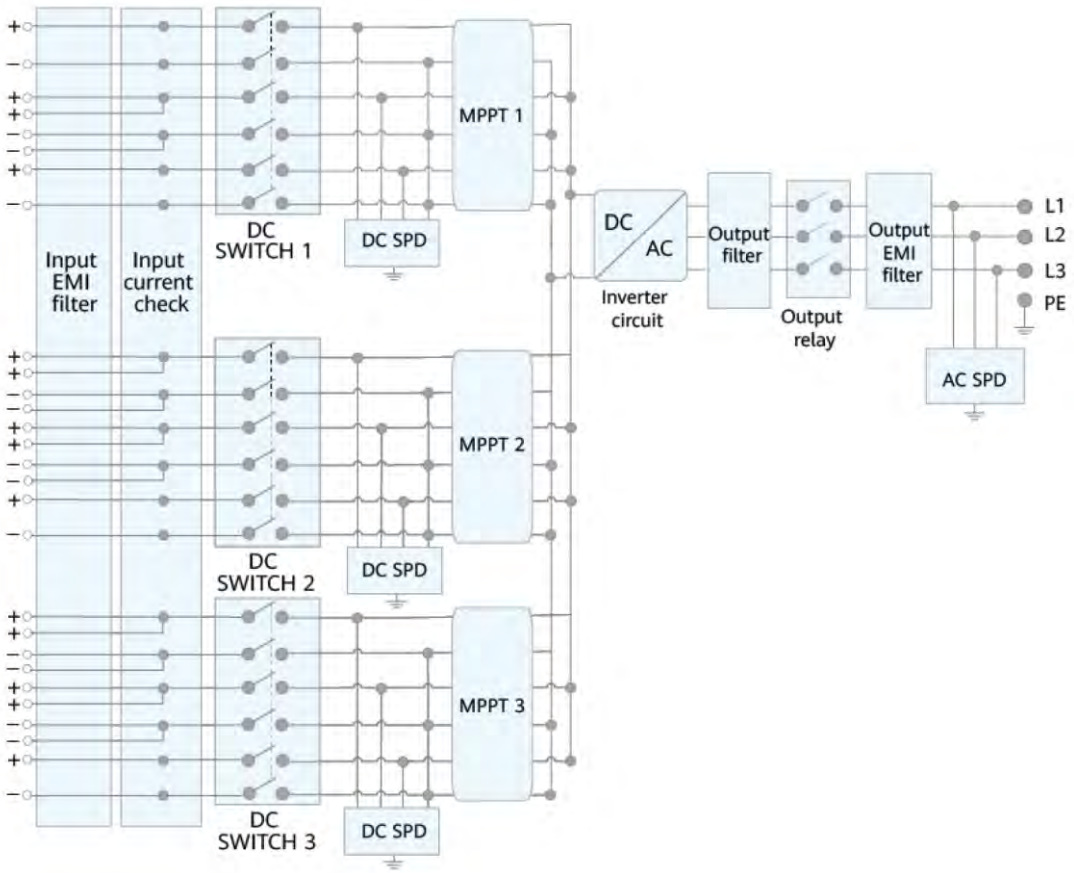


Figure 4 – Block diagram of the power circuit (*SUN2000-215KTL-H3*)

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

Description of the differences of the models within a series:

The units *SUN2000-168KTL-H1* and *SUN2000-185KTL-H1* are identical hardware platform.

The *SUN2000-215KTL-H0* is an enhancement of the basic platform of the product series:

- common-mode inductor removed
- EMI magnetic ring on the input and output side added
- improving heat dissipation by modification of enclosure and mechanical construction

The *SUN2000-215KTL-H3* is similar hardware platform to the *SUN2000-215KTL-H0*, with the following modifications on the DC side of the power circuit:

- DC switch modified
- number of the MPP trackers reduced to 3

The implemented control and firmware are identical in the whole product series. The similar electrical behaviour although differences between some components of the units were proved by additional testing according to [3]:

- verification of the active power control dynamic by test 4.1.2
- verification of the reactive power control dynamic by test 4.2.4
- verification of the power quality by tests 4.3.3, 4.3.4 and 4.3.5

verification of the voltage support and fast fault current injection by test 4.6

Description of a typical installation (Figure 5) *(Manufacturer's data)*:

In the RS485 communication mode a SUN2000 system (including up to 30 units recommended by manufacturer each RS485 port) can be connected to the SmartLogger (data collector) via RS485 bus.

A SmartLogger (data collector) can be connected to a SUN2000 system (including up to 30 units recommended by manufacturer each RS485 port) connected in series via RS485 communication cable (using MODBUS-RTU communication protocol). The length of the communication cable should be limited to max. 1000 m (for RS485 bus using 9600 baud rate). SmartLogger can control active / reactive power control via dry contact. The Ethernet-interface and corresponding WebUI "*Data Collector Web*" are available for setting / controlling active / reactive power and parameter configuration. There are no differences regarding the setpoint accuracy and settling / response times between the interfaces / software tools.

Hereby, the pick-up of a new setpoint of P, Q and cosφ is guaranteed within 2 s.

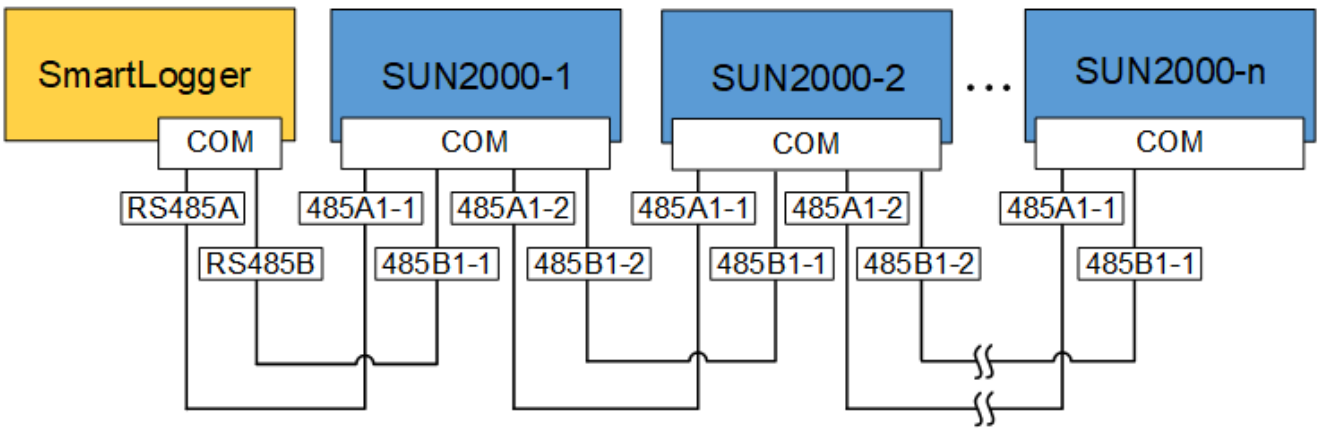


Figure 5 – Scheme of an installation

Description of the connection to the remote-control receiver (Figure 6) *(Manufacturer's data)*:

A generating station can receive the signal from the State Load Dispatch Centre or Regional Load Dispatch Centre for regulation of the active and reactive power output using the Smart Logger (data acquisition device).

The remote-control receiver can be connected to the Smart Logger using dry contact for active / reactive power control, which is connected to the inverters via RS485/MBUS.

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

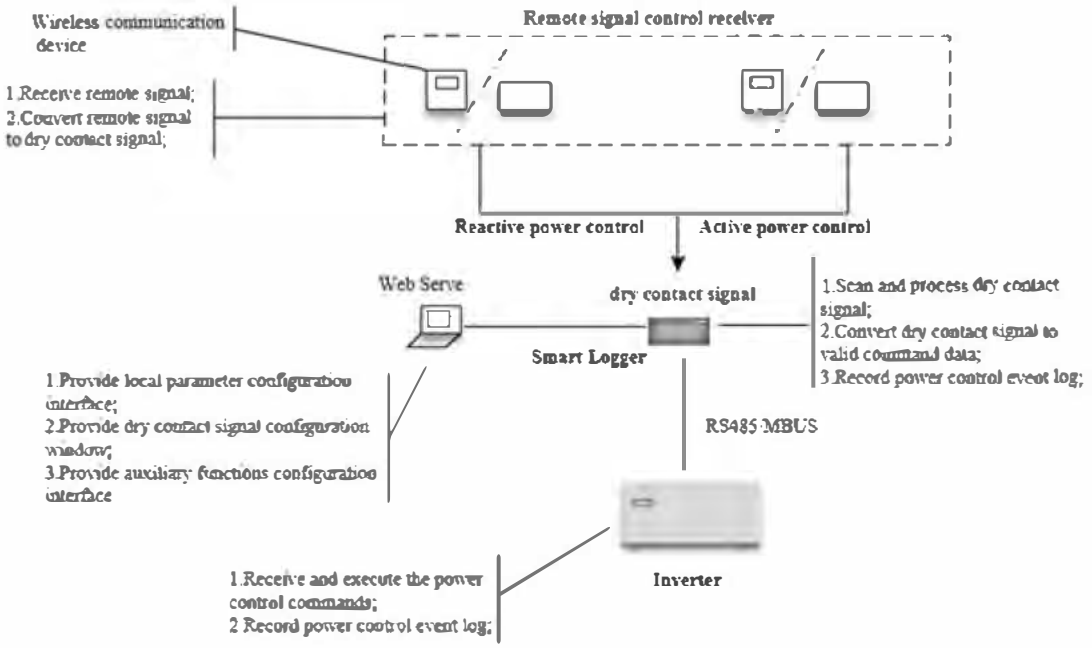


Figure 6 – Connection of the remote-control receiver in an installation

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

2.3. Description of software version and interfaces

Following is the software and firmware version used for the TG3 testing [14]:

4. Main Components of the regulating system

Main components of the control system with firmware and software	
Main component(s) of the control system	Control system integrated in the PGU
Firmware version	V300R001
Software version	V300R001C00SPC[xxx] * * for xxx ≥ 107

Figure 7 – Software and firmware version used for the TG3 testing from [14]

Note:

if not specified otherwise, the following applies:

updates to the key number *xxx* of the software *V300R001C00SPCxxx* have no influence on the verified AC electrical characteristic of the PGU.

(Any updates have influence on the verified AC electrical behaviour of the PGU need to be informed and approved by Bureau Veritas Consumer Products Services Germany GmbH.)

For SW key number *xxx* ≥ 107, following new features provided:

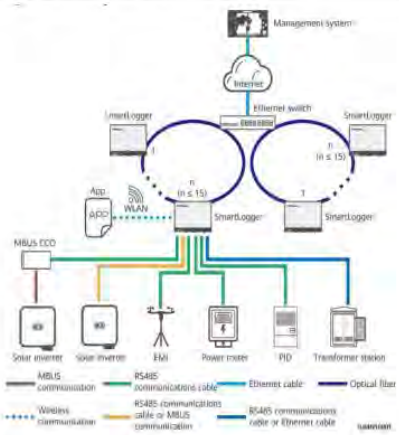
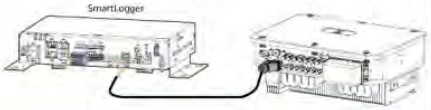
- optimization of the proportional-resonant (PR) current controller to improve the output voltage quality (according to manufacturer this has no influence on the verified AC electrical characteristic of the PGU except the output voltage quality – this was verified by additional testing, for details see TG3 test report [7])
- new function (*Communication disconnection fail-safe*) parameters added (see parameter no. 102 – 107 in Annex 5).

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

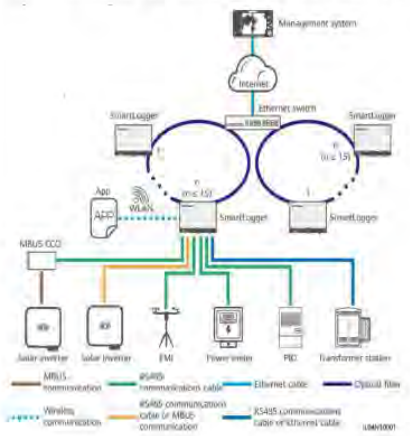
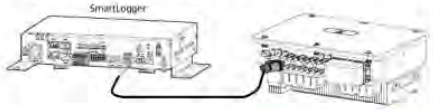
Following are the interfaces provided on the PGU level for active and reactive power setting, and behaviour of the PGU in the event of a communication failure with the PGS controller [15]:

Die Arten der Sollwertvorgabe und Schnittstellen zur Regelung der Blindleistungsbereitstellung sind dokumentiert. Angabe der Q-Übergangsfunktion über eine Sprungantwort für die Schnittstellen/Sollwert-Kombinationen. / *The types of setpoint value specifications and interfaces for control of the reactive power provision are documented.* *Details of the Q-step response via a step response for the interface / setpoint value combinations.*	Following interfaces for control of the reactive power provision are provided on the PGU level, all interface can be seen in chapter2.1 of SmartLogger ModBus Interface Definitions: • Reactive power control mode: 2: Reactive power fix control 3: Power factor fix control 4: Q-U characteristic curve 14: Q-P characteristic curve

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11
Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11
Datum / *Date*: 2021-05-19

Anforderung / *Requirement*	**Erklärung / *Declaration***
	 • connect the inverter to Smartlogger via MBUS or RS485, the following reactive power control functions: ○ *Power factor fix control* ○ *Reactive power fix control* ○ Q-P characteristic curve ○ Q-U characteristic curve can be set using the WebUI.   There are no differences regarding the setpoint accuracy and settling / response times between the interfaces / software tools. Hereby, the pick-up of a new reactive power setpoint is guaranteed within 2 s.

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

4. Wirkleistung / *Active power*	
Angabe zu Schnittstellen zur Wirkleistungsvorgabe (Netzbetreiber, Direktvermarkter) getrennt umgesetzt sowie konzeptionell überprüft, ob niedrigster Wirkleistungswert übernommen wird (auch bei sich zeitlich überschneidenden Vorgaben). / *Details of interfaces for specifying active power (grid operator, direct seller) implemented separately as well as the concept checked to make sure lowest active power value is accepted (even if specifications overlap in time).*	Only one Interface for specifying active power implemented on the PGU. Separate specifying active power by grid operator and direct seller is not possible. For prioritization of different setpoints must be carried out on the plant level e.g. in the superimposed PGS controller. Following interfaces for control of the active power provision are provided on the PGU level: all interface can be seen in chapter2.1 of SmartLogger ModBus Interface Definitions: • Reactive power control mode: 3：Percentage fixed-value limitation (open loop)  • connect the inverter to Smartlogger via MBUS or RS485 for active power setting using the WebUI using the parameter *Fixed active power derated* or *Active power percentage derating*.  

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

Anforderung / *Requirement*	**Erklärung / *Declaration***
	There are no differences regarding the setpoint accuracy and settling / response times between the interfaces / software tools. Hereby, the pick-up of a new active power setpoint is guaranteed within 2 s.

Figure 8 – Interfaces provided on the PGU level for active and reactive power setting from [15]

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

If the active / reactive control functions need to be implemented on the plant level e.g. in the superimposed PGS controller, this can be connected via a Smartlogger [9], [16] & [17]:

2) Interfaces for connection to superordinate power controller

A superordinate power controller can be connected via the Smartlogger, parameters of the Smartlogger have to be set accordingly (chapter "6.3.2 Setting Parameters for Connecting to the ManagementSystem", please refer to User Manual of corresponding SmartLogger model used).

Information about the register definitions can be found in "SmartLogger ModBus Interface Definitions" (Issue 38, Date: 2020-11-25).

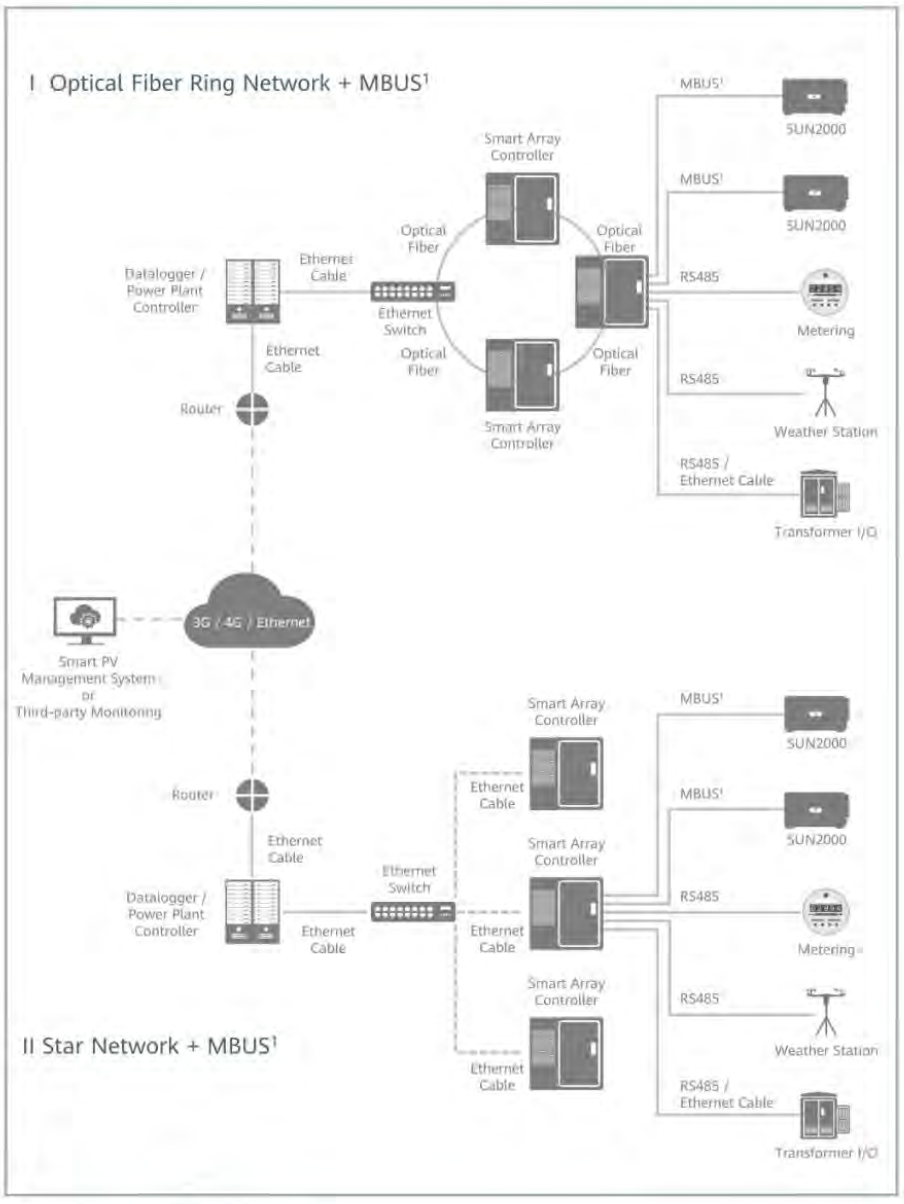


Figure 9 – Interfaces for connection of a superordinate power controller [9], [16] & [17]:

2. Annex 2 – Technical characteristics of the power generating unit (Manufacturer's data)

In the event the communication with the PGS controller is disturbed, the PGU will check continuously if further command receives from the PGS controller, if not it will provide active and reactive power according to the predefined parameters through the function of *Communication disconnection fail-safe* (see parameters 102 – 107 in Annex 5):

Im Falle einer Kommunikationsstörung zum EZA Regler können EZE mit einem vorgegebenen Wert bzw. Verfahren betrieben werden. / *In the event the communication with the PGS controller is disturbed, PGU can be operated with a predefined value or process.*	In the event the communication with the PGS controller is disturbed, the PGU will check continuously if further command receives from the PGS controller, if not it will provide active and reactive power according to the predefined parameters through the function of *Communication disconnection fail-safe.*

Figure 10 – Behaviour of the PGU in the event of a communication failure with the PGS controller [15]

3. Annex 3 – Extract from the test report

3.1. Power quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

4.3.2 Switching operations / *Schalthandlungen*

SUN2000-185KTL-H1				
Case of switching operation / *Art der Schalthandlung*	Start-up at $P_{available}$ < 10%P_n / *Einschalten bei $P_{verfügbar}$ < 10%P_n*			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{10} (Manufacturer's data / *Herstellerangabe*)	20			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{120} (Manufacturer's data / *Herstellerangabe*)	240			
Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Flicker step factor / *Flickerformfaktor*, $k_f(\psi_k)$	0,12	0,10	0,06	0,05
Voltage change factor / *Spannungsänderungsfaktor*, $k_u(\psi_k)$	0,18	0,16	0,14	0,11
Case of switching operation / *Art der Schalthandlung*	Switch-on at $P_{available}$ = 100%P_n / *Einschalten bei $P_{verfügbar}$ = 100%P_n*			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{10} (Manufacturer's data / *Herstellerangabe*)	20			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{120} (Manufacturer's data / *Herstellerangabe*)	240			
Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Flicker step factor / *Flickerformfaktor*, $k_f(\psi_k)$	0,47	0,37	0,23	0,12
Voltage change factor / *Spannungsänderungsfaktor*, $k_u(\psi_k)$	1,03	0,81	0,51	0,24
Case of switching operation / *Art der Schalthandlung*	Service shutdown at $P_{available}$ = 100%P_n *Serviceabschaltung bei Nennleistung*			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{10} (Manufacturer's data / *Herstellerangabe*)	1			
Max. number of switching operations / *Max. Anzahl Schalthandlungen*, N_{120} (Manufacturer's data / *Herstellerangabe*)	12			
Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Flicker step factor / *Flickerformfaktor*, $k_f(\psi_k)$	0,11	0,09	0,05	0,03
Voltage change factor / *Spannungsänderungsfaktor*, $k_u(\psi_k)$	1,04	0,82	0,51	0,24

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*	
Description of the service disconnection procedure / *Beschreibung der Durchführung einer Serviceabschaltung*	1. Shutdown the unit using „Start/Stop control" / *Abschaltung der Einheit mittels „Start/Stop control"* 2. Turn off the AC switch between the unit and the power grid / *Trennen den AC-Schalter vom Netz* 3. Turn off both DC switches / *Trennen den DC-Schalter von den Energiequellen*

Note / *Anmerkung*:

$S_{k,fic}/S_n$ in the fictitious grid was set to / *Das Kurzschlussverhältnis im fiktiven Netz wurde gesetzt zu*: 20.

For the same SCR $S_{k,fic}/S_n$ in the fictitious grid, the flicker step and voltage change factors of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1*, *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly. /

Für das gleiche Verhältnis $S_{k,fic}/S_n$, *die Flickerstufen- und Spannungsänderungsfaktoren des* SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

4.3.3 Flicker

SUN2000-168KTL-H1

Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Operating point / *Betriebspunkt*, [%P_n]	Flicker coefficient / *Flickerkoeffizient*, c(ψ_k)			
0 - 5	0,47	0,48	0,57	0,62
10	0,41	0,45	0,56	0,62
20	0,35	0,43	0,55	0,60
30	0,34	0,45	0,60	0,65
40	0,37	0,46	0,60	0,66
50	0,36	0,48	0,64	0,70
60	0,41	0,69	0,99	1,10
70	0,39	0,70	1,04	1,20
80	0,39	0,67	0,98	1,11
90	0,40	0,70	1,01	1,15
100	0,40	0,73	1,07	1,22
P_{max} (112)	0,55	0,88	1,22	1,37
Max. Flicker coefficient / *Max. Flickerkoeffizient*, c(ψ_k)	0,55	0,88	1,22	1,37
Max. Short-term flicker / *Max. Kurzzeitflickerstörfaktor*, P_{st}	0,03	0,04	0,06	0,07

Reactive power setpoint during testing / *Blindleistungsvorgabe während der Prüfungen* [kvar]:	0
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis / *Das für die Auswertung genutzte Verhältnis* $S_{k,fic}/S_n$:	20

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

SUN2000-185KTL-H1

Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Operating point / *Betriebspunkt*, [%P_n]	Flicker coefficient / *Flickerkoeffizient*, c(ψ_k)			
0 - 5	0,32	0,27	0,27	0,32
10	0,31	0,31	0,38	0,42
20	0,32	0,31	0,41	0,46
30	0,30	0,35	0,46	0,50
40	0,30	0,38	0,49	0,54
50	0,34	0,52	0,73	0,81
60	0,32	0,53	0,76	0,86
70	0,35	0,54	0,77	0,87
80	0,37	0,57	0,81	0,91
90	0,40	0,63	0,89	1,00
100	0,41	0,65	0,91	1,03
P_{max} (106)	0,49	0,69	0,97	1,13
Max. Flicker coefficient / *Max. Flickerkoeffizient*, c(ψ_k)	0,49	0,69	0,97	1,13
Max. Short-term flicker / *Max. Kurzzeitflickerstörfaktor*, P_{st}	0,02	0,03	0,05	0,06

Reactive power setpoint during testing / *Blindleistungsvorgabe während der Prüfungen* [kvar]:	0
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis / *Das für die Auswertung genutzte Verhältnis* $S_{k,fic}/S_n$:	20

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

SUN2000-215KTL-H3

Grid impedance angle / *Netzimpedanzwinkel*, ψ_k	30°	50°	70°	85°
Operating point / *Betriebspunkt*, [%P_n]	Flicker coefficient / *Flickerkoeffizient*, $c(\psi_k)$			
0 - 5	0,42	0,37	0,30	0,27
10	0,34	0,30	0,27	0,25
20	0,31	0,29	0,26	0,25
30	0,30	0,29	0,27	0,25
40	0,86	1,14	1,33	1,39
50	1,01	1,38	1,67	1,79
60	1,02	1,35	1,58	1,64
70	0,93	1,26	1,49	1,57
80	0,55	0,62	0,71	0,75
90	0,54	0,62	0,72	0,77
100	0,56	0,65	0,77	0,82
P_{max} (107,5)	0,55	0,63	0,73	0,77
Max. Flicker coefficient / *Max. Flickerkoeffizient*, $c(\psi_k)$	1,02	1,38	1,67	1,79
Max. Short-term flicker / *Max. Kurzzeitflickerstörfaktor*, P_{st}	0,05	0,07	0,08	0,09

Reactive power setpoint during testing / *Blindleistungsvorgabe während der Prüfungen* [kvar]:	0
Ratio $S_{k,fic}/S_n$ in the fictitious grid used for analysis / *Das für die Auswertung genutzte Verhältnis* $S_{k,fic}/S_n$:	20

Note / *Anmerkung*:

$S_{k,fic}/S_n$ in the fictitious grid was set to / *Das Kurzschlussverhältnis im fiktiven Netz wurde gesetzt zu*: 20.

The results of the flicker coefficientof the *SUN2000-215KTL-H3* can be applied to the *SUN2000-215KTL-H0* directly. /

Die Flickerkoeffizienten des SUN2000-215KTL-H3 *können auf den* SUN2000-215KTL-H0 *direkt übertragen werden.*

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

4.3.4 Harmonics / *Oberschwingungen*

SUN2000-168KTL-H1

Harmonics / *Harmonische*

Rated current / *Nennstrom* [A]: 108,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
Order / *Ordnung*	I_h [%I_n]												
1	2,12	10,15	20,25	30,35	40,42	50,42	60,50	70,52	80,51	90,50	100,41	111,96	111,96
2	0,11	0,13	0,10	0,09	0,10	0,11	0,11	0,11	0,09	0,09	0,11	0,18	0,18
3	0,13	0,11	0,13	0,12	0,11	0,13	0,13	0,16	0,13	0,15	0,14	0,09	0,16
4	0,09	0,04	0,06	0,05	0,03	0,04	0,04	0,06	0,09	0,10	0,11	0,11	0,11
5	0,23	0,57	0,67	0,64	0,46	0,41	0,31	0,26	0,18	0,23	0,22	0,27	0,67
6	0,02	0,02	0,05	0,05	0,03	0,04	0,06	0,07	0,07	0,08	0,08	0,09	0,09
7	0,34	0,44	0,37	0,38	0,27	0,25	0,25	0,29	0,32	0,32	0,33	0,35	0,44
8	0,03	0,04	0,07	0,07	0,07	0,08	0,09	0,10	0,10	0,10	0,09	0,09	0,10
9	0,05	0,06	0,04	0,05	0,05	0,05	0,06	0,07	0,06	0,06	0,06	0,05	0,07
10	0,05	0,03	0,03	0,05	0,05	0,05	0,05	0,06	0,08	0,08	0,08	0,09	0,09
11	0,62	0,43	0,42	0,52	0,57	0,53	0,40	0,30	0,22	0,18	0,16	0,15	0,62
12	0,01	0,03	0,04	0,05	0,05	0,05	0,06	0,07	0,08	0,08	0,08	0,08	0,08
13	0,30	0,33	0,40	0,29	0,16	0,23	0,27	0,27	0,26	0,25	0,23	0,22	0,40
14	0,03	0,04	0,06	0,08	0,09	0,09	0,09	0,10	0,10	0,11	0,11	0,13	0,13
15	0,06	0,07	0,07	0,08	0,09	0,08	0,08	0,09	0,09	0,09	0,08	0,11	0,11
16	0,05	0,05	0,07	0,08	0,09	0,11	0,12	0,13	0,14	0,15	0,16	0,14	0,16
17	0,31	0,33	0,28	0,36	0,22	0,21	0,27	0,23	0,19	0,17	0,17	0,14	0,36
18	0,02	0,03	0,02	0,06	0,07	0,07	0,07	0,08	0,09	0,10	0,10	0,10	0,10
19	0,11	0,29	0,20	0,15	0,29	0,24	0,13	0,24	0,33	0,35	0,33	0,33	0,35
20	0,02	0,04	0,03	0,08	0,10	0,10	0,10	0,11	0,12	0,15	0,14	0,14	0,15
21	0,06	0,04	0,04	0,07	0,10	0,10	0,08	0,09	0,10	0,11	0,10	0,11	0,11
22	0,02	0,03	0,05	0,07	0,09	0,09	0,10	0,12	0,13	0,14	0,15	0,15	0,15
23	0,23	0,18	0,17	0,13	0,25	0,15	0,08	0,14	0,18	0,19	0,19	0,14	0,25
24	0,02	0,02	0,03	0,03	0,07	0,06	0,06	0,07	0,07	0,07	0,08	0,09	0,09
25	0,09	0,16	0,12	0,25	0,11	0,25	0,24	0,19	0,25	0,30	0,31	0,34	0,34
26	0,01	0,02	0,02	0,03	0,08	0,08	0,08	0,07	0,08	0,11	0,12	0,12	0,12
27	0,03	0,04	0,04	0,08	0,09	0,11	0,10	0,09	0,10	0,11	0,12	0,13	0,13
28	0,02	0,02	0,02	0,03	0,07	0,07	0,07	0,08	0,09	0,09	0,09	0,10	0,10
29	0,13	0,08	0,10	0,06	0,05	0,07	0,10	0,06	0,08	0,11	0,12	0,13	0,13
30	0,01	0,01	0,02	0,02	0,04	0,05	0,04	0,04	0,04	0,05	0,06	0,06	0,06
31	0,05	0,05	0,16	0,09	0,18	0,11	0,19	0,14	0,15	0,18	0,19	0,22	0,22
32	0,01	0,01	0,01	0,02	0,04	0,04	0,04	0,04	0,04	0,06	0,07	0,08	0,08
33	0,02	0,04	0,04	0,04	0,06	0,06	0,06	0,05	0,06	0,07	0,06	0,08	0,08
34	0,01	0,01	0,01	0,01	0,04	0,05	0,05	0,06	0,05	0,06	0,06	0,07	0,07
35	0,06	0,08	0,04	0,09	0,08	0,05	0,08	0,08	0,06	0,09	0,10	0,10	0,10
36	0,01	0,01	0,01	0,01	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,05	0,05
37	0,05	0,02	0,03	0,12	0,11	0,09	0,12	0,11	0,10	0,12	0,14	0,15	0,15
38	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,03	0,03	0,04	0,04	0,05	0,05
39	0,02	0,03	0,03	0,04	0,04	0,05	0,06	0,05	0,05	0,05	0,05	0,05	0,06
40	0,01	0,01	0,01	0,01	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,05	0,05
41	0,03	0,07	0,08	0,09	0,07	0,09	0,07	0,09	0,07	0,08	0,09	0,10	0,10
42	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03
43	0,04	0,08	0,09	0,06	0,07	0,10	0,07	0,09	0,08	0,09	0,11	0,12	0,12
44	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,03	0,03	0,03
45	0,03	0,04	0,05	0,04	0,04	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,06
46	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,03	0,03	0,03
47	0,02	0,06	0,08	0,08	0,09	0,07	0,08	0,08	0,08	0,08	0,09	0,10	0,10
48	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
49	0,03	0,06	0,06	0,07	0,07	0,06	0,06	0,07	0,07	0,08	0,09	0,10	0,10
50	0,01	0,01	0,01	0,01	0,02	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02
THC [%I_n]	0,94	1,08	1,10	1,13	1,03	0,97	0,89	0,85	0,87	0,93	0,94	0,98	1,13

Maximum values over harmonic order (from 2nd order, I_n = f(h)) / *Maximalwerte über Oberschwingungsordnung*: 0,67

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Interharmonics / *Zwischenharmonische*

Rated current / *Nennstrom* [A]: 108,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_h [%I_n]												
75	0,04	0,03	0,04	0,04	0,05	0,06	0,06	0,07	0,08	0,09	0,10	0,11	0,11
125	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,04	0,05	0,05	0,05
175	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,03	0,04	0,04
225	0,04	0,05	0,03	0,05	0,05	0,05	0,05	0,05	0,04	0,04	0,04	0,04	0,05
275	0,05	0,06	0,04	0,05	0,06	0,06	0,06	0,06	0,03	0,04	0,03	0,03	0,06
325	0,04	0,05	0,03	0,05	0,05	0,05	0,05	0,05	0,03	0,04	0,04	0,03	0,05
375	0,04	0,06	0,04	0,05	0,06	0,06	0,06	0,05	0,03	0,03	0,03	0,03	0,06
425	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,03	0,03	0,03	0,03
475	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03
525	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,03	0,03	0,03	0,03
575	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03
625	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03
675	0,02	0,03	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
725	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
775	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03
825	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,03	0,04
875	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04
925	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04
975	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	0,04
1025	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,05	0,05	0,04	0,05
1075	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04
1125	0,01	0,03	0,03	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04
1175	0,01	0,03	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04
1225	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,04	0,04	0,04	0,04
1275	0,01	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04
1325	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
1375	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03
1425	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03
1475	0,01	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03
1525	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03
1575	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1625	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1675	0,01	0,01	0,01	0,02	0,02	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1725	0,01	0,01	0,02	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1775	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1825	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1875	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1925	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02
1975	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,02

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Higher Frequencies components / *Höhere Frequenzen*

Rated current / *Nennstrom* [A]: 108,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_h [%I_n]												
2,1	0,05	0,10	0,12	0,11	0,10	0,14	0,11	0,13	0,11	0,13	0,15	0,16	0,16
2,3	0,04	0,08	0,09	0,09	0,10	0,10	0,10	0,09	0,10	0,10	0,11	0,12	0,12
2,5	0,05	0,09	0,09	0,09	0,09	0,08	0,08	0,09	0,08	0,10	0,10	0,11	0,11
2,7	0,05	0,09	0,10	0,11	0,10	0,10	0,11	0,10	0,11	0,11	0,12	0,13	0,13
2,9	0,06	0,13	0,15	0,15	0,14	0,13	0,12	0,11	0,11	0,11	0,11	0,11	0,15
3,1	0,06	0,09	0,10	0,11	0,12	0,12	0,12	0,12	0,10	0,10	0,10	0,10	0,12
3,3	0,04	0,10	0,10	0,11	0,12	0,12	0,12	0,12	0,12	0,13	0,13	0,13	0,13
3,5	0,05	0,10	0,11	0,13	0,13	0,14	0,15	0,15	0,14	0,15	0,14	0,14	0,15
3,7	0,04	0,05	0,05	0,07	0,09	0,10	0,11	0,11	0,12	0,11	0,12	0,12	0,12
3,9	0,03	0,06	0,07	0,09	0,10	0,11	0,11	0,12	0,12	0,13	0,12	0,13	0,13
4,1	0,03	0,06	0,05	0,05	0,05	0,08	0,10	0,12	0,13	0,14	0,14	0,14	0,14
4,3	0,03	0,04	0,04	0,05	0,06	0,07	0,07	0,08	0,08	0,10	0,10	0,11	0,11
4,5	0,02	0,04	0,04	0,04	0,04	0,05	0,07	0,09	0,10	0,12	0,12	0,12	0,12
4,7	0,03	0,04	0,04	0,04	0,04	0,04	0,05	0,06	0,07	0,10	0,12	0,13	0,13
4,9	0,02	0,03	0,04	0,04	0,05	0,04	0,05	0,04	0,05	0,06	0,07	0,09	0,09
5,1	0,02	0,03	0,04	0,04	0,03	0,04	0,04	0,04	0,05	0,06	0,08	0,10	0,10
5,3	0,02	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,04	0,05	0,05	0,07	0,07
5,5	0,02	0,03	0,04	0,04	0,04	0,04	0,05	0,04	0,04	0,04	0,04	0,05	0,05
5,7	0,02	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	0,04
5,9	0,02	0,03	0,03	0,03	0,03	0,04	0,05	0,04	0,04	0,04	0,04	0,04	0,05
6,1	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,05	0,04	0,04	0,04	0,04	0,05
6,3	0,02	0,02	0,02	0,02	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,04	0,04
6,5	0,02	0,02	0,02	0,02	0,03	0,03	0,04	0,05	0,04	0,04	0,04	0,04	0,05
6,7	0,02	0,02	0,02	0,02	0,02	0,02	0,04	0,04	0,04	0,04	0,04	0,04	0,04
6,9	0,02	0,02	0,02	0,02	0,02	0,02	0,04	0,03	0,04	0,04	0,04	0,04	0,04
7,1	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,04	0,04	0,04	0,04	0,04	0,04
7,3	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,04
7,5	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,04	0,03	0,03	0,03	0,03	0,04
7,7	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
7,9	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
8,1	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
8,3	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
8,5	0,02	0,03	0,03	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
8,7	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03
8,9	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,03	0,03	0,03	0,03

Note / *Anmerkung*:

The stated harmonics are maximum values of all 3 phases. / *Die angegebenen Harmonischenwerte sind Maximalwerte über alle 3 Phasen.*

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

SUN2000-185KTL-H1

Harmonics / *Harmonische*

Rated current / *Nennstrom* [A]: 126,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
Order / *Ordnung*	I_h [%I_n]												
1	2,030	9,709	19,890	30,307	40,492	50,673	60,771	70,993	81,047	91,654	102,272	107,236	107,236
2	0,194	0,202	0,206	0,219	0,238	0,241	0,244	0,230	0,221	0,266	0,284	0,301	0,301
3	0,100	0,087	0,104	0,130	0,155	0,158	0,165	0,184	0,184	0,189	0,191	0,638	0,638
4	0,075	0,043	0,074	0,123	0,145	0,150	0,157	0,163	0,190	0,167	0,168	0,155	0,190
5	0,241	0,312	0,181	0,094	0,094	0,106	0,132	0,166	0,229	0,241	0,298	0,451	0,451
6	0,059	0,076	0,079	0,081	0,117	0,132	0,129	0,125	0,128	0,091	0,082	0,087	0,132
7	0,140	0,121	0,154	0,089	0,047	0,070	0,077	0,090	0,121	0,151	0,180	0,174	0,180
8	0,056	0,040	0,056	0,081	0,097	0,128	0,093	0,112	0,112	0,129	0,114	0,118	0,129
9	0,033	0,051	0,032	0,064	0,049	0,066	0,053	0,101	0,107	0,111	0,161	0,159	0,161
10	0,028	0,065	0,074	0,061	0,093	0,084	0,073	0,079	0,079	0,081	0,095	0,076	0,095
11	0,168	0,264	0,159	0,114	0,173	0,196	0,200	0,211	0,168	0,164	0,149	0,171	0,264
12	0,033	0,043	0,076	0,089	0,090	0,111	0,100	0,110	0,085	0,056	0,047	0,090	0,111
13	0,056	0,112	0,149	0,054	0,071	0,117	0,108	0,132	0,121	0,105	0,113	0,113	0,149
14	0,023	0,026	0,035	0,028	0,051	0,056	0,062	0,034	0,034	0,030	0,031	0,026	0,062
15	0,045	0,023	0,047	0,037	0,042	0,044	0,045	0,045	0,040	0,037	0,044	0,054	0,054
16	0,007	0,025	0,030	0,043	0,043	0,047	0,046	0,042	0,032	0,028	0,026	0,022	0,047
17	0,103	0,053	0,152	0,049	0,054	0,080	0,073	0,091	0,067	0,063	0,049	0,085	0,152
18	0,008	0,010	0,026	0,051	0,054	0,047	0,063	0,061	0,046	0,033	0,029	0,037	0,063
19	0,041	0,045	0,084	0,063	0,027	0,047	0,058	0,058	0,050	0,046	0,049	0,060	0,084
20	0,005	0,013	0,017	0,014	0,019	0,022	0,031	0,029	0,026	0,024	0,018	0,012	0,031
21	0,032	0,036	0,027	0,036	0,034	0,030	0,036	0,040	0,030	0,029	0,029	0,035	0,040
22	0,010	0,008	0,013	0,021	0,022	0,025	0,024	0,028	0,019	0,017	0,011	0,016	0,028
23	0,062	0,055	0,011	0,049	0,023	0,030	0,038	0,038	0,033	0,027	0,022	0,034	0,062
24	0,007	0,010	0,011	0,020	0,026	0,028	0,031	0,040	0,028	0,023	0,015	0,022	0,040
25	0,036	0,013	0,024	0,041	0,029	0,024	0,034	0,034	0,033	0,030	0,029	0,040	0,041
26	0,006	0,005	0,010	0,011	0,010	0,010	0,014	0,019	0,021	0,017	0,013	0,011	0,021
27	0,019	0,027	0,024	0,030	0,029	0,030	0,031	0,033	0,033	0,026	0,024	0,028	0,033
28	0,006	0,005	0,010	0,008	0,013	0,016	0,016	0,017	0,016	0,012	0,009	0,013	0,017
29	0,021	0,015	0,018	0,019	0,027	0,015	0,021	0,022	0,018	0,017	0,017	0,023	0,027
30	0,007	0,005	0,007	0,006	0,012	0,015	0,020	0,019	0,022	0,016	0,011	0,016	0,022
31	0,025	0,021	0,019	0,014	0,024	0,019	0,023	0,027	0,024	0,022	0,020	0,027	0,027
32	0,006	0,005	0,006	0,006	0,007	0,009	0,010	0,014	0,015	0,014	0,011	0,008	0,015
33	0,026	0,034	0,033	0,032	0,037	0,031	0,035	0,038	0,033	0,028	0,026	0,032	0,038
34	0,003	0,004	0,006	0,011	0,010	0,012	0,012	0,013	0,013	0,012	0,008	0,010	0,013
35	0,014	0,004	0,005	0,008	0,021	0,016	0,017	0,019	0,017	0,015	0,015	0,021	0,021
36	0,006	0,006	0,006	0,007	0,006	0,007	0,011	0,012	0,014	0,013	0,008	0,012	0,014
37	0,013	0,014	0,011	0,014	0,017	0,016	0,020	0,021	0,022	0,020	0,017	0,021	0,022
38	0,004	0,004	0,007	0,010	0,009	0,008	0,010	0,011	0,013	0,013	0,010	0,008	0,013
39	0,035	0,044	0,045	0,049	0,052	0,049	0,047	0,047	0,043	0,038	0,035	0,039	0,052
40	0,004	0,007	0,011	0,014	0,015	0,015	0,010	0,012	0,013	0,011	0,009	0,010	0,015
41	0,014	0,007	0,011	0,010	0,010	0,014	0,017	0,021	0,018	0,017	0,014	0,022	0,022
42	0,006	0,007	0,006	0,005	0,005	0,005	0,006	0,007	0,009	0,009	0,007	0,010	0,010
43	0,011	0,007	0,015	0,017	0,015	0,017	0,014	0,018	0,018	0,020	0,019	0,021	0,021
44	0,009	0,007	0,010	0,019	0,022	0,019	0,014	0,014	0,015	0,014	0,011	0,011	0,022
45	0,068	0,081	0,090	0,095	0,090	0,091	0,082	0,079	0,070	0,062	0,057	0,059	0,095
46	0,008	0,011	0,020	0,025	0,030	0,029	0,021	0,016	0,014	0,013	0,010	0,009	0,030
47	0,034	0,030	0,025	0,030	0,028	0,030	0,025	0,025	0,021	0,021	0,022	0,034	0,034
48	0,014	0,010	0,014	0,008	0,007	0,009	0,009	0,007	0,006	0,008	0,007	0,007	0,014
49	0,037	0,036	0,042	0,035	0,038	0,039	0,032	0,034	0,026	0,020	0,016	0,032	0,042
50	0,014	0,014	0,028	0,045	0,054	0,049	0,032	0,024	0,023	0,021	0,018	0,020	0,054
THC [%I_n]	0,422	0,510	0,444	0,365	0,408	0,459	0,457	0,498	0,510	0,503	0,562	0,910	0,910

Maximum values over harmonic order (from 2nd order, I_n = f(h)) / *Maximalwerte über Oberschwingungsordnung*: 0,638

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Interharmonics / *Zwischenharmonische*

Rated current / *Nennstrom* [A]: 126,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_n [%I_n]												
75	0,030	0,030	0,029	0,026	0,027	0,031	0,030	0,031	0,036	0,040	0,046	0,049	0,049
125	0,041	0,030	0,033	0,028	0,032	0,039	0,035	0,039	0,039	0,045	0,046	0,050	0,050
175	0,032	0,026	0,029	0,026	0,029	0,032	0,032	0,031	0,034	0,036	0,037	0,046	0,046
225	0,026	0,026	0,033	0,029	0,031	0,031	0,032	0,033	0,034	0,035	0,038	0,043	0,043
275	0,029	0,033	0,040	0,037	0,045	0,040	0,043	0,044	0,034	0,036	0,035	0,042	0,045
325	0,037	0,051	0,080	0,063	0,072	0,075	0,074	0,074	0,062	0,057	0,057	0,070	0,080
375	0,036	0,050	0,052	0,061	0,065	0,068	0,072	0,074	0,073	0,081	0,088	0,092	0,092
425	0,071	0,105	0,117	0,114	0,124	0,130	0,135	0,131	0,115	0,126	0,118	0,134	0,135
475	0,036	0,047	0,038	0,051	0,049	0,048	0,057	0,064	0,074	0,097	0,105	0,107	0,107
525	0,028	0,039	0,031	0,037	0,037	0,038	0,045	0,049	0,055	0,062	0,070	0,081	0,081
575	0,021	0,027	0,026	0,028	0,028	0,027	0,031	0,031	0,034	0,039	0,040	0,046	0,046
625	0,016	0,017	0,018	0,018	0,018	0,021	0,020	0,023	0,020	0,020	0,021	0,023	0,023
675	0,012	0,015	0,015	0,015	0,015	0,015	0,015	0,016	0,016	0,016	0,016	0,018	0,018
725	0,010	0,012	0,011	0,011	0,011	0,012	0,013	0,014	0,013	0,015	0,015	0,018	0,018
775	0,008	0,009	0,009	0,010	0,009	0,009	0,010	0,010	0,011	0,012	0,012	0,013	0,013
825	0,013	0,014	0,014	0,015	0,015	0,016	0,016	0,016	0,016	0,016	0,016	0,017	0,017
875	0,007	0,008	0,007	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,008	0,009	0,009
925	0,006	0,007	0,006	0,007	0,006	0,007	0,007	0,007	0,007	0,008	0,008	0,008	0,008
975	0,005	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,007	0,007	0,008	0,008
1025	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,007	0,006	0,007	0,007	0,008	0,008
1075	0,005	0,005	0,005	0,005	0,006	0,005	0,006	0,006	0,006	0,007	0,006	0,007	0,007
1125	0,007	0,007	0,008	0,008	0,008	0,008	0,007	0,005	0,005	0,005	0,005	0,006	0,008
1175	0,005	0,005	0,005	0,006	0,005	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006
1225	0,006	0,007	0,007	0,007	0,006	0,006	0,006	0,005	0,005	0,005	0,005	0,006	0,007
1275	0,007	0,007	0,008	0,008	0,008	0,008	0,008	0,008	0,007	0,007	0,007	0,007	0,008
1325	0,004	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005
1375	0,004	0,004	0,004	0,005	0,004	0,004	0,004	0,004	0,005	0,005	0,005	0,005	0,005
1425	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004
1475	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004
1525	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,005	0,004	0,005	0,005
1575	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,005	0,005
1625	0,004	0,004	0,005	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,005
1675	0,004	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,005
1725	0,004	0,004	0,005	0,004	0,004	0,004	0,005	0,004	0,004	0,004	0,004	0,004	0,005
1775	0,004	0,004	0,004	0,004	0,004	0,004	0,005	0,004	0,004	0,004	0,004	0,004	0,005
1825	0,004	0,004	0,004	0,004	0,005	0,005	0,005	0,004	0,004	0,005	0,004	0,004	0,005
1875	0,003	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004
1925	0,005	0,005	0,005	0,005	0,005	0,005	0,005	0,004	0,004	0,004	0,004	0,004	0,005
1975	0,003	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Higher Frequencies components / *Höhere Frequenzen*

Rated current / *Nennstrom* [A]: 126,3

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_h [%I_n]												
2,1	0,027	0,026	0,034	0,036	0,038	0,034	0,034	0,038	0,035	0,036	0,033	0,034	0,038
2,3	0,074	0,090	0,095	0,107	0,102	0,101	0,093	0,089	0,079	0,069	0,066	0,072	0,107
2,5	0,144	0,184	0,225	0,202	0,209	0,207	0,175	0,165	0,150	0,132	0,116	0,124	0,225
2,7	0,039	0,049	0,059	0,049	0,056	0,064	0,062	0,058	0,056	0,059	0,052	0,069	0,069
2,9	0,067	0,100	0,130	0,103	0,103	0,103	0,104	0,108	0,104	0,092	0,087	0,092	0,130
3,1	0,081	0,093	0,106	0,099	0,096	0,083	0,073	0,066	0,061	0,055	0,049	0,056	0,106
3,3	0,035	0,038	0,042	0,058	0,048	0,040	0,035	0,032	0,028	0,031	0,029	0,030	0,058
3,5	0,043	0,048	0,066	0,096	0,123	0,078	0,061	0,048	0,042	0,036	0,035	0,035	0,123
3,7	0,026	0,026	0,029	0,037	0,041	0,076	0,070	0,054	0,038	0,031	0,028	0,027	0,076
3,9	0,021	0,021	0,023	0,022	0,023	0,027	0,041	0,034	0,027	0,025	0,024	0,024	0,041
4,1	0,022	0,022	0,023	0,025	0,025	0,025	0,037	0,063	0,045	0,033	0,030	0,025	0,063
4,3	0,020	0,021	0,021	0,028	0,022	0,023	0,023	0,031	0,051	0,035	0,030	0,026	0,051
4,5	0,020	0,020	0,020	0,024	0,022	0,021	0,021	0,023	0,029	0,028	0,025	0,024	0,029
4,7	0,020	0,021	0,021	0,022	0,022	0,021	0,021	0,022	0,024	0,040	0,038	0,028	0,040
4,9	0,020	0,020	0,022	0,021	0,023	0,022	0,020	0,021	0,021	0,023	0,035	0,028	0,035
5,1	0,020	0,020	0,020	0,021	0,024	0,021	0,021	0,020	0,021	0,022	0,024	0,025	0,025
5,3	0,020	0,020	0,020	0,020	0,023	0,021	0,021	0,021	0,021	0,022	0,022	0,031	0,031
5,5	0,020	0,020	0,020	0,021	0,022	0,021	0,021	0,020	0,021	0,021	0,021	0,022	0,022
5,7	0,020	0,020	0,020	0,020	0,023	0,022	0,021	0,020	0,020	0,020	0,021	0,021	0,023
5,9	0,020	0,020	0,020	0,020	0,023	0,023	0,020	0,020	0,020	0,021	0,021	0,021	0,023
6,1	0,020	0,020	0,020	0,020	0,023	0,022	0,021	0,020	0,020	0,020	0,021	0,021	0,023
6,3	0,020	0,020	0,021	0,020	0,021	0,023	0,021	0,021	0,021	0,021	0,021	0,022	0,023
6,5	0,020	0,020	0,020	0,020	0,021	0,023	0,021	0,020	0,020	0,020	0,020	0,022	0,023
6,7	0,020	0,020	0,020	0,020	0,020	0,021	0,021	0,020	0,021	0,020	0,020	0,021	0,021
6,9	0,020	0,020	0,020	0,021	0,020	0,022	0,022	0,020	0,020	0,020	0,021	0,022	0,022
7,1	0,020	0,020	0,020	0,020	0,020	0,020	0,023	0,021	0,020	0,020	0,021	0,021	0,023
7,3	0,020	0,020	0,020	0,021	0,021	0,023	0,022	0,021	0,021	0,021	0,021	0,022	0,023
7,5	0,020	0,020	0,020	0,020	0,020	0,021	0,022	0,021	0,020	0,020	0,020	0,021	0,022
7,7	0,020	0,020	0,020	0,020	0,020	0,022	0,022	0,021	0,021	0,020	0,020	0,021	0,022
7,9	0,020	0,020	0,020	0,020	0,020	0,021	0,022	0,022	0,021	0,020	0,020	0,021	0,022
8,1	0,020	0,020	0,020	0,020	0,020	0,021	0,022	0,021	0,020	0,020	0,020	0,021	0,022
8,3	0,020	0,020	0,020	0,020	0,020	0,021	0,021	0,022	0,021	0,020	0,021	0,021	0,022
8,5	0,020	0,020	0,020	0,020	0,020	0,020	0,021	0,021	0,020	0,020	0,020	0,021	0,021
8,7	0,020	0,020	0,020	0,020	0,020	0,020	0,021	0,021	0,021	0,021	0,020	0,021	0,021
8,9	0,020	0,020	0,019	0,020	0,020	0,020	0,022	0,021	0,021	0,021	0,020	0,021	0,022

Note / *Anmerkung*:

The stated harmonics are maximum values of all 3 phases. / *Die angegebenen Harmonischenwerte sind Maximalwerte über alle 3 Phasen.*

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

SUN2000-215KTL-H3

Harmonics / *Harmonische*

Rated current / *Nennstrom* [A]: 144,4

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
Order / *Ordnung*	I_h [%I_n]												
1	3,036	10,120	20,199	30,304	39,730	50,428	60,112	70,472	80,525	90,397	100,362	106,689	106,689
2	0,231	0,239	0,228	0,235	0,228	0,234	0,252	0,245	0,242	0,247	0,248	0,301	0,301
3	0,087	0,088	0,110	0,100	0,118	0,118	0,139	0,157	0,157	0,181	0,200	0,200	0,200
4	0,067	0,080	0,050	0,062	0,075	0,086	0,094	0,105	0,089	0,095	0,093	0,054	0,105
5	0,340	0,336	0,169	0,106	0,092	0,110	0,118	0,137	0,128	0,154	0,183	0,263	0,340
6	0,089	0,097	0,078	0,036	0,041	0,039	0,037	0,049	0,076	0,082	0,078	0,055	0,097
7	0,111	0,107	0,183	0,097	0,092	0,092	0,121	0,110	0,149	0,158	0,159	0,155	0,183
8	0,035	0,036	0,046	0,039	0,051	0,054	0,054	0,041	0,047	0,069	0,067	0,070	0,070
9	0,030	0,026	0,016	0,030	0,025	0,023	0,038	0,033	0,033	0,050	0,063	0,076	0,076
10	0,037	0,037	0,019	0,017	0,032	0,056	0,077	0,086	0,082	0,079	0,089	0,059	0,089
11	0,118	0,131	0,086	0,087	0,078	0,090	0,065	0,064	0,100	0,091	0,114	0,096	0,131
12	0,014	0,025	0,028	0,041	0,039	0,042	0,048	0,066	0,070	0,066	0,058	0,045	0,070
13	0,066	0,061	0,069	0,016	0,036	0,068	0,091	0,100	0,111	0,111	0,108	0,154	0,154
14	0,026	0,019	0,033	0,014	0,019	0,028	0,035	0,029	0,027	0,035	0,026	0,037	0,037
15	0,010	0,017	0,016	0,011	0,021	0,029	0,028	0,024	0,032	0,030	0,028	0,025	0,032
16	0,011	0,011	0,018	0,017	0,016	0,018	0,029	0,033	0,035	0,026	0,032	0,022	0,035
17	0,059	0,035	0,062	0,019	0,029	0,036	0,038	0,046	0,048	0,043	0,041	0,045	0,062
18	0,015	0,010	0,009	0,014	0,020	0,020	0,025	0,030	0,030	0,033	0,032	0,007	0,033
19	0,020	0,026	0,029	0,026	0,015	0,027	0,039	0,046	0,048	0,046	0,051	0,074	0,074
20	0,004	0,007	0,012	0,011	0,006	0,008	0,014	0,015	0,014	0,013	0,013	0,020	0,020
21	0,007	0,005	0,003	0,009	0,009	0,012	0,014	0,013	0,013	0,013	0,014	0,008	0,014
22	0,003	0,003	0,007	0,009	0,009	0,010	0,012	0,015	0,013	0,011	0,012	0,012	0,015
23	0,024	0,021	0,004	0,020	0,009	0,011	0,015	0,018	0,019	0,019	0,015	0,012	0,024
24	0,003	0,003	0,005	0,004	0,005	0,006	0,009	0,010	0,011	0,010	0,011	0,005	0,011
25	0,014	0,003	0,008	0,015	0,012	0,013	0,018	0,022	0,022	0,021	0,025	0,033	0,033
26	0,004	0,002	0,005	0,005	0,003	0,003	0,006	0,007	0,006	0,004	0,004	0,007	0,007
27	0,003	0,003	0,003	0,004	0,006	0,004	0,005	0,007	0,004	0,005	0,005	0,006	0,007
28	0,002	0,001	0,002	0,003	0,004	0,004	0,004	0,006	0,006	0,005	0,005	0,005	0,006
29	0,003	0,003	0,005	0,007	0,006	0,004	0,007	0,007	0,007	0,007	0,006	0,008	0,008
30	0,001	0,002	0,002	0,002	0,002	0,003	0,003	0,004	0,004	0,003	0,004	0,003	0,004
31	0,006	0,006	0,005	0,004	0,008	0,007	0,009	0,010	0,011	0,011	0,011	0,015	0,015
32	0,001	0,001	0,001	0,001	0,001	0,001	0,003	0,003	0,003	0,002	0,002	0,003	0,003
33	0,001	0,002	0,002	0,001	0,003	0,002	0,003	0,003	0,003	0,002	0,002	0,002	0,003
34	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,003	0,003	0,003	0,003	0,003
35	0,002	0,001	0,001	0,002	0,003	0,002	0,003	0,004	0,004	0,004	0,004	0,005	0,005
36	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002
37	0,002	0,003	0,002	0,004	0,005	0,004	0,005	0,006	0,006	0,006	0,006	0,008	0,008
38	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,001	0,001	0,001	0,002
39	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
40	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002
41	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,003	0,003	0,004	0,004
42	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
43	0,001	0,001	0,002	0,002	0,002	0,002	0,003	0,003	0,003	0,004	0,003	0,005	0,005
44	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
45	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
46	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
47	0,001	0,002	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,003
48	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
49	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,003
50	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
THC [%I_n]	0,459	0,455	0,359	0,289	0,316	0,342	0,373	0,379	0,400	0,416	0,431	0,499	0,499

Maximum values over harmonic order (from 2nd order, I_n = f(h)) / *Maximalwerte über Oberschwingungsordnung*: 0,340

3. Annex 3 – Extract from the test report

Extract from the test report - Part 1: Power Quality

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Interharmonics / *Zwischenharmonische*

Rated current / *Nennstrom* [A]: 144,4

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_n [%I_n]												
75	0,039	0,038	0,043	0,048	0,041	0,045	0,040	0,044	0,044	0,044	0,092	0,025	0,092
125	0,044	0,042	0,042	0,044	0,043	0,045	0,045	0,045	0,047	0,047	0,058	0,024	0,058
175	0,035	0,038	0,040	0,041	0,040	0,041	0,045	0,046	0,046	0,046	0,053	0,022	0,053
225	0,051	0,044	0,035	0,037	0,037	0,041	0,042	0,042	0,043	0,042	0,048	0,022	0,051
275	0,067	0,061	0,051	0,041	0,042	0,047	0,050	0,053	0,051	0,052	0,051	0,021	0,067
325	0,049	0,045	0,038	0,037	0,034	0,038	0,039	0,042	0,041	0,044	0,042	0,034	0,049
375	0,065	0,062	0,050	0,039	0,040	0,046	0,048	0,049	0,044	0,047	0,044	0,022	0,065
425	0,030	0,032	0,043	0,043	0,046	0,046	0,045	0,044	0,040	0,038	0,037	0,036	0,046
475	0,016	0,020	0,026	0,029	0,030	0,030	0,033	0,028	0,027	0,028	0,030	0,029	0,033
525	0,017	0,021	0,024	0,026	0,027	0,029	0,028	0,028	0,028	0,027	0,029	0,025	0,029
575	0,015	0,017	0,019	0,020	0,023	0,024	0,024	0,025	0,025	0,024	0,025	0,022	0,025
625	0,024	0,023	0,019	0,019	0,018	0,020	0,021	0,021	0,023	0,024	0,024	0,027	0,027
675	0,013	0,014	0,012	0,012	0,012	0,014	0,014	0,016	0,018	0,017	0,017	0,016	0,018
725	0,015	0,015	0,012	0,012	0,011	0,011	0,013	0,013	0,014	0,014	0,015	0,015	0,015
775	0,008	0,009	0,008	0,008	0,008	0,009	0,010	0,011	0,011	0,012	0,012	0,012	0,012
825	0,009	0,011	0,010	0,010	0,010	0,011	0,013	0,014	0,015	0,014	0,014	0,014	0,015
875	0,007	0,008	0,006	0,006	0,006	0,007	0,008	0,009	0,009	0,009	0,010	0,009	0,010
925	0,006	0,006	0,006	0,005	0,006	0,006	0,007	0,008	0,008	0,008	0,009	0,010	0,010
975	0,005	0,005	0,004	0,004	0,004	0,005	0,005	0,006	0,006	0,006	0,007	0,007	0,007
1025	0,004	0,004	0,004	0,004	0,004	0,004	0,005	0,005	0,005	0,006	0,006	0,006	0,006
1075	0,003	0,003	0,003	0,003	0,003	0,003	0,004	0,004	0,004	0,005	0,005	0,004	0,005
1125	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,004	0,004	0,004	0,004	0,004	0,004
1175	0,002	0,002	0,002	0,002	0,002	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003
1225	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,002	0,003	0,003	0,003	0,003	0,003
1275	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003
1325	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002
1375	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002
1425	0,002	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002
1475	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002
1525	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,002	0,002	0,002	0,002
1575	0,001	0,001	0,001	0,001	0,001	0,002	0,002	0,002	0,001	0,001	0,002	0,001	0,002
1625	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,001	0,002
1675	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,001	0,002
1725	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
1775	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
1825	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
1875	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
1925	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
1975	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

Higher Frequencies components / *Höhere Frequenzen*

Rated current / *Nennstrom* [A]: 144,4

P [%P_n]	0 - 5	10	20	30	40	50	60	70	80	90	100	P_{max}	Max.
f [Hz]	I_h [%I_n]												
2,1	0,029	0,029	0,049	0,056	0,049	0,055	0,060	0,071	0,081	0,083	0,080	0,114	0,114
2,3	0,025	0,041	0,035	0,036	0,036	0,042	0,043	0,045	0,052	0,053	0,055	0,063	0,063
2,5	0,024	0,035	0,037	0,035	0,035	0,046	0,053	0,059	0,061	0,065	0,062	0,083	0,083
2,7	0,037	0,042	0,058	0,058	0,046	0,052	0,058	0,062	0,073	0,075	0,075	0,093	0,093
2,9	0,058	0,073	0,060	0,063	0,065	0,068	0,069	0,071	0,079	0,082	0,083	0,081	0,083
3,1	0,045	0,066	0,065	0,059	0,047	0,048	0,050	0,055	0,060	0,060	0,062	0,069	0,069
3,3	0,057	0,085	0,080	0,074	0,066	0,065	0,067	0,068	0,076	0,079	0,079	0,081	0,085
3,5	0,034	0,042	0,049	0,070	0,079	0,069	0,066	0,062	0,063	0,064	0,067	0,058	0,079
3,7	0,022	0,023	0,035	0,034	0,047	0,049	0,059	0,057	0,052	0,050	0,047	0,043	0,059
3,9	0,021	0,026	0,025	0,033	0,047	0,065	0,071	0,075	0,073	0,066	0,062	0,047	0,075
4,1	0,019	0,020	0,022	0,022	0,029	0,040	0,069	0,069	0,065	0,060	0,056	0,037	0,069
4,3	0,018	0,019	0,021	0,026	0,025	0,025	0,039	0,051	0,062	0,058	0,045	0,029	0,062
4,5	0,018	0,019	0,020	0,023	0,022	0,023	0,030	0,057	0,066	0,066	0,059	0,030	0,066
4,7	0,018	0,018	0,019	0,022	0,021	0,020	0,022	0,033	0,062	0,074	0,071	0,036	0,074
4,9	0,018	0,018	0,019	0,021	0,020	0,019	0,020	0,024	0,032	0,048	0,057	0,029	0,057
5,1	0,018	0,017	0,018	0,019	0,019	0,019	0,019	0,023	0,028	0,045	0,063	0,035	0,063
5,3	0,017	0,018	0,018	0,019	0,022	0,020	0,019	0,021	0,023	0,027	0,050	0,031	0,050
5,5	0,017	0,018	0,018	0,018	0,021	0,019	0,019	0,019	0,022	0,024	0,031	0,024	0,031
5,7	0,017	0,017	0,018	0,018	0,019	0,019	0,019	0,019	0,020	0,021	0,024	0,024	0,024
5,9	0,017	0,018	0,018	0,018	0,020	0,019	0,020	0,019	0,019	0,021	0,024	0,022	0,024
6,1	0,017	0,017	0,018	0,018	0,021	0,020	0,019	0,018	0,019	0,021	0,021	0,020	0,021
6,3	0,017	0,018	0,018	0,018	0,021	0,019	0,019	0,019	0,019	0,019	0,021	0,021	0,021
6,5	0,017	0,017	0,018	0,018	0,021	0,019	0,018	0,018	0,019	0,020	0,020	0,020	0,021
6,7	0,017	0,017	0,017	0,018	0,019	0,019	0,019	0,019	0,019	0,019	0,020	0,019	0,020
6,9	0,017	0,017	0,017	0,018	0,018	0,020	0,019	0,018	0,019	0,020	0,020	0,019	0,020
7,1	0,017	0,017	0,017	0,018	0,018	0,021	0,019	0,019	0,018	0,019	0,019	0,018	0,021
7,3	0,017	0,017	0,017	0,018	0,018	0,020	0,018	0,019	0,019	0,019	0,019	0,018	0,020
7,5	0,017	0,017	0,017	0,018	0,018	0,020	0,019	0,019	0,018	0,019	0,019	0,019	0,020
7,7	0,017	0,017	0,017	0,018	0,018	0,019	0,018	0,019	0,019	0,019	0,018	0,019	0,019
7,9	0,017	0,017	0,017	0,018	0,018	0,020	0,020	0,018	0,019	0,018	0,019	0,018	0,020
8,1	0,017	0,017	0,017	0,018	0,018	0,021	0,019	0,019	0,019	0,018	0,019	0,018	0,021
8,3	0,017	0,017	0,017	0,018	0,018	0,020	0,020	0,019	0,019	0,018	0,019	0,019	0,020
8,5	0,017	0,017	0,017	0,018	0,017	0,018	0,019	0,018	0,019	0,018	0,019	0,018	0,019
8,7	0,017	0,017	0,017	0,018	0,017	0,018	0,020	0,019	0,019	0,018	0,019	0,018	0,020
8,9	0,017	0,017	0,017	0,018	0,018	0,018	0,020	0,019	0,019	0,019	0,019	0,018	0,020

Note / *Anmerkung*:

The stated harmonics are maximum values of all 3 phases. / *Die angegebenen Harmonischenwerte sind Maximalwerte über alle 3 Phasen.*

A transfer of the relative parts of the Harmonics above order 1 of *SUN2000-215KTL-H3* to the *SUN2000-215KTL-H0* is possible directly. /

Eine Übertragung der relativen Anteile der Harmonischen oberhalb Ordnung 1 des SUN2000-215KTL-H3 *auf den* SUN2000-215KTL-H0 *ist direkt möglich.*

3. Annex 3 – Extract from the test report

4.3 SYSTEM PERTURBATIONS / *NETZRÜCKWIRKUNGEN*

4.3.5 Unbalances of the current / *Umsymmetrien des Stroms*

SUN2000-185KTL-H1

P [%P_n]	P_n* [kW]	U_{L-L}* [V]	U_{L-}* [V]	I_{L-}* [A]	I_L* [A]	u_i* [%I_{L-}]
0 - 5	3,70	463,21	1,75	2,66	0,07	2,63
10	17,77	463,23	1,73	12,78	0,09	0,67
20	35,45	463,27	1,74	25,51	0,10	0,40
30	53,14	463,29	1,73	38,23	0,16	0,43
40	70,74	463,33	1,71	50,90	0,18	0,36
50	88,38	463,37	1,69	63,58	0,24	0,37
60	105,95	463,41	1,69	76,21	0,27	0,36
70	123,49	463,46	1,68	88,82	0,32	0,36
80	140,95	463,51	1,67	101,37	0,28	0,28
90	158,46	463,57	1,66	113,94	0,32	0,28
100	175,86	463,64	1,66	126,44	0,34	0,27
106	185,21	463,67	1,66	133,15	0,28	0,21

Maximum unsymmetry / *maximale Unsymmetrie* u_{imax} (≥10%P_n)	0,67

Note / *Anmerkung*:
The current unbalance of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1* directly. / *Die Unsymmetrie des* SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1 *direkt übertragen werden.*

SUN2000-215KTL-H3

P [%P_n]	P_n* [kW]	U_{L-L}* [V]	U_{L-}* [V]	I_{L-}* [A]	I_L* [A]	u_i* [%I_{L-}]
0 - 5	2,10	462,35	1,63	1,52	0,14	8,92
10	20,16	462,40	1,61	14,54	0,12	0,85
20	40,18	462,45	1,59	28,96	0,17	0,60
30	60,77	462,48	1,59	43,80	0,22	0,51
40	80,45	462,55	1,58	57,97	0,24	0,41
50	100,42	462,61	1,56	72,36	0,25	0,34
60	120,49	462,66	1,55	86,81	0,29	0,33
70	140,34	462,72	1,55	101,10	0,26	0,26
80	160,33	462,76	1,54	115,49	0,29	0,25
90	180,52	462,82	1,53	130,01	0,26	0,20
100	200,45	462,87	1,53	144,35	0,10	0,07
107,5	215,78	462,93	1,53	155,38	0,37	0,24

Maximum unsymmetry / *maximale Unsymmetrie* u_{imax} (≥10%P_n)	0,85

Note / *Anmerkung*:
The current unbalance of the *SUN2000-215KTL-H3* can be applied to the *SUN2000-215KTL-H0* directly.. / *Die Unsymmetrie des* SUN2000-215KTL-H3 *können auf den* SUN2000-215KTL-H0 *direkt übertragen werden.*

Figure 11 – Results of power quality from [10]

3. Annex 3 – Extract from the test report

3.2. Active power

4.1 ACTIVE POWER OUTPUT / *WIRKLEISTUNGSABGABE*

4.1.1 Active power peaks / *Wirkleistungsspitzen*

SUN2000-168KTL-H1

Active power peaks / *Wirkleistungsspitzen* [kW]		Normalised active power peaks / *Normierte Wirkleistungsspitzen* [p.u. base / *Basis* P_n]		Number of 10-minute records used / *Anzahl der verwendeten 10-Minuten-Datensätze*
$P_{0,2}$	168,50	$p_{0,2} = P_{0,2}/P_n$	1,12	
P_{60}	167,91	$p_{60} = P_{60}/P_n$	1,12	2
P_{600}	167,87	$p_{600} = P_{600}/P_n$	1,12	

SUN2000-185KTL-H1

Active power peaks / *Wirkleistungsspitzen* [kW]		Normalised active power peaks / *Normierte Wirkleistungsspitzen* [p.u. base / *Basis* P_n]		Number of 10-minute records used / *Anzahl der verwendeten 10-Minuten-Datensätze*
$P_{0,2}$	185,95	$p_{0,2} = P_{0,2}/P_n$	1,06	
P_{60}	185,66	$p_{60} = P_{60}/P_n$	1,06	2
P_{600}	185,61	$p_{600} = P_{600}/P_n$	1,06	

SUN2000-215KTL-H3

Active power peaks / *Wirkleistungsspitzen* [kW]		Normalised active power peaks / *Normierte Wirkleistungsspitzen* [p.u. base / *Basis* P_n]		Number of 10-minute records used / *Anzahl der verwendeten 10-Minuten-Datensätze*
$P_{0,2}$	215,32	$p_{0,2} = P_{0,2}/P_n$	1,08	
P_{60}	214,98	$p_{60} = P_{60}/P_n$	1,07	2
P_{600}	214,91	$p_{600} = P_{600}/P_n$	1,07	

Note / *Anmerkung*:
The active power results of the *SUN2000-215KTL-H3* can be applied to the *SUN2000-215KTL-H0* directly.
Die Wirkleistungsergebnisse des SUN2000-215KTL-H3 *können auf den* SUN2000-215KTL-H0 *direkt übertragen werden.*

3. Annex 3 – Extract from the test report

4.1 ACTIVE POWER OUTPUT / *WIRKLEISTUNGSABGABE*		
4.1.2 Operating power limited by grid operator / *Leistungsbegrenzter Betrieb durch den Netzbetreiber*		
The unit is able to run at reduced power. / *Die EZEs können mit reduzierter Leistung betrieben werden.*	☒ Yes / *Ja*	☐ No / *Nein*
Disconnection from the grid at external active power set-points at / *Trennung vom Netz bei Wirkleistungssollwertvorgabe von:*	At 0% setpoint the PGU stays connected without power feeding. The PGU can be disconnected from grid using the "Start/Stop control" or set the parameter "Shutdown at 0% power limit" to "Enable". / *Bei 0% sollwertvorgabe bleibt die EZE am Netz ohne Einspeisung. Die EZE kann mittels Parameter "Start/Stop control" oder "Shutdown at 0% power limit" vom Netz getrennt werden.*	

SUN2000-168KTL-H1		
Max. deviation of power setting / *Maximale Sollwertabweichung der Wirkleistung*	Exceeding / *Überschreitung*: 0,5 kW	Undercut / *Unterschreitung*: -1,1 kW
Settling time of the power output after a change in set-point with minimal gradient: / *Einschwingzeit der Leistung für einen Sollwertsprung mit minimalem Gradienten:* ±0,350%P_{max}/s	$P_{70\%} \rightarrow P_{50\%}$	Time / *Zeit*: 39,6 s Gradient: -0,350%P_{max}/s
	$P_{50\%} \rightarrow P_{70\%}$	Time / *Zeit*: 38,0 s Gradient: 0,350%P_{max}/s
Settling time of the power output after a change in set-point with maximum gradient / *Einschwingzeit der Leistung für einen Sollwertsprung mit maximalem Gradienten*: ±0,640%P_{max}/s	$P_{90\%} \rightarrow P_{10\%}$	Time / *Zeit*: 105,2 s Gradient: -0,638%P_{max}/s
	$P_{10\%} \rightarrow P_{90\%}$	Time / *Zeit*: 105,0 s Gradient: 0,641%P_{max}/s

SUN2000-185KTL-H1		
Max. deviation of power setting / *Maximale Sollwertabweichung der Wirkleistung*	Exceeding / *Überschreitung*: 1,0 kW	Undercut / *Unterschreitung*: -0,7 kW
Settling time of the power output after a change in set-point with minimal gradient: / *Einschwingzeit der Leistung für einen Sollwertsprung mit minimalem Gradienten:* ±0,350%P_{max}/s	$P_{70\%} \rightarrow P_{50\%}$	Time / *Zeit*: 40,6 s Gradient: -0,350%P_{max}/s
	$P_{50\%} \rightarrow P_{70\%}$	Time / *Zeit*: 40,6 s Gradient: 0,351%P_{max}/s
Settling time of the power output after a change in set-point with maximum gradient / *Einschwingzeit der Leistung für einen Sollwertsprung mit maximalem Gradienten:* ±0,640%P_{max}/s	$P_{90\%} \rightarrow P_{10\%}$	Time / *Zeit*: 111,2 s Gradient: -0,642%P_{max}/s
	$P_{10\%} \rightarrow P_{90\%}$	Time / *Zeit*: 111,6 s Gradient: 0,637%P_{max}/s

3. Annex 3 – Extract from the test report

4.1 ACTIVE POWER OUTPUT / *WIRKLEISTUNGSABGABE*

SUN2000-215KTL-H3

Max. deviation of power setting / *Maximale Sollwertabweichung der Wirkleistung*	Exceeding / *Überschreitung*: ---	Undercut / *Unterschreitung*: ---
Settling time of the power output after a change in set-point with minimal gradient: / *Einschwingzeit der Leistung für einen Sollwertsprung mit minimalem Gradienten:* ±0,350%P_{max}/s	$P_{70\%} \rightarrow P_{50\%}$	Time / *Zeit*: 39,6 s Gradient: -0,353%P_{max}/s
	$P_{50\%} \rightarrow P_{70\%}$	Time / *Zeit*: 39,6 s Gradient: 0,354%P_{max}/s
Settling time of the power output after a change in set-point with maximum gradient / *Einschwingzeit der Leistung für einen Sollwertsprung mit maximalem Gradienten*: ±0,640%P_{max}/s	$P_{90\%} \rightarrow P_{10\%}$	Time / *Zeit*: 107,8 s Gradient: -0,639%P_{max}/s
	$P_{10\%} \rightarrow P_{90\%}$	Time / *Zeit*: 107,4 s Gradient: 0,639%P_{max}/s
Settling time of the power output after a change in set-point with maximum gradient / *Einschwingzeit der Leistung für einen Sollwertsprung mit maximalem Gradienten*: ±1000%P_{max}/s	$P_{90\%} \rightarrow P_{10\%}$	Time / *Zeit*: 0,25 s Gradient: -1194,791%P_{max}/s
	$P_{10\%} \rightarrow P_{90\%}$	Time / *Zeit*: 0,25 s Gradient: 1060,093%P_{max}/s

Note / *Anmerkung*:

The active power results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* scaled (by the factor $P_{max,\ notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$). /
Die Wirkleistungsergebnisse des SUN2000-185KTL-H1 *können auf den* SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *relativ (über den Faktor* $P_{max,notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$*) übertragen werden.*

3. Annex 3 – Extract from the test report

4.1 ACTIVE POWER OUTPUT / *WIRKLEISTUNGSABGABE*

4.1.3 Active power feed-in as a function of grid frequency / *Wirkleistungseinspeisung in Abhängigkeit der Netzfrequenz*

SUN2000-185KTL-H1		
Overfrequency / *Überfrequenz*	Mean power gradient at overfrequency / *Mittlerer Gradient der Wirkleistung zum Zeitpunkt der Frequenzüberhöhung*	Mean gradient / *Mittlerer Gradient* -39,97%P_{mom}/Hz
	Max. Settling time / *Max. Einschwingzeit*	0,4 s
	Power gradient after recovery of overfrequency / *Gradient der Wirkleistung nach Rückkehr aus Überfrequenz*	Mean gradient / *Mittlerer Gradient:* 9,0%P_N/min Max. gradient / *Max. Gradient:* 10,0%P_N/min
Underfrequency / *Unterfrequenz*	Mean power gradient at underfrequency / *Mittlerer Gradient der Wirkleistung zum Zeitpunkt der Frequenzunterschreitung*	Mean gradient / *Mittlerer Gradient* 39,71%P_{mom}/Hz
	Max. Settling time / *Max. Einschwingzeit*	0,6 s
	Power gradient after recovery of underfrequency / *Gradient der Wirkleistung nach Rückkehr aus Unterfrequenz*	Mean gradient / *Mittlerer Gradient:* -9,0%P_N/min Max. gradient / *Max. Gradient:* -10,0%P_N/min

Note / *Anmerkung:*

The settling time and active power gradient results of the *SUN2000-185KTL-H1* can be applied to *SUN2000-168KTL-H1, SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly. /

Die Einschwingzeiten und Gradienten der Wirkleistung des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*

Figure 12 – Results of active power control from [11]

3. Annex 3 – Extract from the test report

The PGUs are able to be operated at reduced power [7].

At 0% setpoint the PGUs stay connected without power feeding. The PGUs can be disconnected from grid using the “Start/Stop control” or set the parameter “Shutdown at 0% power limit” to “Enable” (parameter No. 9, see *Annex 5 – Certification-relevant parameters*).

4.1 ACTIVE POWER OUTPUT

4.1.2 Operating power limited by grid operator

a) Determine the setpoint accuracy

SUN2000-168KTL-H1

Active power step	Setpoint value		Actual value		Deviation	
[%P_n]	[kW]	[%P_n]	[kW]	[%P_n]	[kW]	[%P_n]
Max. (112)	168,0	112,0	167,4	111,6	-0,6	-0,4
100	150,0	100,0	149,0	99,4	-1,0	-0,6
90	135,0	90,0	133,9	89,3	-1,1	-0,7
80	120,0	80,0	118,9	79,3	-1,1	-0,7
70	105,0	70,0	105,5	70,4	0,5	0,4
60	90,0	60,0	90,5	60,3	0,5	0,3
50	75,0	50,0	75,4	50,3	0,4	0,3
40	60,0	40,0	60,3	40,2	0,3	0,2
30	45,0	30,0	45,2	30,2	0,2	0,2
20	30,0	20,0	30,1	20,1	0,1	0,1
10	15,0	10,0	15,0	10,0	0,0	0,0
0	0,0	0,0	0,0	0,0	0,0	0,0

	Power setpoint [%P_n]	Deviation [kW]	Deviation [%P_n]
Maximum active power above the defined setpoint (1-minute mean)	70	0,5	0,4
Maximum active power below the defined setpoint (1-minute mean)	80	-1,1	-0,7
Grid disconnection at xx% of P_r		*	

DC characteristics for test 4.1.2	
PV-curve simulated according to	EN 50530
Voltage of defined MPP [V]	1080
Power of defined MPP [kW]	170,8
Internal impedance [Ω]	0

Note:
* At 0% setpoint the PGU stays connected without power feeding.
Method for remote disconnection of the unit from grid:
The PGU can be disconnected from grid using the *Start/Stop control (gOD51_CrlCmd_0)*.

3. Annex 3 – Extract from the test report

4.1 ACTIVE POWER OUTPUT

SUN2000-185KTL-H1

Active power step	Setpoint value		Actual value		Deviation	
[%P_n]	[kW]	[%P_n]	[kW]	[%P_n]	[kW]	[%P_n]
Max. (106)	185,0	105,7	184,7	105,6	-0,3	-0,2
100	175,0	100,0	175,6	100,3	0,6	0,3
90	157,5	90,0	157,1	89,8	-0,4	-0,2
80	140,0	80,0	140,5	80,3	0,5	0,3
70	122,5	70,0	122,1	69,8	-0,4	-0,2
60	105,0	60,0	105,5	60,3	0,5	0,3
50	87,5	50,0	87,0	49,7	-0,5	-0,3
40	70,0	40,0	70,4	40,2	0,4	0,2
30	52,5	30,0	51,8	29,6	-0,7	-0,4
20	35,0	20,0	35,2	20,1	0,2	0,1
10	17,5	10,0	18,5	10,6	1,0	0,6
0	0,0	0,0	0,1	0,1	0,1	0,1

	Power setpoint [%P_n]	Deviation [kW]	Deviation [%P_n]
Maximum active power above the defined setpoint (1-minute mean)	10	1,0	0,6
Maximum active power below the defined setpoint (1-minute mean)	30	-0,7	-0,4
Grid disconnection at xx% of P_n		*	

DC characteristics for test 4.1.2	
PV-curve simulated according to	EN 50530
Voltage of defined MPP [V]	1080
Power of defined MPP [kW]	188,7
Internal impedance [Ω]	0

Note:
* At 0% setpoint the PGU stays connected without power feeding.
Method for remote disconnection of the unit from grid:
The PGU can be disconnected from grid using the *Start/Stop control (gOD51_CrlCmd_0)*.

Note:
The output power is set in the control software with an accuracy of 1%P_n or better.
The setpoint was set by the "*Data Collector Web*" using the RS485-interface.

Figure 13 – Results of active power control from [7]

3. Annex 3 – Extract from the test report

The active power gradient is implemented on the PGU level.

Only one Interface for specifying active power implemented on the PGU. Separate specifying active power by grid operator and direct seller is not possible. For prioritization of different setpoints must be carried out on the plant level e.g. in the superimposed PGS controller.

The max. active power output of the PGU is dependent on ambient temperature [15]:

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

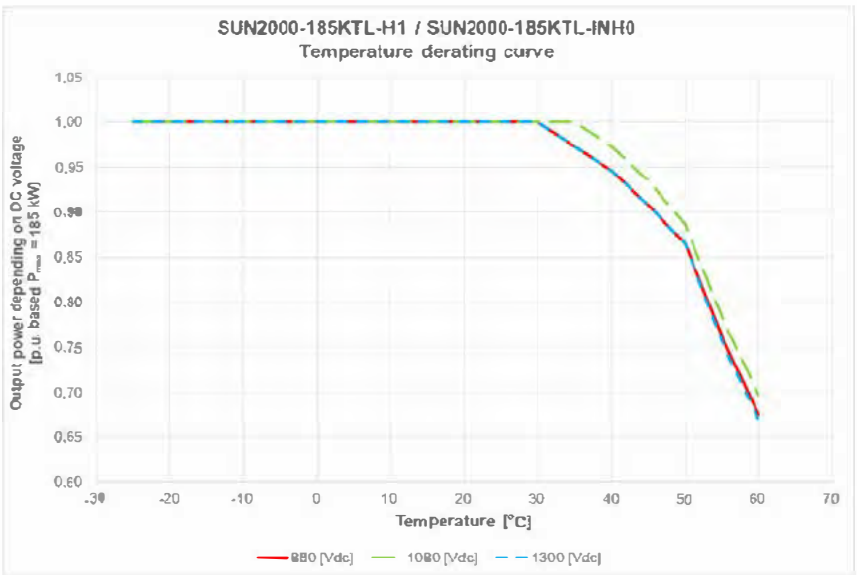
Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

Anhang 5 / Annex 5:

Active power output dependent on ambient temperature:

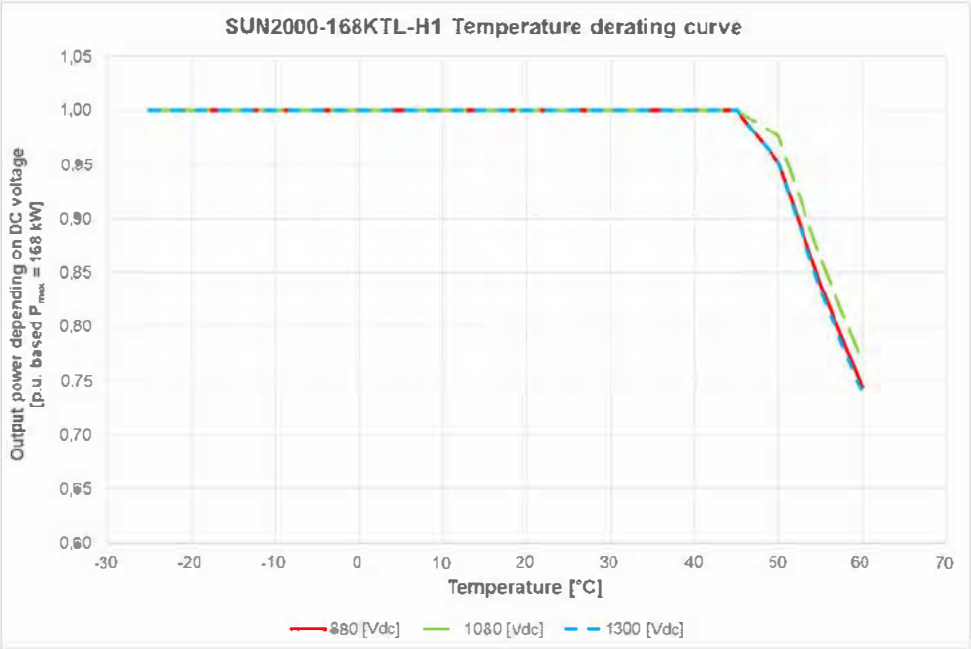
SUN2000-185KTL-H1 Temperature derating curve			
Temperature [°C]	Output power depending on DC voltage [kW]		
	880 [Vdc]	1080 [Vdc]	1300 [Vdc]
-25	185	185	185
-20	185	185	185
-15	185	185	185
-10	185	185	185
-5	185	185	185
0	185	185	185
5	185	185	185
10	185	185	185
15	185	185	185
20	185	185	185
25	185	185	185
30	185	185	185
35	180	185	180
40	175	180	175
45	168	173	168
50	160	164	160
55	141	145	140
60	125	129	124



3. Annex 3 – Extract from the test report

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11
Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11
Datum / *Date*: 2021-05-19

SUN2000-168KTL-H1 Temperature derating curve			
Temperature [°C]	Output power depending on DC voltage [kW]		
	880 [Vdc]	1080 [Vdc]	1300 [Vdc]
-25	168	168	168
-20	168	168	168
-15	168	168	168
-10	168	168	168
-5	168	168	168
0	168	168	168
5	168	168	168
10	168	168	168
15	168	168	168
20	168	168	168
25	168	168	168
30	168	168	168
35	168	168	168
40	168	168	168
45	168	168	168
50	160	164	160
55	141	145	140
60	125	129	124



3. Annex 3 – Extract from the test report

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

SUN2000-215KTL-H0 / SUN2000-215KTL-H3 Temperature derating curve			
Temperature [°C]	Output power depending on DC voltage [kW]		
	930 [V_{dc}]	1080 [V_{dc}]	1230 [V_{dc}]
-25	215	215	215
10	215	215	215
15	215	215	215
20	215	215	215
25	215	215	215
35	203	206	208
40	195	200	208
45	185	191	204
50	174	185	196
60	135	145	148

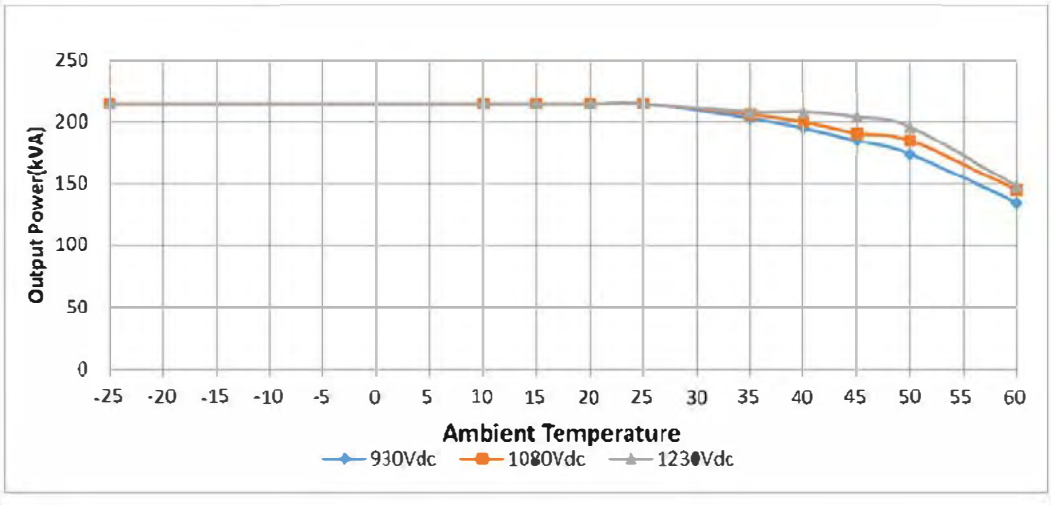


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Figure 14 – Active power output dependent on ambient temperature from [15]

3. Annex 3 – Extract from the test report

3.3. Reactive power

4.2 Reactive power provision / *Blindleistungsbereitstellung*

4.2.1 Reactive power response in the normal operation (Q = 0 kvar) / *Blindleistungsverhalten im Normalbetrieb (Q = 0 kvar)*

4.2.2 Measuring the maximum reactive power range (PQ diagram) / Vermessung des maximalen Blindleistungsstellberich (PQ-Diagramm)

SUN2000-168KTL-H1

	P/P_n [%]	Q_{ind}	Q_0 [kvar]	Q_{cap}	P/P_n [%]	Q_{ind}	Q_0 [kvar]	Q_{cap}
Control of reactive power in normal operation mode and maximum reactive power range / *Blindleistungsverhalten im Normalbetrieb und maximaler Blindleistungsstellbereich*	0 … 5	-100,9	---	100,7	60	-101,2	---	100,2
	10	-101,0	---	100,6	70	-101,4	---	100,1
	20	-101,1	---	100,6	80	-101,5	---	100,1
	30	-101,1	---	100,5	90	-100,8	---	99,2
	40	-101,2	---	100,7	100	-76,6	---	74,6
	50	-101,1	---	100,3	P_{max}	-1,0	---	-1,0

SUN2000-185KTL-H1

	P/P_n [%]	Q_{ind}	Q_0 [kvar]	Q_{cap}	P/P_n [%]	Q_{ind}	Q_0 [kvar]	Q_{cap}
Control of reactive power in normal operation mode and maximum reactive power range / *Blindleistungsverhalten im Normalbetrieb und maximaler Blindleistungsstellbereich*	0	-111,6	0,1	111,5	60	-112,2	0,5	110,8
	10	-111,6	0,1	111,3	70	-112,3	0,6	110,7
	20	-111,8	0,2	111,2	80	-112,4	0,7	110,6
	30	-111,8	0,3	111,1	90	-98,4	0,8	96,4
	40	-111,9	0,4	111,0	100	-61,4	0,9	59,1
	50	-112,1	0,4	110,9	P_{max}	-1,2	1.0	-1,2

Note / *Anmerkung*:

The reactive power results in the normal operation of the *SUN2000-185KTL-H1* can be applied to *SUN2000-168KTL-H1, SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly.
For measurements of maximum reactive power range the reactive power results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* scaled (by the factor $P_{max,\ notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$). /

Die Blindleistungsergebnisse im Normalbetrieb des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*
Für Messungen des maximalem Blindleistungsstellbereichs können die Blindleistungsergebnisse des SUN2000-185KTL-H1 *auf den* SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *relativ (über den Faktor $P_{max,notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$) übertragen werden.*

3. Annex 3 – Extract from the test report

4.2 Reactive power provision / *Blindleistungsbereitstellung*

4.2.3 Measuring separate operating points in the voltage-dependent PQ diagram / *Vermessung einzelner Arbeitspunkte des spannungsabhängigen PQ-Diagramms*

SUN2000-168KTL-H1

Working points of the voltage dependent P-Q-diagram / *Arbeitspunkte des spannungsabhängigen P-Q-Diagramms*

WP / *AP*	U/U_n [%]	P/P_n [%]	Q [kvar]
1 ind.	90,0	0,6	-100,8
2 ind.	90,1	9,6	-100,9
3 ind.	90,1	19,6	-100,9
4 ind.	90,1	29,6	-101,0
5 ind.	90,1	39,5	-101,1
6 ind.	90,1	49,5	-101,1
7 ind.	90,1	59,5	-101,3
8 ind.	90,1	69,5	-101,4
9 ind.	90,1	79,5	-95,2
10 ind.	90,1	89,7	-72,1
11 ind.	90,2	99,8	-29,4
1 cap. / *kap.*	90,1	1,4	100,9
2 cap. / *kap.*	90,1	10,4	100,7
3 cap. / *kap.*	90,1	20,3	100,6
4 cap. / *kap.*	90,1	30,3	100,5
5 cap. / *kap.*	90,3	40,3	100,4
6 cap. / *kap.*	90,4	50,3	100,4
7 cap. / *kap.*	90,5	60,3	100,2
8 cap. / *kap.*	90,6	70,3	100,2
9 cap. / *kap.*	90,7	80,3	93,7
10 cap. / *kap.*	90,7	90,2	70,5
11 cap. / *kap.*	90,2	100,1	27,7

WP / *AP*	U/U_n [%]	P/P_n [%]	Q [kvar]
1 ind.	110,1	0,6	-100,8
2 ind.	110,1	9,6	-100,9
3 ind.	110,1	19,6	-101,0
4 ind.	110,1	29,6	-101,1
5 ind.	110,1	39,6	-101,2
6 ind.	110,1	49,6	-101,2
7 ind.	110,1	59,5	-101,3
8 ind.	110,1	69,5	-101,4
9 ind.	110,1	79,5	-101,5
10 ind.	110,1	89,5	-100,8
11 ind.	110,1	99,6	-76,5
12 ind.	110,2	113,0	-1,0
1 cap. / *kap.*	110,1	1,4	100,8
2 cap. / *kap.*	110,1	10,4	100,7
3 cap. / *kap.*	110,1	20,4	100,6
4 cap. / *kap.*	110,1	30,4	100,5
5 cap. / *kap.*	110,1	40,5	100,7
6 cap. / *kap.*	110,1	50,3	100,3
7 cap. / *kap.*	110,1	60,3	100,2
8 cap. / *kap.*	110,1	70,3	100,2
9 cap. / *kap.*	110,1	80,3	100,1
10 cap. / *kap.*	110,2	90,3	99,2
11 cap. / *kap.*	110,2	100,2	74,7
12 cap. / *kap.*	110,2	113,0	-1,0

3. Annex 3 – Extract from the test report

4.2 Reactive power provision / *Blindleistungsbereitstellung*

SUN2000-185KTL-H1

WP / *AP*	U/U_n [%]	P/P_n [%]	Q [kvar]
1 ind.	90,0	0,5	-111,3
2 ind.	90,0	9,6	-111,4
3 ind.	90,0	19,6	-111,6
4 ind.	90,0	29,7	-111,7
5 ind.	90,0	39,7	-111,9
6 ind.	90,1	49,7	-112,0
7 ind.	90,1	59,7	-112,1
8 ind.	90,1	66,1	-112,2
9 ind.	90,1	79,6	-94,4
10 ind.	90,1	89,7	-60,3
11 ind.	90,1	96,4	-1,1
1 cap. / *kap.*	90,1	1,3	111,2
2 cap. / *kap.*	90,1	10,4	111,2
3 cap. / *kap.*	90,1	20,4	111,1
4 cap. / *kap.*	90,1	30,4	111,0
5 cap. / *kap.*	90,1	40,5	110,9
6 cap. / *kap.*	90,1	50,5	110,8
7 cap. / *kap.*	90,1	60,5	110,7
8 cap. / *kap.*	90,1	68,1	110,7
9 cap. / *kap.*	90,1	80,6	92,6
10 cap. / *kap.*	90,1	90,5	58,3
11 cap. / *kap.*	90,1	96,3	-1,1

Working points of the voltage dependent P-Q-diagram / *Arbeitspunkte des spannungsabhängigen P-Q-Diagramms*

WP / *AP*	U/U_n [%]	P/P_n [%]	Q [kvar]
1 ind.	110,0	0,6	-111,6
2 ind.	110,0	9,6	-111,7
3 ind.	110,0	19,7	-111,8
4 ind.	110,0	29,7	-111,9
5 ind.	110,0	39,7	-112,0
6 ind.	110,0	49,8	-112,0
7 ind.	110,1	59,8	-112,2
8 ind.	110,1	69,8	-112,3
9 ind.	110,1	79,9	-112,4
10 ind.	110,1	90,0	-98,4
11 ind.	110,1	100,1	-61,4
12 ind.	110,1	107,2	-1,2
1 cap. / *kap.*	110,1	1,3	111,4
2 cap. / *kap.*	110,1	10,4	111,3
3 cap. / *kap.*	110,1	20,4	111,2
4 cap. / *kap.*	110,1	30,5	111,1
5 cap. / *kap.*	110,1	40,5	111,0
6 cap. / *kap.*	110,1	50,5	110,8
7 cap. / *kap.*	110,1	60,6	110,7
8 cap. / *kap.*	110,1	70,5	110,6
9 cap. / *kap.*	110,1	80,6	110,6
10 cap. / *kap.*	110,1	90,6	96,3
11 cap. / *kap.*	110,1	100,5	59,1
12 cap. / *kap.*	110,1	107,1	-1,2

Note / *Anmerkung*:

The voltage-dependent reactive power results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* scaled (by the factor $P_{max,\ notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$). /

Die Spannungsabhängigen Blindleistungsergebnisse des SUN2000-185KTL-H1 *auf den* SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *relativ (über den Faktor* $P_{max,\ notmeasure}$ / $P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$*) übertragen werden.*

3. Annex 3 – Extract from the test report

4.2 Reactive power provision / *Blindleistungsbereitstellung*		
4.2.4 Reactive power following setpont / *Blindleistung nach Sollwertvorgabe*		
SUN2000-168KTL-H1		
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☐ Power factor / *Verschiebungsfaktor*	☒ Reactive power / *Blindleistung*
	P_{bin} at / *bei* Q_{max}	50%P_n
Longest settling time / *Längste Einschwingzeit*	Parameter	Settling time / *Einschwingzeit*
	Standard time / *Standardzeit* (125%Q_{max} /s)	1,6 s ($+Q_{max} \rightarrow -Q_{max}$)
	t < 60 s (1,660%Q_{max}/s)	118,0 s ($+Q_{max} \rightarrow -Q_{max}$)
SUN2000-185KTL-H1		
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☐ Power factor / *Verschiebungsfaktor*	☒ Reactive power / *Blindleistung*
	P_{bin} at / *bei* Q_{max}	50%P_n
Longest settling time / *Längste Einschwingzeit*	Parameter	Settling time / *Einschwingzeit*
	Standard time / *Standardzeit* (125%Q_{max} /s)	1,8 s ($+Q_{max} \rightarrow -Q_{max}$)
	t < 60 s (1,660%Q_{max}/s)	117,4 s ($+Q_{max} \rightarrow -Q_{max}$)
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☒ Power factor / *Verschiebungsfaktor* [1)]	☐ Reactive power / *Blindleistung*
	P_{bin} at / *bei* Q_{max}	50%P_n
Longest settling time / *Längste Einschwingzeit*	Parameter	Settling time / *Einschwingzeit*
	Fast settling time / *Schnelle Einschwingzeit* (3τ = 5 s)	6,2 s ($+Q_{max} \rightarrow -Q_{max}$)
	t < 60 s (3τ = 60 s)	73,2 s ($+Q_{max} \rightarrow -Q_{max}$)
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☐ Power factor / *Verschiebungsfaktor*	☒ Reactive power / *Blindleistung*
	P_{bin} at / *bei* Q_{max}	50%P_n
Set-point accuracy of reative power / *Einstellgenauigkeit der Blindleistung*	Set-point / *Sollwert*	Measured value / *Istwert*
	-55,50 kvar	-56,36 kvar
	0,00 kvar	-1,68 kvar
	55,50 kvar	54,91 kvar

3. Annex 3 – Extract from the test report

Extract from the test report - Part 2: grid control capability

4.2 Reactive power provision / *Blindleistungsbereitstellung*		
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☐ Power factor / *Verschiebungsfaktor*	☒ Reactive power / *Blindleistung*
	P_{bln} at / *bei* Q_{max}	100%P_n
Set-point accuracy of reative power / *Einstellgenauigkeit der Blindleistung*	Set-point / *Sollwert*	Measured value / *Istwert*
	-55,50 kvar	-56,03 kvar
	0,00 kvar	-1,45 kvar
	55,50 kvar	55,82 kvar
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☒ Power factor / *Verschiebungsfaktor*	☐ Reactive power / *Blindleistung*
	P_{bln} at / *bei* Q_{max}	50%P_n
Set-point accuracy of power factor / *Einstellgenauigkeit des Verschiebungsfaktors*	Set-point / *Sollwert*	Measured value / *Istwert*
	0,845 (ind.)	0,845 (ind.)
	1,000	1,000
	0,845 (cap.)	0,845 (cap.)
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☒ Power factor / *Verschiebungsfaktor*	☐ Reactive power / *Blindleistung*
	P_{bln} at / *bei* Q_{max}	100%P_n
Set-point accuracy of power factor / *Einstellgenauigkeit des Verschiebungsfaktors*	Set-point / *Sollwert*	Measured value / *Istwert*
	0,800 (ind.)	0,800 (ind.)
	1,000	1,000
	0,800 (cap.)	0,799 (cap.)
SUN2000-215KTL-H3		
Control of reactive power through set-point signal / *Blindleistungsregelung durch Sollwertvorgabe*	☐ Power factor / *Verschiebungsfaktor*	☒ Reactive power / *Blindleistung*
	P_{bln} at / *bei* Q_{max}	50%P_n
Longest settling time / *Längste Einschwingzeit*	Parameter	Settling time / *Einschwingzeit*
	Fast settling time / *Schnelle Einschwingzeit* (1000%Q_{max} /s)	0,55 s (+Q_{max} → -Q_{max})
	Standard time / *Standardzeit* (125%Q_{max} /s)	1,55 s (+Q_{max} → -Q_{max})
	t < 60 s (1,660%Q_{max}/s)	116,2 s (+Q_{max} → -Q_{max})

3. Annex 3 – Extract from the test report

4.2 Reactive power provision / *Blindleistungsbereitstellung*

Note / *Anmerkung:*

$Q_{max} = 0{,}6 \cdot S_{max} = 0{,}6 \cdot P_{max}$.

The reactive power gradient $\%Q_{max}/s$ means $\%(0{,}6 \cdot S_{max})/s$. /
Der Blindleistungsgradient $\%Q_{max}/s$ bedeutet $\%(0{,}6 \cdot S_{max})/s$.

The Q setpoint control function does not provide PT1 (1st order lowpass) filtering effect. The settling time was determined using a tolerance band of $\pm 5\%P_n$.
For country code setting VDE-AR-N 4110:2018-11, the cosφ control function shows PT1 behaviour. The settling time was determined using a tolerance band of $\pm 2\%P_n$. /
Die Q-Sollwertvorgabe bietet keinen PT1-Filtereffekt, die Blindleistungsänderung erfolgt mit dem vordefinierten Gradient. Die Einschwingzeit wurde mit einem Toleranzband von $\pm 5\%P_n$ bestimmt.
Für Ländereinstellung VDE-AR-N 4110:2018-11 zeigt die cosφ Regelungsfunktion PT1 Verhalten. Die Einschwingzeit wurde mit einem Toleranzband von $\pm 2\%P_n$ bestimmt.

Note / *Anmerkung:*

The reactive power results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1*, *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* scaled (by the factor $P_{max,\ notmeasure} / P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$).

The displacement factor results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1*, *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly.

The settling time results (using cosφ setpoint control) of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1*, *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly.

The settling time results of the *SUN2000-215KTL-H3* can be applied to the *SUN2000-215KTL-H0* directly. /

Die Blindleistungsergebnisse des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *relativ (über den Faktor $P_{max,notmeasure} / P_{max,\ SUN2000\text{-}185KTL\text{-}H1}$) übertragen werden.*

Die Verschiebungsfaktorsergebnisse des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*

Die Einschwingzeitsergebnisse (mittels cosφ-Sollwertvorgabe) des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werde.*

Die Einschwingzeitsergebnisse des SUN2000-215KTL-H3 *können auf den* SUN2000-215KTL-H0 *direkt übertragen werde.*

3. Annex 3 – Extract from the test report

Extract from the test report - Part 2: grid control capability

4.2 Reactive power provision / *Blindleistungsbereitstellung*	
4.2.5 Q(U) control / *Q(U) Regelung*	
4.2.6 Q(P) control / *Q(P) Regelung*	
4.2.7 Reactive power Q with voltage limitation function / *Blindleistung Q mit Spannungsbegrenzungsfunktion*	
Remark / *Anmerkung:*	The Q(U), Q(P) and reactive power Q with voltage limitation function were tested, please see test report. / *Die Q(U)-, Q(P)-Regelung und Blindleistung Q mit Spannungsbegrenzungsfunktion wurden geprüft, diese sind im Prüfbericht hinterlegt.*

Figure 15 – Results of reactive power control from [11]

3. Annex 3 – Extract from the test report

Description of methods for the reactive power supply [7]:

4.2 REACTIVE POWER PROVISION

Description of methods for the reactive power supply:

The control of the reactive power on the lowest level of the controller is realized by Q-regulation.

The *SUN2000-168KTL-H1*, *SUN2000-185KTL-H1*, *SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* provide setting of the reactive power by:

a) Settable Q-parameter (range: +/- 60%P_{max}) [1]
b) Settable cosφ-set-parameter (range: +/- 0,8)) [1]
c) Configurable Q(U)-characteristic line (No. of supporting points: 10) [1], [2]
d) Configurable Q(P)-characteristic line (No. of supporting points: 10) [1]

Note:

[1]
- For country code setting VDE-AR-N 4110:2018-11:
  for all abrupt set-point changes, the reactive power control methods b), c) and d) (see above) provide PT1 (1st order lowpass) filtering effect.
- For country code setting VDE-AR-N 4120:2018-11:
  for all abrupt set-point changes, the reactive power control methods c) (see above) provides PT1 (1st order lowpass) filtering effect.

[2] The PGUs in the series provide only one kind of Q(U) control function (methods c), see above), the Q(U)-characteristic line is free programmable using up to 10 supporting points.

The provided Q(U) control function was used both for test *4.2.5 Q(U) control* and *4.2.7 Reactive power Q with voltage limitation function*.

But please note that the implementation may deviate to requirement of VDE-AR-N 4110:2018-11. This needs to be considered for project planning. If needed, this has to be implemented on the plant level e.g. in the superimposed PGS controller.

Note (*Manufacturer's data*)

The interface (RS485) and corresponding software tool (*Data Collector Web*) is available for setting / controlling active and reactive power.

Description of the reactive power provision within the voltage corridor (*Manufacturer's data*)

The reactive power is prioritised versus the active power.

A maximum reactive power provision of 60%S_{max} (using Q set-point) or cosφ = 0,8 (using cosφ set-point) is possible.

At overvoltage the apparent / active power threshold limits the injected power. At undervoltage the apparent current limitation will also contribute.

The continuous provision is possible within the voltage corridor 80%U_n through 120%U_n and the frequency range between 47,5 and 52,0 Hz

A permanent active power reduction can be applied by setting parameters *Plimilt* and *Pmaxref* (the following applies: *Plimilt* ≤ *Pmaxref* ≤ *Pmax*. Default: *Plimilt* = *Pmaxref* = *Pmax*. See parameters no. 6 / 7 / 8 in Annex 4). The value of *Plimilt* will then be the new active power limitation which will not be exceeded during operation of the PGU, while *Pmaxref* will be the new reference for the P set-point control. Any signal for a setpoint of 100%*Pmaxref*, by the ripple control receiver or other P-parameter setpoint, causes the PGU to inject the new lower P_{max}-value (active power higher than new lower P_{max}-value will never be injected). The reference power for percentage or p.u. in this limited mode is the new lower *Pmaxref*-value.

The power control is therefore based on the following values:

PGU	Apparent current limit [A]	Active / Apparent power limit [kW / kVA]
SUN2000-168KTL-H1	122,5	168 [3] / 168
SUN2000-185KTL-H1	134,9	185 [3] / 185
SUN2000-215KTL-H0	155,2	215 [3] / 215
SUN2000-215KTL-H3		

The resulting voltage dependent PQ operating points can be found in manufacturer's declaration document *F.4_Huawei_SUN2000-215KTL Series_Declaration of manufacturer_V2* (see Annex 5)

3. Annex 3 – Extract from the test report

4.2 REACTIVE POWER PROVISION

Note:

3) The table above and diagrams in *Annex 5* show the default PQ-mode of the units - parameter *Plimit* (parameter No.7 in *Annex 4 – Parameter list*) set to default (=*Pmax*), in this case the reactive power supply at full load ($P = P_{max} = S_{max}$) is zero (power factor = 1).

In other PQ-mode with reduced output active power – e.g. *Plimit* set to P_n (nominal active power defined by manufacturer), in this case the units can provie a reactive power supply corresponding to

- cosφ = 0,893 (*SUN2000-168KTL-H1*)
- cosφ = 0,946 (*SUN2000-185KTL-H1*)
- cosφ = 0,930 (*SUN2000-215KTL-H0, SUN2000-215KTL-H3*)

at full load operation at $U = U_n$,

or a reactive power supply corresponding to

- cosφ = 0,982 (*SUN2000-168KTL-H1*)
- cosφ = 1,000 (*SUN2000-185KTL-H1*, P_{max} = 168,2 kW at defined operating condition)
- cosφ = 1,000 (*SUN2000-215KTL-H0, SUN2000-215KTL-H3*, P_{max} = 193,5 kW at defined operating condition)

at full load operation at $U = 0,9 \cdot U_n$.

In the PQ-mode with reduced output active power by setting *Plimit* = P_n the power control is therefore based on the following values:

PGU	Apparent current limit [A]	Active / Apparent power limit [kW / kVA]
SUN2000-168KTL-H1	122,5	150 3) / 168
SUN2000-185KTL-H1	134,9	175 3) / 185
SUN2000-215KTL-H0	155,2	200 3) / 215
SUN2000-215KTL-H3		

The resulting voltage dependent PQ operating points can be found in manufacturer's declaration document *F.4_Huawei_SUN2000-215KTL Series_Declaration of manufacturer_V2* (see Annex 5) with additional active power limitation to P_n (see Figure 9).

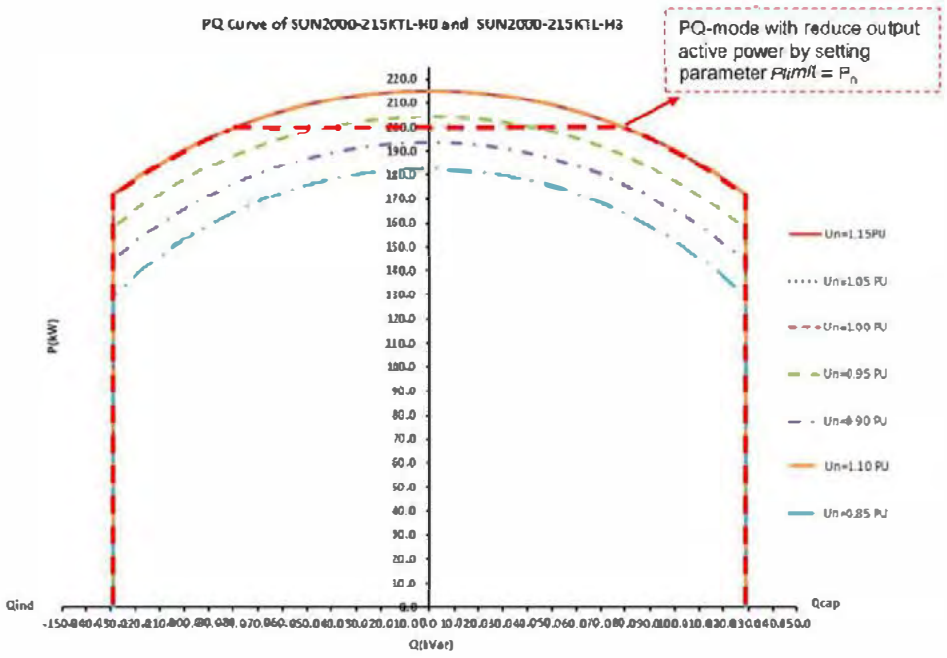

Figure 9 – Example for PQ-mode with reduced output active power

3. Annex 3 – Extract from the test report

Note to control functions for reactive power supply implemented on the PGU level ([9]):

- The on the PGU level implemented reactive power set point changes (parameter No. 30 in parameter list, see Annex 5) does not provide PT1 filtering effect.
- The on the PGU level implemented Q(U) control function deviates from requirements according to [1]. This needs to be considered for project planning.
- The PGUs in the series provide only one kind of Q(U) control function. The on the PGU level implanted Q(U) control function can be used as *reactive power with voltage limitation function* by suitable setting of the characteristic curve. But this also deviates from requirements according to [1].

These need to be considered for project planning. If needed, these have to be implemented on the plant level e.g. in the superimposed PGS controller.

3. Annex 3 – Extract from the test report

The resulting voltage dependent PQ operating points as follows [15]:

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Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11
Datum / *Date*: 2021-05-19

Anhang 4 / *Annex 4*:

Operating points in the voltage dependent PQ diagram:

SUN2000-168KTL-H1		
Un=1.0 / 1.05 / 1.1 / 1.15 p.u.		
P (kW)	Q (kvar)	
168	0	0
149.70	96.30	-96.30
135.00	100.00	-100.00
120.00	100.80	-100.80
105.00	100.80	-100.80
90.00	100.80	-100.80
75.00	100.80	-100.80
60.00	100.80	-100.80
45.00	100.80	-100.80
30.00	100.80	-100.80
15.00	100.80	-100.80
0.00	100.80	-100.80
Un=0.95 PU		
P (kW)	Q (kvar)	
161.2	0	0
150.50	57.80	-57.80
135.20	87.80	-87.80
120.00	100.80	-100.80
105.00	100.80	-100.80
90.00	100.80	-100.80
75.00	100.80	-100.80
60.00	100.80	-100.80
45.00	100.80	-100.80
30.00	100.80	-100.80
15.00	100.80	-100.80
0.00	100.80	-100.80
Un=0.9 PU		
P (kW)	Q (kvar)	
152.8	0	0
150.50	29.10	-29.10
135.20	71.70	-71.70
120.00	100.80	-100.80
105.00	100.80	-100.80
90.00	100.80	-100.80
75.00	100.80	-100.80
60.00	100.80	-100.80

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Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

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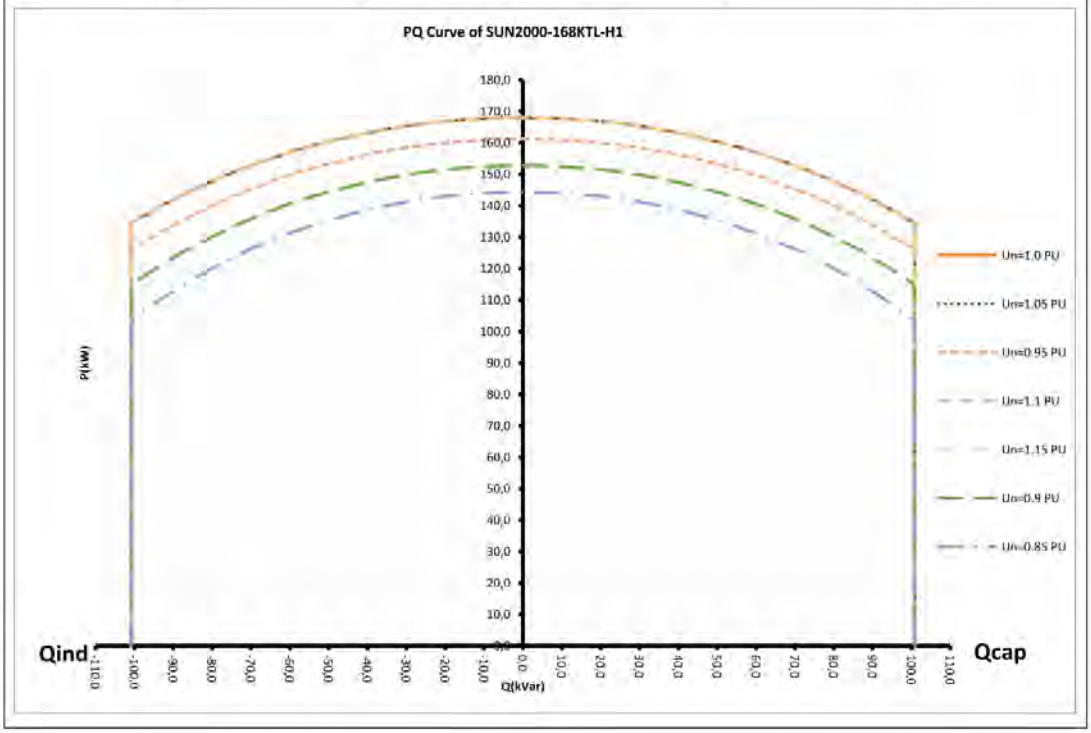
45.00	100.80	-100.80
30.00	100.80	-100.80
15.00	100.80	-100.80
0.00	100.80	-100.80
Un=0.85 PU		
P (kW)	Q (kvar)	
144.3	0.00	0.00
134.70	51.70	-51.70
119.60	80.70	-80.70
105.50	98.40	-98.40
90.00	100.80	-100.80
75.00	100.80	-100.80
60.00	100.80	-100.80
45.00	100.80	-100.80
30.00	100.80	-100.80
15.00	100.80	-100.80
0.00	100.80	-100.80



3. Annex 3 – Extract from the test report

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

SUN2000-185KTL-H1 / SUN2000-185KTL-INH0		
Un=1.0 / 1.05 / 1.1 / 1.15 p.u.		
P (kW)	Q (kvar)	
185	0	0
175.75	57.77	-57.77
157.25	97.45	-97.45
148.00	111.00	-111.00
140.00	111.00	-111.00
122.50	111.00	-111.00
105.00	111.00	-111.00
87.50	111.00	-111.00
70.00	111.00	-111.00
52.50	111.00	-111.00
35.00	111.00	-111.00
17.50	111.00	-111.00
0.00	111.00	-111.00
Un=0.95 PU		
P (kW)	Q (kvar)	
177.6	0	0
174.90	57.80	-57.80
156.80	83.40	-83.40
148.90	96.70	-96.70
139.90	109.30	-109.30
122.50	111.00	-111.00
105.00	111.00	-111.00
87.50	111.00	-111.00
70.00	111.00	-111.00
52.50	111.00	-111.00
35.00	111.00	-111.00
17.50	111.00	-111.00
0.00	111.00	-111.00
Un=0.9 PU		
P (kW)	Q (kvar)	
-	-	-
168.2	0.00	0.00
157.10	60.30	-60.30
148.50	79.00	-79.00
139.50	94.10	-94.10
122.50	111.00	-111.00
105.00	111.00	-111.00
87.50	111.00	-111.00

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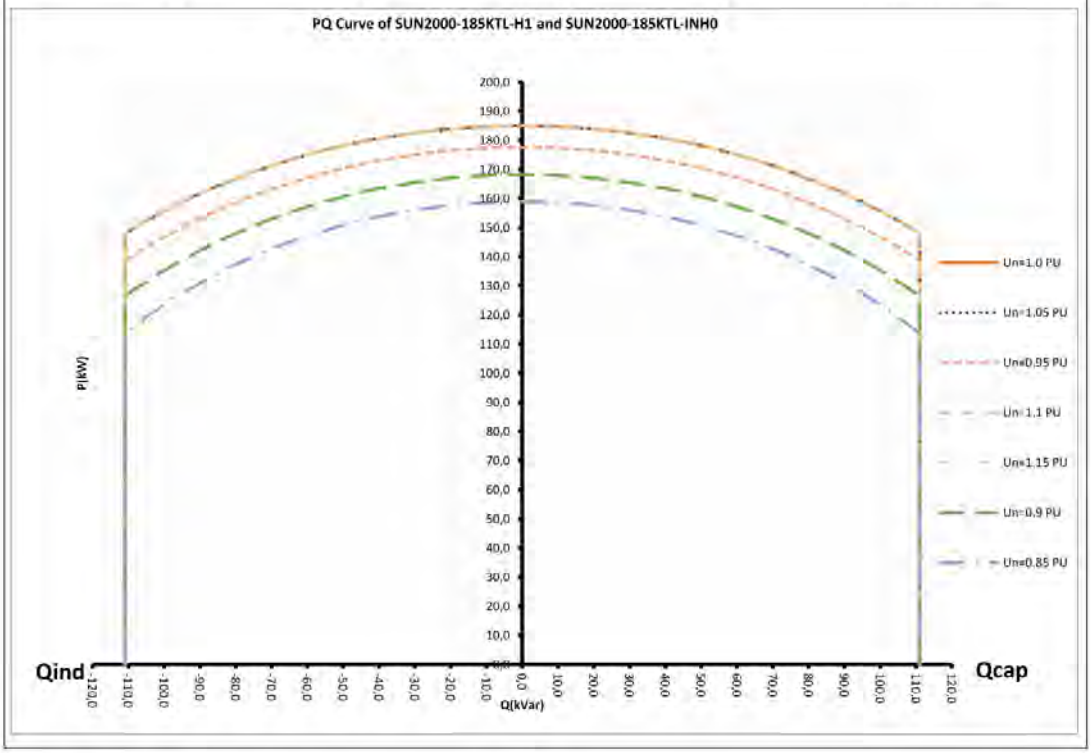
Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

70.00	111.00	-111.00
52.50	111.00	-111.00
35.00	111.00	-111.00
17.50	111.00	-111.00
0.00	111.00	-111.00
Un=0.85 PU		
P (kW)	Q (kvar)	
-	-	-
158.9	0.00	0.00
156.90	24.90	-24.90
148.30	56.90	-56.90
140.30	74.60	-74.60
121.70	102.10	-102.10
105.00	111.00	-111.00
87.50	111.00	-111.00
70.00	111.00	-111.00
52.50	111.00	-111.00
35.00	111.00	-111.00
17.50	111.00	-111.00
0.00	111.00	-111.00



3. Annex 3 – Extract from the test report

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

SUN2000-215KTL-H0 / SUN2000-215KTL-H3		
U_n = 1.00 / 1.05 / 1.10 / 1.15 p.u.		
P (kW)	Q (kvar)	
215	0.00	0.00
200	78.90	-78.90
180	117.58	-117.58
160	129.00	-129.00
140	129.00	-129.00
120	129.00	-129.00
100	129.00	-129.00
80	129.00	-129.00
60	129.00	-129.00
40	129.00	-129.00
20	129.00	-129.00
0	129.00	-129.00
U_n = 0.95 p.u.		
P (kW)	Q (kvar)	
204.3	0	0.00
200	41.70	-41.70
180	96.64	-96.64
160	127.04	-127.04
140	129.00	-129.00
120	129.00	-129.00
100	129.00	-129.00
80	129.00	-129.00
60	129.00	-129.00
40	129.00	-129.00
20	129.00	-129.00
0	129.00	-129.00
U_n = 0.90 p.u.		
P (kW)	Q (kvar)	
193.5	0.00	0.00
180	71.01	-71.01
160	108.82	-108.82
140	129.00	-129.00
120	129.00	-129.00
100	129.00	-129.00
80	129.00	-129.00
60	129.00	-129.00
40	129.00	129.00
20	129.00	129.00
0	129.00	-129.00

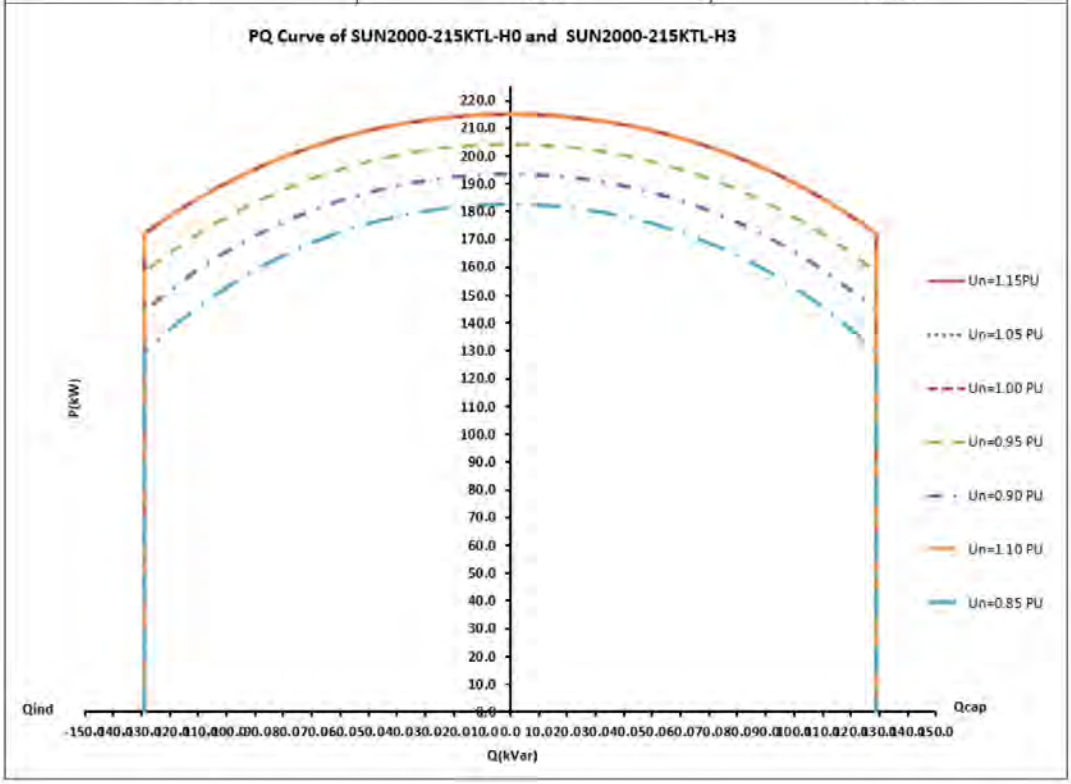
3. Annex 3 – Extract from the test report

Herstellererklärung zur Einhaltung der technischen Anforderungen der VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Manufacturer's declaration for compliance to technical requirements of the VDE-AR-N 4110:2018-11 / VDE-AR-N 4120:2018-11

Datum / *Date*: 2021-05-19

U_n = 0.85 p.u.		
P (kW)	Q (kvar)	
182.8	0.00	-0.00
180	31.87	-31.87
160	88.41	-88.41
140	117.54	-117.54
120	129.00	-129.00
100	129.00	129.00
80	129.00	-129.00
60	129.00	-129.00
40	129.00	-129.00
20	129.00	-129.00
0	129.00	129.00



F.4 BUREAU VERITAS CPS Germany – Manufacturer declaration / V01 09/19
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Figure 16 – Voltage dependent PQ operating points from [15]

3. Annex 3 – Extract from the test report

3.4. Protection system (on PGU level)

The following tests were carried out on the PGU integrated protection relay and the generating unit switch, the possible parameter setting of the PGU integrated protection relay is documented in [14], see *Annex 5 – Certification-relevant parameters*:

Extract from the test report - Part 3: Protection system

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4.4 PGU DISCONNECTION FROM THE GRID / *PGU DISCONNECTION FROM THE GRID*

SUN2000-185KTL-H1

☒ The test of the whole trip circuit led to a successful shut down. / *Die Prüfung der Gesamtwirkungskette führte zu einer erfolgreichen Abschaltung.*

	Setting / *Einstellwert* [p.u. U_n] / [Hz]	[ms]	Release value / *Auslösewert* [p.u. U_n] / [Hz]		Disconnection time / *Abschaltzeit* [ms]		Resetting ratio / *Rückfallverhältnis*	
	Value / *Schwelle*	Time / *Zeit*	min.	max.	min.	max.		
Overvoltage protection / *Spannungssteigerungsschutz*: U>	1,000	100000	0,998	1,000	100024	100027	☒	≥ 0,98
	1,250	50	1,249	1,250	79,0	87,8	☐	< 0,98
Overvoltage protection / *Spannungssteigerungsschutz*: U>>	1,000	100000	0,993	1,003	100019	100040		----
	1,300	50	1,299	1,299	72,5	79,5		----
Undervoltage protection / *Spannungsrückgangsschutz*: U< [2)]	0,150	50	0,148	0,149	71,4	94,9	☒	≤ 1,02
	1,000	100000	0,998	1,000	100025	100028	☐	> 1,02
Undervoltage protection / *Spannungsrückgangsschutz*: U<< [2)]	0,150	50	0,148	0,149	82,3	94,2		----
	1,000	100000	0,997	1,000	100022	100042		----
Overfrequncy protection / *Frequenzsteigerungsschutz*: f>	50,00	100000	50,00		100047			----
	57,50	50	57,50		85			----
Overfrequncy protection / *Frequenzsteigerungsschutz*: f>>	50,00	100000	49,99		100045			----
	57,50	50	57,49		92,8			----
Underfrequncy protection / *Frequenzrückgangsschutz*: f<	42,50	50	42,50		90,4			----
	50,00	100000	50,00		100045			----
Underfrequncy protection / *Frequenzrückgangsschutz*: f<<	42,50	50	42,50		83,5			----
	50,00	100000	50,00		100030			----

Operating time of circuit breaker / *Eigenzeit der Abschalteinheit* [ms] (Manufacturer's data / *Herstellerdaten*)	≤ 30	☒	by measurement / *aus Messung*	☐	by test certificate / *aus Prüfzertifikat*	☒ from manufacturer specification / *aus Herstellerangabe*

3. Annex 3 – Extract from the test report

4.4 PGU DISCONNECTION FROM THE GRID / *PGU DISCONNECTION FROM THE GRID*

Note / *Anmerkung*:

The following minimum / maximum threshold / trigger time were used for the testing /
Für die Prüfungen wurde die folgende minimale / maximale Schwelle / Auslösezeit verwendet:

	Trigger values / times			
	min. threshold	max. threshold	min. delay [2]	max. delay [3]
Overvoltage [U>]	1,00·U_n	1,25·U_n [4]	50 ms	100000 ms
Overvoltage [U>>]	1,00·U_n	1,30·U_n	50 ms	100000 ms
Undervoltage [U<]	0,15·U_n [1]	1,00·U_n	50 ms	100000 ms
undervoltage [U<<]	0,15·U_n [1]	1,00·U_n	50 ms	100000 ms
Overfrequency [f>]	50,0 Hz	57,5 Hz	50 ms	100000 ms
Overfrequency [f>>]	50,0 Hz	57,5 Hz	50 ms	100000 ms
Underfrequency [f<]	42,5 Hz	50,0 Hz	50 ms	100000 ms
Underfrequency [f<<]	42,5 Hz	50,0 Hz	50 ms	100000 ms

[1] The min. settable threshold of the undervoltage protection is 0,15·U_n. /
Die min. einstellbare Schwelle des Unterspannungsschutzes ist 0,15·U_n.

[2] The min. settable trigger time of the voltage / frequency protection is 50 ms /
Die min. einstellbare Auslösezeit des Spannungs- / Frequenzschutzes ist 50 ms.

[3] The trip time range is settable between 0 and 7200 s, during the test the max. delay was limited to 100 s, according to manufacture, this has no influence on the evaluation algorithm of the grid monitoring. /
Der Einstellbereich der Frequenz-und Spannungsüberwachung liegt zwsischen 0 und 7200 s. Bei der Prüfung wurde die max. Verzögerung auf 100 s begrenzt. (Herstellerklärung) Dies hat keinen Einfluss auf das Auswertungsverfahren der Frequenz-und Spannungsüberwachung.

[4] The max. settable threshold of the 1st level overvoltage protection is 1,25·U_n. /
Die max. einstellbare Schwelle des 1-Level-Überspannungsschutzes ist 1,25·U_n.

Note / *Anmerkung*:

The results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1, SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly. /
Die Ergbenisse des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*

3. Annex 3 – Extract from the test report

4.5 VERIFICATION OF CONNECTION CONDITIONS / *NACHWEIS DER ZUSCHALTBEDINGUNGEN*

4.5.1 Connection without previous protection trigger / *Zuschalten ohne vorherige Schutzauslösung*

SUN2000-185KTL-H1			
Parameterization according to / *Parametrierung entsprechend*: *VDE-AR-N 4110:2018-11*			
	Range / Bereich [p.u. U_n] / [Hz]	Cut in occured within the given range / *Zuschaltung erfolgte im angegebenen Bereich*	
Voltage / *Spannung*:	0,90 – 1,10	☒ Yes / *Ja*	☐ No / *Nein*
Frequency / *Frequenz*:	47,5 – 50,2	☒ Yes / *Ja*	☐ No / *Nein*
Parameterization according to / *Parametrierung entsprechend*: *VDE-AR-N 4120:2018-11*			
	Range / Bereich [p.u. U_n] / [Hz]	Cut in occured within the given range / *Zuschaltung erfolgte im angegebenen Bereich*	
Voltage / *Spannung*:	0,90 – 1,10	☒ Yes / *Ja*	☐ No / *Nein*
Frequency / *Frequenz*:	47,5 – 51,0	☒ Yes / *Ja*	☐ No / *Nein*

4.5.2 Connection after triggering of the decoupling protection / *Zuschalten nach Auslösung der Entkupplungsschutzes*

SUN2000-185KTL-H1			
	Range / Bereich [p.u. U_n] / [Hz]	Cut in occured within the given range / *Zuschaltung erfolgte im angegebenen Bereich*	
Undervoltage / Unterspannung:	< 0,95	☐ Yes / *Ja*	☒ No / *Nein*
Underfrequency / Unterfrequenz:	≤ 49,9	☐ Yes / *Ja*	☒ No / *Nein*
Overfrequency / Überfrequenz:	≥ 50,1	☐ Yes / *Ja*	☒ No / *Nein*

Note / *Anmerkung*:
The results of the *SUN2000-185KTL-H1* can be applied to the *SUN2000-168KTL-H1, SUN2000-215KTL-H0* and *SUN2000-215KTL-H3* directly. /
Die Ergbenisse des SUN2000-185KTL-H1 *können auf den* SUN2000-168KTL-H1, SUN2000-215KTL-H0 *und* SUN2000-215KTL-H3 *direkt übertragen werden.*

Figure 17 – Results of grid protection from [12]

3. Annex 3 – Extract from the test report

Note (*manufacturer's data*):

The function of the integrated grid monitoring and disconnection is independent from other parameters and functions.

The grid monitoring functions can be maintained for at least 5 s during grid voltage loss.

The loss of power supply for the grid monitoring results in a non-delayed triggered disconnection.

The generating units monitor the phase-to-phase voltages.

The three phase-to-phase voltages are logical OR connected to trigger the operation of the separation device.

An external monitoring relay can trigger the power generating unit's integrated breakers (by digital input).

Description of the interface for on-site testing

The PGU does not provide test terminals for on-site testing. For necessary on-site testing, an external monitoring relay with corresponding test terminals must be installed and the PGU's monitoring parameters must be set accordingly. The integrated grid monitoring/protection parameters can be checked via remote control (Smartlogger / App).

3. Annex 3 – Extract from the test report

3.5. Self-protection

According to [14] if the connection voltage exceeds $1{,}35 \cdot U_n$ (line-to-line peak value) will lead to a non-delayed self-protection tripping.

3. Annex 3 – Extract from the test report

3.6. Quasi-static operation

Manufacturer's data from [7]

The unit can be continuously operated within the voltage / frequency range of 80%U_n and 120%U_n / 47.5 Hz and 52 Hz. The operating range of voltage and frequency can also be limited using the protection functions.

(*Manufacturer's data*) [15]

The required quasi-steady-state operation in the frequency and voltage range according to VDE-AR-N 4120:2018-11 [2] is possible.

3. Annex 3 – Extract from the test report

3.7. Fault ride through capability

Within the adjustable parameter ranges of the grid monitoring the PGU can ride through the symmetrical and asymmetrical faults according to the Fault Ride-Through (FRT) limit curve for a Type 2 power generating plant specified in [2].

Additionally, a fault ride-through tripping curve function is implemented in the unit (parameter No. 91 - 101, see Annex 5). This function defines a curve exceeding which for 500 ms the unit disconnects from the grid. The priority of the protection can be switched between grid protection parameter function and ride-through tripping curve function via parameter "*Grid voltage protection shield during HVRT/LVRT*" (parameter No. 88, see Annex 5. Disable: high priority of grid protection function; Enable: high priority of ride-through tripping curve function).

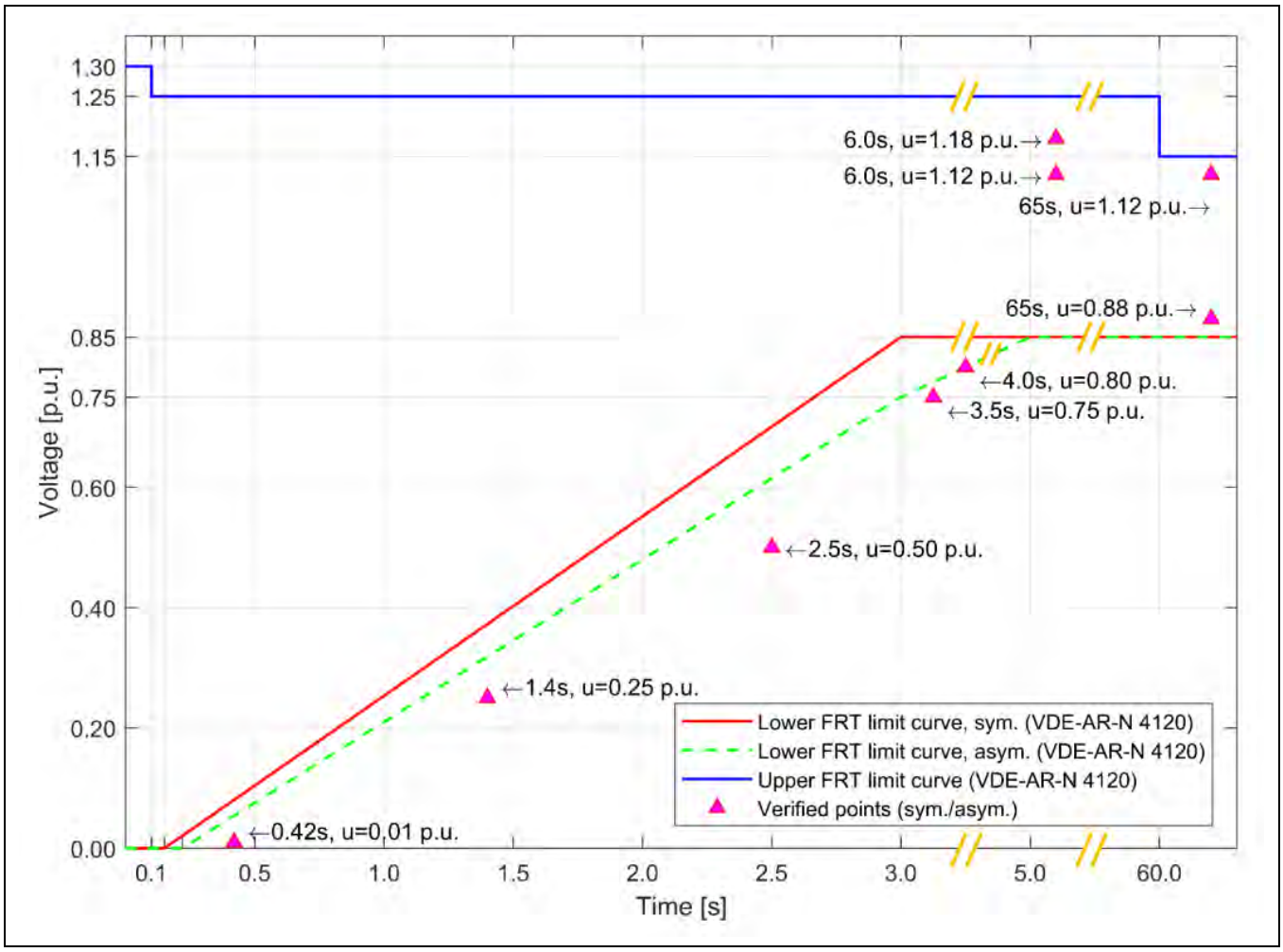


Figure 18 – Verified Fault Ride-Through (FRT) limit curve from [7]

3. Annex 3 – Extract from the test report

3.8. Short-circuit current contributions

In the following the test results from [7] are summarized:

SUN2000-168KTL-H1

No. / *Nr.*	Test no. [1] / *Test Nr.* [1]	Short-circuit currents, peak value (max. of L1, L2, L3) [A] / *Kurzschlussströme Scheitelwerte (max. von L1, L2, L3) [A]*	*Short-circuit currents, 1-period RMS value (max. of L1, L2, L3) [p.u. based In] /* t1 + 20ms	t1 + 100ms	t1 + 150ms	t1 + 300ms	t1 + 500ms	t1 + 1000ms
1	0.1	179,7	0,932	1,030	1,030	1,028	0,233	1,001
2	0.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
3	0.3	208,7	0,933	1,029	1,031	1,028	0,214	0,999
4	0.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
5	25.1	159,3	0,963	1,031	1,032	1,033	1,033	1,032
6	25.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
7	25.4	174,0	0,875	1,025	1,028	1,026	1,026	1,025
8	25.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
9	50.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
10	50.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
11	50.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
12	50.3	195,0	0,936	1,004	1,007	1,013	1,012	1,018
13	50.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
14	50.6	[2]	[2]	[2]	[2]	[2]	[2]	[2]
15	75.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
16	75.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
17	75.3	166,3	0,999	1,035	1,036	1,035	1,034	1,035
18	75.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
19	75.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
20	75.6	[2]	[2]	[2]	[2]	[2]	[2]	[2]
21	75.7	[2]	[2]	[2]	[2]	[2]	[2]	[2]
22	75.8	144,0	0,630	0,906	0,916	0,939	0,982	0,980
23	80.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
24	80.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
25	85.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
26	110.1	147,0	0,958	0,958	0,959	0,959	0,957	0,954
27	110.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
28	110.3	60,0	0,309	0,288	0,281	0,285	0,301	0,306
29	115.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
30	115.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]

Note: / Anmerkung:

[1] Test no. defined according to [3]. / *Test Nr. definiert entspricht [3].*

[2] Due to spot testing the tests marked were not conducted. / Die markierten Tests wurden im Rahmen der Stichprobenvermessung nicht durchgeführt..

3. Annex 3 – Extract from the test report

SUN2000-185KTL-H1

No. / *Nr.*	Test no. [1] / *Test Nr.* [1]	Short-circuit currents, peak value (max. of L1, L2, L3) [A] / *Kurzschlussströme Scheitelwerte (max. von L1, L2, L3) [A]*	*Short-circuit currents, 1-period RMS value (max. of L1, L2, L3) [p.u. based In] /*					
			t1 + 20ms	t1 + 100ms	t1 + 150ms	t1 + 300ms	t1 + 500ms	t1 + 1000ms
1	0.1	191,3	0,903	1,027	1,028	1,026	0,239	1,001
2	0.2	192,0	0,806	1,028	1,028	1,028	0,170	0,203
3	0.3	231,3	0,937	1,029	1,031	1,030	0,221	1,000
4	0.4	190,7	0,779	1,031	1,031	1,030	0,186	0,202
5	25.1	188,0	0,994	1,025	1,025	1,026	1,025	1,028
6	25.2	181,7	0,751	1,027	1,027	1,027	1,025	1,028
7	25.4	166,7	0,610	1,024	1,026	1,027	1,025	1,025
8	25.5	202,0	0,778	1,025	1,026	1,026	1,027	1,025
9	50.1	181,7	0,977	1,029	1,028	1,032	1,032	1,031
10	50.2	183,7	0,782	1,030	1,030	1,030	1,031	1,030
11	50.3	224,7	0,920	1,001	1,003	1,006	1,006	1,004
12	50.4	188,0	0,738	0,989	0,990	0,992	1,010	1,010
13	50.5	63,0	0,209	0,063	0,063	0,062	0,062	0,061
14	50.6	81,7	0,241	0,056	0,055	0,054	0,055	0,054
15	75.1	186,7	1,012	0,982	0,983	0,984	0,985	0,988
16	75.2	94,7	0,371	0,532	0,531	0,549	0,562	0,574
17	75.3	194,0	1,008	1,030	1,030	1,029	1,033	1,032
18	75.4	119,3	0,360	0,317	0,316	0,309	0,295	0,292
19	75.5	169,0	0,660	0,895	0,895	0,953	0,998	1,010
20	75.6	168,7	0,932	0,940	0,941	0,941	0,942	0,941
21	75.7	95,0	0,498	0,505	0,505	0,513	0,533	0,540
22	75.8	172,3	0,847	0,897	0,898	0,942	0,958	0,961
23	80.1	181,3	1,003	0,977	0,977	0,980	0,980	0,983
24	80.2	171,0	0,931	0,953	0,955	0,957	0,957	0,957
25	85.1	60,3	0,323	0,313	0,313	0,322	0,327	0,336
26	110.1	172,3	0,956	0,957	0,956	0,956	0,954	0,949
27	110.2	63,7	0,296	0,302	0,305	0,305	0,309	0,319
28	110.3	62,7	0,302	0,281	0,278	0,284	0,293	0,306
29	115.1	154,0	0,666	0,930	0,927	0,921	0,924	0,924
30	115.2	71,7	0,338	0,375	0,377	0,377	0,397	0,406

Note: / Anmerkung:

[1] Test no. defined according to [3]. / *Test Nr. definiert entspricht [3].*

3. Annex 3 – Extract from the test report

SUN2000-215KTL-H3

No. / Nr.	Test no. [1] / Test Nr. [1]	Short-circuit currents, peak value (max. of L1, L2, L3) [A] / Kurzschlussströme Scheitelwerte (max. von L1, L2, L3) [A]	Short-circuit currents, 1-period RMS value (max. of L1, L2, L3) [p.u. based In] /					
			t1 + 20ms	t1 + 100ms	t1 + 150ms	t1 + 300ms	t1 + 500ms	t1 + 1000ms
1	0.1	217,3	0,868	0,958	0,957	0,952	0,364	0,996
2	0.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
3	0.3	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4	0.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
5	25.1	202,0	0,886	0,976	0,968	0,963	0,963	0,962
6	25.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
7	25.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
8	25.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
9	50.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
10	50.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
11	50.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
12	50.3	[2]	[2]	[2]	[2]	[2]	[2]	[2]
13	50.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
14	50.6	[2]	[2]	[2]	[2]	[2]	[2]	[2]
15	75.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
16	75.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
17	75.3	142,7	0,352	0,312	0,309	0,301	0,298	0,296
18	75.4	[2]	[2]	[2]	[2]	[2]	[2]	[2]
19	75.5	[2]	[2]	[2]	[2]	[2]	[2]	[2]
20	75.6	[2]	[2]	[2]	[2]	[2]	[2]	[2]
21	75.7	[2]	[2]	[2]	[2]	[2]	[2]	[2]
22	75.8	193,3	0,851	0,881	0,883	0,895	0,963	0,966
23	80.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
24	80.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
25	85.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
26	110.1	[2]	[2]	[2]	[2]	[2]	[2]	[2]
27	110.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]
28	110.3	[2]	[2]	[2]	[2]	[2]	[2]	[2]
29	115.1	188,7	0,750	0,871	0,868	0,856	0,853	0,850
30	115.2	[2]	[2]	[2]	[2]	[2]	[2]	[2]

Note: / Anmerkung:

[1] Test no. defined according to [3]. / *Test Nr. definiert entspricht [3].*

[2] Due to spot testing the tests marked were not conducted. / Die markierten Tests wurden im Rahmen der Stichprobenvermessung nicht durchgeführt..

Figure 19 – Summary results of short-circuit current contributions

The following reference values are applied for calculation of the p.u. values specified in the table above:

	SUN2000-168KTL-H1	SUN2000-185KTL-H1
Rated active power, P_n [kW]	150	175
Rated voltage (phase-to-phase), U_n [V]	800	
Rated current, I_n [A]	108,3	126,3
	SUN2000-215KTL-H0	**SUN2000-215KTL-H3**
Rated active power, P_n [kW]	200	
Rated voltage (phase-to-phase), U_n [V]	800	
Rated current, I_n [A]	144,4	

The FRT behaviour of the *SUN2000-185KTL-H1* can be applied to *SUN2000-168KTL-H1, SUN2000-215KTL-H0,* and *SUN2000-215KTL-H3*.

The current peak values and current rms values of the *SUN2000-185KTL-H1* can be applied to *SUN2000-168KTL-H1, SUN2000-215KTL-H0,* and *SUN2000-215KTL-H3*scaled (by the factor $I_{n,\ notmeasure}$ / $I_{n,\ SUN2000\text{-}185KTL\text{-}H1}$).

3. Annex 3 – Extract from the test report

Parameters necessary for calculating the short-circuit currents as specified in DIN EN 60909-0 (VDE 0102) [6] (*Manufacturer's data* from [15]):

Herstellerangabe erforderlich: /

Manufacturer specifications needed:

Table 12 – Extent of the information on short-circuit current contributions to be given in the unit certificate

Type of power generating unit	Information	Symbol
Power generating units with full-scale converters	R.m.s. value of the source current for three-phase fault	I_{skPF}
	R.m.s. value of the source current for two-phase fault	$I_{(1)sk2PF}$
	R.m.s. value of the source current for single-phase fault	$I_{(1)sk1PF}$
	Negative-sequence short-circuit impedance (manufacturer information for integer k-factors only)	$Z_{(2)PF}$

SUN2000-185KTL-H1：

- I_{skPF} = 134,9 A
- $I_{(1)sk2PF}$ = 134,9 A
- $I_{(1)sk1PF}$ = 134,9 A
- $Z_{(2)PF}$ = 0,5

SUN2000-168KTL-H1：

- I_{skPF} = 122,5 A
- $I_{(1)sk2PF}$ = 122,5 A
- $I_{(1)sk1PF}$ = 122,5 A
- $Z_{(2)PF}$ = 0,5

SUN2000-215KTL-H0, SUN2000-215KTL-H3

- I_{skPF} = 155,2A
- $I_{(1)sk2PF}$ = 155,2A
- $I_{(1)sk1PF}$ = 155,2A
- $Z_{(2)PF}$ = 0,5

Figure 20 – Parameters necessary for calculating the short-circuit currents according to DIN EN 60909-0

4. Annex 4 – Validated simulation model

4.1. General information about the simulation model [8]:

Simulation environment used for creation of the PGU model:	PowerFactory 2019 SP1 (x64)
Simulation environment used for conducting simulation/validation:	PowerFactory 2021 SP2 (x64)
Data format of the simulation model:	.pfd: PowerFactory model file .zip: Compressed file archive
Identification number of the validated model of the generating unit:	File name: Huawei_19-0650_1_TR4_SUN2000-168-215KTL_V2.zip MD5 - Checksum: 922c8ff5d481200bc7140ea28cedfef2 **Archive content:** File name: HW_VDE4120&4110_215KTL_ENCV1_0.pfd * MD5 - Checksum: 6ab60bfb02f06b675da077d020125fb7
Certification the PGU according to:	☒ VDE-AR-N 4110:2018-11 ☒ VDE-AR-N 4120:2018-11
Available model documentation:	User Manual of DIgSILENT Model for HW_VDE4110&4120_215KTL_ENCV1.0.pdf (Issue: V1.0, date: 30.08.2021)
Model type:	☐ EMT model ☒ RMS model
The model is suitable for	☒ static simulation ☒ dynamic simulation ☒ simulation of symmetrical and asymmetrical faults ☐ only simulation of symmetrical faults
Implemented FRT modes:	☒ Full dynamic grid support ☒ Limited dynamic grid support
Is k-factor adjustable?	☒ yes ☐ no
Further functions implemented in the model:	See *4.3 Model parameters [8]*
Is a simulation on a PGS configuration with SCR = 5 possible?	☒ yes ☐ no, for a stable simulation the SCR has to be limited to: ___

4. Annex 4 – Validated simulation model	
Limitation for usage of the simulation model:	* Simulation model updated: compared to the last certified models (Huawei_VDE4120&4110_SUN2000-168KTL-H1_Enc_V1.1.pfd MD5 – Checksum: f8d43a83e68500a2f05ce15539c9cbc9 Huawei_VDE4120&4110_SUN2000-185KTL-H1_Enc_V1.5.pfd MD5 – Checksum: 7300dbdbd838d0bbcd57314f2beae4a9) the following changes have been made: o Parameter of power gradient of overfrequency response updated (from *Pf_slope* to *P_Limit* which corresponding to implementation in SW of the PGU) o DSL model *Idq_Control* optimized to avoid the convergence issues in some test scenarios under certain simulation environment All changes have no influence on the certified behaviour of the simulation model, simulation results done on the last certified model remain valid. The *SUN2000-168 -215KTL* simulation model mirrors the behaviour of the inverters / converters in the product series. It contains the same high-level control logic as the PGU – almost all the control functions implemented in the PGU SW are included in the model. Only the control functions descripted in *Scope of the validation and plausibility tests [8]* were tested. This needs to be considered for project planning.

4. Annex 4 – Validated simulation model

4.2. Description of the PGU simulation model [8]:

The simulation model of the *SUN2000-168 - 215KTL-M3* product series are implemented in DIgSILENT PowerFactory Version 2019 SP1. In time-domain the static generator model acts as a current source and is suitable for RMS simulations. It is recommended that the integration step size to be set to 1 ms for the simulations

Description of the main control circuit (Figure 21, Figure 22 & Figure 23):

The PV inverter is represented by the built-in PowerFactory element *Static Generator*. The behaviour of dynamic model is determined by the DSL models connected to the *Static Generator* as showed in *Figure 23*.

- The (measurement element) *PQ_Meas* measures the active and reactive power;
- The (measurement element) *Ulv_Meas* determines positive and negative sequence of voltage;
- The (measurement element) voltage transformer *VT* located to the terminal *LV* and measures the three-phase voltage on the secondary side of the transformer;
- The (measurement element) phase locked loop *PLL_prot* determines the frequency for grid protection and phase angle for calculation of the pos. / neg. sequence of active / reactive current references;
- The (measurement element) phase locked loop *PLL* determines the phase angle for active and reactive current control;
- The model *Pf Changes* reproduces the active power behaviour of the converter in case of overfrequency;
- The model *Q_Control* determines the reactive current reference according to the reactive power set value in consideration of the measured voltage;
- The model *Udc_Control* determines the active current reference according to the active power set value in consideration of the measured voltage;
- The model *Curr_Ctrl* detects the FRT events and calculates the pos. / neg. sequence of active / reactive current references in consideration of the current limitation;
- The model *Protection* disconnects the static generator from grid in case of a voltage or frequency grid fault longer than the protection set delay.

Detection of FRT event:

The implementation of the FRT detection is identical to the implementation in the PGU:

- If the minimum (for LVRT) or maximum (for HVRT) value of the three phase-to-phase voltages exceeds the activation threshold (default: Un ± 10%Un), a FRT event will be detected.
- A FRT event will be detected if an abrupt voltage change occurs (the absolute difference between the actual value of the positive and negative sequence voltage and the 1s (50 periods) average of the positive and negative sequence exceeds the activation threshold (default: 5%U_n).

Voltage reference for additional reactive current calculation:

The reference voltage is the 60 s (needs to be adapted if needed, default setting: 5s, settable in the simulation model using parameter *Tu*, see *4.3 Model parameters [8]*) average of the positive and negative sequence voltage before fault occurs.

The voltage reference will not be updated during faults.

4. Annex 4 – Validated simulation model

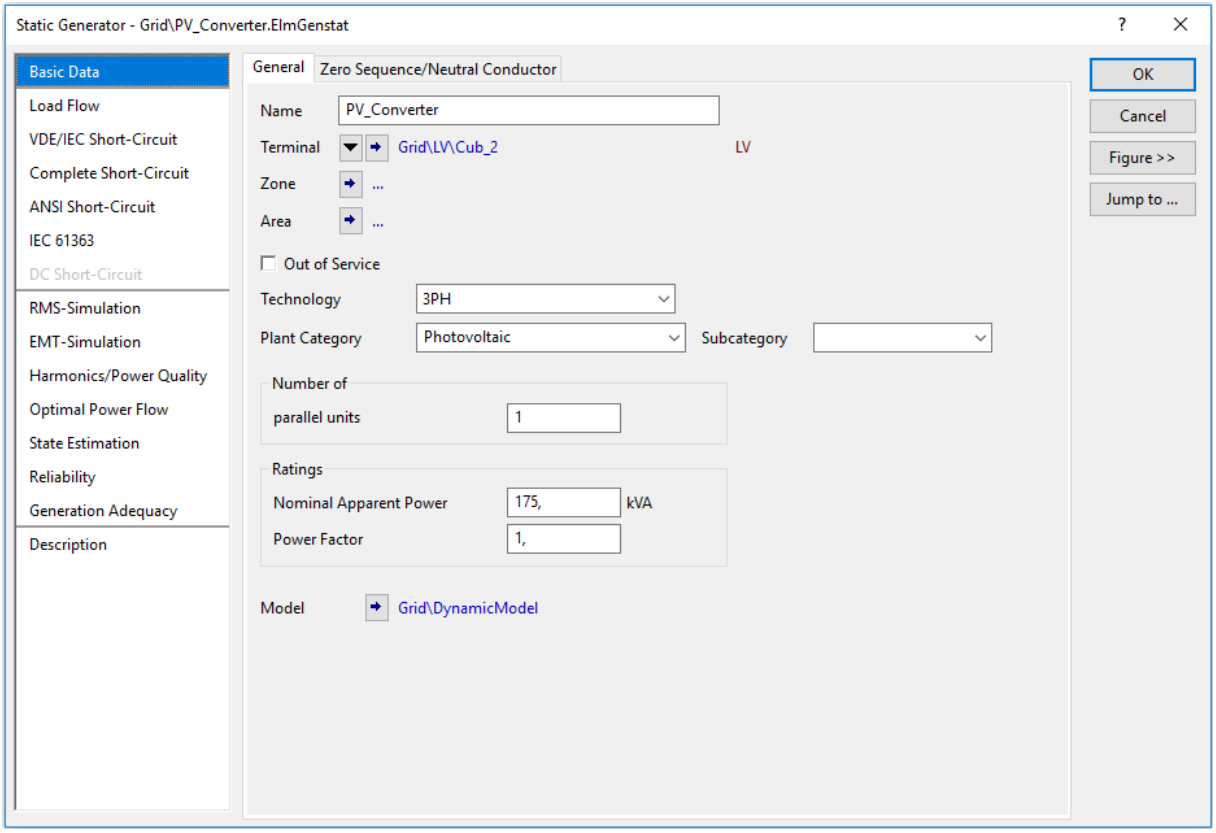


Figure 21 – Static Generator Dialogue window for *Basic Data*

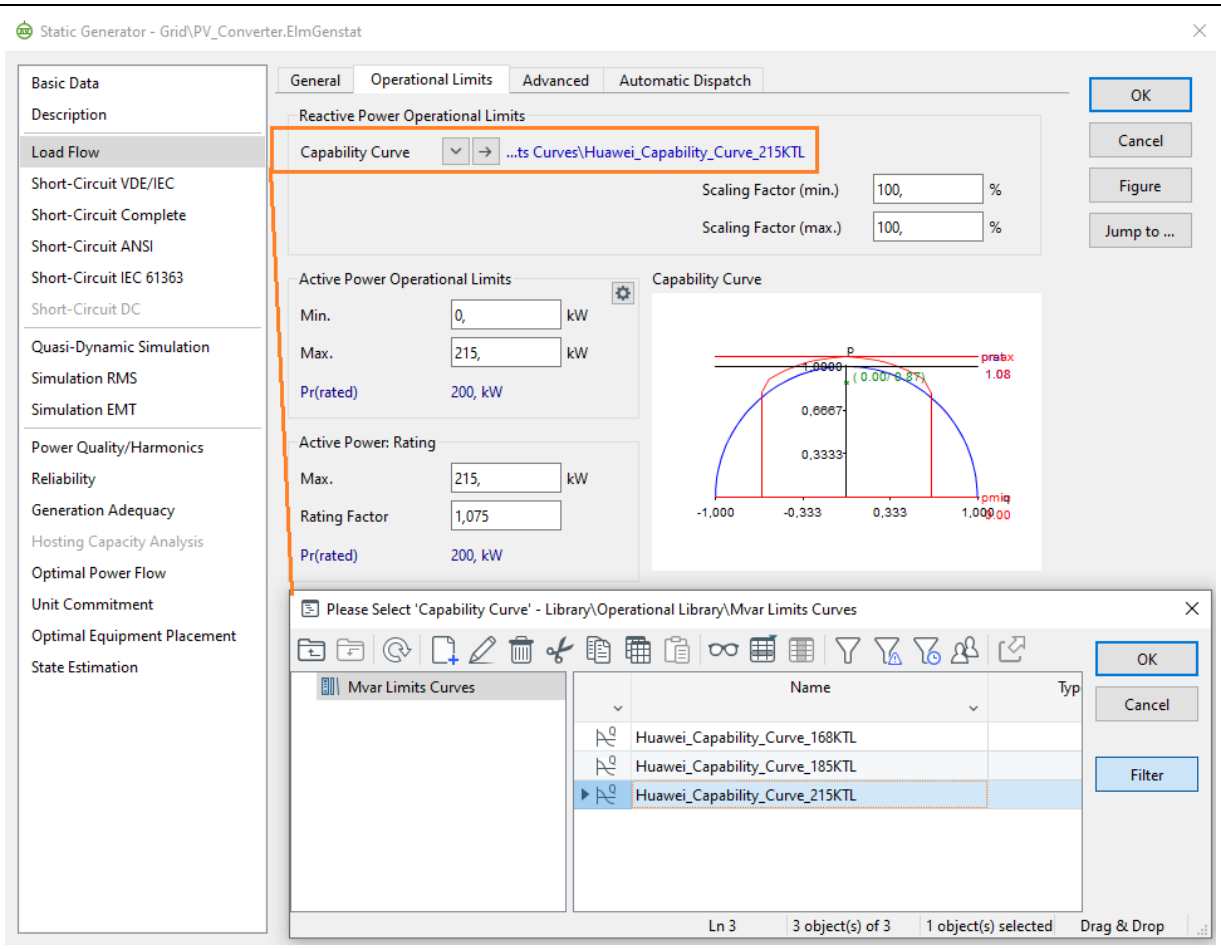


Figure 22 – Static Generator Dialogue window for *Load Flow – Operational Limits*

4. Annex 4 – Validated simulation model

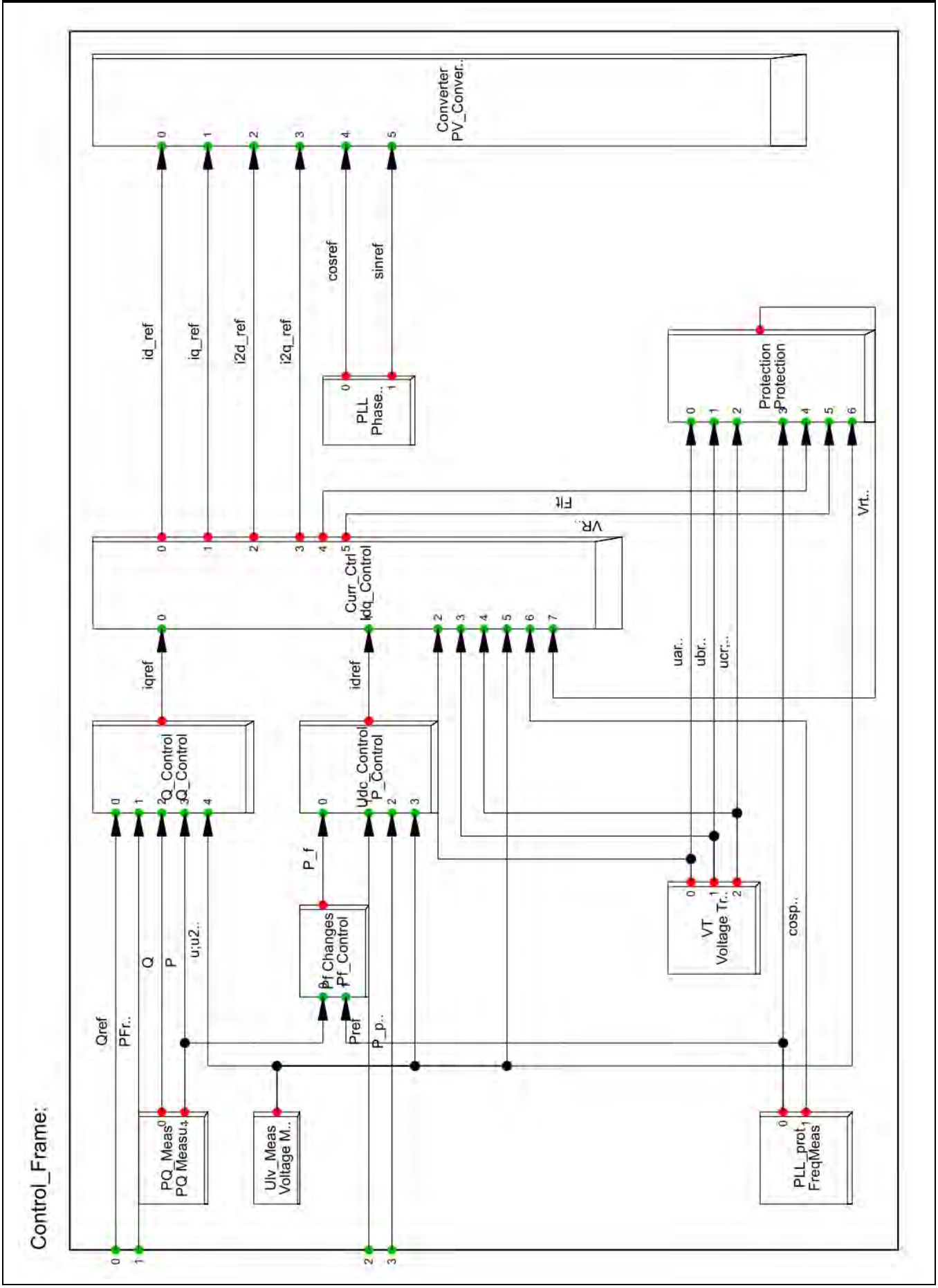


Figure 23 – Control frame of the simulation model

4. Annex 4 – Validated simulation model

Description of the interface to DC input and AC output (Figure 24):

The PV converter is connected to AC mains via the 0,80 kV three phase busbar (which is the measuring point of the above-mentioned voltage measuring elements) and also contains the relays of the internal disconnection function.

In time-domain simulations the static generator model acts as a current source, no explicit primary energy conversion is implemented.

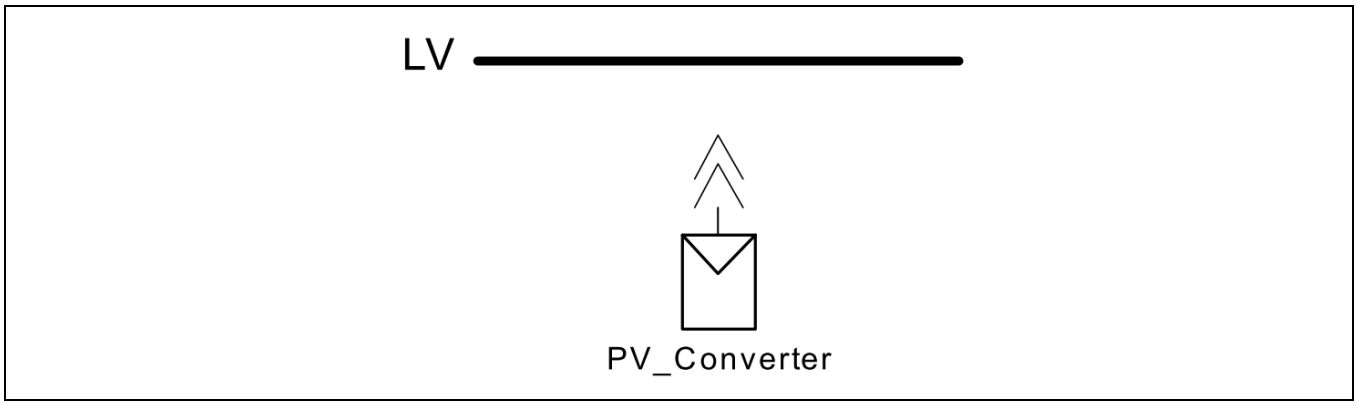


Figure 24 – Interface of the model towards the simulation environment

4. Annex 4 – Validated simulation model

4.3. Model parameters [8]

Description of the accessible parameterization of the model:

The ranges of the following parameters need to be selected in a sensible way: i.e. using the default values or parameter ranges stated in the TG 3 parameters (see *Annex 5 – Certification-relevant parameters*).

Figure 25 shows the composite model *DynamicModel* which references to *Control_Frame* showed in Figure 23 and connects to the common models

- *Pf_Control*;
- *Q_Control*;
- *P_Control*;
- *Idq_Control*;
- *Protection*.

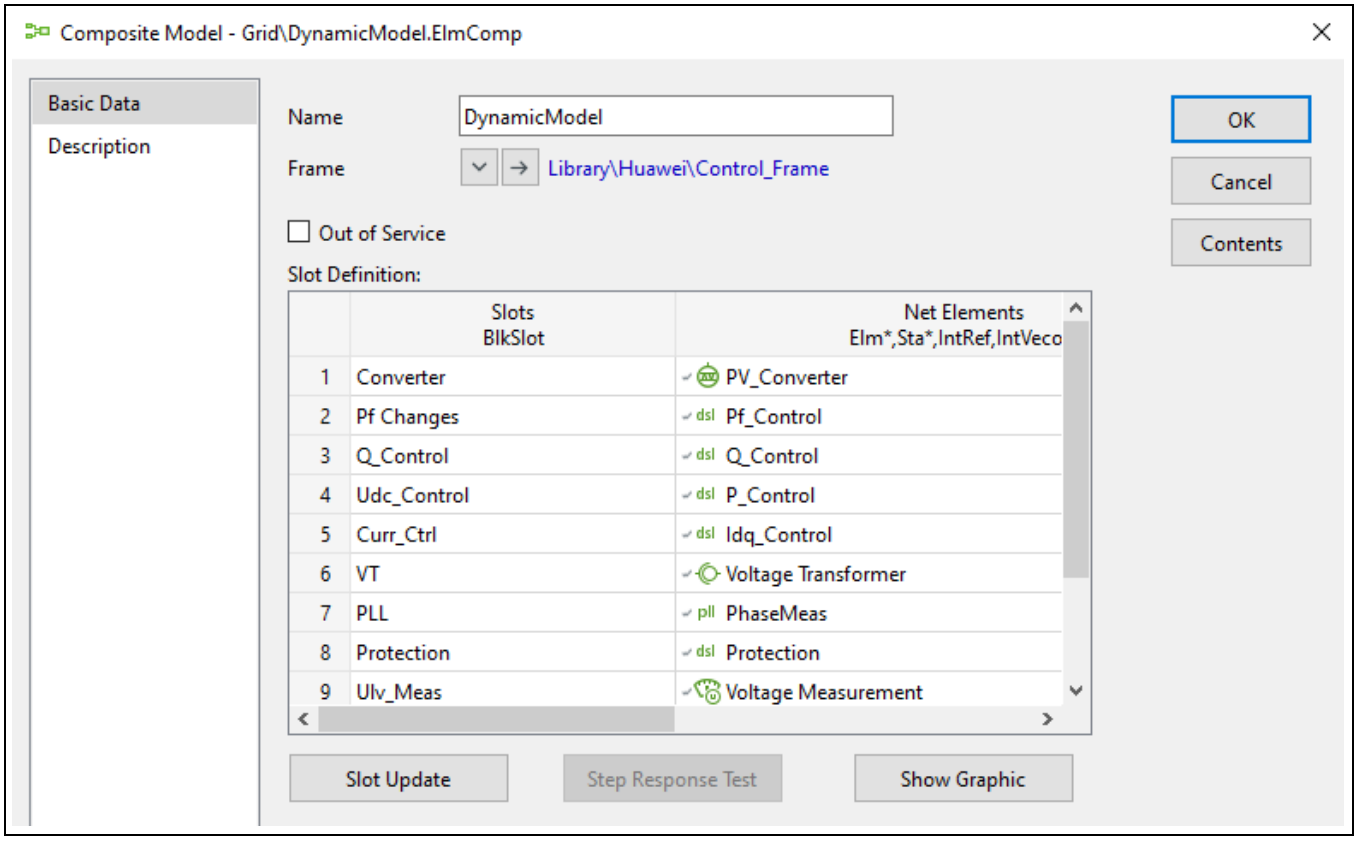
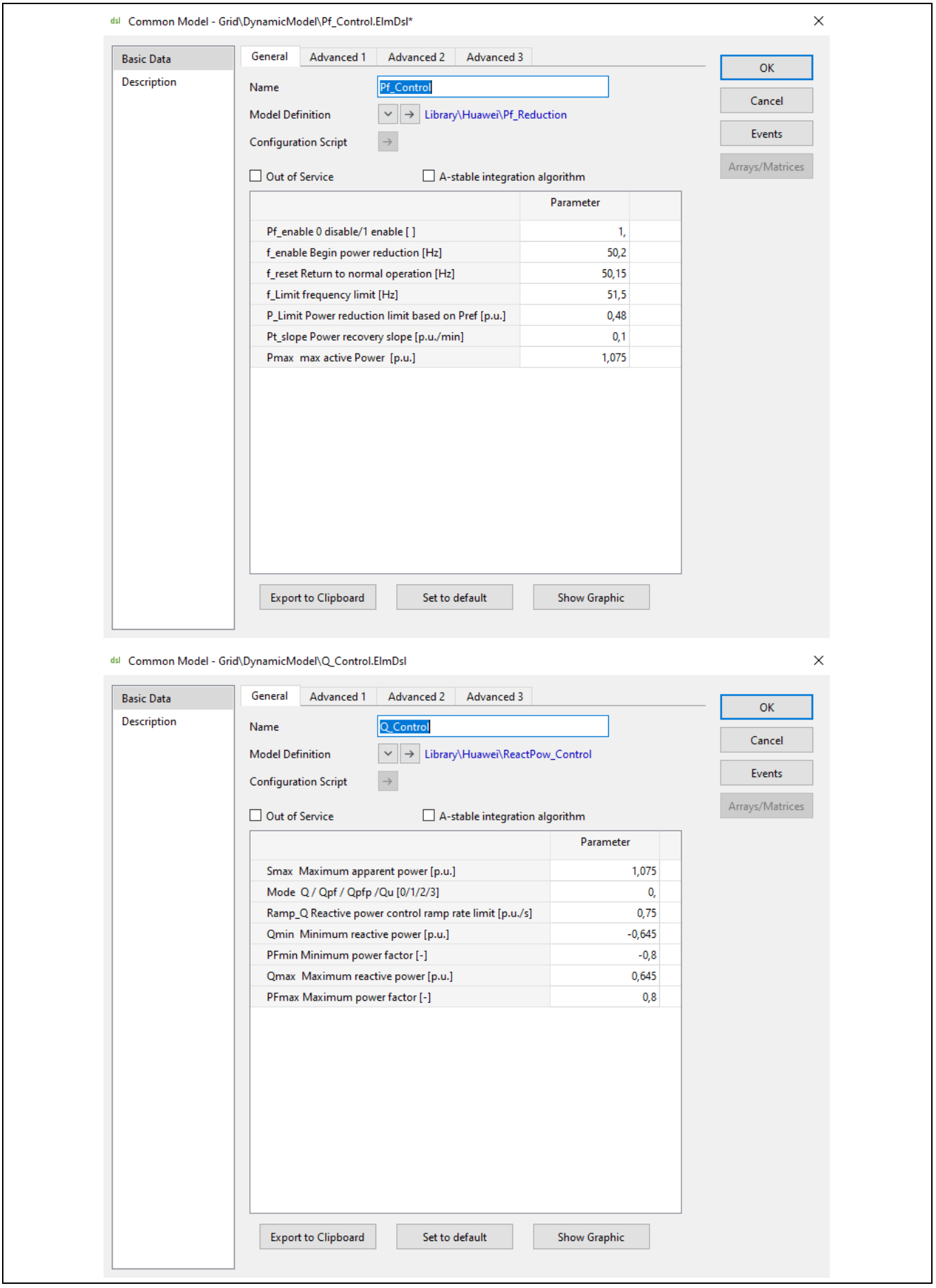


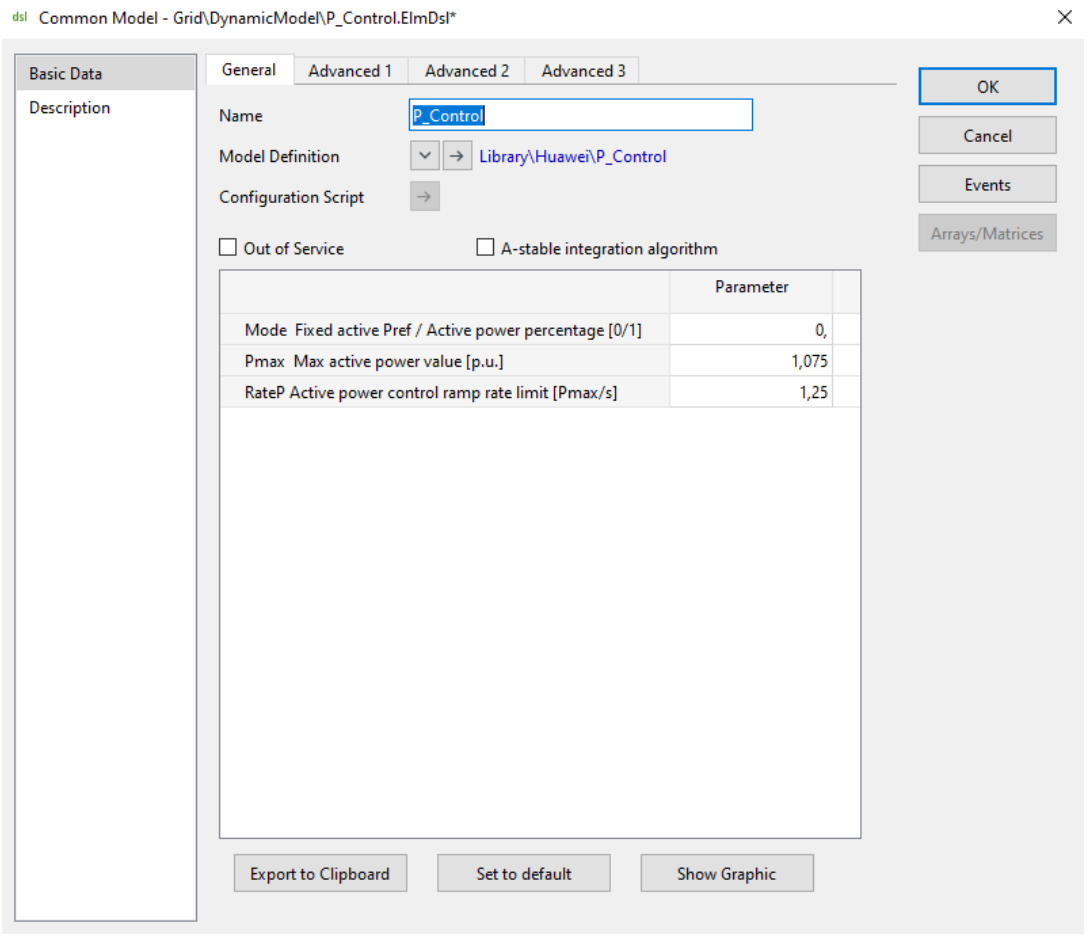
Figure 25 – Composite model *DynamicModel* references to *Control_Frame*

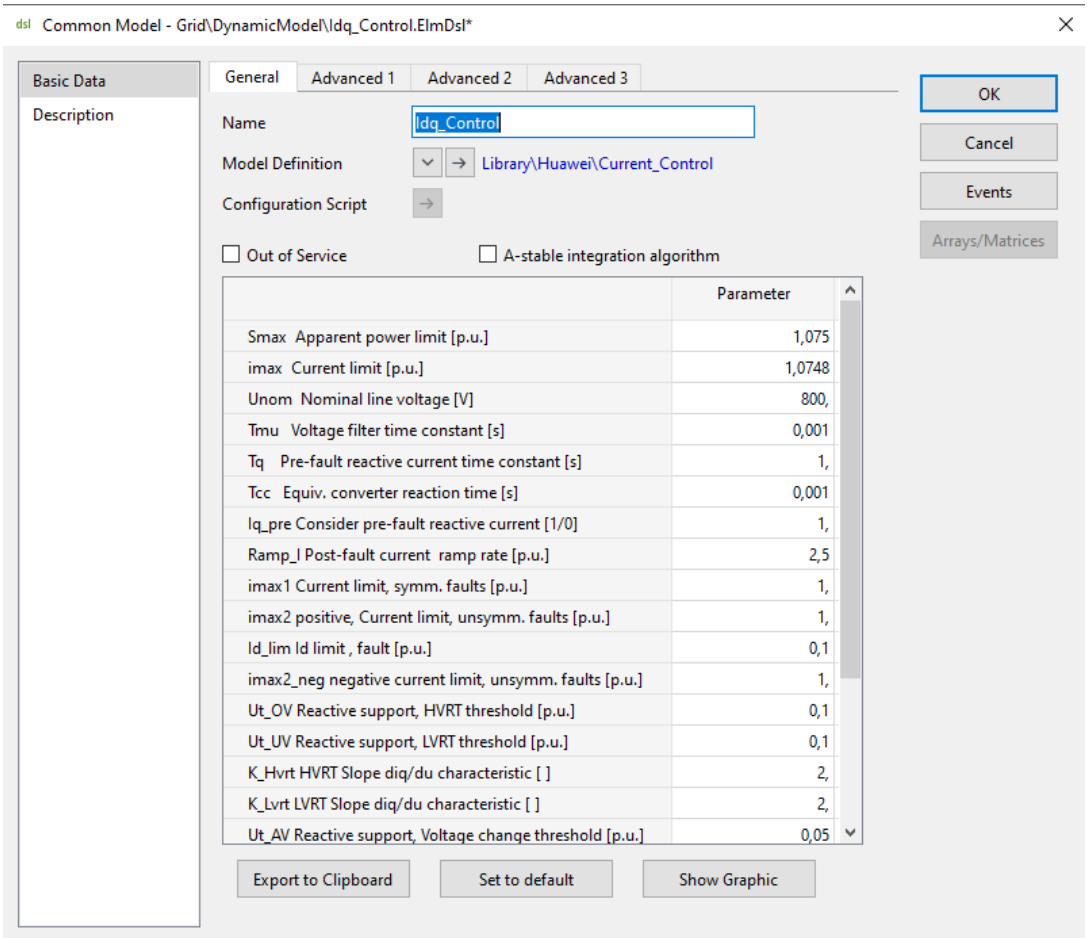
4. Annex 4 – Validated simulation model

Via the common models the parameters of the controllers are accessible and can be set:



4. Annex 4 – Validated simulation model





4. Annex 4 – Validated simulation model

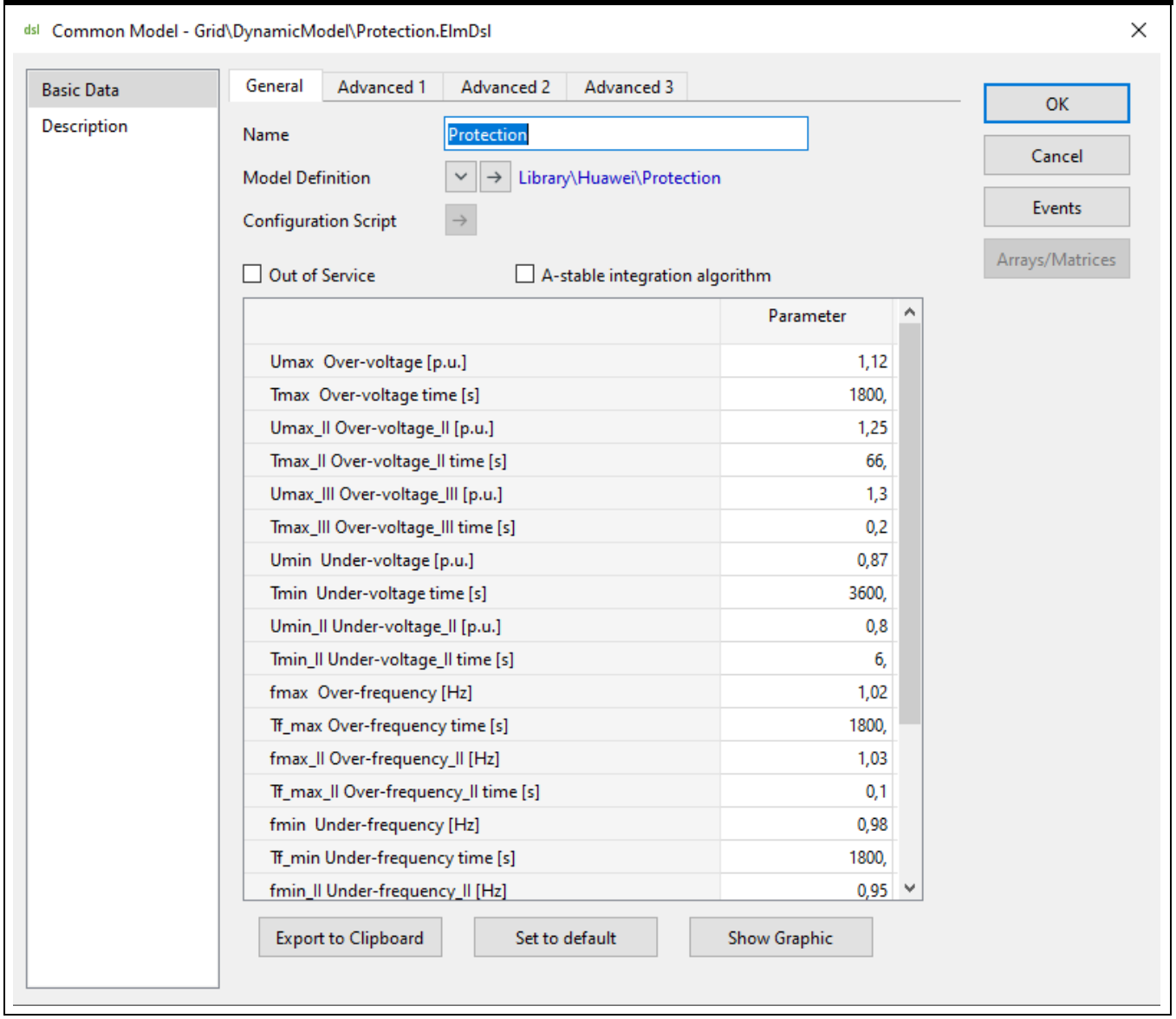


Figure 26 – Common models from [8]

4. Annex 4 – Validated simulation model

A4. Model parameters

Parameter name	Parameter description	Unit	Default
Static Generator – Grid\PV_Converter.ElmGenstat (Basic Data\General)			
Nominal Apparent Power	Nominal apparent and active power rating of the inverter	[kVA]	See *Table 1*
Power Factor	Default reactive power setting	[-]	1
Parallel Machines	Number of inverters simulated by one model block	[-]	1
Static Generator – Grid\PV_Converter.ElmGenstat (Load Flow\Operational Limits)			
Capability Curve, Min.	Min. reactive power limitation of the PQ capacity of the inverter	[p.u.] (base P_n)	See *Table 1*
Capability Curve, Max.	Max. reactive power limitation of the PQ capacity of the inverter	[p.u.] (base P_n)	See *Table 1*
Active Power Operational Limits, Min.	Min. active power operating limit	[MW]	0
Active Power Operational Limits, Max.	Max. active power operating limit	[MW]	See *Table 1*
Active Power: Rating, Max.	Max. active power rating	[MW]	See *Table 1*
Active Power: Rating, Rating Factor	Rating factor of active power (P_{max} / P_n)	[-]	See *Table 1*
Common Model – Grid\DynamicModel\Pf_Control.ElmDsl			
Pf_enable	0: p(f) control function disable 1: p(f) control function enable	[-]	1
f_enable	Frequncy threshold exceeds which begins power reduction	[Hz]	50,2
f_reset	Frequncy threshold below which the PGU returns to norml operation	[Hz]	50,15
f_Limit	Overfrequency limit	[Hz]	51,5
P_limit	End power of P(f) function (cut off power of frequency regulation)	[p.u.] (base P_M)	0,48 (the corresponding power gradient calculated with: $\frac{1-\text{PLimit\_OF}}{\text{fenable\_OF}-\text{fLimit\_OF}} \cdot 100$ [%P_M/Hz], the resulting gradient with default setting of the parameters is therefore: -40%P_M/Hz or a droop of -5.
Pt_slope	Power recovery slope	[p.u./min] (base P_n)	0,1
Pmax	max active Power	[p.u.] (base P_n)	See *Table 1*
Common Model – Grid\DynamicModel\Q_Control.ElmDsl			
Smax	Maximum apparent power	[p.u.] (base P_n)	See *Table 1*

4. Annex 4 – Validated simulation model

A4. Model parameters			
Parameter name	**Parameter description**	**Unit**	**Default**
Mode	0: Q setpoint control 1: cosφ setpoint control 2: cosφ(P) control function [1)] 3: Q(U) control function [1)]	[0/1/2/3]	0
Ramp_Q	Number of inverters simulated by one model block	[p.u./s] (base Q_{max})	0,75
Qmin	Minimum reactive power	[p.u.] (base P_n)	See *Table 1*
PFmin	Minimum power factor	[-]	-0,8
Qmax	Maximum reactive power	[p.u.] (base P_n)	See *Table 1*
PFmax	Maximum power factor	[-]	0,8
Common Model – Grid\DynamicModel\P_Control.ElmDsl			
Mode	0: P setpoint control in p.u. based P_n 1: P setpoint control in % based P_n	[0/1]	0
Pmax	Maximum active power	[p.u.] (base P_n)	See *Table 1*
RateP	Active power control ramp rate	[p.u./s] (base P_{max})	1,25
Common Model – Grid\DynamicModel\Current_Control.ElmDsl			
Smax	Apparent power limit	[p.u.] (base P_n)	See *Table 1*
imax	Current limit	[p.u.] (base I_n)	See *Table 1*
Unom	Nominal line voltage	[V]	800
Tmu	Voltage filter time constant	[s]	0,001
Tq	Pre-fault reactive current time constant	[s]	1
Tcc	Equiv. converter reaction time (Internal time delay of the control algorithm, *(specific to simulation model)*)	[s]	0,001
Iq_pre	0: reactive current before fault will not be taken in to account for calculation of the reactive current injection 1: reactive current before fault will be taken in to account for calculation of the reactive current injection	[0/1]	1
Ramp_I	Post-fault current ramp rate	[p.u.] (base I_n)	2,5
imax1	Current limit during symmetrical faults	[p.u.] (base I_n)	1
imax2	Positive sequence current limit during asymmetrical faults	[p.u.] (base I_n)	1
Id_lim	Lower limit of the active current reference during grid faults	[p.u.] (base I_n)	0,1
imax2_neg	Negative sequence current limit during asymmetrical faults	[p.u.] (base I_n)	1

4. Annex 4 – Validated simulation model

A4. Model parameters

Parameter name	Parameter description	Unit	Default
Ut_OV	HVRT voltage threshold	[p.u.] (base U_n)	0,1 (above U_n)
Ut_UV	LVRT voltage dead-band	[p.u.] (base U_n)	0,1 (below U_n)
K-Hvrt	HVRT Slope di_q/du characteristic (range: 0 - 6)	[-]	2
K-Lvrt	LVRT Slope di_q/du characteristic (range: 0 - 6)	[-]	2
Ut_AV	FRT activation threshold due to abrupt voltage change	[p.u.] (base U_n)	0,05
Udz	FRT deadband hysteresis	[p.u.] (base U_n)	0,02
LVRT_EN	0: LVRT disable 1: LVRT enable	[0/1]	1
HVRT_EN	0: HVRT disable 1: HVRT enable	[0/1]	1
ZeroCurrMode	0: Limited dynamic grid support disable 1: Limited dynamic grid support enable	[0/1]	0
Tu	Pre-fault voltage time constant (pre-fault voltage averaging interval)	[s]	5
Common Model – Grid\DynamicModel\Protection.ElmDsl			
Umax	Tripping threshold for 1st level of overvoltage protection	[p.u.] (base U_n)	1,12
Tmax	Tripping delay for 1st level of overvoltage protection	[s]	1800
Umax_II	Tripping threshold for 2nd level of overvoltage protection	[p.u.] (base U_n)	1,25
Tmax_II	Tripping delay for 2nd level of overvoltage protection	[s]	66
Umax_III	Tripping threshold for 3rd level of overvoltage protection	[p.u.] (base U_n)	1,3
Tmax_III	Tripping delay for 3rd level of overvoltage protection	[s]	0,2
Umin	Tripping threshold for 1st level of undervoltage protection	[p.u.] (base U_n)	0,87
Tmin	Tripping delay for 1st level of undervoltage protection	[s]	3600
Umin_II	Tripping threshold for 2nd level of undervoltage protection	[p.u.] (base U_n)	0,8
Tmin_II	Tripping delay for 2nd level of undervoltage protection	[s]	6
fmax	Tripping threshold for overfrequency protection	[p.u.] (base f_n)	1,02
Tf_max	Tripping delay for overfrequency protection	[s]	1800
fmax_II	Tripping threshold for 2nd level overfrequency protection	[p.u.] (base f_n)	1,03

4. Annex 4 – Validated simulation model

A4. Model parameters

Parameter name	Parameter description	Unit	Default
Tf_max_II	Tripping delay for 2nd level overfrequency protection	[s]	0,1
fmin	Tripping threshold for underfrequency protection	[p.u.] (base f_n)	0,98
Tf_min	Tripping delay for underfrequency protection	[s]	1800
fmin_II	Tripping threshold for 2nd level underfrequency protection	[p.u.] (base f_n)	0,95
Tf_min_II	Tripping delay for 2nd level underfrequency protection	[s]	0,1
VRTProc_Select	0: high priority for grid protection function 1: high priority for fault ride-through tripping curve function [2)]	[0/1]	0
fnom	Nominal grid frequency	[Hz]	50
Unom	Nominal line voltage	[V]	800
Tmu	Time constant for voltage measurement	[s]	0,01

Note:
[1)] The cosφ(P)- and Q(U)-curve can be defined under "*Common Model – Grid\DynamicModel\Q_Control.ElmDsl - Basic Data\Advanced 1*" (for details see model user guide (*A2. General information, 2.5 Description of the provided model documentation*))
[2)] The fault ride-through tripping curve can be defined under "*Common Model – Grid\DynamicModel\Protection.ElmDsl - Basic Data\Advanced 1*" (for details see model user guide (*A2. General information, 2.5 Description of the provided model documentation*))

Figure 27 – Accessible parameters of the model from [8]

4. Annex 4 – Validated simulation model

4.4. Model application guide [8]

Adaption of model parameters for different PGU types

(see also chapter 4 *Model extension* in User Manual of the simulation model - *Available model documentation*)

The PowerFactory Static Generator can be parameterized according to *Figure 21* & *Figure 22* where exemplary values are chosen. These parameters need to be adapted to the value of the specific PGU type (see *Table 1*).

Furthermore, for application of other inverter types in the product series following parameters (see *Table 1*) in the DSL blocks need to be set accordingly.

Finally, the busbar (*LV* in *Figure 24*) voltage must be adjusted to the corresponding nominal voltage value (*Unom*) as presented in *Table 1* for the desired inverter type to be used.

Techincal data / Units	SUN2000-168KTL-H1	SUN2000-185KTL-H1	SUN2000-215KTL-H0 SUN2000-215KTL-H3
Un [V]	800	800	800
Smax [kVA]	168,0	185,0	215,0
Sn [kVA]	150,0	175,0	200,0
Smax / Sn	1,120	1,057	1,075
Imax [A]	122,5	134,9	155,2
In [A]	108,3	126,3	144,4
Imax / In	1,1316	1,0681	1,0748
PV_Converter			
Basic Data \ Rated Apparent Power [MVA]	0,15	0,175	0,2
Load Flow \ Operational Limits \ Capbility Curve	Select the corresponding Capability Curve of the PGU type		
Load Flow \ Operational Limits \ Active Power Operation Limits \ Min. [MW]	0	0	0
Load Flow \ Operational Limits \ Active Power Operation Limits \ Max. [MW]	0,168	0,185	0,215
Load Flow \ Operational Limits \ Active Power: Rating \ Max. [MW]	0,168	0,185	0,215
Load Flow \ Operational Limits \ Active Power: Rating \ Rating Factor	1,120	1,057143	1,075
Idq_Control			
Smax [p.u.] (Smax / Sn)	1,120	1,057	1,075
imax [p.u.] (Imax / In)	1,1316	1,0681	1,0748
Unom [V]	800	800	800
Pf_Control			
Pmax [p.u.]	1,120	1,057	1,075
P_Control			
Pmax [p.u.]	1,120	1,057	1,075
Q_Control			
Smax [p.u.] (Smax / Sn)	1,120	1,057	1,075
Qmin	-0,672	-0,6343	-0,645
Qmax	0,672	0,6343	0,645
Protection			
Unom [V]	800	800	800

Table 1 - Model parameters for different inverter types in the product series from [8]

4. Annex 4 – Validated simulation model

Description of the steps for integration of the simulation model in a power generating system project (Manufacturer's information) [8]

1. Import the project "*HW_VDE4120&4110_215KTL_ENCV1_0.pfd*" into PowerFactory 2019 SP1 (or later version).
2. Activate the power plant project. Copy the model template in the project "*HW_VDE4120&4110_215KTL_ENCV1_0*" under the folder *Library\Templates* into the folder *Library\Templates* of power plant project.
3. Select the imported model template from the *Drawing Tools* tool-window (which appears by default on the left-hand side of the graphic window in the PowerFactory 2021) and place the inverter model into the single-line diagram.
4. Select the corresponding Capability Curve of the PGU type in *Static Generator* \ *Load Flow* \ *Operational Limits* dialogue window (see *Figure 22*).
5. Edit the parameters in the DLS models under guidance of manufacturer.
6. Edit the active and reactive power operating point on the *Load Flow* page of the static generator.
7. Calculate the load flow and ensure that there are no warnings or error messages.
8. Calculate the initial conditions (RMS simulation, symmetrical or unsymmetrical network representation, recommended integration step size: 1 ms constant step size).
9. Define network events and select the variables to be recorded.
10. Start the simulation, plot result variables and observe the converter behaviour.

4. Annex 4 – Validated simulation model

4.5. Scope of the validation and plausibility tests [8]

The simulation model was checked for validity and plausibility according to TG 4 for following test scenarios:

- Validating P setpoint control and overfrequency response measured according to TG3 Chapters 4.1.1, 4.1.2 and 4.1.3 (chapter 3.1.1, 3.1.2, 3.1.3 and 5.5.4.1 in [4]) [1)]
- Validating the P-Q diagram measured according to TG3 Chapters 4.2.2 and 4.2.3 (chapter 3.2.1 and 5.5.2.1 in [4])
- Validating the Q and cosφ set-point control measured according to TG3 Chapters 4.2.4 (chapter 3.2.2 in [4]) [2)]
- Validating the protection relay measured according to TG3 Chapters 4.4 (chapter 3.4 in [4])
- Validating all TG3 FRT tests (chapter 3.3, 3.5 and 5 in [4])
- Plausibility tests on single model for different
    - fault types;
    - voltage depth;
    - pre-fault voltages
    - pre-fault active powers
    - pre-fault reactive powers
    - k-factors

  (chapter 5.5.2 in [4])
- Plausibility checks of the steady-state operation (chapter 5.5.2.2 in [4])
- Plausibility tests for typical PGS configuration for different
    - fault types;
    - voltage depth;
    - pre-fault voltages
    - pre-fault active powers
    - pre-fault reactive powers
    - k-factors

  (chapter 5.5.3.1 in [4])
- Simulating of unsuccessful automatic reconnection for typical PGS configuration (chapter 5.5.3.2 in [4])

For all the test scenarios the simulation ran stably without any error messages and showed satisfying behaviour.

Note:

1) Only overfrequency response implemented in the model and tested.

2) The unit provides setting of the reactive power by:
    - Q fixed Q reference (tested for both setpoint accuracy and dynamic behaviour)
    - power factor control (tested for setpoint accuracy) *
    - cosφ(P) control function (not tested)
    - Q(U) control function (not tested)

  For all reactive power control functions implemented in the model do NOT provide PT1 filtering effect.

4. Annex 4 – Validated simulation model

4.6. Results of Validating simulation models (PGU) [8]

Summary of validation results - SUN2000-168KTL-H1

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
U_rest < 0,05	Pre	0,044	0,001	0,001	0,003	0,000	0,000	0,014	0,001	0,001	0,004	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,013	0,001	0,001	0,005	-0,003	0,003
0.1 according to IEC	Fault	0,025	0,006	0,018	0,055	-0,003	0,005	0,419	0,366	0,407	0,112	-0,094	0,105	0,001	0,000	0,000	0,000	0,000	0,000	0,015	0,003	0,001	0,002	0,002	0,001
3ph / Full Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,003	0,005	-0,002	0,003	0,003	-0,001	0,003	0,005	-0,003	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,003	-0,002	0,002
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest < 0,05	Pre	0,005	0,001	0,001	0,071	0,000	0,001	0,032	0,001	0,001	0,074	0,000	0,001	0,002	0,000	0,000	0,001	0,000	0,000	0,036	0,000	0,000	0,015	-0,002	0,002
0.3 according to IEC	Fault	0,060	-0,026	0,012	0,119	0,013	0,014	0,108	-0,042	0,022	0,168	0,019	0,025	0,045	0,014	0,021	0,225	0,006	0,008	0,190	0,028	0,046	0,146	0,000	0,009
2ph / Full Load / Kp = 2, Kn=2	Post	0,003	0,000	0,002	0,006	-0,003	0,003	0,003	0,000	0,002	0,006	-0,003	0,004	0,000	0,000	0,000	0,000	0,001	0,001	0,001	0,001	0,001	0,003	0,000	0,003
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,20 ≤ U_rest ≤ 0,30	Pre	0,045	0,000	0,000	0,001	0,000	0,000	0,015	0,001	0,001	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,014	0,001	0,001	0,004	-0,003	0,003
25.1 according to IEC	Fault	0,004	-0,001	0,003	0,064	0,006	0,005	0,020	0,004	0,010	0,031	0,026	0,025	0,001	0,000	0,000	0,000	0,000	0,000	0,020	0,002	0,002	0,002	0,000	0,001
3ph / Full Load / Kp = 2, Kn=2	Post	0,002	-0,002	0,003	0,005	-0,001	0,002	0,007	0,000	0,003	0,005	-0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,001	0,003	-0,001	0,001
0,20 ≤ U_rest ≤ 0,30	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,20 ≤ U_rest ≤ 0,30	Pre	0,034	0,000	0,001	0,040	0,000	0,001	0,018	0,001	0,001	0,042	0,000	0,001	0,001	0,000	0,000	0,001	0,000	0,000	0,018	0,001	0,001	0,009	-0,002	0,002
25.4 according to IEC	Fault	0,052	-0,014	0,008	0,089	0,009	0,009	0,085	-0,018	0,012	0,147	0,019	0,020	0,036	0,013	0,014	0,134	0,002	0,002	0,187	0,037	0,039	0,133	-0,004	0,005
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	-0,001	0,002	0,006	-0,001	0,002	0,003	-0,001	0,002	0,005	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,001	0,001	0,003	-0,001	0,002
0,20 ≤ U_rest ≤ 0,30	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	0,008	0,000	0,000	0,050	0,000	0,001	0,036	0,001	0,001	0,052	0,000	0,001	0,002	0,000	0,000	0,001	0,000	0,000	0,037	0,000	0,001	0,014	-0,002	0,002
50.3 according to IEC	Fault	0,032	-0,010	0,011	0,090	0,011	0,011	0,044	-0,014	0,016	0,180	0,011	0,011	0,021	0,011	0,012	0,089	0,006	0,006	0,161	0,045	0,046	0,147	-0,001	0,006
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	-0,001	0,001	0,003	-0,001	0,002	0,002	0,000	0,002	0,003	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,001	0,001	0,001	-0,001	0,001
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.6 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4. Annex 4 – Validated simulation model

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	0,019	0,000	0,000	0,008	0,001	0,001	0,021	0,000	0,000	0,003	0,002	0,002	0,001	0,000	0,000	0,000	0,000	0,000	0,018	0,001	0,001	0,006	0,000	0,000
75.3 according to IEC	Fault	0,040	-0,028	0,028	0,061	0,016	0,016	0,054	-0,036	0,036	0,154	0,025	0,026	0,001	0,000	0,000	0,003	0,000	0,000	0,032	0,004	0,004	0,083	-0,007	0,008
3ph / Partial Load / Kp = 2, Kn=2	Post	0,004	-0,001	0,001	0,005	0,001	0,002	0,004	0,000	0,001	0,008	0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,001	0,001	0,001	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 4, Kn=4	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.6 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.7 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	0,013	0,000	0,000	0,033	-0,001	0,001	0,014	0,001	0,001	0,036	-0,001	0,001	0,002	0,000	0,000	0,003	0,000	0,000	0,024	-0,001	0,001	0,027	-0,001	0,001
75.8 according to IEC	Fault	0,032	0,004	0,008	0,027	0,011	0,016	0,037	0,005	0,010	0,034	0,015	0,021	0,013	0,007	0,007	0,032	0,004	0,003	0,123	0,061	0,061	0,049	0,019	0,018
2ph / Partial Load / Kp = 4, Kn=4	Post	0,003	0,000	0,001	0,005	-0,002	0,002	0,003	0,000	0,001	0,005	-0,002	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,001	0,001	0,002	0,000	0,001
0,75 ≤ U_rest ≤ 0,85	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80.1	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,75 ≤ U_rest ≤ 0,85	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80.2	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,85 ≤ U_rest ≤ 0,90	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	0,131	-0,001	0,001	0,009	0,000	0,000	0,121	-0,001	0,001	0,009	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,050	-0,001	0,001	0,025	-0,001	0,001
110.3 according to IEC	Fault	0,009	-0,001	0,001	0,025	-0,002	0,003	0,006	-0,001	0,001	0,020	-0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,036	0,006	0,006	0,028	-0,005	0,005
3ph / Full Load / Kp = 2, Kn=2	Post	0,001	0,000	0,000	0,006	0,000	0,002	0,001	0,000	0,000	0,006	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,001	0,001	0,002	0,000	0,000
U_rest ≥ 1,15	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,15	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4. Annex 4 – Validated simulation model

Summary of validation results - SUN2000-185KTL-H1

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
U_rest < 0,05	Pre	0,046	0,000	0,000	0,002	0,000	0,000	0,006	0,001	0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,008	-0,003	0,003	0,002	-0,001	0,001
0.1 according to IEC	Fault	0,032	0,008	0,020	0,086	-0,001	0,009	0,417	0,349	0,380	0,189	-0,097	0,108	0,014	0,000	0,000	0,019	0,000	0,000	0,105	0,002	0,007	0,137	0,005	0,006
3ph / Full Load / Kp = 2, Kn=2	Post	0,002	-0,003	0,003	0,004	-0,001	0,002	0,002	-0,002	0,003	0,004	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,003	0,003	0,002	-0,001	0,001
U_rest < 0,05	Pre	0,006	0,000	0,000	0,001	0,000	0,000	0,017	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,016	-0,001	0,001	0,005	0,000	0,000
0.2 according to IEC	Fault	0,046	0,017	0,021	0,090	-0,001	0,010	0,416	0,372	0,385	0,196	-0,101	0,112	0,012	0,000	0,000	0,023	0,001	0,001	0,080	0,002	0,006	0,161	0,006	0,007
3ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,001	0,000	0,001	0,003	-0,001	0,001	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,000
U_rest < 0,05	Pre	0,024	0,000	0,000	0,059	0,000	0,000	0,025	0,001	0,001	0,062	0,000	0,000	0,002	0,000	0,000	0,001	0,000	0,000	0,026	-0,003	0,003	0,015	-0,001	0,001
0.3 according to IEC	Fault	0,053	-0,019	0,010	0,124	0,015	0,016	0,101	-0,035	0,020	0,164	0,019	0,027	0,044	0,015	0,021	0,229	0,012	0,012	0,193	0,031	0,047	0,162	0,005	0,007
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	0,000	0,002	0,002	-0,001	0,002	0,005	0,000	0,002	0,002	-0,002	0,003	0,000	0,000	0,000	0,000	0,001	0,001	0,003	-0,003	0,003	0,002	0,001	0,002
U_rest < 0,05	Pre	0,014	0,000	0,000	0,034	0,000	0,000	0,022	0,000	0,000	0,035	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,033	-0,001	0,001	0,003	0,000	0,000
0.4 according to IEC	Fault	0,055	-0,012	0,009	0,118	0,013	0,016	0,103	-0,024	0,019	0,176	0,015	0,024	0,044	0,017	0,022	0,223	0,005	0,008	0,194	0,034	0,049	0,172	0,000	0,010
2ph / Partial Load / Kp = 2, Kn=2	Post	0,003	0,000	0,001	0,001	-0,001	0,001	0,003	0,000	0,001	0,001	-0,002	0,002	0,000	0,000	0,000	0,000	0,001	0,001	0,002	-0,001	0,001	0,001	0,002	0,002
0,20 ≤ U_rest ≤ 0,30	Pre	0,053	0,000	0,000	0,003	0,000	0,000	0,006	0,001	0,001	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,003	0,003	0,005	-0,001	0,001
25.1 according to IEC	Fault	0,077	-0,003	0,002	0,076	0,005	0,004	0,090	-0,002	0,006	0,170	0,020	0,021	0,010	0,000	0,000	0,015	0,000	0,000	0,109	-0,001	0,002	0,146	0,000	0,003
3ph / Full Load / Kp = 2, Kn=2	Post	0,015	-0,003	0,003	0,006	-0,001	0,003	0,015	-0,001	0,003	0,006	-0,001	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,002	0,003	0,004	-0,001	0,001
0,20 ≤ U_rest ≤ 0,30	Pre	0,017	0,000	0,000	0,002	0,000	0,000	0,030	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,029	-0,001	0,001	0,001	0,000	0,000
25.2 according to IEC	Fault	0,085	0,000	0,002	0,052	0,006	0,005	0,089	0,003	0,005	0,129	0,021	0,022	0,009	0,000	0,000	0,016	0,000	0,000	0,087	-0,001	0,002	0,157	-0,001	0,003
3ph / Partial Load / Kp = 2, Kn=2	Post	0,002	-0,001	0,001	0,001	0,000	0,001	0,002	0,000	0,001	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,001	0,001	0,001	0,000	0,000
0,20 ≤ U_rest ≤ 0,30	Pre	0,049	0,000	0,000	0,034	0,000	0,000	0,002	0,000	0,000	0,036	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	-0,003	0,003	0,005	-0,001	0,001
25.4 according to IEC	Fault	0,070	-0,010	0,007	0,107	0,016	0,016	0,107	-0,015	0,011	0,233	0,022	0,023	0,044	0,014	0,014	0,172	0,009	0,008	0,270	0,039	0,041	0,232	0,004	0,004
2ph / Full Load / Kp = 2, Kn=2	Post	0,003	0,001	0,002	0,004	-0,002	0,003	0,004	0,001	0,003	0,004	-0,003	0,003	0,000	0,000	0,000	0,000	0,001	0,001	0,004	-0,003	0,003	0,002	0,001	0,003
0,20 ≤ U_rest ≤ 0,30	Pre	0,009	0,000	0,000	0,022	0,000	0,000	0,016	0,000	0,000	0,023	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,022	-0,001	0,001	0,002	0,000	0,000
25.5 according to IEC	Fault	0,070	-0,004	0,006	0,114	0,016	0,015	0,108	-0,007	0,010	0,174	0,021	0,022	0,040	0,014	0,015	0,170	0,006	0,006	0,253	0,040	0,043	0,187	0,000	0,002
2ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,001	-0,001	0,002	0,003	-0,001	0,001	0,001	-0,002	0,002	0,000	0,000	0,000	0,000	0,001	0,001	0,001	-0,001	0,001	0,001	0,001	0,002
0,45 ≤ U_rest ≤ 0,60	Pre	0,053	0,000	0,000	0,002	0,000	0,000	0,005	0,001	0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,005	-0,003	0,003	0,002	-0,001	0,001
50.1 according to IEC	Fault	0,051	-0,003	0,002	0,052	0,009	0,008	0,053	-0,005	0,003	0,043	0,022	0,022	0,006	0,000	0,000	0,012	0,000	0,000	0,082	0,001	0,001	0,160	-0,004	0,005
3ph / Full Load / Kp = 2, Kn=2	Post	0,003	-0,004	0,004	0,002	0,000	0,001	0,004	-0,002	0,003	0,002	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,003	0,003	0,002	-0,001	0,001
0,45 ≤ U_rest ≤ 0,60	Pre	0,018	0,000	0,000	0,001	0,000	0,000	0,032	0,000	0,000	0,001	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,029	-0,001	0,001	0,001	0,000	0,000
50.2 according to IEC	Fault	0,047	-0,002	0,002	0,063	0,009	0,008	0,047	-0,003	0,004	0,044	0,022	0,022	0,005	0,000	0,000	0,011	0,000	0,000	0,070	0,001	0,001	0,152	-0,004	0,006
3ph / Partial Load / Kp = 2, Kn=2	Post	0,002	-0,001	0,001	0,001	0,000	0,001	0,002	0,000	0,001	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,000
0,45 ≤ U_rest ≤ 0,60	Pre	0,014	0,000	0,000	0,001	0,000	0,000	0,032	0,000	0,000	0,001	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,027	-0,001	0,001	0,003	0,000	0,000
50.5 according to IEC	Fault	0,008	0,006	0,005	0,006	0,004	0,004	0,015	0,011	0,011	0,009	0,008	0,008	0,001	0,000	0,000	0,001	0,000	0,000	0,012	0,000	0,000	0,011	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	0,002	0,000	0,001	0,001	0,000	0,000	0,002	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,000
0,45 ≤ U_rest ≤ 0,60	Pre	0,022	0,000	0,000	0,043	0,000	0,000	0,027	0,001	0,001	0,045	0,000	0,000	0,002	0,000	0,000	0,001	0,000	0,000	0,027	-0,003	0,003	0,015	-0,001	0,001
50.3 according to IEC	Fault	0,052	0,008	0,008	0,091	0,005	0,006	0,074	0,010	0,011	0,191	0,007	0,008	0,019	0,010	0,010	0,115	0,007	0,006	0,156	0,041	0,042	0,211	0,009	0,008
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	0,004	0,005	0,004	-0,003	0,003	0,002	0,004	0,005	0,004	-0,003	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,003	0,003	0,002	0,000	0,002
0,45 ≤ U_rest ≤ 0,60	Pre	0,013	0,000	0,000	0,022	0,000	0,000	0,024	0,000	0,000	0,023	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,028	-0,001	0,001	0,005	0,000	0,000
50.4 according to IEC	Fault	0,077	0,001	0,016	0,082	0,009	0,010	0,103	0,000	0,021	0,182	0,010	0,013	0,020	0,011	0,011	0,116	0,006	0,006	0,155	0,043	0,045	0,209	0,010	0,009
2ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,005	-0,002	0,003	0,003	0,000	0,001	0,005	-0,003	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,001	0,001
0,45 ≤ U_rest ≤ 0,60	Pre	0,014	0,000	0,000	0,020	0,000	0,000	0,024	0,000	0,000	0,021	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,027	-0,001	0,001	0,006	0,000	0,000
50.6 according to IEC	Fault	0,042	-0,004	0,005	0,019	0,009	0,009	0,055	-0,005	0,006	0,024	0,012	0,012	0,003	-0,003	0,003	0,003	0,001	0,001	0,027	-0,011	0,010	0,045	0,004	0,004
2ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	0,003	0,000	0,001	0,005	0,000	0,002	0,003	0,000	0,001	0,005	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,001	0,001	0,002	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,018	0,000	0,000	0,004	0,000	0,000	0,031	0,001	0,001	0,004	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,020	-0,003	0,003	0,008	-0,001	0,001
75.1 according to IEC	Fault	0,143	-0,014	0,015	0,089	-0,001	0,002	0,174	-0,019	0,020	0,129	-0,002	0,004	0,002	0,000	0,000	0,003	0,000	0,000	0,051	0,004	0,004	0,071	-0,006	0,007
3ph / Full Load / Kp = 2, Kn=2	Post	0,002	-0,002	0,002	0,005	-0,001	0,002	0,005	0,000	0,003	0,005	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,003	0,003	0,002	-0,001	0,001

4. Annex 4 – Validated simulation model

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
0,70 ≤ U_rest ≤ 0,80	Pre	0,023	0,000	0,000	0,002	0,000	0,000	0,027	0,000	0,000	0,002	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,018	-0,001	0,001	0,003	0,000	0,000
75.2 according to IEC	Fault	0,157	-0,005	0,006	0,103	0,004	0,007	0,211	-0,006	0,007	0,144	0,006	0,013	0,003	0,000	0,000	0,004	0,000	0,000	0,094	0,002	0,003	0,108	-0,003	0,004
3ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,005	0,000	0,001	0,003	0,000	0,002	0,005	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,001	0,001	0,001	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,022	0,000	0,000	0,005	0,003	0,003	0,026	0,000	0,000	0,006	0,004	0,004	0,001	0,000	0,000	0,000	0,000	0,000	0,014	0,000	0,000	0,006	-0,002	0,002
75.3 according to IEC	Fault	0,062	-0,029	0,029	0,045	0,012	0,012	0,067	-0,037	0,037	0,081	0,020	0,020	0,002	0,000	0,000	0,002	0,000	0,000	0,043	0,004	0,004	0,067	-0,009	0,010
3ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,008	0,002	0,002	0,003	-0,001	0,001	0,009	0,003	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,003	-0,001	0,002
0,70 ≤ U_rest ≤ 0,80	Pre	0,018	0,000	0,000	0,011	-0,001	0,001	0,023	0,000	0,000	0,004	-0,001	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,019	-0,001	0,001	0,010	0,001	0,001
75.4 according to IEC	Fault	0,143	-0,002	0,003	0,114	0,006	0,010	0,162	-0,001	0,002	0,134	0,008	0,012	0,002	0,000	0,000	0,004	0,000	0,000	0,060	0,004	0,004	0,100	-0,001	0,001
3ph / Partial Load / Kp = 2, Kn=2	Post	0,002	-0,001	0,001	0,006	-0,001	0,002	0,002	0,000	0,001	0,009	-0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,002	0,002	0,002	0,001	0,001
0,70 ≤ U_rest ≤ 0,80	Pre	0,022	0,000	0,000	0,001	0,000	0,000	0,025	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,015	-0,001	0,001	0,002	0,000	0,000
75.5 according to IEC	Fault	0,145	-0,014	0,014	0,118	0,011	0,018	0,170	-0,017	0,017	0,168	0,018	0,030	0,005	0,000	0,000	0,007	0,000	0,000	0,125	0,004	0,006	0,149	-0,015	0,017
3ph / Partial Load / Kp = 4, Kn=4	Post	0,003	-0,001	0,001	0,001	0,000	0,001	0,003	-0,001	0,001	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,051	0,000	0,000	0,020	0,000	0,000	0,030	0,001	0,001	0,021	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,030	-0,003	0,003	0,034	-0,001	0,001
75.6 according to IEC	Fault	0,040	0,001	0,004	0,089	-0,002	0,002	0,040	0,003	0,004	0,110	-0,002	0,002	0,008	0,003	0,003	0,024	0,003	0,003	0,095	0,027	0,027	0,120	0,019	0,018
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	0,001	0,001	0,001	0,000	0,001	0,003	0,002	0,002	0,001	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,003	0,003	0,002	-0,001	0,001
0,70 ≤ U_rest ≤ 0,80	Pre	0,031	0,000	0,000	0,021	0,000	0,000	0,022	0,000	0,000	0,023	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,030	-0,001	0,001	0,030	0,000	0,000
75.7 according to IEC	Fault	0,032	-0,006	0,007	0,025	0,005	0,007	0,047	-0,007	0,007	0,020	0,006	0,009	0,004	0,003	0,003	0,016	0,001	0,001	0,060	0,026	0,026	0,026	0,007	0,006
2ph / Partial Load / Kp = 2, Kn=2	Post	0,003	0,000	0,001	0,001	0,000	0,000	0,003	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	-0,001	0,001	0,001	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,031	0,000	0,000	0,024	0,000	0,000	0,021	0,000	0,000	0,025	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,033	-0,001	0,001	0,031	0,000	0,000
75.8 according to IEC	Fault	0,048	-0,014	0,014	0,051	0,017	0,021	0,063	-0,014	0,014	0,042	0,022	0,027	0,006	0,005	0,005	0,027	0,003	0,003	0,054	0,045	0,046	0,030	0,017	0,016
2ph / Partial Load / Kp = 4, Kn=4	Post	0,003	-0,001	0,001	0,001	0,000	0,001	0,003	0,000	0,001	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,001
0,75 ≤ U_rest ≤ 0,85	Pre	0,021	0,000	0,000	0,006	0,000	0,000	0,025	0,001	0,001	0,006	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,018	-0,003	0,003	0,017	-0,001	0,001
80.1	Fault	0,030	-0,020	0,021	0,070	0,005	0,007	0,052	-0,026	0,027	0,096	0,006	0,009	0,001	0,000	0,000	0,002	0,000	0,000	0,038	0,004	0,004	0,061	-0,005	0,005
3ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	0,003	-0,001	0,001	0,005	-0,001	0,001	0,006	0,002	0,002	0,005	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,003	0,003	0,002	0,000	0,001
0,75 ≤ U_rest ≤ 0,85	Pre	0,015	0,000	0,000	0,016	0,000	0,000	0,027	0,001	0,001	0,016	0,000	0,000	0,002	0,000	0,000	0,001	0,000	0,000	0,038	-0,003	0,003	0,008	-0,001	0,001
80.2	Fault	0,022	0,006	0,006	0,043	0,005	0,006	0,021	0,007	0,007	0,041	0,006	0,007	0,002	0,002	0,002	0,005	0,004	0,004	0,025	0,023	0,023	0,042	0,025	0,024
2ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	0,003	-0,001	0,001	0,006	-0,001	0,001	0,002	0,000	0,002	0,006	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,002	0,003	0,002	-0,001	0,001
0,85 ≤ U_rest ≤ 0,90	Pre	0,012	0,000	0,000	0,030	0,000	0,000	0,010	0,000	0,000	0,035	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,009	-0,001	0,001	0,007	0,000	0,000
85.1 according to IEC	Fault	0,033	-0,001	0,001	0,097	0,000	0,000	0,040	-0,002	0,002	0,109	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,020	0,004	0,004	0,039	-0,004	0,004
3ph / Partial Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,001	0,001	0,000	0,000	0,003	-0,001	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,001	0,000	0,000
U_rest ≥ 1,10	Pre	0,055	-0,001	0,001	0,058	0,000	0,001	0,097	-0,001	0,001	0,055	0,000	0,001	0,003	0,000	0,000	0,003	0,000	0,000	0,062	-0,004	0,004	0,056	-0,001	0,001
110.1 according to IEC	Fault	0,043	-0,032	0,032	0,104	0,000	0,002	0,043	-0,029	0,029	0,097	0,000	0,002	0,002	0,001	0,001	0,006	0,000	0,000	0,062	0,018	0,018	0,105	-0,004	0,006
2ph / Full Load / Kp = 2, Kn=2	Post	0,002	0,000	0,001	0,006	0,000	0,002	0,002	0,001	0,002	0,006	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,003	0,003	0,002	0,000	0,001
U_rest ≥ 1,10	Pre	0,038	0,000	0,000	0,027	0,000	0,000	0,043	0,000	0,001	0,026	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,043	-0,001	0,001	0,029	0,000	0,000
110.2 according to IEC	Fault	0,008	0,000	0,000	0,074	0,004	0,004	0,018	0,000	0,000	0,067	0,004	0,003	0,002	-0,002	0,002	0,006	0,000	0,000	0,053	-0,031	0,031	0,052	-0,002	0,004
2ph / Partial Load / Kp = 2, Kn=2	Post	0,003	0,000	0,000	0,005	0,000	0,002	0,003	0,000	0,000	0,005	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,001	0,003	0,001	0,001
U_rest ≥ 1,10	Pre	0,097	-0,001	0,001	0,083	0,000	0,001	0,084	-0,001	0,001	0,077	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,038	-0,001	0,001	0,025	0,000	0,000
110.3 according to IEC	Fault	0,018	-0,002	0,002	0,166	-0,006	0,006	0,014	-0,002	0,002	0,149	-0,005	0,005	0,000	0,000	0,000	0,000	0,000	0,000	0,039	0,007	0,007	0,023	-0,006	0,006
3ph / Full Load / Kp = 2, Kn=2	Post	0,003	0,000	0,000	0,005	-0,001	0,002	0,003	0,000	0,000	0,005	-0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,004	-0,001	0,001	0,001	0,000	0,000
U_rest ≥ 1,15	Pre	0,020	0,001	0,001	0,002	0,000	0,000	0,029	0,001	0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,024	-0,003	0,003	0,013	-0,001	0,001
115.1 according to IEC	Fault	0,072	-0,006	0,003	0,165	-0,002	0,007	0,020	-0,005	0,003	0,118	-0,002	0,005	0,001	0,000	0,000	0,000	0,000	0,000	0,052	0,006	0,006	0,054	-0,005	0,005
3ph / Full Load / Kp = 2, Kn=2	Post	0,003	-0,001	0,002	0,002	0,002	0,002	0,006	-0,002	0,002	0,002	0,001	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,003	-0,003	0,003	0,001	-0,001	0,001
U_rest ≥ 1,15	Pre	0,127	-0,001	0,001	0,076	0,000	0,000	0,133	-0,001	0,001	0,070	0,000	0,000	0,002	0,000	0,000	0,002	0,000	0,000	0,077	-0,001	0,001	0,066	0,000	0,000
115.2 according to IEC	Fault	0,006	-0,004	0,003	0,118	-0,002	0,007	0,014	-0,003	0,003	0,078	-0,001	0,005	0,001	0,000	0,000	0,000	0,000	0,000	0,051	0,007	0,007	0,054	-0,006	0,006
3ph / Partial Load / Kp = 2, Kn=2	Post	0,003	0,000	0,000	0,004	0,000	0,002	0,003	0,000	0,001	0,004	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,002	0,000	0,001

4. Annex 4 – Validated simulation model

Summary of validation results - SUN2000-215KTL-H0 / SUN2000-215KTL-H3

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.3 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest < 0,05	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,20 ≤ U_rest ≤ 0,30	Pre	0,001	0,000	0,000	0,001	0,000	0,000	0,002	0,001	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	-0,001	0,001
25.1 according to IEC	Fault	0,004	-0,004	0,001	0,055	-0,010	0,013	0,032	-0,006	0,005	0,045	-0,036	0,043	0,001	0,000	0,000	0,000	0,000	0,000	0,020	0,000	0,000	0,002	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2	Post	0,003	0,003	0,004	0,004	0,001	0,003	0,004	0,005	0,006	0,004	-0,001	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,002	-0,001	0,002
0,20 ≤ U_rest ≤ 0,30	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,20 ≤ U_rest ≤ 0,30	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,20 ≤ U_rest ≤ 0,30	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.3 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,45 ≤ U_rest ≤ 0,60	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.6 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2 / Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4. Annex 4 – Validated simulation model

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	0,001	0,000	0,000	0,003	-0,002	0,002	0,001	0,000	0,000	0,003	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,001	0,001	0,001	0,000	0,000
75.3 according to IEC	Fault	0,007	0,003	0,003	0,020	0,001	0,003	0,007	0,005	0,005	0,025	0,001	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	0,000	0,001
3ph / Partial Load / Kp = 2, Kn=2	Post	0,001	0,000	0,001	0,010	-0,001	0,003	0,002	0,000	0,001	0,010	-0,002	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,001	0,002	0,001	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.4 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.5 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 4, Kn=4	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.6 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.7 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,70 ≤ U_rest ≤ 0,80	Pre	0,001	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,001	0,001
75.8 according to IEC	Fault	0,115	0,111	0,112	0,197	0,012	0,017	0,130	0,127	0,128	0,237	0,014	0,021	0,005	0,005	0,005	0,023	0,019	0,019	0,049	0,045	0,045	0,238	0,078	0,079
2ph / Partial Load / Kp = 4, Kn=4	Post	0,001	0,000	0,001	0,003	0,002	0,003	0,002	0,000	0,001	0,003	0,002	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,002	-0,002	0,003
0,75 ≤ U_rest ≤ 0,85	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80.1	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,75 ≤ U_rest ≤ 0,85	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80.2	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2, Limited Mode	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0,85 ≤ U_rest ≤ 0,90	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110.1 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,10	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110.3 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Full Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U_rest ≥ 1,15	Pre	0,001	0,000	0,000	0,001	0,000	0,000	0,002	0,001	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	-0,001	0,001
115.1 according to IEC	Fault	0,079	-0,073	0,071	0,083	0,055	0,056	0,069	-0,064	0,062	0,069	0,048	0,048	0,000	0,000	0,000	0,000	0,000	0,000	0,004	0,000	0,001	0,006	-0,003	0,003
3ph / Full Load / Kp = 2, Kn=2	Post	0,004	-0,001	0,004	0,004	0,000	0,003	0,005	-0,001	0,005	0,004	0,000	0,003	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	-0,001	0,001
U_rest ≥ 1,15	Pre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115.2 according to IEC	Fault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3ph / Partial Load / Kp = 2, Kn=2	Post	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4. Annex 4 – Validated simulation model

Summary of validation results - SUN2000-168KTL-H1 *vs* SUN2000-215KTL-H0 / SUN2000-215KTL-H3

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
SUN2000-168KTL-H1 VS SUN2000-215KTL-H0 / SUN2000-215KTL-H3																									
0,20 ≤ U_rest ≤ 0,30	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
25.1 according to IEC	Fault	0,000	-0,002	0,000	0,000	0,001	0,000	0,000	-0,003	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2	Post	0,000	0,001	0,001	0,000	0,000	0,001	0,000	0,001	0,001	0,000	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
75.3 according to IEC	Fault	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Partial Load / Kp = 2, Kn=2	Post	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
75.8 according to IEC	Fault	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,001
2ph / Partial Load / Kp = 4, Kn=4	Post	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001
U_rest ≥ 1,15	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
115.1 according to IEC	Fault	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2	Post	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

4. Annex 4 – Validated simulation model

Summary of validation results - SUN2000-185KTL-H1 *vs* SUN2000-215KTL-H0 / SUN2000-215KTL-H3

Test label according to TG3, chapter 4.6 - Behavior during grid disturbance - Table 4-68 and 4-69		Positive Sequence												Negative Sequence											
		P			Q			I_w			I_b			P			Q			I_w			I_b		
		MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE	MXE	ME	MAE
SUN2000-185KTL-H1 VS SUN2000-215KTL-H0 / SUN2000-215KTL-H3																									
0,20 ≤ U_rest ≤ 0,30	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
25.1 according to IEC	Fault	0,000	-0,002	0,000	0,000	0,001	0,000	0,000	-0,002	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2	Post	0,000	0,001	0,001	0,000	0,000	0,001	0,001	0,000	0,001	0,000	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,000	0,000	0,000	0,003	0,003	0,003	0,000	0,000	0,000	0,002	0,002	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
75.3 according to IEC	Fault	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Partial Load / Kp = 2, Kn=2	Post	0,000	0,000	0,000	0,003	0,002	0,003	0,000	0,000	0,000	0,002	0,002	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,70 ≤ U_rest ≤ 0,80	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
75.8 according to IEC	Fault	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2ph / Partial Load / Kp = 4, Kn=4	Post	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001
U_rest ≥ 1,15	Pre	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
115.1 according to IEC	Fault	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	-0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3ph / Full Load / Kp = 2, Kn=2	Post	0,000	0,000	0,000	0,000	0,001	0,001	0,001	0,000	0,001	0,000	0,001	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

5. Annex 5 – Certification-relevant parameters

Parameter list from [14]:

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
	Ansprechpartner / *Customer Contact:*	Chen Qingbin Website: http://www.huawei.com Email: support@huawei.com	BV-Kontakt / *BV Contact:*	Weizhao Zheng Tel: +49 40 74041 - 2267 weizhao.zheng@de.bureauveritas.com

Parameter list of SUN2000-185KTL-H1, SUN2000-168KTL-H1, SUN2000-215KTL-H0, SUN2000-215KTL-H3 series

1. General information regarding the Parameter list

Manufacturer:	Huawei Technologies Co., Ltd.
Created by:	Sun Yashen
Created on:	2021-04-30
Revised on:	V2.0

2. Information regarding the power generating unit

Type designation	Rated power [kW]	Rated active current [A] (at cosφ = 1)
SUN2000-185KTL-H1	175	126.3
SUN2000-168KTL-H1	150	108.3
SUN2000-215KTL-H0	200	144.4
SUN2000-215KTL-H3	200	144.4

3. Parameter set during the measurement

If no noted otherwise the following standard parameters were used during the measurement.

All adaptations to the standard parameters used during the measurement were documented in the TG3 test report.

4. Main Components of the regulating system

Main components of the control system with firmware and software	
Main component(s) of the control system	Control system integrated in the PGU
Firmware version	V300R001
Software version	V300R001C00SPC[xxx] * * for xxx ≥ 107

5. Relevant parameters for the electrical behaviour

General parameter settings (rated values or reference values)

No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
1	Pn	Rated active power	kW	Parameter not adjustable		SUN2000-185KTL-H1: 175 SUN2000-168KTL-H1: 150

5. Annex 5 – Certification-relevant parameters

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
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No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
						SUN2000-215KTL-H0: 200 SUN2000-215KTL-H3: 200
2	Smax	Max apparent power	kVA	Parameter not adjustable		SUN2000-185KTL-H1: 185 SUN2000-168KTL-H1: 168 SUN2000-215KTL-H0: 215 SUN2000-215KTL-H3: 215
3	Un	Rated voltage	V	Parameter not adjustable		800
4	In	Rated current	A	Parameter not adjustable		SUN2000-185KTL-H1: 126.3 SUN2000-168KTL-H1: 108.3 SUN2000-215KTL-H0: 144.4 SUN2000-215KTL-H3: 144.4
5	Fn	Rated frequency	Hz	Parameter not adjustable		50
Active power peaks						
6	Pmax	Maximum active power limit	kW	Parameter not adjustable		SUN2000-185KTL-H1: 185 SUN2000-168KTL-H1: 168 SUN2000-215KTL-H0: 215 SUN2000-215KTL-H3: 215
7	Maximum active power	Plimit	kW	0.100	Pmax	Pmax
8	Active power baseline	Pmaxref	kW	0.100	Pmax	Pmax
Operating power limited by grid operator						
9	Shutdown at 0% power limit	Shutdown at 0% power limit function enable	-	Disable / Enable		Disable
10	Active power change gradient	Active power change gradient	%Pmaxref/s	0.100	1000.000	125.000

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5. Annex 5 – Certification-relevant parameters

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
	Ansprechpartner / *Customer Contact:*	Chen Qingbin Website: http://www.huawei.com Email: support@huawei.com	BV-Kontakt / *BV Contact:*	Weizhao Zheng Tel: +49 40 74041 - 2267 weizhao.zheng@de.bureauveritas.com

No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
11	Fixed active power derated	Fixed active power derated	kW	0.0	Plimilt	Plimilt
12	Active power percentage derating	Active power percentage derating	%Pmaxref	0.0	100.0	100.0
13	Reactive power change gradient	Reactive power change gradient	%(0.6Smax)/s	0.100	1000.000	125.000
14	Reactive power adjustment time	Reactive power adjustment time [1)]	s	1	1000	10
Note: [1)] For country code setting VDE-AR-N 4110:2018-11 and VDE-AR-N 4120:2018-11: for all abrupt set-point changes, the reactive power control methods Q(U), Q(P), PF provide PT1 (1st order low pass) filtering effect, in this case the time constant parameter *Reactive power adjustment time* will be effective and corresponding to 3τ.						
Active power feed-in as a function of grid frequency						
15	Overfrequency derating	Overfrequency derating function enable	---	Disable / Enable		Enable
16	Trigger frequency of over frequency derating	Start frequency P(f) (Start of frequency regulation - power reduction)	Hz	40.00	60.00	50.20
17	Quit frequency of over frequency derating	Quit frequency P(f) (End of frequency regulation - power reduction)	Hz	40.00	60.00	50.15
18	Cuttoff frequency of over frequency derating	End frequency P(f) (End of frequency regulation - power reduction)	Hz	40.00	60.00	51.50
19	Cutoff power of over frequency derating	End power P(f) (End of power of frequency regulation - power reduction)	$\%P_M$	0	100	48
20	Power recovery gradient of overfrequency derating	Power recovery gradient when quit overfrequency derating	%Prated/min	1	6000	10
21	Underfrequency rise power	Underfrequency derating function enable	---	Disable / Enable		Disable
22	Trigger frequency of underfrequency rise power	Start frequency P(f) (Start of frequency regulation - power rise)	Hz	40.00	60.00	49.80
23	Quit frequency of underfrequency rise power	Quit frequency P(f) (End of frequency regulation - power rise)	Hz	40.00	60.00	49.90
24	Cuttoff frequency of	End frequency P(f) (End of frequency regulation - power rise)	Hz	40.00	60.00	47.50

5. Annex 5 – Certification-relevant parameters

Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240	
Ansprechpartner / *Customer Contact:*	Chen Qingbin Website: http://www.huawei.com Email: support@huawei.com	BV-Kontakt / *BV Contact:*	Weizhao Zheng Tel: +49 40 74041 - 2267 weizhao.zheng@de.bureauveritas.com	

No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
	underfrequency rise power					
25	Cutoff power of underfrequency rise power	End power P(f) (End of power of frequency regulation - power rise)	%Pmax	0	100	92
26	Power recovery gradient of underfrequency rise power	Power recovery gradient when quit underfrequency rise power	%Prated/min	1	6000	10
Note: The required gradient (or droop) of the frequency dependent active power derating can be defined using the Parameters *Trigger frequency of over frequency derating*, *Cuttoff frequency of over frequency derating* and *Cutoff power of over frequency derating*. The required gradient (or droop) of the frequency dependent active power increasing can be defined using the Parameters *Trigger frequency of underfrequency rise power*, *Cuttoff frequency of underfrequency rise power* and *Cutoff power of underfrequency rise power*.						
Active power gradient following disconnection from the grid						
27	Soft start time after grid failure	The soft start time the active power from 0 to power rated after fault	s	1	1800	600
Reconnection time following disconnection from the grid						
28	Grid connection duration after power grid recovery	Time until reconnection	s	0	7200	600
Reactive power provision						
a) Power factor fix control						
29	Power factor	Cos phi specifications	-	[-1.000,-0.800] & [0.800,1.000]		1.000
b) Reactive power fix control						
30	Reactive power	Q specifications	kVar	-0.6 Smax	0.6 Smax	0.0
c) Q-U characteristic curve [2)]						
Note: [2)] The Q-U characteristic curve is free programmable with up to 10 supporting points.						
31	Trigger power ratio	Q(U) function trigger power ratio of Pmax	%Pmax	10	100	20
32	Characteristic curve points	Number of Q-U characteristic curve	-	2	10	• VDE 4110: 3 • VDE 4120: 4
33	U/Un(A)	Q(U) characteristic node 1 U	%Un	80.0	136.0	• VDE 4110: 96.0 • VDE 4120: 94.0
34	Q/S(A)	Q(U) characteristic node 1 Q	/Smax	-0.600	0.600	• VDE 4110: 0.330 • VDE 4120: 0.330
35	U/Un(B)	Q(U) characteristic node 2 U	%Un	80.0	136.0	• VDE 4110: 100.0 • VDE 4120: 96.0

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5. Annex 5 – Certification-relevant parameters

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
	Ansprechpartner / *Customer Contact:*	Chen Qingbin Website: http://www.huawei.com Email: support@huawei.com	BV-Kontakt / *BV Contact:*	Weizhao Zheng Tel: +49 40 74041 - 2267 weizhao.zheng@de.bureauveritas.com

No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
36	Q/S(B)	Q(U) characteristic node 2 U	/Smax	-0.600	0.600	• VDE 4110: 0.000 • VDE 4120: 0.000
37	U/Un(C)	Q(U) characteristic node 3 U	%Un	80.0	136.0	• VDE 4110: 104.0 • VDE 4120: 104.0
38	Q/S(C)	Q(U) characteristic node 3 Q	/Smax	-0.600	0.600	• VDE 4110: -0.330 • VDE 4120: 0.000
39	U/Un(D)	Q(U) characteristic node 4 U	%Un	80.0	136.0	• VDE 4120: 106.0
40	Q/S(D)	Q(U) characteristic node 4 Q	/Smax	-0.600	0.600	• VDE 4120: -0.330
	d) Q-P characteristic curve [3]					
Note: [3] The Q-P characteristic curve is free programmable with up to 10 supporting points.						
41	Characteristic curve points	Number of Q-P characteristic curve	-	2	10	5
42	P/Pmax(A)	Q(P) characteristic node 1 P	%Pmax	0.0	100.0	10.0
43	Q/Qmax(A)	Q(P) characteristic node 1 Q	/Smax	-0.600	0.600	0.000
44	P/Pmax(B)	Q(P) characteristic node 2 P	%Pmax	0.0	100.0	50.0
45	Q/Qmax(B)	Q(P) characteristic node 2 Q	/Smax	-0.600	0.600	0.000
46	P/Pmax(C)	Q(P) characteristic node 3 P	%Pmax	0.0	100.0	60.0
47	Q/Qmax(C)	Q(P) characteristic node 13 Q	/Smax	-0.600	0.600	-0.050
48	P/Pmax(D)	Q(P) characteristic node 4 P	%Pmax	0.0	100.0	90.0
49	Q/Qmax(D)	Q(P) characteristic node 4 Q	/Smax	-0.600	0.600	-0.330
50	P/Pmax(E)	Q(P) characteristic node 5 P	%Pmax	0.0	100.0	100.0
51	Q/Qmax(E)	Q(P) characteristic node 5 Q	/Smax	-0.600	0.600	-0.330
PGU disconnection from the grid						
52	10 minute OV protection	10 minute voltage average value protection point	p.u	1.00Un	1.25Un	1.25Un
53	10 minute OV protection time	10 minute voltage average value protection time	ms	50	7200000	200
54	Level-1 OV protection	Level 1 over voltage protection point	p.u	1.00Un	1.25Un	1.12Un
55	Level-1 OV protection time	Level 1 over voltage protection time	ms	50	7200000	• VDE 4110: 180000

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5. Annex 5 – Certification-relevant parameters

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
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No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
						• VDE 4120: 1800000
56	Level-2 OV protection	Level 2 over voltage protection point	p.u	1.00Un	1.36Un	1.25Un
57	Level-2 OV protection time	Level 2 over voltage protection time	ms	50	7200000	66000
58	Level-3 OV protection	Level 3 over voltage protection point	p.u	1.00Un	1.36Un	1.30Un
59	Level-3 OV protection time	Level 3 over voltage protection time	ms	50	7200000	200
60	Level-1 UV protection	Level 1 under voltage protection point	p.u	0.15Un	1.00Un	0.87Un
61	Level-1 UV protection time	Level 1 under voltage protection time	ms	50	7200000	• VDE 4110:66000 • VDE 4120:3600000
62	Level-2 UV protection	Level 2 under voltage protection point	p.u	0.15Un	1.00Un	0.80Un
63	Level-2 UV protection time	Level 2 under voltage protection time	ms	50	7200000	6000
64	Level-1 OF protection	Level 1 over frequency protection point	Hz	50.00	60.00	51.00
65	Level-1 OF protection time	Level 1 over frequency protection time	ms	50	7200000	1800000
66	Level-2 OF protection	Level 2 over frequency protection point	Hz	50.00	60.00	51.50
67	Level-2 OF protection time	Level 2 over frequency protection time	ms	50	7200000	100
68	Level-1 UF protection	Level 1 under frequency protection point	Hz	40.00	50.00	49.00
69	Level-1 UF protection time	Level 1 under frequency protection time	ms	50	7200000	1800000
70	Level-2 UF protection	Level 2 under frequency protection point	Hz	40.00	50.00	47.50
71	Level-2 UF protection time	Level 2 under frequency protection time	ms	50	7200000	100
Connection conditions						
72	Grid connection voltage upper limit	Limit value connection U>	p.u	Un	1.36Un	1.10Un
73	Grid connection voltage lower limit	Limit value connection U<	p.u	0.45Un	Un	0.9Un
74	Grid connection frequency upper limit	Limit value connection f>	Hz	50.00	60.00	• VDE 4110:50.20 • VDE 4120: 51.00
75	Grid connection frequency lower limit	Limit value connection f<	Hz	40.00	50.00	47.50

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5. Annex 5 – Certification-relevant parameters

	Firma / *Company:*	Huawei Technologies Co., Ltd.	Projekt-Nr. / *Project-no.:*	19TH0240
	Ansprechpartner / *Customer Contact:*	Chen Qingbin Website: http://www.huawei.com Email: support@huawei.com	BV-Kontakt / *BV Contact:*	Weizhao Zheng Tel: +49 40 74041 - 2267 weizhao.zheng@de.bureauveritas.com

No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
76	Auto start upon grid recovery	Enable Auto start upon grid after grid fault	/	Disable/Enable		Enable
77	Grid reconnection voltage upper limit	Limit value connection U>	p.u	Un	1.36Un	1.10Un
78	Grid reconnection voltage lower limit	Limit value connection U<	p.u	0.45Un	Un	0.95Un
79	Grid reconnection frequency upper limit	Limit value connection f>	Hz	50.00	60.00	50.10
80	Grid reconnection frequency lower limit	Limit value connection f<	Hz	40.00	50.00	49.90
Response during grid faults						
81	LVRT	LVRT enable	-	Enable/Disable		Enable
82	LVRT triggering threshold	LVRT triggering threshold	p.u	0.50Un	1.00Un	0.90Un
83	LVRT reactive power compensation factor	k factor	-	0.0	10.0	2.0
84	HVRT	HVRT enable	-	Enable/Disable		Enable
85	HVRT triggering threshold	LVRT triggering threshold	p.u	1.00Un	1.36Un	1.10Un
86	HVRT reactive power compensation factor	k factor	-	0.0	6.0	2.0
87	VRT exit hysteresis threshold	VRT exit hysteresis threshold	p.u	0.02Un	0.1Un	0.02Un
88	Grid voltage protection shield during HVRT/LVRT	Grid voltage protection shield during HVRT/LVRT	-	Enable/Disable		Disable
89	Zero current due to power grid fault	Zero current due to power grid fault	-	Enable/Disable		Disable
90	Grid voltage jump triggering threshold	Grid voltage jump triggering threshold	%Un	3.0	30.0	5.0
LVRT Characteristic Curve						
91	Characteristic Curve points	Number of LVRT characteristic curve points	-	2	10	5

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5. Annex 5 – Certification-relevant parameters

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No.	Name	Description	Unit	Setting range		Default value (acc. to parameter set)
				Min.	Max.	
92	t(A)	LVRT characteristic node 1 t	ms	0	60000	0
93	U(A)	LVRT characteristic node 1 U	%Un	0	100	100
94	t(B)	LVRT characteristic node 2 t	ms	0	60000	0
95	U(B)	LVRT characteristic node 2 U	%Un	0	100	0
96	t(C)	LVRT characteristic node 3 t	ms	0	60000	220
97	U(C)	LVRT characteristic node 3 U	%Un	0	100	0
98	t(D)	LVRT characteristic node 4 t	ms	0	60000	3000
99	U(D)	LVRT characteristic node 4 U	%Un	0	100	75
100	t(E)	LVRT characteristic node 5 t	ms	0	60000	5000
101	U(E)	LVRT characteristic node 5 U	%Un	0	100	85
Communication disconnection fail-safe						
102	Communication disconnection fail-safe	-	-	Enable/Disable		Disable
103	Communication disconnection detection time	-	s	1	7200	3
104	Failsafe Active Power Mode	-	%Pmax/ Fixed Value	-	-	-
105	Failsafe Active Power Limits	-	%Pmax	0.0	100.0	0.0
			Fixed Value	0.0	Pmax	0.0
106	Failsafe Reactive Power Mode	-	Power factor/ Q/S	-	-	-
107	Failsafe reactive power limit	-	Power factor	(-1.000,-0.800] & [0.800,1.000]		1
			Q/S	[-1.000, 1.000]		0
Self-protection						
108	Line voltage peak value protection point	Line voltage peak value protection point, exceeds which a non-delayed self-protection tripping occurs	V	parameter not adjustable		$1.35U_n$

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5. Annex 5 – Certification-relevant parameters

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6. Relevant parameters for the electrical behaviour

Reading out the parameters

☒ The parameters can be read out using the following software.

Name:	SmartLogger WebUI and SUN2000 APP
Version:	SmartLogger:V200R002 SUN2000 APP:3.2.00.002

☐ The parameters can be read out using the display in the control system.

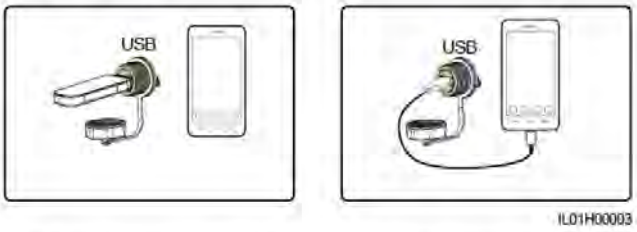
7. Interfaces

7.1. Active power specification

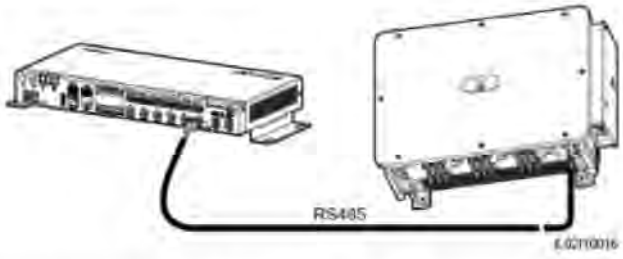
Interfaces for the active power reduction by defined set point

Following interfaces for control of the active power provision are provided on the PGU level:

- connect a mobile phone that runs the SUN2000 app to the inverter using a Bluetooth module, a WLAN module, or a USB data cable for active power setting using parameter *Fixed active power derated* or *Active power percentage derating*;



- connect the inverter to Smartlogger via MBUS or RS485 for active power setting using the WebUI using the parameter *Fixed active power derated* or *Active power percentage derating*.



- connect the inverter to Smartlogger via MBUS or RS485, the digital interfaces DI1, DI2, DI3, DI4 of the Smartlogger can be connected to the dry contacts for active power setting.

5. Annex 5 – Certification-relevant parameters

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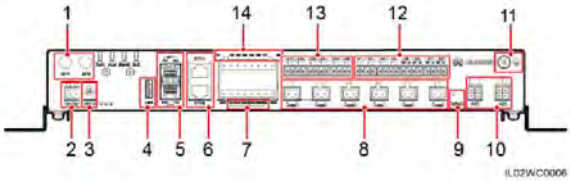
Figure 2-4 SmartLogger2000-10/10-B/11-B bottom



14	DI1–DI8	Digital parameter input	Connects to a dry contact input. GND1 and GND2 are grounding ports for DI signals.

8.1.2 DI Active Scheduling

NOTICE

- When setting this function, ensure that the DI port for customized control is not occupied. Otherwise, the setting will fail.
- Before setting this function, ensure that the SmartLogger is properly connected to the Ripple Control Receiver.

Parameter	Description
Active Power Control Mode	Set this parameter to **DI active scheduling**.
DI **NOTE** The DI parameters include **DI1**, **DI2**, **DI3**, **DI4**, and **Percentage(%)**.	• Supports 16 levels of percentages. • "√" indicates a low level. When DI+ and DI– are connected, the four DI ports of the SmartLogger are low-level ports. If not connected, the ports are high-level ports. • The percentage levels of DI1–DI4 should differ from each other. Otherwise, an abnormal command will be generated. • If the actual input DI signal is inconsistent with that configured on the WebUI, the SmartLogger controls the inverter to work at full power and the Abnormal Reactive Schedule alarm is raised.

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5. Annex 5 – Certification-relevant parameters

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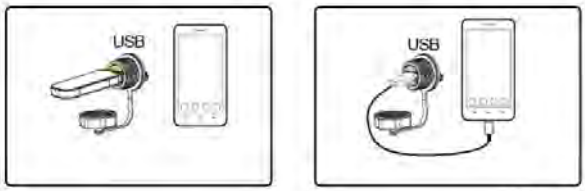
7.2. Reactive power specification

Interfaces for the provision of reactive power

Following interfaces for control of the reactive power provision are provided on the PGU level:

- connect a mobile phone that runs the SUN2000 app to the inverter using a Bluetooth module, a WLAN module, or a USB data cable for:
  - *Power factor fix control*
  - *Reactive power fix control*
  - Q-P characteristic curve
  - Q-U characteristic curve

  setting;

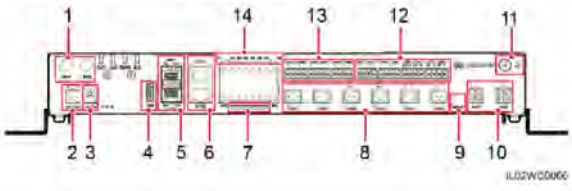


- connect the inverter to Smartlogger via MBUS or RS485, the following reactive power control functions:
  - *Power factor fix control*
  - *Reactive power fix control*
  - Q-P characteristic curve
  - Q-U characteristic curve

  can be set using the WebUI.

- connect the inverter to Smartlogger via MBUS or RS485, the digital interfaces DI5, DI6, DI7, DI8 of the Smartlogger can be connected to the dry contacts for power factor (cosφ) setting.

Figure 2-4 SmartLogger2000-10/10-B/11-B bottom



14	DI1-DI8	Digital parameter input	Connects to a dry contact input. GND1 and GND2 are grounding ports for DI signals.

5. Annex 5 – Certification-relevant parameters

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8.2.2 DI Reactive Scheduling

NOTICE

- When setting this function, ensure that the DI port for customized control is not occupied. Otherwise, the setting will fail.
- Before setting this function, ensure that the SmartLogger is properly connected to the Ripple Control Receiver.

Parameter	Description
Reactive power control mode	Set this parameter to **DI reactive scheduling**.
DI **NOTE** The DI parameters include **DI5**, **DI6**, **DI7**, **DI8**, and **Power factor**.	• Sixteen levels are supported for power factors. • "√" indicates a low level. When connecting to GND2, the four DI ports of the SmartLogger are low-level ports. If not connected, the ports are high-level ports. • The percentage levels of DI5–DI8 should differ from each other. Otherwise, an abnormal command is generated. • If the actual input DI signal is inconsistent with that configured on the WebUI, the SmartLogger controls the inverter to work at full power and the Abnormal Reactive Schedule alarm is raised.

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Figure 28 – Parameter list from [14]