TEST REPORT

CEI 0-21

Reference technical rules for the connection of active and passive users to the LV networks of electrical distribution companies

Report No. :	**CQEY-ESH-P25071524**
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Testing laboratory name :	**Bureau Veritas Consumer Products Services Germany GmbH**
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Accreditation :	ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12024-03-00
Applicant's name :	**Guangdong Felicity New Energy Co., Ltd.**
Address :	(KongGangBaiYun)No. 2, Donghua Huaye Road, Renhe Town, Baiyun Area Guangzhou Guangdong P.R. China
Test specification	
Standard :	CEI 0-21:2022-03 + V1:2022 + V2:2024 + V2/EC:2024+ V2/EC2:2025 Note:. The device is for systems up to 11,08kW Annex Bbis Testing of storage systems
Certificate :	**Certificate of compliance**
Template number standard :	CEI 0-21_11
Master TRF originator :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description :	**Hybrid Inverter**
Trademark :	FelicityESS
Model / Type :	T-REX-3KLP1G01, T-REX-3K6LP1G01, T-REX-4KLP1G01, T-REX-4K6LP1G01, T-REX-5KLP1G01, T-REX-6KLP1G01

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Characteristics of the static converter and storage system (SdA)			
Static converter model	T-REX-6KLP1G01	T-REX-5KLP1G01	T-REX-4K6LP1G01
Input (PV DC)			
MPP voltage range [V]	100-500		
Max. input voltage [V]	550		
Max. input current per MPP tracker [A]	15/15		
Input (battery DC)			
DC voltage range [V]	40-60		
Max. DC voltage [V]	60		
Max. DC current per DC input [A]	120	100	
AC connection			
Nominal AC voltage [V]	L/N/PE, 230V, 50/60Hz		
Rated output current [A]	26	21,7	20
Max. output current [A]	30	25	25
Nominal output power converter (P_{NINV}) [W]	6000	5000	4600
Rated apparent output power converter [VA]	6000	5000	4600
On-grid battery mode			
P_{sn} (nominal discharge power) [W].	6000	5000	4600
P_{cn} (nominal charging power) [W]	6000	5000	4600
P_{smax} (max. discharge power) [W]	6000	5000	4600
P_{cmax} (max. charging power) [W]	6000	5000	4600
Type	Bidirectional		
Off-grid battery mode			
P_{sn} (nominal discharge power) [W]	6000	5000	4600
P_{smax} (max. discharge power) [W]	6000	5000	4600

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Characteristics of the static converter and storage system (SdA)			
Static converter model	T-REX-4KLP1G01	T-REX-3K6LP1G01	T-REX-3KLP1G01
Input (PV DC)			
MPP voltage range [V]	100-500		
Max. input voltage [V]	550		
Max. input current per MPP tracker [A]	15/15		
Input (battery DC)			
DC voltage range [V]	40-60		
Max. DC voltage [V]	60		
Max. DC current per DC input [A]	100		
AC connection			
Nominal AC voltage [V]	L/N/PE, 230V, 50/60Hz		
Rated output current [A]	17,4	15,6	13
Max. output current [A]	21,7	19,5	16,3
Nominal output power converter (P_{NINV}) [W]	4000	3600	3000
Rated apparent output power converter [VA]	4000	3600	3000
On-grid battery mode			
P_{sn} (nominal discharge power) [W].	4000	3600	3000
P_{cn} (nominal charging power) [W]	4000	3600	3000
P_{smax} (max. discharge power) [W]	4000	3600	3000
P_{cmax} (max. charging power) [W]	4000	3600	3000
Type	Bidirectional		
Off-grid battery mode			
P_{sn} (nominal discharge power) [W]	4000	3600	3000
P_{smax} (max. discharge power) [W]	4000	3600	3000

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Batteries that can be used with the above static converters								
Brand	Guangdong Felicity New Energy Co., Ltd.							
Technology	LiFePO4							
Model	FLB48314TG1							
Nominal voltage [V]	51,2							
CUS Module (kWh)	16,08	32,15	48,23	64,31	80,38	96,46	112,54	128,61
Nominal Capacity [Ah]	314	628	942	1256	1570	1884	2198	2512
Version firmware BMS	V201-00							
No. of modules	1	2	3	4	5	6	7	8
Brand	Guangdong Felicity New Energy Co., Ltd.							
Technology	LiFePO4							
Model	FLB48314TG1							
Nominal voltage [V]	51,2							
CUS Module (kWh)	144,69	160,77	176,84	192,92	209,00	225,08	241,15	257,23
Nominal Capacity [Ah]	2826	3140	3454	3768	4082	4396	4710	5024
Version firmware BMS	V201-00							
No. of modules	9	10	11	12	13	14	15	16
Brand	Guangdong Felicity New Energy Co., Ltd.							
Technology	LiFePO4							
Model	FLB48314TG1							
Nominal voltage [V]	51,2							
CUS Module (kWh)	273,31	289,38	305,46	321,54	337,61	353,69	369,77	385,84
Nominal Capacity [Ah]	5338	5652	5966	6280	6594	6908	7222	7536
Version firmware BMS	V201-00							
No. of modules	17	18	19	20	21	22	23	24
Brand	Guangdong Felicity New Energy Co., Ltd.							
Technology	LiFePO4							
Model	FLB48314TG1							
Nominal voltage [V]	51,2							
CUS Module (kWh)	401,92	418,00	434,07	450,15	466,23	482,30	498,38	514,46
Nominal Capacity [Ah]	7850	8164	8478	8792	9106	9420	9734	10048
Version firmware BMS	V201-00							
No. of modules	25	26	27	28	29	30	31	32

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Testing Location..... :	**LCIE China Company Limited**
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Tested by (name, function and signature)..... :	Joell Qin Joell Qin Test Engineer Digitally signed by Joell Qin DN: cn=Joell Qin, o=LCIE CHINA COMPANY LIMITED, ou=New energy, email=joell.qin@bureauveritas.com, c=CN Date: 2025.11.11 11:08:36 +08'00'
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Manufacturer's name..... :	**Guangdong Felicity New Energy Co., Ltd.**
Manufacturer's address ..... :	(KongGangBaiYun)No. 2, Donghua Huaye Road, Renhe Town, Baiyun Area Guangzhou Guangdong P.R. China
Factory name..... :	**Guangdong Felicity New Energy Co., Ltd.**
Factory address..... :	(KongGangBaiYun)No. 2, Donghua Huaye Road, Renhe Town, Baiyun Area Guangzhou Guangdong P.R. China

Document History

Date	Internal reference	Modification / Change / Status	Revision
2025-11-11	Joell Qin	Initial report was written	0

Supplementary information:

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TEMP-0058-TG-EAW-ES-V01

Test items particulars	
Equipment mobility ..... :	Permanent connection
Operating condition ..... :	Continuous
Class of equipment..... :	Class I
Protection against ingress of water..... :	IP65 according to EN 60529
Mass of equipment [kg]..... :	32,4 kg for all models
Test case verdicts	
Test case does not apply to the test object..... :	N/A
Test item does meet the requirement..... :	P(ass)
Test item does not meet the requirement..... :	F(ail)
Testing	
Date of receipt of test item ..... :	2025-10-10
Date(s) of performance of test..... :	2025-10-10 to 2025-11-05

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General remarks

The test result presented in this report relate only to the object(s) tested.

The report shall state compliance of the tested objects with the requirements of CEI 0-21. This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

All information in this test report limited to the type label, warning markings, trademark, block diagram, manual and datasheets are provided by the customer.

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed. The measurement result is considered as "pass" according to the requirement if it is within the prescribed limit or exactly on the limit.

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

Throughout this report a comma is used as the decimal separator.

- “P_{rE}” for the rated active power:
- “P_{rE}” = U_n x I_r x cos φ (single-Phase); P_{rE} = √ 3 U_n x I_r x cos φ (three-Phase)
- “P_{ref}” for the momentary power
- “P_n” nominal active output power
- “f_n” is the nominal frequency
- “S_n” is the nominal Apparent power
- “CUS” (Useful Capacity of the Storage System): quantity of energy available at the terminals of the storage system between the minimum and maximum states of charge of the system
- “P_{SN}” (Nominal Discharge Power): the maximum power the system can discharge throughout the
- “P_{CN}” (Nominal Charge Power): the maximum power the system can charge throughout the CUS
- $2P_{SMAX}$” (Maximum Discharge Power): the discharge power that the system must guarantee within the range 10 % - 90 % of the CUS.
- “P_{CMAX}” (Maximum Charge Power): the charging power that the system must guarantee within the range 10 % - 90 % of the CUS.
- “P_{NINV}”=(Nominal power of bidirectional inverter/converter): the nominal power of the inverter or of the bidirectional converter which connects the storage system to the network.
- “ΔP_{E60}” in [%] = ($P_{Setpoint}$ – P_{E60}) / P_{rE}
- “ΔQ_{E60}” in [%] = ($Q_{expected}$ – Q_{E60}) / P_{Emax}
- “$_{E0,2}$” for gliding average values over 200 milliseconds
- “$_{E60}$” for gliding average values over 60 seconds
- “$_{E600}$” for gliding average values over 10 minutes
- “(c)” for over-excited
- “(i)” for under-excited

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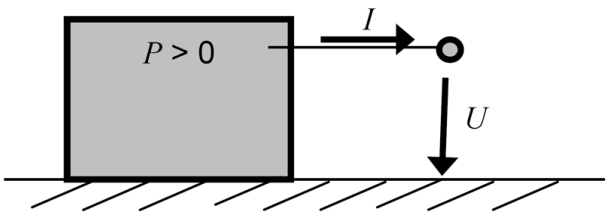
Active and reactive power

The regarded system of the voltage and current vectors is the producer view (Figure 2):

- if the inverter feeds to the grid the active power is measured with positive sign.



For the representation in quadrants, a power circle is chosen whose representation is compatible with mathematical representations of trigonometry and complex numbers (see Figure 2). Angles are counted positively counter-clockwise as in mathematics. The phase angle is defined as the angle from the current pointer to the voltage pointer. The current pointer is always in the real axis; the position of the voltage pointer corresponds to the apparent power and the phase angle.

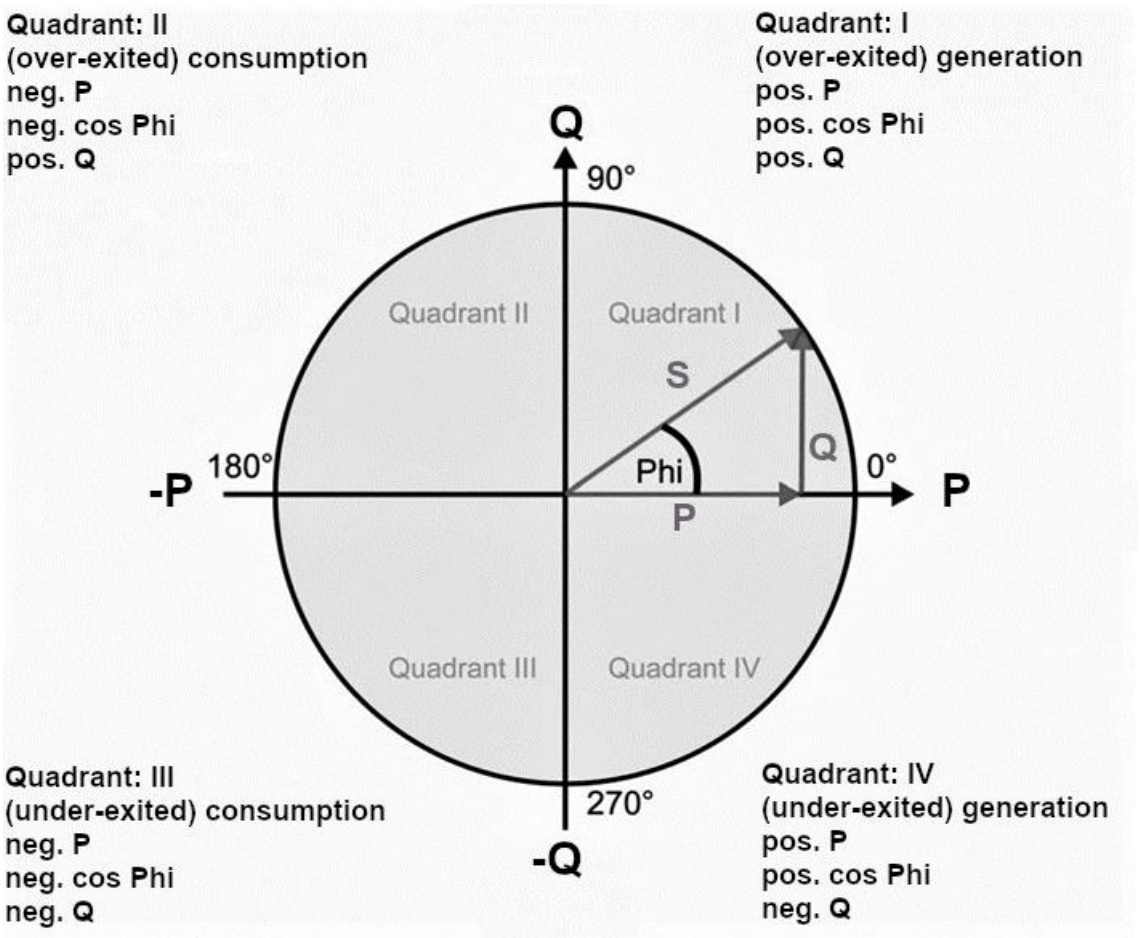


Figure 2

The different operating states can be represented in quadrants I to quadrant IV. The quadrants are named in a counter-clockwise direction.

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This Test Report consists of the following documents

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Copy of marking plate

FelicityESS™

Model: T-REX-3KLP1G01	
Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	100Ad.c/100Ad.c
Max. Charging and Discharging Power	3000W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	3900W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	13Aa.c
Max. Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	3000W
AC Output Rated Apparent Power	3000VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	13Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	3000W
AC Output Rated Apparent Power	3000VA
Non-isolated topology, IP65,Class i protective class	

RoHS

CAUTION:

High Voltage,warning electric shock

Keep the equipment well ventilated

The capacitors store hazardous energy Do not touch while working

Manufacturer:
Guangdong Felicity New Energy Co., Ltd

Address:
(KongGangBaiYun)No. 2, Donghua Huaye Road, Renhe Town, Baiyun Area, Guangzhou, Guangdong, P. R. CHINA

FelicityESS™

Model: T-REX-3K6LP1G01	
Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	100Ad.c/100Ad.c
Max. Charging and Discharging Power	3600W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	4700W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	15.6Aa.c
Max. Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	3600W
AC Output Rated Apparent Power	3600VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	15.6Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	3600W
AC Output Rated Apparent Power	3600VA
Non-isolated topology, IP65,Class i protective class	

RoHS

CAUTION:

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FelicityESS™

Model: T-REX-4KLP1G01

Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	100Ad.c/100Ad.c
Max. Charging and Discharging Power	4000W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	5200W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	17.4Aa.c
Max.Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	4000W
AC Output Rated Apparent Power	4000VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	17.4Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	4000W
AC Output Rated Apparent Power	4000VA
Non-isolated topology, IP65,Class i protective class	

RoHS

CAUTION:
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- The capacitors store hazardous energy Do not touch while working !

Manufacturer:
Guangdong Felicity New Energy Co., Ltd
Address:
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FelicityESS™

Model: T-REX-4K6LP1G01

Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	100Ad.c/100Ad.c
Max. Charging and Discharging Power	5000W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	6500W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	20Aa.c
Max. Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	4600W
AC Output Rated Apparent Power	4600VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	20Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	4600W
AC Output Rated Apparent Power	4600VA
Non-isolated topology, IP65,Class i protective class	
4.6KW/4.6KVA for VDE-AR-4105 and NRS 097-2-1	

RoHS

CAUTION:
- High Voltage,warning electric shock
- Keep the equipment well ventilated
- The capacitors store hazardous energy Do not touch while working !

Manufacturer:
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FelicityESS™

Model: T-REX-5KLP1G01

Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	100Ad.c/100Ad.c
Max. Charging and Discharging Power	5000W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	6500W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	21.7Aa.c
Max. Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	5000W
AC Output Rated Apparent Power	5000VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	21.7Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	5000W
AC Output Rated Apparent Power	5000VA
Non-isolated topology, IP65,Class i protective class	
4.6KW/4.6KVA for VDE-AR-4105 and NRS 097-2-1	

RoHS

CAUTION:

- High Voltage,warning electric shock
- Keep the equipment well ventilated
- The capacitors store hazardous energy Do not touch while working !

Manufacturer:
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FelicityESS™

Model: T-REX-6KLP1G01

Product Type	Hybrid Inverter
Overvoltage-category	DC II:AC III
Ambient Temperture	–25°C~60°C,>45°C Derating
Battery	
Battery Voltage Range	40Vd.c~60Vd.c
Max. Charging and Discharging Current	120Ad.c/120Ad.c
Max. Charging and Discharging Power	6000W
PV	
PV Input Voltage	360Vd.c(90Vd.c~550Vd.c)
MPPT Input Range	100Vd.c~500Vd.c
Max. Input Current	15Ad.c/15Ad.c
Max. Shorted Current	18Ad.c/18Ad.c
Max. PV Input Power	7800W
On-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	26Aa.c
Max. Continuous AC Passthrough	40Aa.c
AC Output Rated Active Power	6000W
AC Output Rated Apparent Power	6000VA
AC Output Power Factor	0.8 Leading To 0.8 Lagging
Off-Grid Mode	
AC Output Voltage	230Va.c
AC Output Frequency	50/60Hz
AC Output Rated Current	26Aa.c
Max. AC Output Current	30Aa.c
AC Output Rated Active Power	6000W
AC Output Rated Apparent Power	6000VA
Non-isolated topology, IP65,Class i protective class	
4.6KW/4.6KVA for VDE-AR-4105 and NRS 097-2-1	

RoHS

CAUTION:

- High Voltage,warning electric shock
- Keep the equipment well ventilated
- The capacitors store hazardous energy Do not touch while working !

Manufacturer:
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Note

Example of marking plate

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General product information

USER GUIDE

T-REX-3KLP1G01/3K6LP1G01/
4KLP1G01/4K6LP1G01/
5KLP1G01/6KLP1G01

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Hybrid inverters

Power factor	>0.99					
Displacement power factor	0.8leading...0.8lagging					
THDI	<3%					
AC Output Data(Back Up)						
Rated output power	3000VA/3000W	3600VA/3600W	4000VA/4000W	4600VA/4600W	5000VA/5000W	6000VA/6000W
Max. Output current	30A					
Rated AC output voltage	230Vac					
Rated AC output frequency	50/60Hz					
AC Output Data(Back Up)						
Max. efficiency	97.5%	97.5%	97.5%	97.6%	97.6%	97.6%
Euro efficiency	96.7%	96.7%	96.8%	97%	97%	97%
MPPT efficiency	99.9%					
Protection						
Output over current protection	Integrated					
Output over power protection	Integrated					
Output shorted protection	Integrated					
Anti-islanding protection	Integrated					
GFCI Protection	Integrated					
Insulation Resistor Detection	Integrated					
General Data						
Operating temperature range	-25°C~60°C,>45°C Derating					
Protection degree	IP65					
Relative humidity	100%					
Cooling concept	Nature					Intelligent Air Cooling
Altitude	2000m					
Communication	RS232/RS485					
BMS Communication	CAN/RS485					
Monitor module	WiFi/GPRS					

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TEMP-0058-TG-EAW-ES-V01

Appendix

Model	T-REX-3KLP1G01	T-REX-3K6LP1G01	T-REX-4KLP1G01	T-REX-4K6LP1G01	T-REX-5KLP1G01	T-REX-6KLP1G01
Battery Input Data						
Battery Voltage Range	40V~60V					
Max. charging and discharging current	100A/100A					120A/120A
Max. charging and discharging power	3000W	3600W	4000W	4600W	5000W	6000W
Battery type	Li-Ion /Lead-acid					
DC Input Data (PV side)						
Max. recommended PV power	3900W	4700W	5200W	6000W	6500W	7800W
Max. PV voltage	550V					
Start voltage	130V					
PV voltage range	90V~550V					
MPPT voltage range	100V~500V					
MPPT Voltage Range for Full Load	140V~500V	160V~500V	175V~500V	200V~500V	220V~500V	260V~500V
Nominal voltage	360V					
Max. input current	15A/15A					
Max. shorted curent	18A/18A					
Number of MPP trackers /strings per MPP tracker	2/1					
Grid Data						
Nominal Input Voltage	230Vac					
Input Voltage Range	184~264.5Vac					
Nominal grid frequency	50/60Hz					
Max. input current	40A					
Max. Charge Current	100A					120A
Max. AC output power	3000W	3600W	4000W	4600W	5000W	6000W
AC Output Rated Current	13A	15.6A	17.4A	20A	21.7A	26A
Max. output current	16.3A	19.5A	21.7A	25A	25A	30A
Max. Continuous AC Passthrough	30A					

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Hybrid inverters

Display	LCD+LED
Installation Style	Wall-mounted
Warranty	10 years
Grid Regulation	VDE-AR-N 4105; G99/1; EN50549-1; CEI 0-21; AS 4777.2; NRS 097-2-1;
Safety Regulation	IEC 62109-1/2 , IEC 62040-1
EMC	EN61000-6-1 , EN61000-6-3
Net Weight	32.4KG
Gross Weight	39.1KG
Product Dimension	530*493*228MM
Package Dimension	632*570*315MM
[1]Conditions apply,refer to FelicityESS Warranty policy.	

* **According to local grid-connected standards**

Features:

- Support WiFi for mobile monitoring
- 48V low voltage battery, transformer isolation topology
- Max. charging/discharging current of 120A
- AC couple to retrofit existing solar system
- Support storing energy from diesel generator
- Power supply can be switched automatically and switching time within 20ms

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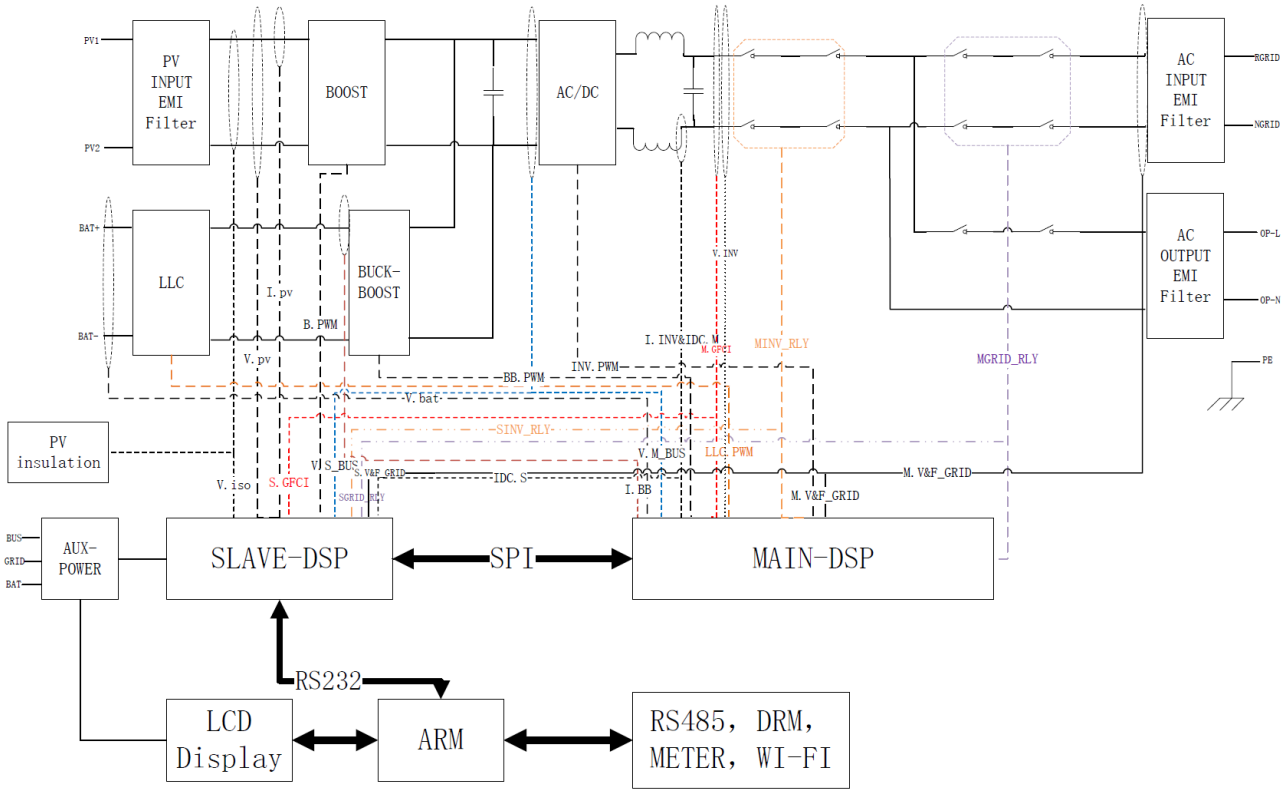
Block diagram of the utility interactive inverter:

The DC input of solar converter can be supplied from PV array and Batteries.
The charging current to batteries can from PC array or Grid through the inversion circuit, battery management unit is integrated in External Energy storage system.
The Solar inverter is a single-phase type, the unit is providing EMC filtering at the output toward mains. The unit doesn't 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 will also operate in case of on error. And the battery is charged from PV array or Grid.

The internal control is redundant built, It consists of master controller(U10) and slave controller(U27), the master controller(U10) can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current, The slave controller (U27) can control the relays, measures the voltage and frequency, Both controllers communicate with each other. The voltage and frequency measurement is achieved with resistors in serial which are connected directly to line and neutral. The master controllers get these signals and calculate the data.

The unit provides multiple relays in series in each phase. The relays are tested before each start up. In addition the power bridge can be stopped by master controllers

Figure 1 – Block Diagram for All model



Differences of the models in the series

The only difference between model T-REX-3KLP1G01, T-REX-3K6LP1G01, T-REX-4KLP1G01, T-REX-4K6LP1G01, T-REX-5KLP1G01 and T-REX-6KLP1G01 is the product label model and the software, others are the same.

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The product was tested on

The product(s) with serial number, 100202001624210005, 020505004823490186, 020505004822470295, 020505004822380076, 020505004823280034 was/were tested on 100202001624210004

Model	Serial number	Photo
T-REX-6KLP1G01	100202001624210004	
T-REX-5KLP1G01	020505004823280034	
T-REX-4K6LP1G01	020505004822380076	
T-REX-4KLP1G01	020505004822470295	

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T-REX-3K6LP1G01	020505004823490186	
T-REX-3KLP1G01	100202001624210005	

Hardware: V2203

Software: Main DSP: V2203, Slave DSP: V202, ARM: V202

All tests were performed on EUT T-REX-6KLP1G01 and are valid for the whole series. Tests of the EUT T-REX-6KLP1G01not applicable for the model(s) T-REX-3KLP1G01, T-REX-3K6LP1G01, T-REX-4KLP1G01, T-REX-4K6LP1G01, T-REX-5KLP1G01 were performed on the concerned model(s) and a statement is given at the relevant test.

TOPOLOGY OF THE DEVICE, WHICH THIS CERTIFICATE IS BASED ON			
Disconnection Device	**Interface Protection Device**	**Device For Static Conversion**	**Rotating Generator Device**
X	**X**	**X**	

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Test Results

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
A.2	Features of the SPI	**P**
A.3.1-3.4	Adjustable ranges of the interface protection system	**P**
A.4.3	Functional tests on the interface protection system (SPI)	**P**
A.4.4	Self-test	**P**
A.4.5	Single fault tolerance	**P**
A.4.6	EMC compatibility tests	**P**
A.4.7	Climatic compatibility tests	**P**
A.4.8	Insulation tests	**P**
A.4.9	Tests for the overload capacity of measuring circuits	**N/A**
A.4.10	Compliance of equipment	**N/A**
A.4.11	Automatic mechanism to prevent current imbalance during production	**P**

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A.2	Features of the SPI	P

The SPI must provide

- a minimum voltage protection function with two thresholds;

- a maximum voltage protection function with two thresholds;

- a minimum frequency protection function with two thresholds;

- a maximum frequency protection function with two thresholds;

- a signal processing function in the case of installation of a dedicated device (protective relay);

- a presence signal processing function;

- a self-diagnosis function;

- a self-test function (obligatory if integrated in the inverter control system of a production plant with a total power output of up to 11,08 kW); any transducers for the acquisition of voltage signals;

- an opening circuit of the interface device;

- for the external SPI only, an auxiliary power supply system which allows it to operate for at least 5 s in the absence of the main power supply. The auxiliary power supply system must be suitably dimensioned to allow, in the absence of the main power supply, the operation of the SPI, the closing of the DDI and for the backup control device (if any), at least the time defined above (63). The integrated SPI must meet the "single fault tolerance" requirement. This requirement implies that in the event of failure of a component of the SPI, the device must continue to ensure its proper functioning or cause the DDI to open and signal the fault condition.

The rated voltage and frequency for all protective functions are:

Rated voltage: (230/400) V(64)

Nominal frequency: 50 Hz

SPI accuracies are:

Voltage: ± 1 % Vn

Frequency: ± 20 mHz

(63) It is intended that, when the power supply returns, the relay will check the mains parameters (voltage; frequency) before allowing the DDI to close again.

(64) For networks operated at different voltages, SPI adjustments must be referred to the operating voltage.

Note

The SPI is an internal SPI.

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A.3	Setting ranges for the SPI							P
Adjustable ranges								
All thresholds must be adjustable								
Voltage values								
Threshold	85% (27.S1)	t_{min} (27.S1)	15% (27.S2)	T_{min} (27.S2)	110% (*) (59.S1)	t_{max} (59.S1)	115% (59.S2)	T_{max} (59.S2)
Range	0,2-1,0 V_n	0,05-5 s	0,05-1,0 V_n	0,05-5 s	1,0-1,2 V_n	≤ 3 s	1,0-1,3 V_n	0,5-1,0 s
Steps	0,05 V_n	0,05 s	0,05 V_n	0,05 s	0,01 V_n	--	0,01 V_n	0,05 s
Note: (*) The maximum voltage function (59.S1) must be configured for protection based on the calculation of the average value of 10 minutes in accordance with the standard EN 61000-4-30. A new average value over the previous 10 minutes must be calculated at least every 3 s for comparison with the threshold value for protection 59.S1 as indicated in Table 13.								
Frequency values								
Threshold	49,80 Hz (81<.S1)	tmin (81<.S1)	47,50 Hz (81<.S2)	tmin (81<.S2)	50,20 Hz (81>.S1)	tmax (81>.S1)	51,50 Hz (81>.S2)	tmax (81>.S2)
Range	47,0-50,0 Hz	0,05-5 s	47,0-50,0 Hz	0,05-5 s	50,0-52,0 Hz	0,05-5s	50,0-52,0 Hz	0,05-5 s
Steps	0,1 Hz	0,05 s	0,1 Hz	0,05 s	0,1 Hz	0,05 s	0,1 Hz	0,05 s

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
A.4.3	**Functional tests on the interface protection system (SPI)**	
A.3.1-3.4	Checking the adjustable values and the description in the user manual	**P**
A.4.3.1	Checking of connection and reconnection conditions	**P**
A.4.3.2	Checking gradual supply of active power	**P**
A.4.3.3	Additional requirements for functional tests	**P**
A.4.3.3.1	Insensitivity to harmonics of the frequency relay	**P**
A.4.3.3.2	Remote trip signal	**P**
A.4.3.3.3	Communication signal	**P**
A.4.3.4	Verification of insensitivity to the frequency derivative	**P**

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A.4.3	Functional tests on the interface protection system (SPI)	P

Purpose of testing

The tests for checking the functions and the measurement of accuracy are listed below:

a) checking all functions;

b) measuring the accuracy of tripping thresholds;

c) measuring the accuracy of trip times;

d) measuring the accuracy of the falling ratio (not required for an interface protection system (SPI) integrated into the inverter up to a maximum of 11,08 kW);

e) Measuring accuracy of the falling time (not required for an interface protection system (SPI) integrated into the inverter up to a maximum of 11,08 kW).

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A.4.3.1 A4.3.2	Test procedure for maximum/minimum frequency						P
Operating time of the monitoring device							
	Under frequency (81<.S2)			**Over frequency (81>.S2)**			
A) STEPS for trip value [Hz to Hz]	1,01 threshold -> decrease by max 10 mHz steps			0,99 threshold -> increase by max 10 mHz steps			
D) STEP trip time [Hz to Hz]	1,01 threshold -> 0,99 threshold			0,99 threshold -> 1,01 threshold			
	Ambient temperature						
Limit [Hz]	47,50			51,50			
Measurement accuracy of the tripping value [Hz]	47,50	47,50	47,50	51,51	51,51	51,51	
Disconnection limit [s]	0,100			0,100			
Measurement the trip time [s]	0,094	0,093	0,102	0,091	0,092	0,103	
	-10°C temperature						
Limit [Hz]	47,50 Hz			51,50 Hz			
Measurement accuracy of the tripping value [Hz]	47,50	47,50	47,50	51,51	51,51	51,51	
Disconnection limit [s]	0,100			0,100			
Measurement the trip time [s]	0,083	0,099	0,083	0,104	0,093	0,092	
	+55°C temperature						
Limit [Hz]	47,50 Hz			51,50 Hz			
Measurement accuracy of the tripping value [Hz]	47,50	47,50	47,50	51,51	51,51	51,51	
Disconnection limit [s]	0,100			0,100			
Measurement the trip time [s]	0,085	0,093	0,088	0,100	0,085	0,100	

Test

To measure the disconnection time a step of 1% f_n is taken from the nominal frequency for underfrequency and overfrequency.

Assessment criterion

For frequencies of between 47,5 Hz and 51,5 Hz (±0,1% f_n) automatic disconnection from the network as a result of a deviation in frequency is not permitted.

Limit values:

Frequency decrease protection f<47,5 Hz 0,100 s

Frequency increase protection f<51,5 Hz 0,100 s

For each repetition of the tests, the max tolerances of the values are:

Voltage: 2% for voltages

Frequency: ±20 mHz for frequency trip thresholds

Trip times: 1% ±20 ms for disconnection times

Note

The setting value and the trip value of the frequency may not vary by more than **±20 mHz** and **3% of the disconnection limit ±20 ms**. Differences between the test values: **±20 mHz** and **1% of the disconnection limit ±20ms.**

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A.4.3.1 A4.3.2	Test procedure for maximum/minimum frequency	P

Operating time of the monitoring device

	Under frequency (81<.S1)			Over frequency (81>.S1)		
A) STEPS for trip value [Hz to Hz]	1,01 threshold -> decrease by max 10 mHz steps			0,99 threshold -> increase by max 10 mHz steps		
D) STEP trip time [Hz to Hz]	1,01 threshold -> 0,99 threshold			0,99 threshold -> 1,01 threshold		
	Ambient temperature					
Limit [Hz]	49,80			50,20		
Measurement accuracy of the tripping value [Hz]	49,80	49,80	49,80	50,21	50,21	50,21
Disconnection limit [s]	0,100			0,100		
Measurement the trip time [s]	0,111	0,098	0,096	0,099	0,102	0,098
	-10°C temperature					
Limit [Hz]	49,80			50,20		
Measurement accuracy of the tripping value [Hz]	49,80	49,80	49,80	50,21	50,21	50,21
Disconnection limit [s]	0,100			0,100		
Measurement the trip time [s]	0,100	0,100	0,100	0,097	0,096	0,102
	+55°C temperature					
Limit [Hz]	49,80			50,20		
Measurement accuracy of the tripping value [Hz]	49,80	49,80	49,80	50,21	50,21	50,21
Disconnection limit [ms]	0,100			0,100		
Measurement the trip time [ms]	0,099	0,101	0,104	0,091	0,098	0,090

Test

To measure the disconnection time a step of 1% f_n is taken from the nominal frequency for underfrequency and overfrequency.

Assessment criterion

For frequencies of between 49,5 Hz and 50,5 Hz (±0,1% f_n) automatic disconnection from the network as a result of a deviation in frequency is not permitted.

Limit values:

Frequency decrease protection f<49,5 Hz 0,100 s

Frequency increase protection f< 50,5 Hz 0,100 s

For each repetition of the tests, the max tolerances of the values are:

Voltage: 2% for voltages

Frequency: ±20 mHz for frequency trip thresholds

Trip times: 1% ±20 ms for disconnection times

Note

The setting value and the trip value of the frequency may not vary by more than **±20 mHz** and **3%of the disconnection limit ±20 ms**. Differences between the test values: **±20 mHz** and **1% of the disconnection limit ±20 ms.**

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A.4.3.1 A.4.3.2	Test procedure for maximum/minimum voltage		P
Operating time of the monitoring device			
	Under voltage (27.S2)		
A) STEPS for trip value [V to V]	1,1 threshold -> decrease by max 0,5% V_n steps		
D) STEP for trip time [V to V]	V_n-> 0,15 Vn		
	Ambient temperature		
Limit [V]	34,5 V		
Measurement accuracy of the tripping value [V]	33,0	33,0	33,0
Disconnection limit [s]	0,200		
Measurement the trip time [s]	0,213	0,207	0,201
	-10°C temperature		
Limit [V]	34,5 V		
Measurement accuracy of the tripping value [V]	33,0	33,0	33,0
Disconnection limit [s]	0,200		
Measurement the trip time [s]	0,205	0,202	0,198
	+55°C temperature		
Limit [V]	34,5 V		
Measurement accuracy of the tripping value [V]	33,0	33,0	33,0
Disconnection limit [s]	0,200		
Measurement the trip time [s]	0,194	0,192	0,193

Assessment criterion

Limit values:

Voltage drop protection 27.S2 0.15 V_n 0,200 s

The setting value and the trip value of the frequency may not vary by more than **≤5% V_n** and **3% of the disconnection limit ±20ms**.

For each repetition of the tests, the max tolerances of the values are:

Voltage: 2% for voltages

Frequency: ±20 mHz for frequency trip thresholds

Trip times: 1% ±20 ms for disconnection times

Note

The indicated value for the tripping time must be adopted when the total power is greater than 11,08kW, while for lower powers a tripping time without intentional delay may optional be used. In the case of synchronous generators, the value may be raised to 0,7 Vn and t = 0,150s.

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A.4.3.1 A.4.3.2	Test procedure for maximum/minimum voltage						P
Operating time of the monitoring device							
	Under voltage (27.S1)			**Over voltage (59.S2)**			
A) STEPS for trip value [V to V]	1,1 threshold -> decrease by max 5 V steps			0,9 threshold -> increase by max 5 V steps			
D) STEP for trip time [V to V]	1,1 threshold -> 0,9 threshold			0,9 threshold -> 1,01 threshold			
	Ambient temperature						
Limit [V]	195,5			264,5			
Measurement accuracy of the tripping value [V]	195,4	195,4	195,4	264,4	264,4	264,4	
Disconnection limit [s]	1,500			0,200			
Measurement the trip time [s]	1,507	1,501	1,518	0,199	0,203	0,212	
	-10°C temperature						
Limit [V]	195,5			264,5			
Measurement accuracy of the tripping value [V]	195,4	195,4	195,4	264,4	264,4	264,4	
Disconnection limit [s]	1,500			0,200			
Measurement the trip time [s]	1,517	1,510	1,505	0,197	0,211	0,202	
	+55°C temperature						
Limit [V]	195,5			264,5			
Measurement accuracy of the tripping value [V]	195,4	195,4	195,4	264,4	264,4	264,4	
Disconnection limit [s]	1,500			0,200			
Measurement the trip time [s]	1,513	1,515	1,517	0,202	0,211	0,212	

Test

To measure the disconnection time a step of 84% V_n is taken from the nominal voltage and of 116% V_n from the nominal voltage for undervoltage and overvoltage.

The voltages should be measured per phase conductor, in which current is fed between the line conductor and the neutral conductor.

Assessment criterion

Limit values

Voltage drop protection 27.S1 0,85 V_n 1,500 s

Rise-in voltage protection 59.S2 1,15 V_n 0,200 s

The setting value and the trip value of the frequency may not vary by more than **≤5% V_n** and **3% of the disconnection limit ±20 ms**.

For each repetition of the tests, the max tolerances of the values are:

Voltage: 2% for voltages

Frequency: ±20 mHz for frequency trip thresholds

Trip times: 1% ±20 ms for disconnection times

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A.4.3.1 A.4.3.2	Test procedure for falling time						N/A
Operating time of the monitoring device							
	Falling time at under voltage			**Falling time at over voltage**			
B) STEP [V to V]	real threshold (of A)-> increase by one step to 1,1 threshold			real threshold (of A)-> decrease by one step to 0,9 threshold			
	Ambient temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	
	-10°C temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	
	+55°C temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	
	Falling time at under frequency			**Falling time at over frequency:**			
B) STEP [Hz to Hz]	real threshold (of A)-> increase by one step to 1,01 threshold			real threshold (of A)-> decrease by one step to 0,99 threshold			
	Ambient temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	
	-10°C temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	
	+55°C temperature						
Limit [s]	0,040 – 0,100			0,040 – 0,100			
Falling time [s]	-	-	-	-	-	-	

Note

The measuring points are the trip signal of the AC source and the output of the SPI to control the relays (DDI).

For each repetition of the tests, the max tolerances of the values are:

Voltage: 2% for voltages

Frequency: ±20 mHz for frequency trip thresholds

Trip times: 1% ±20 ms for disconnection times

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A.4.3.1 A.4.3.2	Test procedure for falling ratio (voltage)	N/A

Operating time of the monitoring device

	Falling ratio at under voltage			Falling ratio at over voltage		
C) STEP [V to V]	0,8 threshold -> increase by max 5 V steps until reset value is reached			1,2 threshold -> decrease by max 5 V steps until reset value is reached		
	Ambient temperature					
Limit of ratio	1,03-1,05			0,95-0,97		
Measurement reset value [V]	-	-	-	-	-	-
	100			100		
Calculated falling ratio V_{in}/V_{end}	-	-	-	-	-	-
	-10°C temperature					
Limit of ratio	1,03-1,05			0,95-0,97		
Measurement reset value [V]	-	-	-	-	-	-
	100			100		
Calculated falling ratio V_{in}/V_{end}	-	-	-	-	-	-
	+55°C temperature					
Limit of ratio	1,03-1,05			0,95-0,97		
Measurement reset value [V]	-	-	-	-	-	-
	100			100		
Calculated falling ratio V_{in}/V_{end}	-	-	-	-	-	-

Test

To measure the falling ratio, the voltage or frequency brought out the operation range by 20% of the nominal and in-/decrease in maximal 10 mHz or 5 V steps until the SPI connects.

Assessment criterion

Calculation:

V_{in} (reset value) f_{in} (reset value)

V_{end} (trip value) f_{end} (trip value)

Limit values

The setting value and the trip value of the frequency may not vary by more than **≤5% V_n** and **±20 ms**.

The value of the falling ratio may not vary by more than **≤ 2%**.

The ratio limits: 85% (27.S1) between 1.03 and 1.05

115% (59.S2) between 0.95 and 0,97

49,50 Hz (81<S1) 1,001-1,003

50,50 Hz (81>S1) 0,997-0,999

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A.4.3.1 A.4.3.2	Test procedure for falling ratio (frequency)						N/A
Operating time of the monitoring device							
	Falling ratio at under frequency			**Falling ratio at over frequency**			
C) STEP [Hz to Hz]	0,8 threshold -> increase by max 10 mHz steps until reset value is reached			1,2 threshold -> decrease by max 10 mHz steps until reset value is reached			
Limit of ratio	**Ambient temperature**						
	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	
	-10°C temperature						
Limit of ratio	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	
	+55°C temperature						
Limit of ratio	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	

Test

To measure the falling ratio, the voltage or frequency brought out the operation range by 20% of the nominal and in-/ decrease in maximal 10 mHz or 5 V steps until the SPI connects.

Assessment criterion

Calculation:

V_{in} (reset value) **f_{in} (reset value)**

V_{end} (trip value) **f_{end} (trip value)**

Limit values:

The setting value and the trip value of the frequency may not vary by more than **≤ 5% V_n** and **± 20ms**.

The value of the falling ratio may not vary by more than **≤ 2%**.

The ratio limits: 85% (27.S1) between 1.03 and 1.05

115% (59.S2) between 0.95 and 0,97

49,50 Hz (81<S1) 1,001-1,003

50,50 Hz (81>S1) 0,997-0,999

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A.4.3.1 A.4.3.2	Test procedure for falling ratio (frequency)						N/A
Operating time of the monitoring device							
	Falling ratio at under frequency			**Falling ratio at over frequency**			
C) STEP [Hz to Hz]	0,8 threshold -> increase by max 10mHz steps until reset value is reached			1,2 threshold -> decrease by max 10mHz steps until reset value is reached			
Limit of ratio	**Ambient temperature**						
	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	
	-10°C temperature						
Limit of ratio:	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	
	+55°C temperature						
Limit of ratio	1,001-1,003			0,997-0,999			
Measurement reset value [Hz]	-	-	-	-	-	-	
Calculated falling ratio f_{in}/f_{end}	-	-	-	-	-	-	

Test

To measure the falling ratio, the voltage or frequency brought out the operation range by 20%of the nominal and in-/decrease in maximal 10 mHz or 5 V steps until the SPI connects.

Assessment criterion

Calculation:

V_{in} (reset value) **f_{in} (reset value)**

V_{end} (trip value) **f_{end} (trip value)**

Limit values:

The setting value and the trip value of the frequency may not vary by more than **≤5% V_n** and **±20 ms**.

The value of the falling ratio may not vary by more than **≤ 2%**.

The ratio limits: 85% (27.S1) between 1.03 and 1.05

115% (59.S2) between 0.95 and 0,97

49,50 Hz (81<S1) 1,001-1,003

50,50 Hz (81>S1) 0,997-0,999

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	Measuring the rise-in voltage protection as a running 10-minute mean value		**P**
Test			
(59.S1) moving average measurement over 10min according to EN 61000-4-30			
		Disconnection time	Limit
a)	The voltage is set to 100% V_n and held for 600 s. Thereafter the voltage is set to 112% V_n. Disconnection must take place within 600 s.		
	Phase 1	501,6s	≤ 600 s
	Phase 2	-	
	Phase 3	-	
b)	The voltage is set to V_n for 600 s and then to 108% V_n for 600 s. No disconnection should take place.		
	Phase 1	No Disconnection	Disconnection should not take place.
	Phase 2	-	
	Phase 3	-	
c)	The voltage is set to 106 % V_n and held for 600 s. Thereafter the voltage is set to 114 % V_n. Disconnection must take place within 300 s or about 50 % of the disconnection time measured in point a).*		
	Phase 1	300,2s	The disconnection time should be about 50 % of the value measured in a). *
	Phase 2	-	
	Phase 3	-	
Note			
*If the setting value is set to 600 s, then the disconnection time can be in the range between 225 s and 375 s.			

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A.4.3.3.1	Insensitivity to harmonics of the frequency relay							P	
AC-Source Setting	Harmonics order:	2nd	3rd	5th	7th	9th	11th	13th	17th
	$\%V_n$:	4,0	10,0	12,0	10,0	3,0	7,0	6,0	4,0

Operating time of the monitoring device							
	Under frequency			**Over frequency**			
A) STEPS for trip value [Hz to Hz]	1,01 threshold -> decrease by max 10mHz steps			0,99 threshold -> increase by max 10mHz steps			
D) STEP trip time [Hz to Hz]	1,01 threshold -> 0,99 threshold			0,99 threshold -> 1,01 threshold			
Limit [Hz]	47,50			51,50			
Measurement accuracy of the tripping value [Hz]	47,50	47,50	47,50	51,51	51,51	51,51	
Disconnection limit [s]	0,100			0,100			
Measurement the trip time [s]	0,094	0,087	0,092	0,084	0,083	0,090	
Limit [Hz]	49,80			50,20			
Measurement accuracy of the tripping value [Hz]	49,80	49,80	49,80	50,21	50,21	50,21	
Disconnection limit [s]	0,100			0,100			
Measurement the trip time [s]	0,096	0,098	0,099	0,118	0,081	0,086	

Test:

The test setup for the harmonic distortion, was set with the fallowing values:

Harmonics order:	2nd	3rd	5th	7th	9th	11th	13th	17th
$\%V_n$:	4,0	10,0	12,0	10,0	3,0	7,0	6,0	4,0

The frequency test was performed as in A.4.3

Note

The setting value and the trip value of the frequency may not vary by more than **±20 mHz** and **3% of the disconnection limit ±20 ms**. Differences between the test values: **±20 mHz** and **1% of the disconnection limit ±20 ms.**

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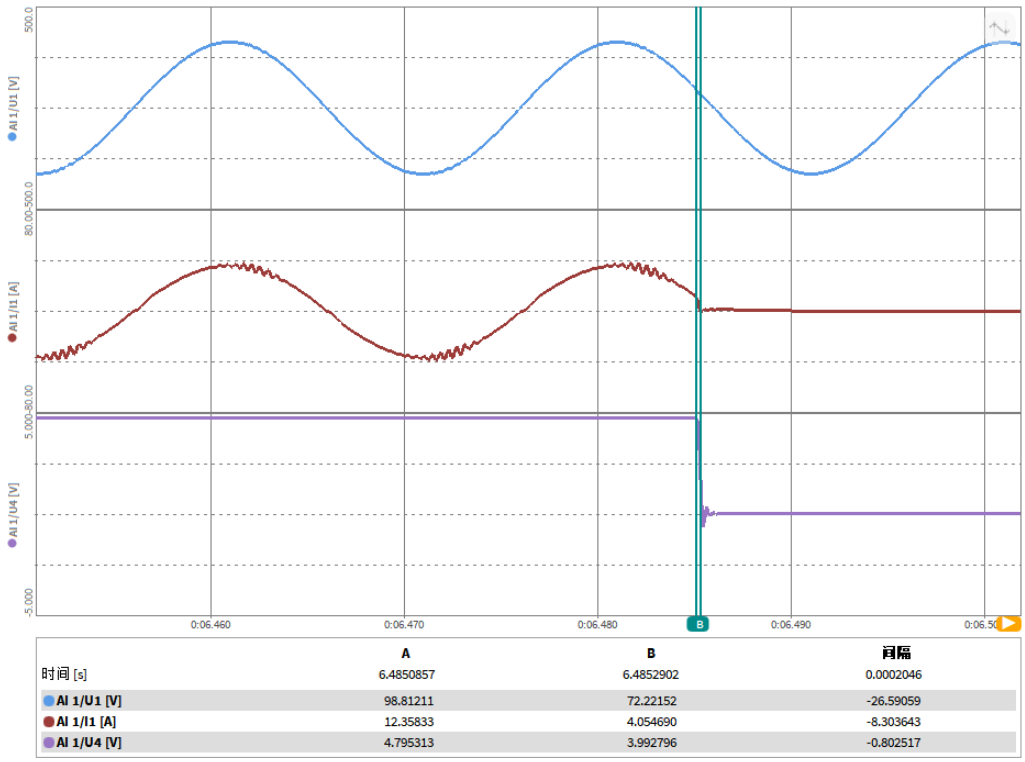
A.4.3.3.2	Remote trip signal	P
Operating time of the monitoring device		
Test	Remote tripping signal for the external disconnection	
Limit [s]	0,050	
Reaction time of the tripping value [s]	0,0002	
Graph		



	A	B	间隔
时间 [s]	6.4850857	6.4852902	0.0002046
AI 1/U1 [V]	98.81211	72.22152	-26.59059
AI 1/I1 [A]	12.35833	4.054690	-8.303643
AI 1/U4 [V]	4.795313	3.992796	-0.802517

Note

The protection interface has to have a maximum delay of the remote tripping signal from receiving to transmitting to the DDI of 50 ms.

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A.4.3.3.3	Communication Signal	P
Operating time of the monitoring device		
Without communication signal		
f_{soll}	**f_{ist}**	**Limit:**
49,80 Hz	49,80 Hz	<81.S1
50,20 Hz	50,20 Hz	>81.S1
With communication signal		
f_{soll}	**f_{ist}**	**Limit:**
47,50 Hz	47,50 Hz	<81.S2
51,50 Hz*	51,50 Hz	>81.S2
Note		

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A.4.3.4	Verification of insensitivity to the frequency derivative	P

Test result

	Start and End Frequency [Hz]	Change	Confirm
Positive Frequency drift	47,550 – 51,450	+2,5 Hz/sec	No trip and inverter continue operation
Negative Frequency drift	51,450 – 47,550	-2,5 Hz/sec	No trip and inverter continue operation

Note

Frequency protection settings:

81>: tripping threshold 51,5 Hz, tripping time 0,15 s

81<: tripping threshold 47,5 Hz, tripping time 0,15 s

1) Apply a symmetrical triad of direct cyclic sequence voltages having a modulus of 100 % of the nominal voltage and a frequency of 47,550 Hz;

2) increase the frequency of the three ramp voltages, with ramp steps having an amplitude of 12,5 mHz and a duration of 5 ms, until a frequency value of 51,450 Hz is reached (*);

3) decrease the frequency of the three ramp voltages, with ramp steps having an amplitude of 12,5 mHz and a duration of 5 ms until the frequency value of 47,550 Hz is reached (*);

4) repeat the tests in 2 and 3 above four times, for a total of five positive and negative ramps.

The test is deemed to have been passed if the minimum and maximum frequency protection is not triggered.

If the SPI is integrated in the inverter, in addition to the absence of minimum and maximum frequency protection trips, it must also be verified that the inverter continues to operate.

(*) These ramp settings produce a frequency derivative of 12,5 mHz / 5 ms = 2,5 Hz/s.

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A.4.4	Self-test	P

Self-test function

If the interface protection functions are integrated in the inverter, at least one self-test system must be provided which checks the maximum/minimum frequency and maximum/minimum voltage functions provided in the interface protection system (SPI), as described below:

- for each frequency and voltage protection function, the tripping threshold varies linearly upward or downward with a slope of ≤ 0,05 Hz/s or ≤ 0,05 V_n/s respectively for the frequency and voltage protection;
- This will determine, at a certain point in the test, whether the threshold and the actual value of the controlled parameter (frequency or voltage) coincide, and thus whether the protection was triggered and the interface device subsequently opened.

For each test, the person conducting the test must be able to view the quantity and trip time values, in addition to the current value of the voltage and frequency detected by the converter.

The tests must measure the:

- accuracy of tripping thresholds;
- accuracy of trip times.

After each test, the inverter must exit the test mode, reset the normally used settings and automatically reconnect to the network when the conditions are appropriate.

Any user must be able to activate the procedure and it must be clearly described in the converter user manual.

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A.4.4	Self-test	P
Description of the Self-test		

Note

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A.4.5	Single fault tolerance	P

The "single fault tolerance" intended function integrated SPI must be verified by examination of documentation provided by the manufacturer, and additional evidence on the immunity to single event of failure of the SPI.

The test is successful if the SPI, in the face of a failure of a single component (for example, CPU, power supply, main electronic components, etc.),

- maintains its protective functions unaltered indicating the place of an internal fault or event

- It outputs the opening command of the DDI

No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
1	AC Output (L-PE)	S-C	PV Input: 500Vdc Output: 230Vac	10 min.	--	--	The PCE reports error message. EUT disconnected from grid immediately, No damage, no hazard.
2	Battery Output (+ to -)	S-C	PV Input: 500V Output: 50Vdc	10 min.	--	--	The PCE reports error message. EUT shut down immediately, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14 damage, no hazard.
3	Battery terminal (+/- to PE)	S-C	DC Input: 53Vdc Output: 230Vac	10 min.	--	--	The PCE reports error message. EUT disconnected from grid immediately, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14 damage, no hazard.
4	AC Output	O-L	PV Input: 500Vdc Output: 230Vac	30 min.	--	--	The PCE reports error message. EUT shut down, no damage, no hazard, and no higher temperature observed.
5	Battery Output	O-L	PV Input: 500Vdc Output: 230Vac	30 min.	--	--	The PCE reports error message. EUT shut down, no damage, no hazard, and no higher temperature observed.
6	PCE Cooling system failure	Fan locked	PV Input: 500Vdc Output: 230Vac	4h30min.	--	--	The PCE reports error message. EUT disconnected from grid after over temperature. No damage, no hazard
7	PV input	Reverse polarity	PV Input: 500Vdc Output: 230Vac	10min	--	--	The inverter reports error message, EUT doesn't work. No damage, no hazard.
8	Battery Input	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The inverter reports error message, EUT doesn't work. EUT disconnected from grid immediately, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14 damage, no hazard.
BUS board							
9	C49	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately, No damage, no hazard.
10	C6	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT restarts and the LCD screen does not light up. No damage, no hazard.

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11	D4	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
12	Q13 Pin D-G	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
13	Q13 Pin D-S	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
14	Q13 Pin G-S	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
15	R86	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
16	U2 Pin 7-5	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
17	T2 Pin 1-3	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
18	T2 Pin 5-6	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
19	T2 Pin 8-11	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
20	D19	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
21	PC4 Pin 1-2	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
22	PC4 Pin 3-4	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT shut down, and the LCD screen does not light up. No damage, no hazard.
23	PC4 Pin 1	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The Unit shut down, no hazards, no damage, and no high temperature observed.
CNTL board							

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24	C326	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT restarts and the LCD screen does not light up. No damage, no hazard.
25	X3	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT does not light up. EUT disconnected from grid immediately. No damage, no hazard.
26	R555	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
27	R554	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
28	X1	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
29	X2	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
30	C6	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
31	C6	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
32	C108	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
33	C362	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
34	R463	O-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
35	C268	S-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
36	C269	S-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	EUT works normally. No damage, no hazard.

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37	R464	O-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
38	R469	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT works normally. No damage, no hazard.
39	C272	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
40	R470	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
41	R161	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. Warning but bypass work. No damage, no hazard.
42	C87	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. Warning but bypass work. No damage, no hazard.
43	C144	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. Warning but bypass work. No damage, no hazard.
44	C290	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
45	C129	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The LCD screen lights up and the machine does not work. No damage, no hazard.
46	C124	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The LCD screen lights up and the machine does not work. No damage, no hazard.
47	C410	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
48	C227	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
49	C223	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.

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50	C142	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
51	C138	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
52	C312	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
53	C311	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
DCDCL board							
54	T1 Pin 15-16	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
55	T1 Pin 13-14	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
56	T1 Pin 11-12	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
57	T1 Pin 9-10	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
58	Q7 Pin G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q7, R55, R56, R113 damage, no hazard.
59	Q8 Pin G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q8, R57 damage, no hazard.
60	Q9 Pin G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q9, R63 damage, no hazard.
61	Q10 Pin G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q10, R64 damage, no hazard.
62	R45	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.

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63	R45	O-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. Warning and bypass work. No damage, no hazard.
64	U6 Pin 4-6	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. D14, D15 damage, no hazard.
65	C105	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. D14, D15 damage, no hazard.
INV board							
66	C54	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
67	Q5 G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q5, Z9, R33, R19, D9 damage, no hazard.
68	Q9 G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q9, Z13, R55, R43, D13 damage, no hazard.
69	Q6 G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q6, Z10, R34, R20, D10 damage, no hazard.
70	Q10 G-D	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. Q10, Z14, R44, R58, D14 damage, no hazard.
71	R61	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
72	R61	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
73	C19	S-C	DC Input: 53Vdc Output: 230Vac	10min	--	--	EUT restarts and the LCD screen does not light up. No damage, no hazard.
74	C65	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The machine restarts. No damage, no hazard.

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75	R70	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
76	R70	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
77	R92	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
78	R92	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
79	C90	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
80	R140	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
81	R140	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The LCD screen is on and EUT does not connect to the grid. No damage, no hazard.
82	C70	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT restarts and LCD screen does not light up. No damage, no hazard.
83	C164	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT restarts and LCD screen does not light up. No damage, no hazard.
84	C151	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
85	R176	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
86	C119	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
87	C122	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT restarts and LCD screen does not light up. No damage, no hazard.

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88	JK11	S-C before starting	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
89	JK12	S-C before starting	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
90	JK13	S-C before starting	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
91	JK5	S-C before starting	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
92	JK3	S-C before starting	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
93	JK4	S-C before starting	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
94	JK6	S-C before starting	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
95	JK7	S-C before starting	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT doesn't work. No damage, no hazard.
96	R313	O-C on Off Grid	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
97	C126	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT restarts and LCD screen does not light up. No damage, no hazard.
98	C130	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	EUT restarts and LCD screen does not light up. No damage, no hazard.
99	R243	S-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
100	R243	O-C	PV Input: 500Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.

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101	R228	S-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
102	R228	O-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
103	R159	S-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
104	R159	O-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
105	R196	S-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.
106	R196	O-C	PV Input: 220Vdc Output: 230Vac	10min	--	--	The PCE reports error message. EUT disconnected from grid immediately. No damage, no hazard.

supplementary information

The errors in the control circuit simulate that the safety is even ensured during a single fault.

Note 1: All single fault tests were carried out by a 30A non-time delay fuse connected between the protective earthing terminal and the protective earthing conductor in the test setup which had not opened during the tests. All single fault tests were conducted with the AC output protected by external circuit breaker provided in all live connections to the AC supply.
Note 2: Pass the dielectric strength test of basic insulation test voltage for accessible DVC-A, reinforced or double Insulation and basic insulation in protective class I equipment.
Note 3: The equipment was placed on white tissue-paper covering a softwood surface and covering the equipment with cheesecloth during the fault testing, no emission of molten metal, burning insulation, or flaming or glowing particles from the fire enclosure, and there was no charring, glowing, or flaming of the cheesecloth.

Note 4: No other hazard (e.g. chemical, expulsion) observed after each test.

Assessment criterion

The NS protection must send a shutdown command to the coupling switch.

If the error is detected, the device is switched off within 10 s after error detection.

If the auxiliary voltage fails with the central NS protection or if the control fails with the integrated NS protection, the switch-off command must be given immediately.

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A.4.6	EMC compatibility testing	P

Table 18 - List of immunity tests on measuring relays and protective devices according to IEC EN 50263 and IEC EN 60255-26 Class B severity levels (industrial environment)

Electrical disturbance tests on relays: acceptance criteria and test procedures		IEC Basic Standard	Enclosure	Auxiliary power supply (Note a)	Communication (Note b)	Entry/Exit (Note c)	Functional earth (Note d)	Acceptance criterion
IEC EN 60255-22-1 (2008-10)	Oscillation train immunity tests at 1 MHz	61000-4-18		1 kV diff. mode 2.5 kV m. com.	1 kV m. common	1 kV diff. mode 2.5 kV m. com.		B
IEC EN 60255-22-2 (2009-05)	Electrostatic discharge tests	61000-4-2	6 kV air 8 kV contact					B
IEC EN 60255-22-3 (2009-02)	Immunity to radiated electromagnetic fields	61000-4-3	10 V/m (80 MHz - 2.7 GHz) Includes 900 MHz					A
IEC EN 60255-22-4 (2008-09)	Testing for immunity to fast electrical transients/pulse trains	61000-4-4		2 kV	1 kV	2 kV	2 kV	B
IEC EN 60255-22-5 (2002-12)	Impulse test	61000-4-5		1 kV phase-to-phase 2 kV phase-to-ground (next steps)	1 kV phase-to-ground (successive steps)	1 kV phase-to-phase 2 kV phase-to-ground (next steps)		B
IEC EN 60255-22-6 (2001-11)	Immunity to conducted disturbances induced by radio frequency fields	61000-4-6		10 V	10 V	10 V	10 V	A
IEC EN 60255-22-7 (2003-09)	Mains frequency immunity tests	61000-4-16				100 V rms diff 300 V rms com. (10 s only on binary inputs)		A
EN 60255-11 (2010-01)	Interruption of auxiliary DC voltage	61000-4-29		100 % reduction for 50 ms (*) Requirements for VRT with UPS				B
IEC 61000-4-8 (2009-09)	Mains frequency magnetic field	61000-4-8	30 A/m (continuous) 300 A/m (1 s)					A

NOTE a): in the case of integrated SPI, this refers to the AC power supply of the inverter
NOTE (b): In the case of an integrated SPI, this refers to the inverter signal intended to perform the communication function with the integrated SPI
NOTE (c): Examples of input signal: local command, telescope signal, DDI status. Examples of output signal: DDI command
NOTE d): in the case of integrated SPI, this refers to the functional earth of the inverter

Note

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A.4.7	Climatic compatibility tests	P

Test result

Detail	Notes/Evidence Levels	Standards	Acceptance criterion
Non-powered equipment	dry heat +70 °C ± 2 °C (16 hours)	EN 60068-2-2	B
	humid heat +40 °C ± 2 °C, RH = 93 % ± 3 % (4 days)	EN 60068-2-78	B
	Cold -10 °C ± 2 °C (16 hours)	EN 60068-2-1	B
	temperature change -10/+70 °C ± 2 °C (3 hours + 3 hours)	EN 60068-2-14	B
Powered equipment	dry heat + 55 °C ± 2 °C (16 hours)	EN 60068-2-2	A
	humid heat + 40 °C ± 2 °C, RH = 93 % ± 3 % (4 days)	EN 60068-2-78	A
	Cold -10 °C ± 2 °C (16 hours)	EN 60068-2-1	A
	temperature change -10 °C/+55 °C ± 2 °C (3 hours + 3 hours)	EN 60068-2-14	A

Assessment criterion

For acceptance, during the climatic tests the following must be checked

- all functions;
- measuring the accuracy of tripping thresholds;
- measuring the accuracy of trip times.

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A.4.8	Insulation tests	P

Rigidity of electricity		
Location	Test voltage	Result
AC to PE	2kVac / 2,8kVdc	No breakdown of insulation
DC to PE	2kVac / 2,8kVdc	No breakdown of insulation
Impulse test		
AC and DC inputs	4 kV (1,2 / 50 µs)	No breakdown of insulation
Measurement of the insulation resistance		
AC and DC inputs	>100MΩ at 500Vdc	>100 MΩ

Criteria

Location	Verification of dielectric properties	Notes/Evidence Levels	Technical Standard
Input Power supply, both AC and DC	Impulse hold	Overvoltage category IV see V2 IEC Standard 0-16	IEC EN 60255-27
Input AC power supply	Dielectric strength	Test voltage 2 kV for AC circuits	IEC EN 60255-27
Input Power supply, both AC and DC	Insulation resistance	>100MΩ at 500Vdc	IEC EN 60255-27

Note

In the case of an SPI integrated in the inverter (see definition in note 70), unless it is realised with a dedicated board whose power supply is accessible from the outside, reference shall be made to CEI EN 60146-1-1 for the purposes of insulation tests.

The expected altitude oversea for the test values above is 2000m.

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A.4.9	Tests for the overload capacity of measuring circuits	N/A
Voltage	Test time	Result
≥130% V_n	permanent	--
≥150% V_n	1 s	--

Note

No external protectors by the meaning of this clause present.

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A.4.10	Equipment compliance	N/A
Note		
The equipment compliance declaration is issued by the manufacturer and not part of the test report.		

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A.4.11	Automatism to avoid current imbalances in production	N/A
Test result		
Test No. 1	Imbalance 6 kW to 10 kW	Limit 30 min.
Measured values	-	-
Test No. 2	Imbalance above 10 kW	Limit 1 min.
Measured values	-	-
Criteria		

The following tests are only to be performed if the entire production plant can be operated with power imbalances of less than 10 kW (test 1) or more than 10 kW (test 1 and 2).

On completion of the system and before final parallel connection to the network, the following two test conditions must be verified.

Test No. 1

- plant in operation at its nominal conditions;
- creation of a permanent artificial imbalance of more than 6 kW and less than 10 kW;
- verification of the disconnection of the entire production plant via the DDI within a maximum

time of 30 min.

Test No. 2:

- plant in operation at its nominal conditions;
- creation of a permanent artificial imbalance greater than 10 kW;
- verification of the disconnection of the entire production plant via the DDI within a maximum

time of 1 min.

(74) The temporary connection for testing purposes must be agreed between the DSO and the Active User.

Note

The Inverter is a single-phase inverter and not intended for the use as multi-inverter application above 6 kW per phase.

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1	Tests on the inverter	**P**
a)	Harmonic emission	**P**
b)	Harmonic emission exceeding 75A per phase	**N/A**
c)	Flicker emission	**P**
B.1.1	Conditions of connection, reconnection and gradual power supply	**P**
B.1.2	Reactive power exchange	**P**
B.1.3	Limitation of active power	**P**
B.1.4	Output of DC component in the output current	**P**
B.1.5	Checking insensitivity to voltage dips (LVRT capability)	**N/A**
	Checking insensitivity to overvoltage dips (OVRT capability)	**N/A**
B.1.6	Checking the insensitivity to automatic reclosing during phase accordance	**P**

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (Ambient)						P
T-REX-6KLP1G01							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1983,6		3961,5		6014,5		
AC Voltage [V]	230,2		230,5		230,9		
AC Current [A]	8,64		17,19		26,08		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	3,069		1,814		3,762		
PWHD	1,839		1,790		4,989		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,635	--	17,184	--	26,047	--	-
2nd	0,023	0,086	0,059	0,226	0,102	0,393	8,00
3rd	0,133	0,510	0,206	0,789	0,331	1,270	N/A
4th	0,006	0,022	0,010	0,040	0,015	0,056	4,00
5th	0,095	0,365	0,091	0,347	0,139	0,532	10,70
6th	0,004	0,014	0,005	0,019	0,009	0,036	2,67
7th	0,098	0,375	0,096	0,367	0,111	0,425	7,20
8th	0,004	0,014	0,006	0,022	0,008	0,031	2,00
9th	0,091	0,348	0,086	0,331	0,111	0,426	N/A
10th	0,004	0,016	0,005	0,019	0,006	0,023	1,60
11th	0,084	0,323	0,089	0,343	0,124	0,476	3,10
12th	0,004	0,016	0,005	0,019	0,008	0,031	1,33
13th	0,075	0,286	0,074	0,285	0,124	0,475	2,00
14th	0,004	0,016	0,004	0,014	0,007	0,026	N/A
15th	0,062	0,238	0,064	0,244	0,110	0,420	N/A
16th	0,004	0,015	0,004	0,016	0,006	0,023	N/A
17th	0,058	0,223	0,056	0,213	0,092	0,352	N/A
18th	0,005	0,017	0,005	0,018	0,007	0,028	N/A
19th	0,043	0,163	0,046	0,178	0,078	0,299	N/A
20th	0,004	0,014	0,005	0,021	0,006	0,022	N/A
21th	0,033	0,127	0,035	0,134	0,063	0,243	N/A
22th	0,002	0,009	0,003	0,011	0,004	0,015	N/A
23th	0,025	0,095	0,017	0,064	0,046	0,177	N/A
24th	0,002	0,007	0,003	0,013	0,005	0,019	N/A
25th	0,018	0,068	0,016	0,063	0,033	0,128	N/A
26th	0,002	0,008	0,004	0,017	0,005	0,020	N/A
27th	0,017	0,064	0,012	0,047	0,023	0,089	N/A
28th	0,002	0,007	0,006	0,025	0,007	0,027	N/A
29th	0,015	0,057	0,011	0,040	0,025	0,098	N/A
30th	0,006	0,025	0,012	0,046	0,012	0,046	N/A

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (Ambient)						P
T-REX-6KLP1G01							
31th	0,015	0,059	0,008	0,031	0,017	0,064	N/A
32th	0,002	0,008	0,006	0,023	0,006	0,024	N/A
33th	0,011	0,042	0,004	0,014	0,033	0,125	N/A
34th	0,002	0,009	0,005	0,019	0,009	0,033	N/A
35th	0,009	0,033	0,009	0,035	0,062	0,238	N/A
36th	0,002	0,006	0,004	0,014	0,008	0,029	N/A
37th	0,008	0,032	0,004	0,014	0,089	0,341	N/A
38th	0,002	0,008	0,003	0,012	0,014	0,052	N/A
39th	0,007	0,025	0,004	0,015	0,118	0,453	N/A
40th	0,002	0,007	0,003	0,012	0,023	0,087	N/A
41th	0,005	0,019	0,003	0,010	0,196	0,753	N/A
42th	0,001	0,004	0,002	0,009	0,034	0,130	N/A
43th	0,004	0,017	0,010	0,038	0,301	1,155	N/A
44th	0,001	0,004	0,003	0,012	0,043	0,163	N/A
45th	0,007	0,027	0,016	0,060	0,413	1,583	N/A
46th	0,001	0,003	0,002	0,008	0,049	0,189	N/A
47th	0,004	0,014	0,017	0,066	0,476	1,825	N/A
48th	0,001	0,003	0,003	0,010	0,048	0,185	N/A
49th	0,007	0,026	0,015	0,056	0,407	1,559	N/A
50th	0,001	0,003	0,002	0,006	0,039	0,148	N/A
Note							

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (-10°C)						P
T-REX-6KLP1G01							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1983,4		3961,0		6011,8		
AC Voltage [V]	230,2		230,5		230,9		
AC Current [A]	8,64		17,19		26,07		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	3,077		1,841		3,739		
PWHD	1,869		1,880		5,002		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,634	--	17,181	--	26,037	--	-
2nd	0,022	0,084	0,054	0,208	0,101	0,388	8,00
3rd	0,133	0,510	0,209	0,803	0,331	1,271	N/A
4th	0,007	0,025	0,014	0,052	0,014	0,055	4,00
5th	0,095	0,365	0,091	0,348	0,141	0,539	10,70
6th	0,005	0,019	0,006	0,024	0,010	0,038	2,67
7th	0,098	0,376	0,098	0,374	0,112	0,430	7,20
8th	0,004	0,014	0,006	0,022	0,008	0,031	2,00
9th	0,092	0,351	0,088	0,339	0,113	0,432	N/A
10th	0,005	0,017	0,005	0,020	0,006	0,023	1,60
11th	0,085	0,324	0,090	0,343	0,125	0,479	3,10
12th	0,005	0,018	0,006	0,022	0,008	0,031	1,33
13th	0,074	0,284	0,075	0,288	0,125	0,479	2,00
14th	0,004	0,015	0,004	0,016	0,006	0,025	N/A
15th	0,062	0,236	0,064	0,247	0,111	0,426	N/A
16th	0,004	0,016	0,005	0,018	0,006	0,023	N/A
17th	0,058	0,221	0,056	0,216	0,093	0,357	N/A
18th	0,004	0,017	0,005	0,018	0,007	0,027	N/A
19th	0,042	0,161	0,047	0,179	0,079	0,303	N/A
20th	0,004	0,014	0,006	0,021	0,006	0,021	N/A
21th	0,033	0,127	0,035	0,133	0,064	0,244	N/A
22th	0,003	0,011	0,003	0,010	0,004	0,017	N/A
23th	0,024	0,093	0,018	0,067	0,046	0,177	N/A
24th	0,002	0,008	0,004	0,014	0,005	0,021	N/A
25th	0,018	0,069	0,017	0,063	0,033	0,127	N/A
26th	0,003	0,010	0,005	0,021	0,006	0,022	N/A
27th	0,016	0,063	0,012	0,047	0,023	0,088	N/A
28th	0,004	0,015	0,011	0,042	0,009	0,034	N/A
29th	0,015	0,056	0,011	0,043	0,026	0,099	N/A

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (-10°C)						P
T-REX-6KLP1G01							
30th	0,020	0,076	0,023	0,087	0,016	0,062	N/A
31th	0,015	0,057	0,008	0,030	0,018	0,068	N/A
32th	0,004	0,014	0,012	0,046	0,009	0,035	N/A
33th	0,011	0,041	0,004	0,014	0,032	0,124	N/A
34th	0,002	0,008	0,007	0,028	0,010	0,039	N/A
35th	0,009	0,033	0,009	0,034	0,062	0,236	N/A
36th	0,002	0,007	0,005	0,018	0,008	0,029	N/A
37th	0,008	0,031	0,004	0,014	0,088	0,339	N/A
38th	0,002	0,007	0,003	0,012	0,013	0,052	N/A
39th	0,007	0,026	0,004	0,015	0,118	0,451	N/A
40th	0,002	0,006	0,003	0,013	0,022	0,083	N/A
41th	0,005	0,019	0,003	0,011	0,195	0,748	N/A
42th	0,001	0,004	0,003	0,011	0,032	0,121	N/A
43th	0,004	0,017	0,009	0,036	0,300	1,149	N/A
44th	0,001	0,005	0,003	0,012	0,039	0,151	N/A
45th	0,007	0,026	0,015	0,056	0,410	1,572	N/A
46th	0,001	0,003	0,003	0,010	0,046	0,177	N/A
47th	0,004	0,014	0,017	0,064	0,471	1,804	N/A
48th	0,001	0,003	0,003	0,010	0,046	0,177	N/A
49th	0,006	0,025	0,014	0,054	0,401	1,538	N/A
50th	0,001	0,003	0,002	0,007	0,037	0,141	N/A
Note							

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (+55°C)						P
T-REX-6KLP1G01							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1984,0		3960,8		6011,6		
AC Voltage [V]	230,2		230,5		230,9		
AC Current [A]	8,64		17,19		26,07		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	3,101		1,812		3,741		
PWHD	1,928		1,930		4,987		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,637	--	17,179	--	26,035	--	-
2nd	0,022	0,083	0,045	0,172	0,099	0,381	8,00
3rd	0,136	0,520	0,205	0,787	0,331	1,268	N/A
4th	0,007	0,028	0,010	0,040	0,014	0,054	4,00
5th	0,097	0,372	0,091	0,349	0,141	0,539	10,70
6th	0,004	0,017	0,007	0,027	0,010	0,038	2,67
7th	0,097	0,373	0,095	0,363	0,113	0,432	7,20
8th	0,003	0,013	0,006	0,022	0,008	0,030	2,00
9th	0,090	0,347	0,087	0,335	0,113	0,434	N/A
10th	0,004	0,016	0,004	0,016	0,006	0,023	1,60
11th	0,084	0,322	0,090	0,344	0,125	0,480	3,10
12th	0,004	0,016	0,005	0,019	0,008	0,032	1,33
13th	0,074	0,285	0,075	0,286	0,125	0,480	2,00
14th	0,004	0,016	0,004	0,015	0,006	0,025	N/A
15th	0,062	0,236	0,064	0,247	0,111	0,425	N/A
16th	0,004	0,016	0,004	0,015	0,006	0,023	N/A
17th	0,058	0,221	0,057	0,217	0,093	0,356	N/A
18th	0,005	0,019	0,004	0,015	0,007	0,027	N/A
19th	0,042	0,162	0,047	0,181	0,079	0,303	N/A
20th	0,004	0,015	0,005	0,020	0,006	0,021	N/A
21th	0,033	0,126	0,035	0,133	0,064	0,245	N/A
22th	0,003	0,012	0,003	0,010	0,004	0,016	N/A
23th	0,025	0,094	0,018	0,068	0,046	0,177	N/A
24th	0,002	0,007	0,004	0,015	0,005	0,019	N/A
25th	0,018	0,067	0,017	0,065	0,033	0,128	N/A
26th	0,003	0,012	0,006	0,024	0,005	0,019	N/A
27th	0,017	0,064	0,012	0,047	0,023	0,089	N/A
28th	0,006	0,022	0,014	0,052	0,006	0,024	N/A
29th	0,015	0,057	0,011	0,043	0,026	0,098	N/A
30th	0,029	0,110	0,028	0,106	0,011	0,044	N/A

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B.1 a) b)	Emission Test Harmonics DIN EN 61000-3-12 (≥16 A and ≥75 A per Phase) (+55°C)						P
T-REX-6KLP1G01							
31th	0,015	0,059	0,008	0,031	0,017	0,066	N/A
32th	0,005	0,018	0,014	0,055	0,006	0,023	N/A
33th	0,011	0,043	0,004	0,015	0,032	0,124	N/A
34th	0,002	0,008	0,008	0,031	0,008	0,031	N/A
35th	0,009	0,034	0,009	0,033	0,061	0,235	N/A
36th	0,002	0,007	0,005	0,019	0,008	0,029	N/A
37th	0,008	0,032	0,003	0,011	0,089	0,340	N/A
38th	0,002	0,008	0,003	0,011	0,013	0,050	N/A
39th	0,007	0,026	0,003	0,013	0,118	0,451	N/A
40th	0,002	0,008	0,003	0,011	0,022	0,085	N/A
41th	0,005	0,019	0,003	0,011	0,195	0,748	N/A
42th	0,001	0,005	0,003	0,010	0,032	0,125	N/A
43th	0,004	0,017	0,009	0,036	0,300	1,149	N/A
44th	0,001	0,005	0,003	0,011	0,040	0,154	N/A
45th	0,007	0,027	0,015	0,056	0,411	1,574	N/A
46th	0,001	0,003	0,002	0,009	0,048	0,185	N/A
47th	0,003	0,013	0,017	0,064	0,471	1,807	N/A
48th	0,001	0,003	0,002	0,009	0,047	0,180	N/A
49th	0,007	0,025	0,014	0,054	0,402	1,540	N/A
50th	0,001	0,003	0,002	0,007	0,036	0,139	N/A
Note							

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B.1 c)	Flicker emission			P
Ambient				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-3	0,026	0,027	0,006
66%	EN 61000-3-3	0,039	0,039	0,009
100%*	EN 61000-3-3	0,050	0,050	0,021
-10°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-3	0,028	0,028	0,008
66%	EN 61000-3-3	0,039	0,039	0,016
100%*	EN 61000-3-3	0,050	0,050	0,017
+55°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-3	0,026	0,026	0,008
66%	EN 61000-3-3	0,038	0,038	0,017
100%*	EN 61000-3-3	0,048	0,048	0,026

Note

Mains Impedance according EN61000-3-3:

R_{max} = 0,24Ω; jX_{max}= 0,15Ω @50Hz (|Z_{max}| = 0,473 Ω)

R_n = 0,16 Ω; jX_n= 0,1 Ω

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3,3\% / d_c(P_n)$

The tests are based on the limits of the EN61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.

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B.1.1 Conditions of connection, reconnection and gradual power supply		
Clause	**Test**	**Result**
B.1.1.1	Checking of connection and reconnection conditions	**P**
B.1.1.2	Checking gradual supply of active power	**P**

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B.1.1.1 B.1.1.2	**Conditions of connection, reconnection and gradual power supply and gradual supply of active power**	**P**

Test result

	Voltage conditions	
a) Out of voltage range	84% V_n for 30 s	111% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V < 110% V_n
Reconnection time [s]	92,6	90,3
Limit	Reconnection after 30s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n/min For recorded gradient see diagram underneath	
c) In voltage range at start-up	85% V_n < V	V < 110% V_n
Reconnection time [s]	330,8	330,6
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n/min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	50,12 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n/min For recorded gradient see diagram underneath	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	90,6	90,2
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n/min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	330,4	330,6
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n/min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

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B.1.1.1 B.1.1.2	**Conditions of connection, reconnection and gradual power supply and gradual supply of active power**	**P**

Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

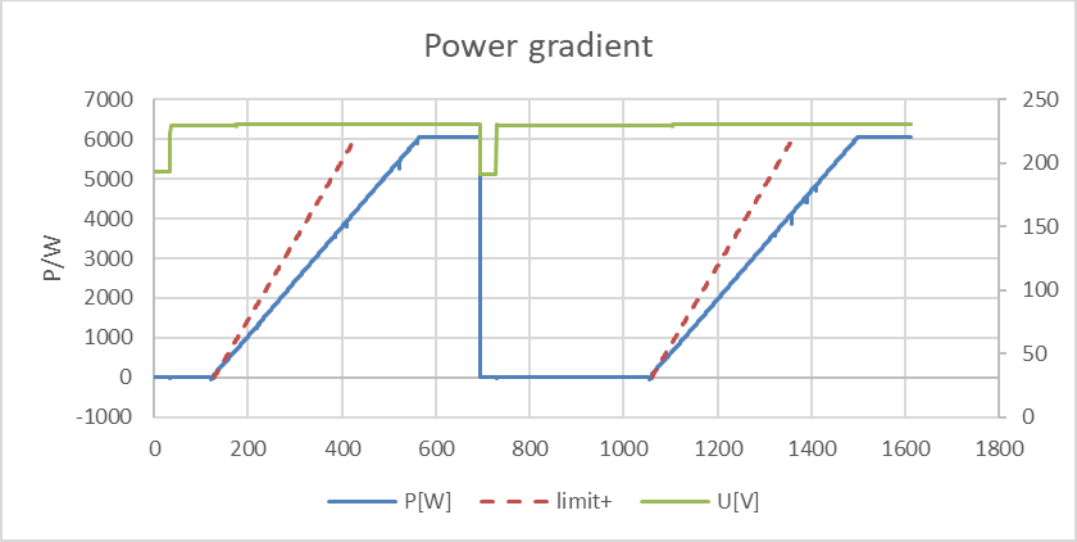
- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range between 49,00 Hz and 51,00 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

In the case of systems with power lower than 800 W:

- the power output must have a positive gradient from a delivered power no greater than 50 W.
- a fixed interval is selected (not adjustable) for the frequency in the phases of Start-Up, Reconnection and Return from a temporary over-frequency of between 49,90 Hz and 50,10 Hz and a residence time in this range equal to 300 s.

Graph of the gradual power supply



Note

The verification of the gradual output with ramp-up from "no load" to the rated value in at least 300 s is carried out by recording during test sequences b), c), e) and f) with the network analyser the output parameters to the inverter at a rate of one sample equal to the mean value every 200 ms (5 samples/s). The samples recorded from the instant the inverter exceeds a power output level of 5% of the nominal power P_n, shown on a graph, shall all be below the limiting curve P< (0,333* P_n)/s with a maximum positive deviation of +2,5 % * P_n.

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1.2	**Reactive power exchange (not applicable for installations less 800 W)**	
B.1.2.1	Checking construction standards: Reactive power capability	**P**
B.1.2.2	Test performance and recording mode	**P**
B.1.2.2.1	Inverters in systems with total power up to 11,08 kW	**P**
B.1.2.2.2	Inverters in systems with total capacity greater than 11,08 kW	**N/A**
B.1.2.3	Reactive power exchange at a given level	**N/A**
B.1.2.3.1	Procedures for preforming tests and recording results	**N/A**
B.1.2.4	Response time to an assigned step level change	**N/A**
B.1.2.5	Automatic supply of reactive power according to a characteristic curve cos φ = f(P)	**P**
B.1.2.5.1	Checking compliance with the rule for implementing the standard supply curve	**P**
B.1.2.6	Automatic exchange of reactive power according to a characteristic curve Q = f(V)	**N/A**
B.1.2.6.1	Checking compliance with the rules for the implementing the characteristic curve Q = f(V)	**N/A**

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B.1.2.1	Checking construction standards: Reactive power capability		
Type of generator	Rated Power	Reactive power absorption	Reactive power delivery
asynchronous non-self-excited	any	cos φ ≥ 0,95 (*)	cos φ ≥ 0,95 (*)
synchronous	any	cos φ ≥ 0,95 (*) adjustable	cos φ ≥ 0,95 (*) adjustable
inverter	≤11,08 kW	capability triangular in Fig. 13 (*)	
inverter	>11,08 kW	capability rectangular Fig. 13 (**)	

(*) For output powers less than 20% of the rated power the generator must not exchange a reactive power higher than 10% of the rated power.

(**) For output powers less than 10% of the rated power the generator must not exchange a reactive power higher than 10% of the rated power.

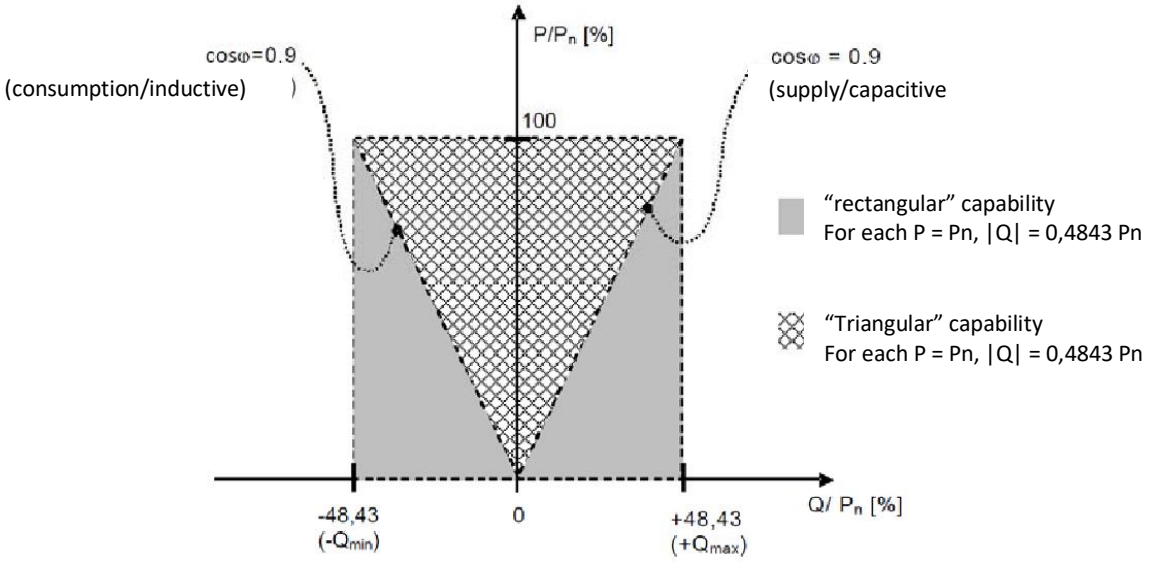

Figure 13 - "Triangular" and "rectangular" capability curves

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B.1.2.2	Test performance and recording mode

- The converter must be set so that it can, respectively, absorb (induction) and supply (resistance) the maximum reactive power available at each level of active power supplied according to its capability.
- At this point the DC source must be regulated so that the converter can supply active power in sequence included in the 10 intervals [0-10]%; [10-20]%;...; [90-100]% of nominal power (1-min average values calculated on the basis of the values measured at the fundamental frequency in a 200-ms window).
- For each of the 10 levels of active power at least 3 values for inductive reactive power and 3 for capacitive power shall be reported as 1-min average values calculated based on measurements at the fundamental frequency of a 200-ms window.
- In addition to measurements of reactive power limit values, the measured values should be recorded by setting the reactive power supplied to 0 ($\cos \varphi = 1$).

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B.1.2.2.1	Test performance and recording mode up to 11,08 kW	P

Inductive reactive power absorption

Power-BIN [%]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 -10 (*)	453,4	-217,0	0,9020	522,5
10 -20 (**)	1021,5	-471,1	0,9081	1101,5
20 -30	1578,7	-751,9	0,9028	1671,8
30 -40	2181,3	-1020,3	0,9058	2291,3
40 -50	2779,3	-1347,1	0,8999	2908,1
50 -60	3362,8	-1596,2	0,9034	3509,2
60 -70	3946,6	-1842,1	0,9062	4112,1
70 -80	4530,1	-2087,4	0,9082	4716,5
80 -90	5121,4	-2472,1	0,9006	5342,8
90 -100 (***)	5416,0	-2594,7	0,9018	5655,3

capacitive reactive power absorption

Power-BIN [%]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 -10 (*)	335,2	158,0	0,9046	399,8
10 -20 (**)	907,0	435,2	0,9016	980,5
20 -30	1515,2	726,2	0,9018	1602,6
30 -40	2026,1	982,1	0,8999	2126,1
40 -50	2691,2	1264,7	0,9051	2807,6
50 -60	3301,7	1521,0	0,9083	3436,5
60 -70	3930,8	1870,7	0,9030	4086,0
70 -80	4560,9	2104,0	0,9080	4737,9
80 -90	5192,6	2424,9	0,9061	5405,5
90 -100 (***)	5504,4	2580,5	0,9054	5736,1

cos φ = 1

Power-BIN [%]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 -10 (*)	304,3	49,7	0,9909	367,4
10 -20 (**)	904,0	-176,8	0,9904	978,1
20 -30	1498,2	-160,5	0,9943	1583,0
30 -40	2104,1	-129,6	0,9981	2202,7
40 -50	2705,5	-97,4	0,9994	2822,5
50 -60	3309,9	-77,0	0,9997	3440,2
60 -70	3906,6	-44,0	0,9999	4057,0
70 -80	4505,3	-14,6	1,0000	4674,2
80 -90	5103,9	20,9	1,0000	5300,9
90 -100 (***)	6006,5	45,5	1,0000	6247,2

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B.1.2.2.1	Test performance and recording mode up to 11,08 kW	P

Note

(*) For output powers of less than 10% of rated power the generator must not exchange a reactive

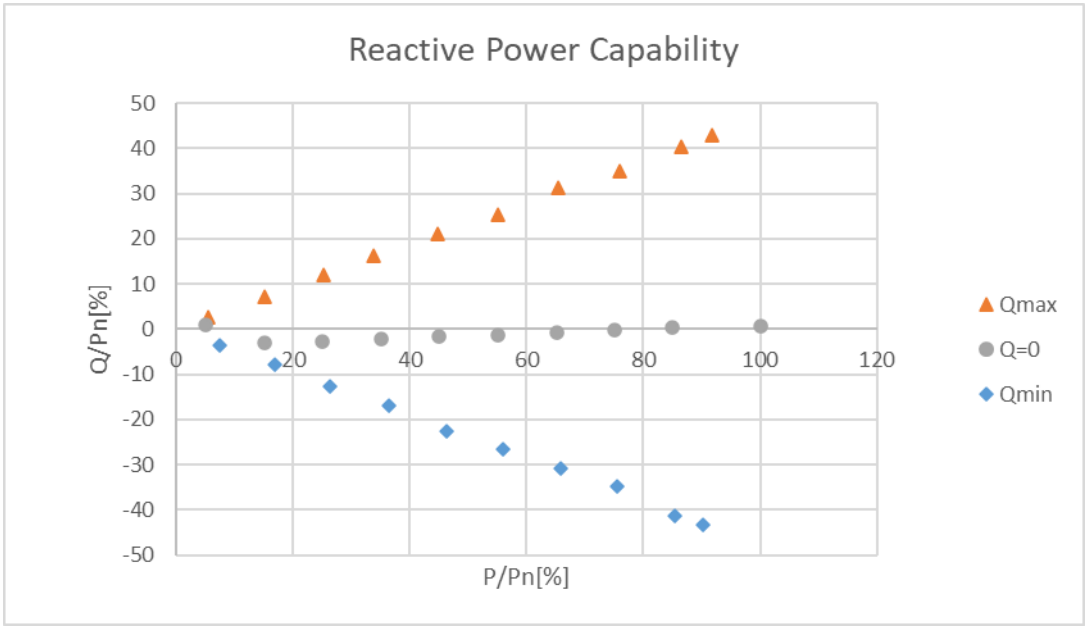
power higher than 10% of the rated power.

(**) For output powers of less than 20% of rated power the generator must not exchange a reactive power higher than 10% of the rated power.

(***) Check that the minimum requirement is supported cos φ steadily to reach a thermal balance.

The cos φ must be 0,9 or less at the 10 levels

Graph



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B.1.2.5	Automatic supply of reactive power according to a characteristic curve cos φ = f(P)

All static converters in systems able to absorb reactive power automatically and independently (local control logic) in accordance with a characteristic curve of the power/active power factor = f(P).

The purpose of the test is to check that the converter follows the methods for automatic supply of reactive power according to the standard characteristic curve cos φ = f(P) outlined in E.2, according to method a).

The standard curve is uniquely defined by linear interpolation of the three characteristic points:

A: P = 0,2 P_n; cos φ = 1

B: P = 0,5 P_n; cos φ = 1

C: P = P_n; cos φ = cos φ_max = 0,9 (inductive)

Adjustment along the characteristic curve is enabled when the voltage detected at the output terminals exceeds the "critical" lock-in value (e.g. set to V_n = 1,05 V_n, see paragraph E.2).

The lock-in voltage value that enables the automatic supply of reactive power and that during testing must be set to 1,05 V_n (default setting also for production), must be adjustable in the range between V_n and 1,1 V_n at intervals of 0,01 V_n.

The Distributor shall specify the required lock-in voltage value in the Operating Regulations.

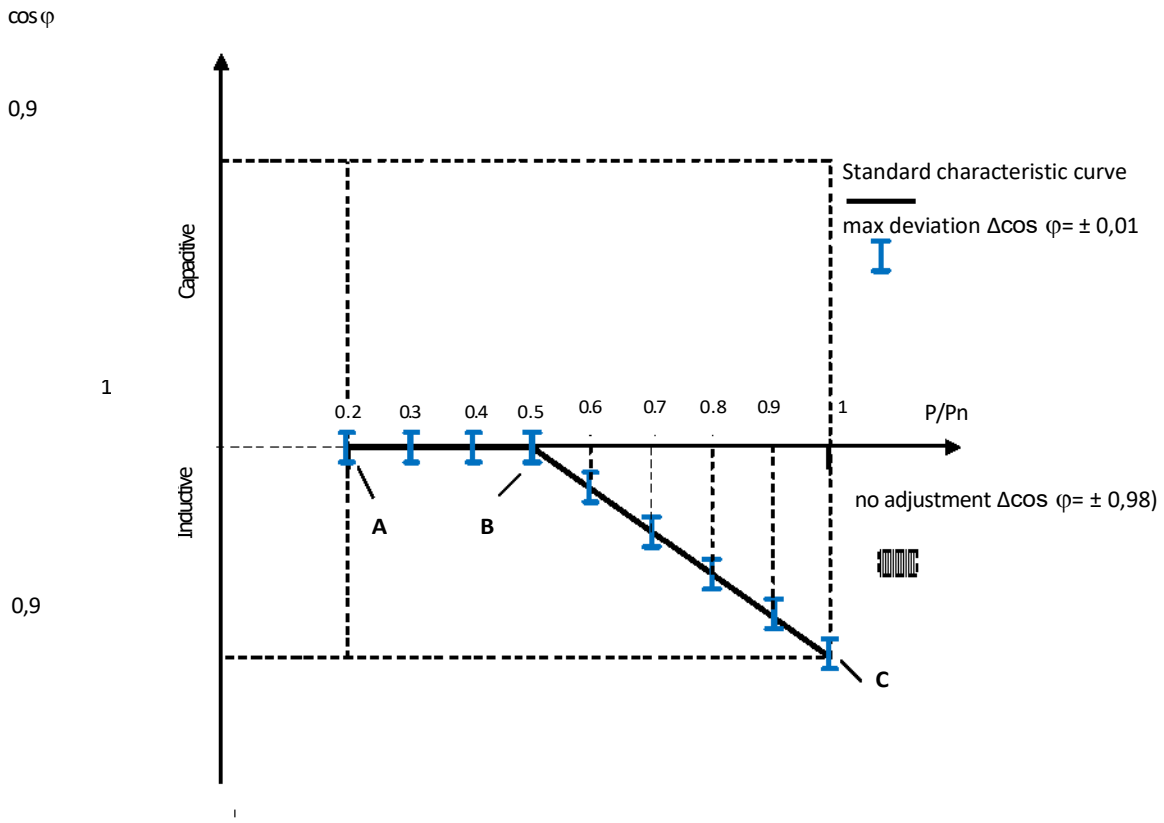

Figure 27 - Standard characteristic curve cos φ= f(P)

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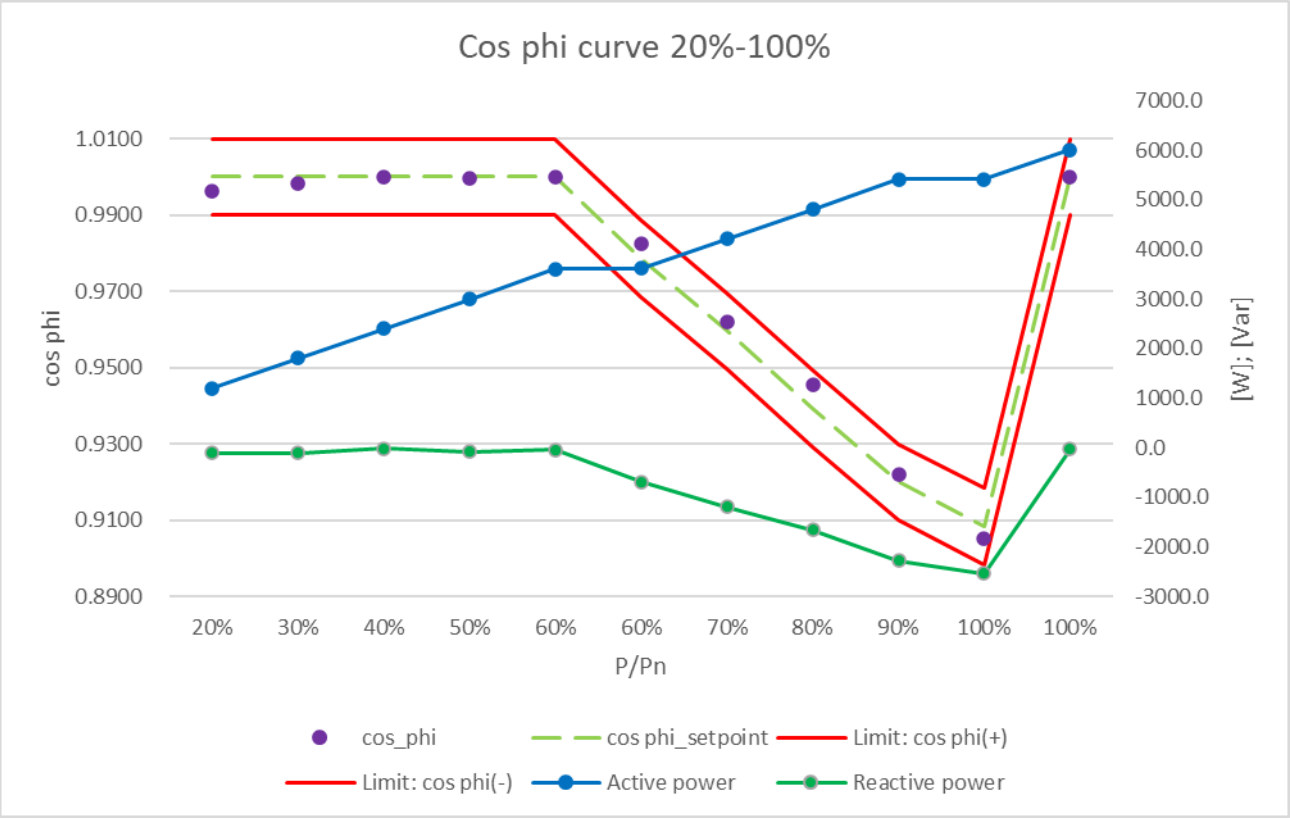
B.1.2.5.1	Checking compliance with the rules for implementing of the standard supply curve	P

Test result

Inductive reactive power absorption

Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	1200,5	-103,8	0,9963	1,0000	-0,0037
30	1800,9	-104,2	0,9983	1,0000	-0,0017
40	2401,6	-19,8	1,0000	1,0000	0,0000
50	2994,9	-83,6	0,9996	1,0000	-0,0004
60	3605,0	-40,8	0,9999	1,0000	-0,0001
60	3611,6	-687,5	0,9824	0,9786	0,0038
70	4214,0	-1196,2	0,9620	0,9597	0,0023
80	4811,7	-1655,2	0,9456	0,9392	0,0064
90	5420,1	-2277,5	0,9219	0,9200	0,0019
100	5417,3	-2545,5	0,9051	0,9083	-0,0032
100	6016,3	-28,2	1,0000	1,0000	0,0000

Graph of cos φ(P) 20% to 100%



Note

The lock-in value is adjustable between V_n and $1{,}1V_n$ and the lock-out value between V_n and $0{,}9V_n$ in 0,01V steps.

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1.3	**Limitation of power**	
B.1.3.1	Automatic limitation of active power for voltage values close to 110% of the rated voltage	**P**
B.1.3.2	Adjusting active power in the presence of transients on the transmission network	**P**
B.1.3.2.1	Testing procedure	**P**
B.1.3.2.2	Test results	**P**
B.1.3.3	Checking the operating range in voltage and frequency	**P**
B.1.3.3.1	Reduction of the active power in the presence of transients under frequency on the transmission network	**P**
B.1.3.4	Limitation of the active power by an external control from the distributer	**P**

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B.1.3.1	Automatic limitation of active power for voltage values close to 110% of the rated voltage	P
Test result		
1-min mean value / P_n/P [%]	100% to under 20%	
Activation threshold [%]	112	
1-min mean value / P/ P_n [%]	100% to 20%	
Settling time [s]	13,9	
P_{E60} [%]	16,67%	
$\Delta P_{E60}/P_{Setpoint}$ [%]	20 % or less of P_n	
Limit settling time [s]	300	

Test:

a) Set the voltage to 2% V_n lower than the activation threshold stated by the manufacturer.

b) Set the voltage to 112% V_n. The inverter now has to reduce its output power to value lower than 20% P_n within 5 min.

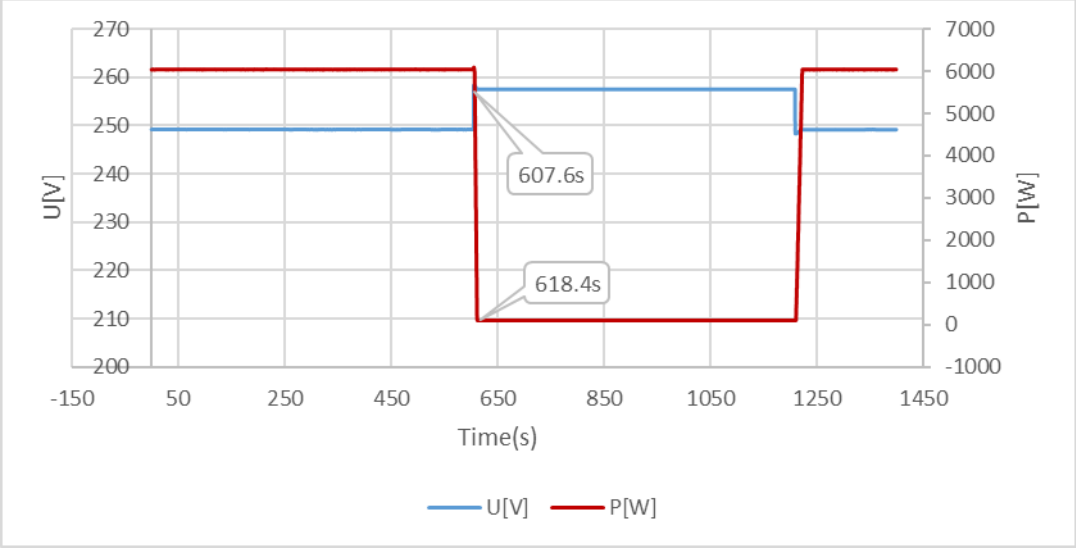
c) Set the voltage back to 2% V_n lower than the activation threshold. Check that the active power will return to the value consistent with the power available from the primary source or simulated.

Assessment criterion

for adjustable PGUs:

- no network disconnection
- the active power value does not exceed the setpoint of 20% P_n
- the setting time determined is equal or less than 300 s

Graph



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B.1.3.2	Adjusting active power in the presence of transients on the transmission network

The purpose of the test is to check the function that reduces active power automatically in case of over-frequency by extrapolating a P graph as a function of the frequency.

Two measurement sequences must be performed: starting from 100% nominal power (sequence A) and starting from 50% (sequence B).

For each measurement sequence, the frequency must be gradually increased, and the power value measured (average values over 0,2 s). A network simulator must be used for the measurement. The test can be carried out either with a network simulator capable of changing the frequency parameters available at the inverter output terminals, or directly on the electrical network. In this case, the frequency parameters controlling the power regulation system in the event of over-frequency may be adjusted, in order to simulate a progressive increase in the frequency and subsequent return to around the nominal value.

At the end of each sequence the frequency must be reduced to a value close to the nominal value to ensure that the timing requirements are met for the gradual recovery of power supplied before the frequency transient (i.e., before exceeding the 50,3 Hz limit).

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B.1.3.2.1	Testing procedure

- Connect the test object following the manufacturer's instructions.
- Set all parameters of the simulated network to the respective normal operation values.
- Set all the parameters of the test object to the respective normal operation values, so that the output AC power of the inverter is equal to the maximum AC output for sequence A, and 50% in the case of sequence B.
- Take measurements at 7 points (the frequency value should have a maximum uncertainty of ± 10 mHz) consecutively over time:

1) f = 47,51 Hz (t1 for sequence A, t'1 for sequence B)

2) f =50 Hz + 0,15 Hz (t2 for sequence A, t'2 for sequence B)

3) f =50 Hz + 0,40 Hz (t3 for sequence A, t'3 for sequence B)

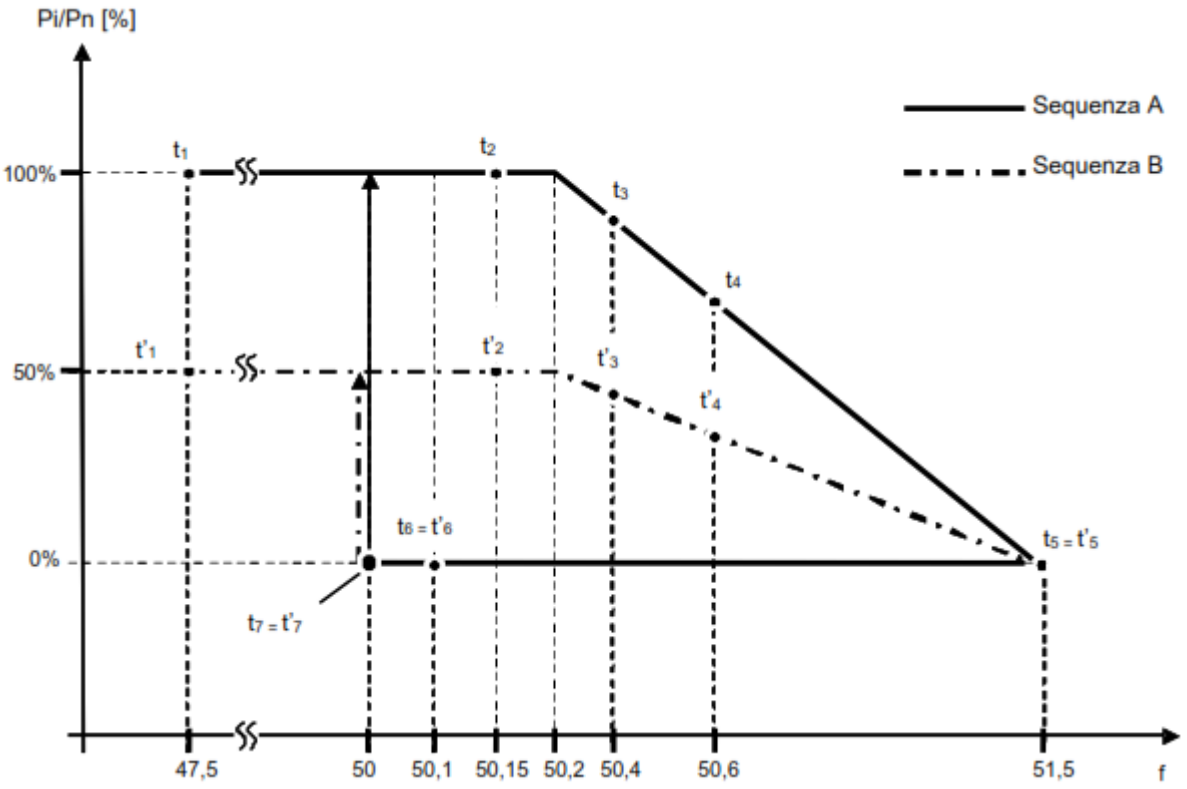
4) f =50 Hz + 0,60 Hz (t4 for sequence A, t'4 for sequence B)

5) f =50 Hz + 1,49 Hz (t5 for sequence A, t'5 for sequence B)

6) f =50 Hz + 0,11 Hz (t6 for sequence A, t'6 for sequence B)

At this point, perform step 7 bringing the frequency back to the nominal value in order to check the conditions for a gradual recovery of the maximum supply (sequence A), or 50% of the maximum power (sequence B).

7) f = 50 Hz (t7 for sequence A, t'7 for sequence B)



Note

The inverter is able to set a delay for the activation of the curve from 0 s – 1 s (in 50 ms steps / default setting: 0)

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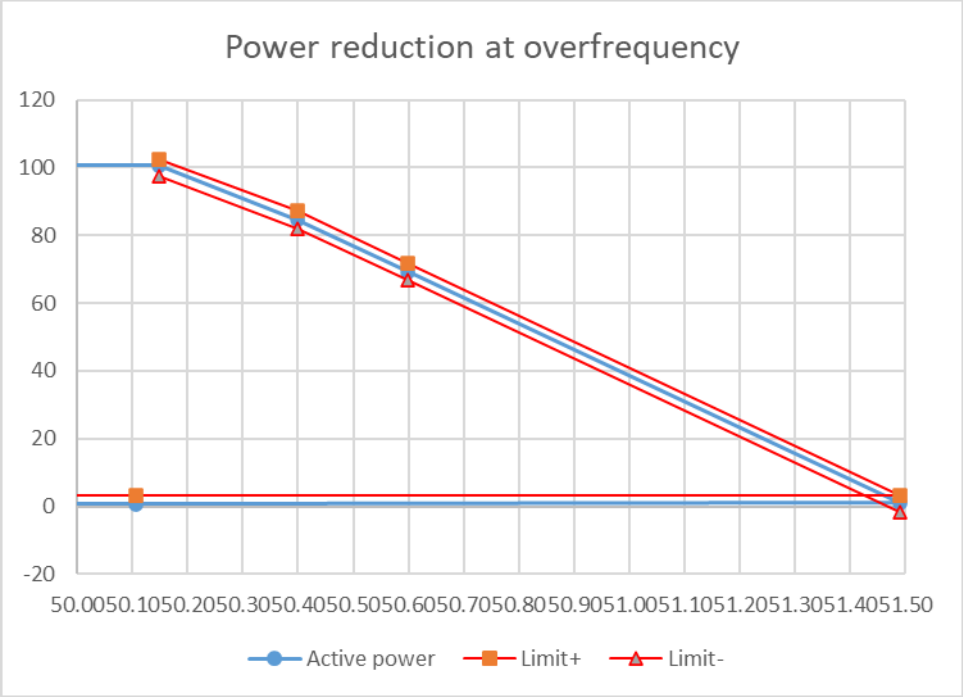
B.1.3.2.2	Adjusting active power in the presence of transients on the transmission network						P
Test result							
1-min mean value [Hz]	1) 47,51	2) 50,15	3) 50,40	4) 50,60	5) 51,49	6) 50,11	7) 50,00
1. Measurement 1) to 7): Active power output > 100% P_{nx}							
Frequency [Hz]	47,51	50,15	50,40	50,60	51,49	50,11	50,00
$P_{setpoint}$ [W]	6000,0	6000,0	5076,9	4153,8	46,2	46,2	46,2
P_{E60} [W]	6032,6	6031,4	5068,7	4150,9	63,2	40,5	38,4
ΔP_{E60} [%]	0,54	0,52	-0,14	-0,05	0,28	-0,09	-0,13
2. Measurement 1) to 7): Active power output 50%							
Frequency [Hz]	47,51	50,15	50,40	50,60	51,49	50,11	50,00
$P_{setpoint}$ [W]	3000,0	3000,0	2538,5	2076,9	23,1	23,1	23,1
P_{E60} [W]	3031,8	3035,3	2531,2	2073,6	63,1	40,1	40,8
ΔP_{E60} [%]	0,53	0,59	-0,12	-0,06	0,67	0,28	0,30
Limit							
ΔP_{E60}	± 2,5% of P_n						
Graph of Measurement 1.: Active power output reduction 100% P_{nom}							



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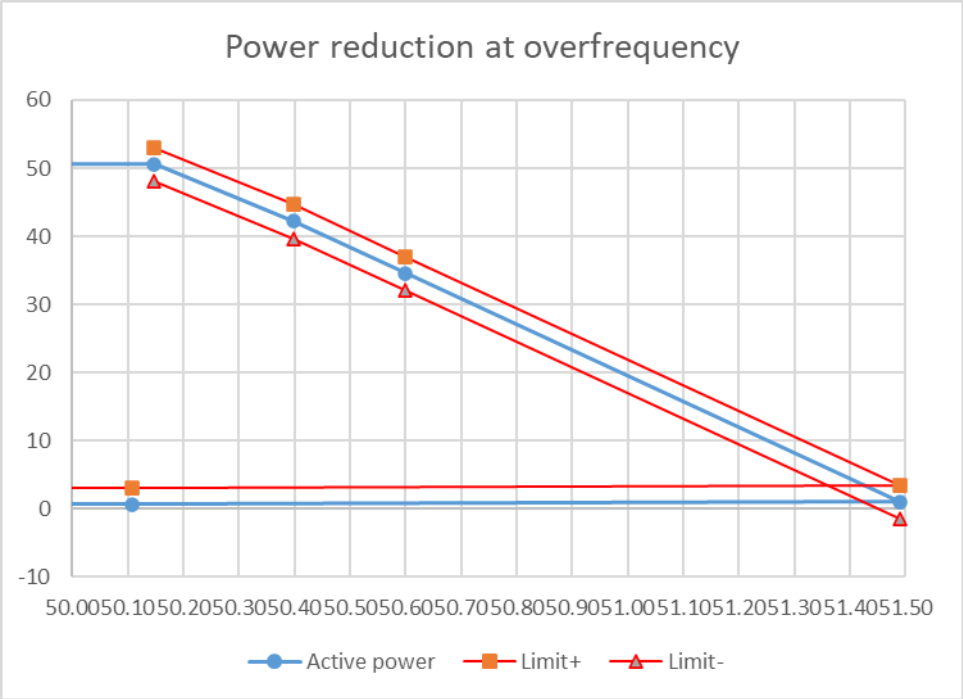
B.1.3.2.2	Adjusting active power in the presence of transients on the transmission network	P

Graph of Measurement 2.: Active power output reduction 50% P_{nom}



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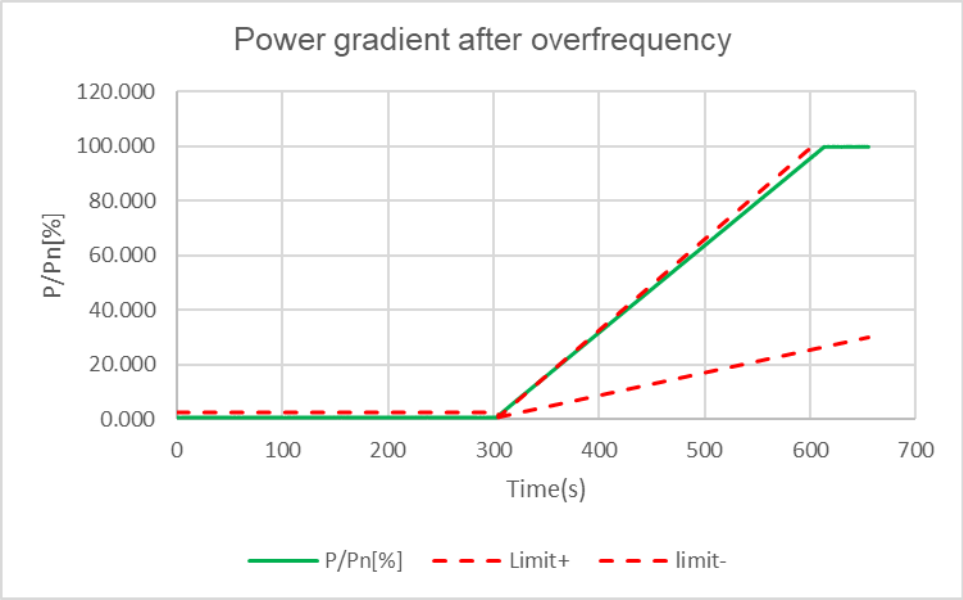
B.1.3.2.2	Adjusting active power in the presence of transients on the transmission network	P

Graph of Measurement 2.: Power gradient 100% P_{nom}



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B.1.3.3	Checking the operating range in voltage and frequency			P
Test result				
Test 1	V = 110% * Vn; f = 51,5 Hz; P = 100% * P_n; cos φ = 1 (duration: at least 5 minutes)			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	253,3	51,50	5980,1	0,9993
Limit	No disconnection allowed			
Test 2	V = 85% * V_n; f = 47,5 Hz; P = 100% * P_n; cos φ = 1 (duration: at least 5 minutes)			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	195,9	47,50	5937,6	0,9991
Limit	No disconnection allowed			

Test

(*) Unit can operate at reduced power of P ≥ 85% * S_n

(**) Over frequency reduction function must be deactivated

Supplied power must remain stable within ± 5% S_n at the entire duration

Assessment criterion

The test is intended to check the capacity of the generator to maintain the connection with the grid for an indefinite time in the field of voltage and frequency

85% V_n = V = 110% V_n

47,5 Hz = f = 51,5 Hz

The test should provide for the test of stable operation at the extreme limits of voltage and frequency for a minimum time of 5 minutes, for each working point (limited to 3 minutes in the field of tensions between 85% Vn = V = 90% Vn for only wind power generators).

Note

During the tests the interface protection was disabled.

Operation at reduced power is allowed during test 1, equal to the maximum power that can be supplied on reaching the maximum output current limit (P ≥ 0,85 S_n).

During the sequence of test 2, automatic adjustment to reduce power in the case of over-frequency was disabled.

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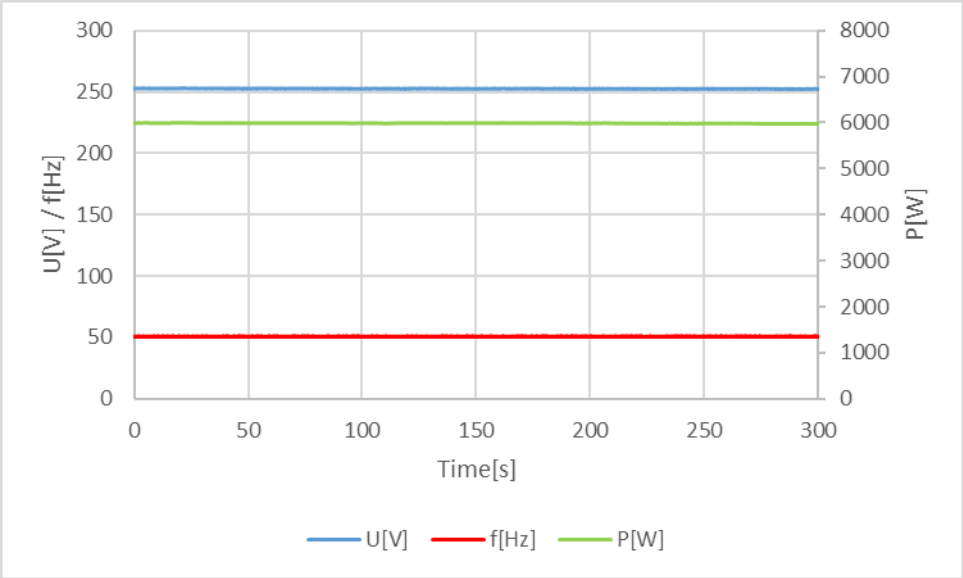
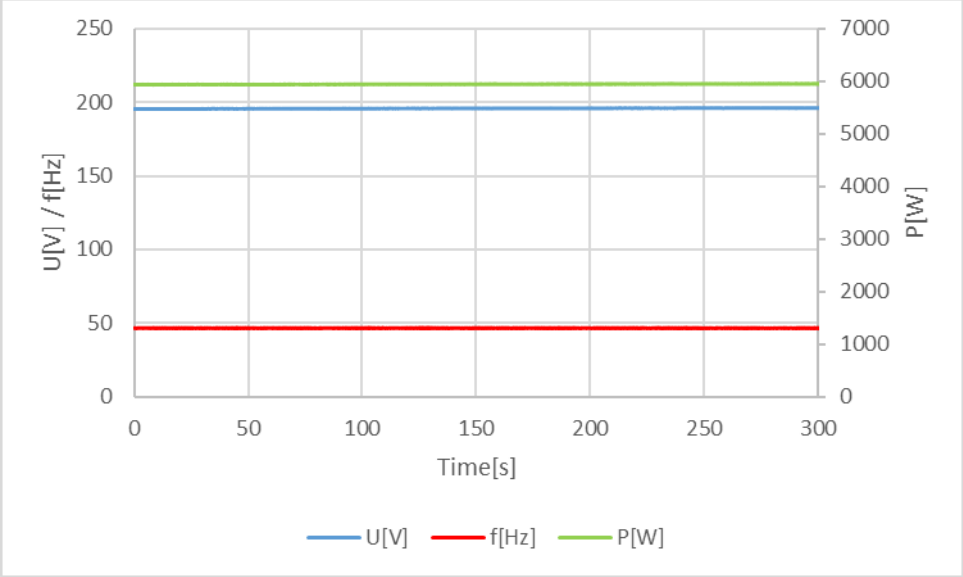
B.1.3.3	Checking the operating range in voltage and frequency	P

Graph Test 1



Graph Test 2



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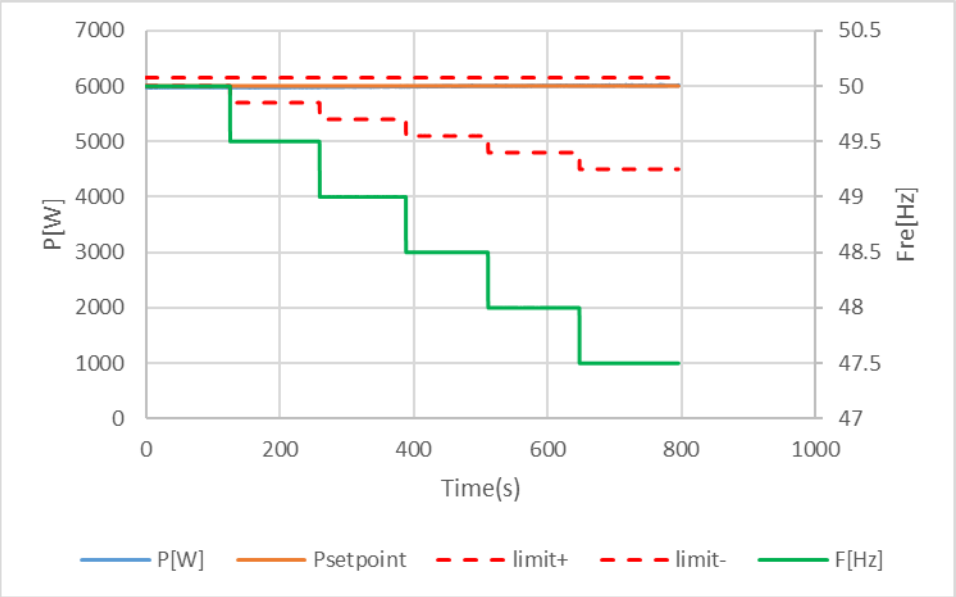
B.1.3.3.1	Reduction of the active power in the presence of transients under frequency on the transmission network					P
Test result						
	Switch to:					
1-min mean value (each) [Hz]	a) 50 ± 0,01	b) - 0,4 to – 0,5	c) – 0,9 to – 1,0	d) - 1,4 to – 1,5	e) - 1,9 to – 2,0	f) - 2,4 to – 2,5
Frequency [Hz]	50,00	49,50	49,00	48,50	48,00	47,55
Active power [W]	5971,8	5973,9	5984,4	5994,2	6000,8	6007,7
$\Delta P_{E60}/P_n$ [%]	-0,47	-0,44	-0,26	-0,10	0,01	0,13
Graph						



Note

SPI deactivated for the test.

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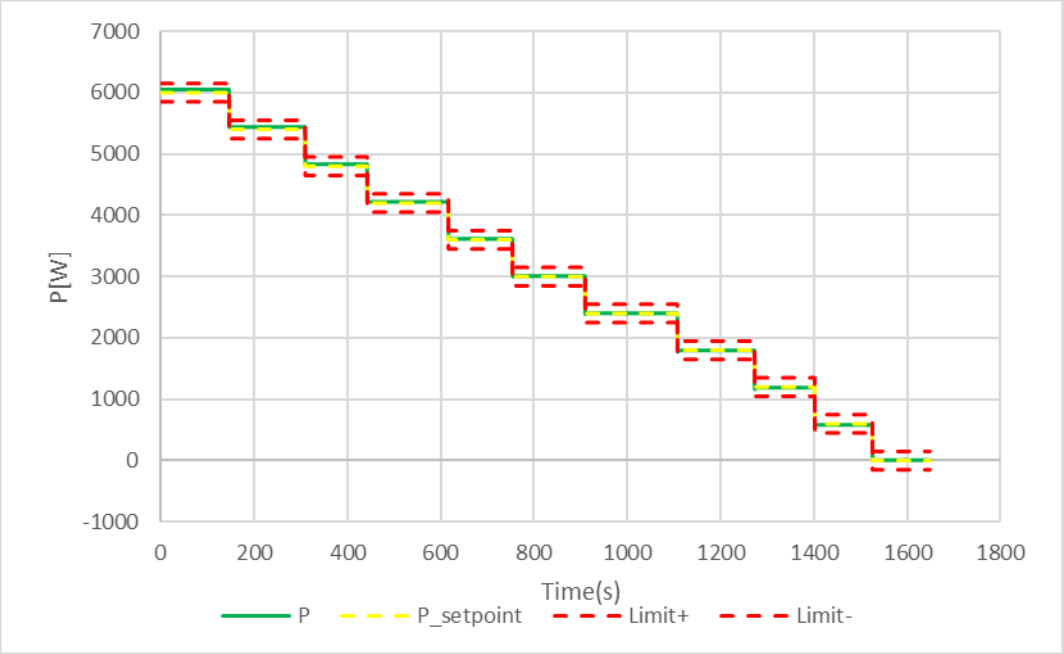
B.1.3.4	Limitation of the active power by an external control from the distributer										P
Test result											
1-min mean value / P_n/P [%]	100	90	80	70	60	50	40	30	20	10	0
$P_{Setpoint}$ [kW]	6000,0	5400,0	4800,0	4200,0	3600,0	3000,0	2400,0	1800,0	1200,0	600,0	0
P_{E60} [kW]	6051,6	5440,8	4834,4	4221,0	3614,6	3009,7	2403,2	1796,4	1190,0	583,2	8,6
ΔP [%]	0,86	0,68	0,57	0,35	0,24	0,16	0,05	-0,06	-0,17	-0,28	0,14
Limit											
ΔP [%]	± 2,5% % of P_n										
Graph of the setting accuracy											



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B.1.3.4	Limitation of the active power by an external control from the distributer	P

Test

The setpoint signal must be reduced from 100% to 10% P_n:

For adjustable PGUs in increments of 10% P_n. 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint. Then the active power of the PGU must be measured as a 1-min mean value.

Assessment criterion

for adjustable PGUs

- no network disconnection
- the active power value does not exceed the setpoint by more than 5% P_n
- the setting time determined this way is ≤ 1min

Note

The setting time is ≤ 1min. See below “Graph of the setting accuracy”.

This paragraph did not apply for installations less 800W.

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1.4	**Output of the DC component in the output current**	
B.1.4.1	Checking the DC component output	**P**
B.1.4.2	Checking the protection against DC input	**P**

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B.1.4.1	Checking the DC component output		P
Phase 1 (Ambient)			
Power Level [% of VA_r]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1969,8	3955,1	6005,8
AC Voltage [V]	230,5	230,7	230,9
AC Current [A]	8,57	17,16	26,02
PF [1]	0,9978	0,9992	0,9995
Cosφ [1]	0,9978	0,9992	0,9995
DC Current in AC [mA]	40,0	44,7	49,3
DC Current in AC [% of I_r]	0,15	0,17	0,19
Phase 1 (-10°C)			
Power Level [% of VA_r]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1970,3	3948,0	6011,7
AC Voltage [V]	230,5	230,7	230,9
AC Current [A]	8,57	17,13	26,05
PF [1]	0,9977	0,9992	0,9995
Cosφ [1]	0,9977	0,9992	0,9995
DC Current in AC [mA]	31,9	40,8	29,1
DC Current in AC [% of I_r]	0,12	0,16	0,11
Phase 1 (+55°C)			
Power Level [% of VA_r]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1969,2	3948,7	5990,1
AC Voltage [V]	230,5	230,7	230,9
AC Current [A]	8,56	17,13	25,96
PF [1]	0,9977	0,9992	0,9995
Cosφ [1]	0,9977	0,9992	0,9995
DC Current in AC [mA]	36,7	40,4	42,4
DC Current in AC [% of I_r]	0,14	0,15	0,16

Note

Limits of clause 8.4.4.1

The measurement is be performed by averaging the measured quantity of a maximum time window of 1 sec., by recording the performance for a minimum period of 5 minutes and acquiring a minimum number of samples equal to the reciprocal of the time window in which the quantity was averaged (for 1 sec, at least 300 samples). The output rms current and rms voltage of the inverter are measured and recorded in the same manner.

Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

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B.1.4.2	Checking the protection against DC injection			P
Test result				
Actual Power	Limits	Measurement [mA]	Limiting value [mA]	Disconnection time [s]
I_{dc} = 0,5% of I_n (Positive)				
33%	0,5% I_n / 1 s	424	130	0,182
66%	0,5% I_n / 1 s	220	130	0,181
100%	0,5% I_n / 1 s	390	130	0,180
I_{dc} = 0,5% of I_n (Negative)				
33%	0,5% I_n / 1 s	640	130	0,203
66%	0,5% I_n / 1 s	333	130	0,273
100%	0,5% I_n / 1 s	563	130	0,184
I_{dc} = >1 A (Positive)				
33%	1 A / 0,2 s	1296	1000	0,182
66%	1 A / 0,2 s	1301	1000	0,181
100%	1 A / 0,2 s	1390	1000	0,179
I_{dc} = >1 A (Negative)				
33%	1 A / 0,2 s	7766	1000	0,198
66%	1 A / 0,2 s	3688	1000	0,182
100%	1 A / 0,2 s	1836	1000	0,195

Note

Checking the switch-off of the converter, if the first protection threshold Idc> (>0,5% In; in the case of systems with a power of less than 800 W: >20 mA)

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1.5	**Checking insensitivity to voltage dips (LVRT capability)**	
B.1.5	Checking insensitivity to voltage dips (LVRT capability)	**N/A**
B.1.5	Checking insensitivity to voltage dips (OVRT capability)	**N/A**

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CEI 0-21		
Clause	**Requirement – Test**	**Verdict**
B.1.6	**Checking the insensitivity to automatic reclosing during phase accordance**	
B.1.6.1	Test on the simulation network	**P**

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B.1.6	Checking the insensitivity to automatic reclosing during phase accordance

General

This type of test can be performed in two ways:

1. with the inverter connected to a simulated network (B.1.6.1)
2. with the inverter connected to the distribution network (B.1.6.2 and alternatively B.1.6.3).

The generator must not be damaged as a result of the tests. Protective devices may be switched off or released.

With reference to the diagram in Figure 35 – Using the simulated network:

- The network simulator should be able to produce phase shifts in of the output voltage at the inverter terminals of 90° and 180°, respectively.
- Generator: inverter operating at nominal power with unity power factor (cos φ= 1)
- VR: simulated network voltage
- The generator must start operating at nominal power. Let the system operate under the conditions set for at least 5 minutes or the time needed to stabilise the internal temperature of the converter.

After the stabilisation period two tests should be performed in sequence, by inducing the transient that produces a phase shift angle on the simulated network voltage VR of 180° and 90°.

In the test report the following data for each of the two test sequences shall be indicated:

- the angle between the voltage before and after the phase shift, with an instrument with a 1° error;
- the generator current on a time window starting from 20 ms before until at least 200 ms after the phase shift of the simulated network voltage.

Note

The inverter was restarted after the test has been performed.

There are no damages on the complete system.

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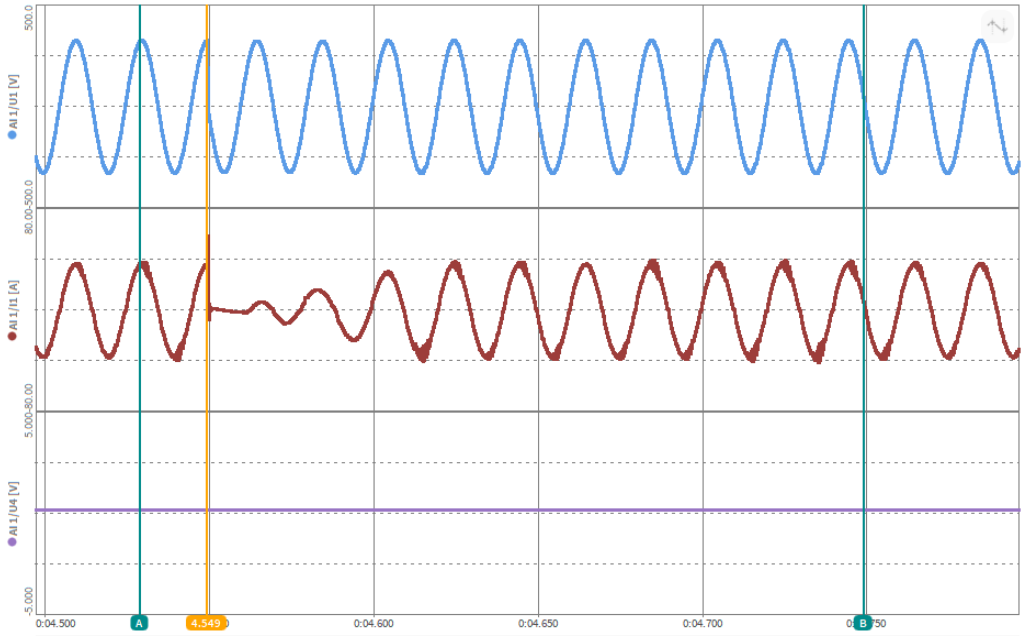
B.1.6.1	Test on the simulation network	P

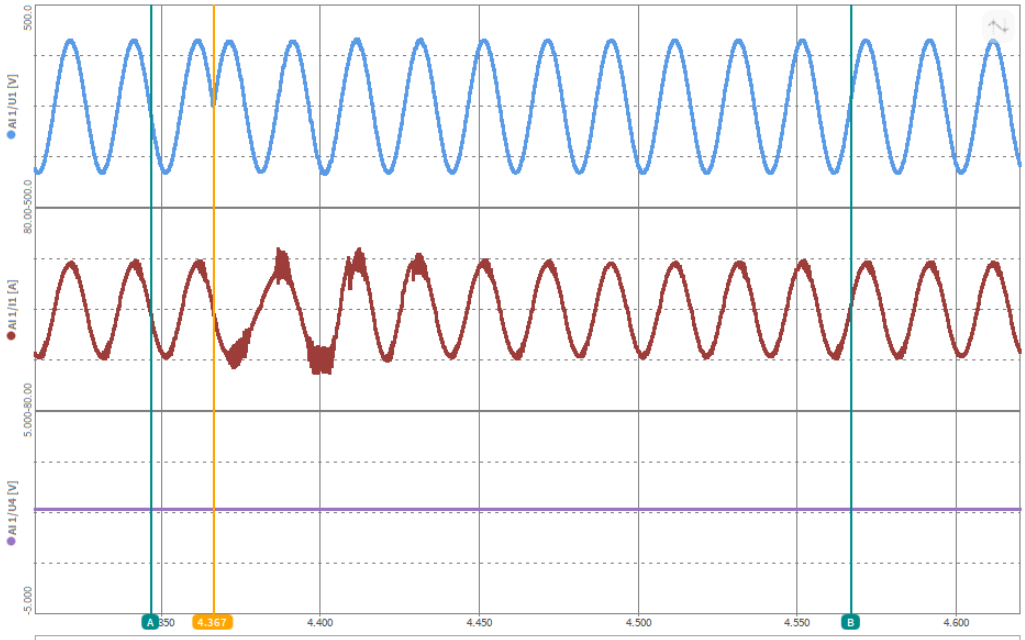
Test results

90° phase shift



	A	B	间隔
时间 [s]	4.529000	4.749000	0.220000
AI 1/U1 [V]	322.8364	56.81157	-266.0248
AI 1/I1 [A]	36.49974	7.479668	-29.02007
AI 1/U4 [V]	0.180006	0.178814	-1.192e-3

180° phase shift



	A	B	间隔
时间 [s]	4.347000	4.567000	0.220000
AI 1/U1 [V]	-36.65781	25.45047	62.10828
AI 1/I1 [A]	-2.657032	1.183653	3.840685
AI 1/U4 [V]	0.181437	0.184298	2.861e-3

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Annex L	Input Limitation System (SLI)	
Clause	**Requirement – Test**	**Verdict**
L.4	Compliance Testing	**P**

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L.4	Compliance Testing

The test serves to prove the requirements of CEI 0-21:V2:2024-01 Annex L. Systems for limiting the power fed into the grid (SLI) are intended to prevent the power fed into the grid, by the prosumer user, from exceeding the value of the PIR agreed with the distributor.

SLI systems may only be installed on single-phase plants whose PIR does not exceed 6 kW andthe total rated power of the installed generation plants does not exceed 11.08 kW.

Under all operating conditions of the plant, it must be ensured that the immission limit curve defined in the figure is not exceeded. This curve defines the maximum tripping times of t h e immission limitation according to the instantaneous exceeding of the PIR.

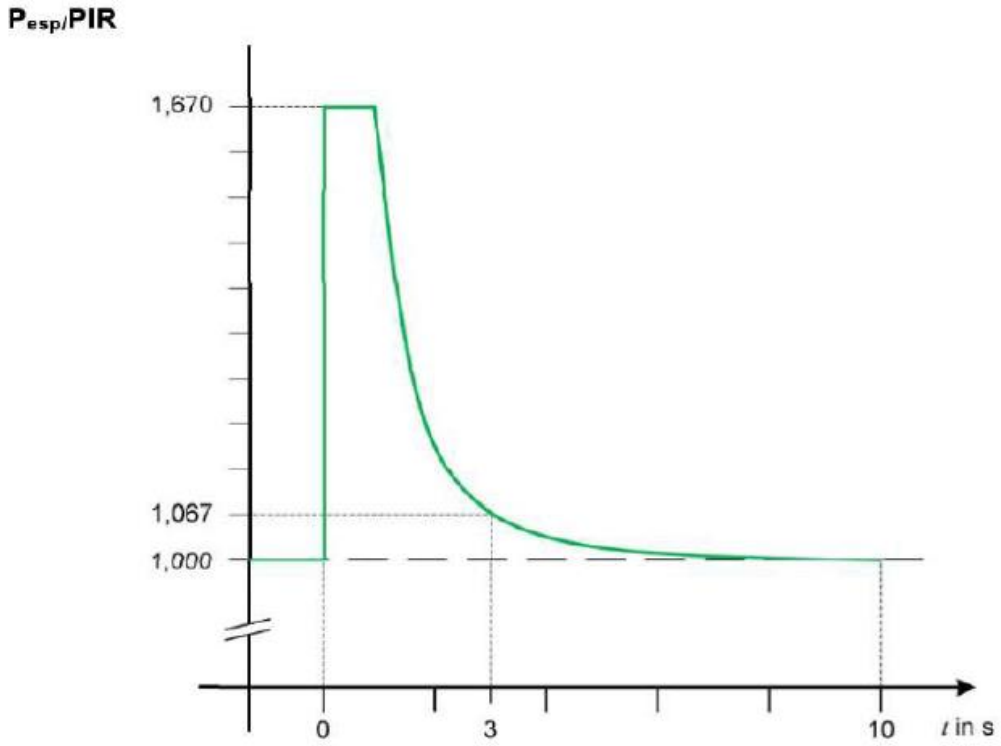

Figura 4- Curva limite di immissione

La curva segue l'equazione

$$\begin{cases} P_{esp}(t) = 1{,}67 \cdot PIR\,; 0 \le t < 0.8s \\ P_{esp}(t) = PIR\left(1 + 0.67e^{-1.05(t-0.8)}\right); t \ge 0.8s \\ PIR \le 6kW^{(7)} \end{cases}$$

Dove $P_{esp}(t)$ è la potenza istantanea esportata in rete, mentre il tempo t= 0 definisce l'inizio dell' evento che ha innescato l'intervento del controllore SLI.

Where esp(t) is the instantaneous power exported to the network, while time t= 0 defines the beginning of the event that triggered t h e SLI controller.

The measuring device for SLI control purposes must calculate the active P on the basis of a time of 200ms.

With regard to the uncertainty class of the measuring device, this must be taken into account as it will be added to the other tolerances of the system and will contribute to defining the margin that must be considered in relation to the limit curve above in order to ensure that it is not exceeded under all operating conditions o f the system.

An error is allowed:

for P>1 kW: 2.5%.

If P<=1 kW: 25 W

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L.4.2	Verification of the ability of the SLI system to comply with the maximum input curve described in L.3 following a load change				
L.4.2	Test 1				P
Step	P_{Grid} [W]	P_{Load} [W]	Limit [W]	Settling time[s]	Limit [s]
1	0%	100%	P>1kw:2.5% P<=1kw:25W	0,6	3
2	40%	0%			
L.4.2	Test2				P
Step	P_{Grid} [W]	P_{Load} [W]	Limit [W]	Settling time[s]	Limit [s]
1	0%	100%	P>1kw:2.5% P<=1kw:25W	0,4	3
2	0%	0%			

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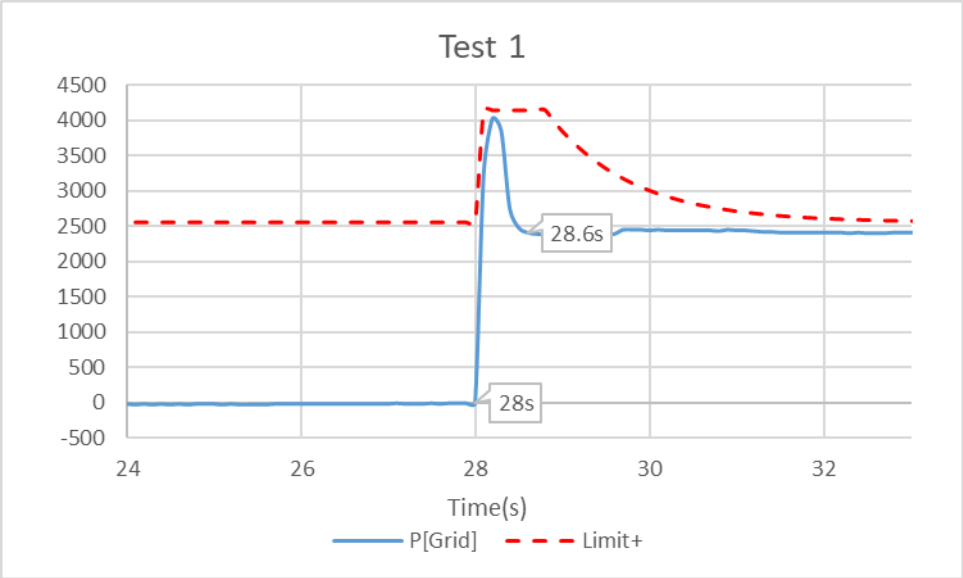
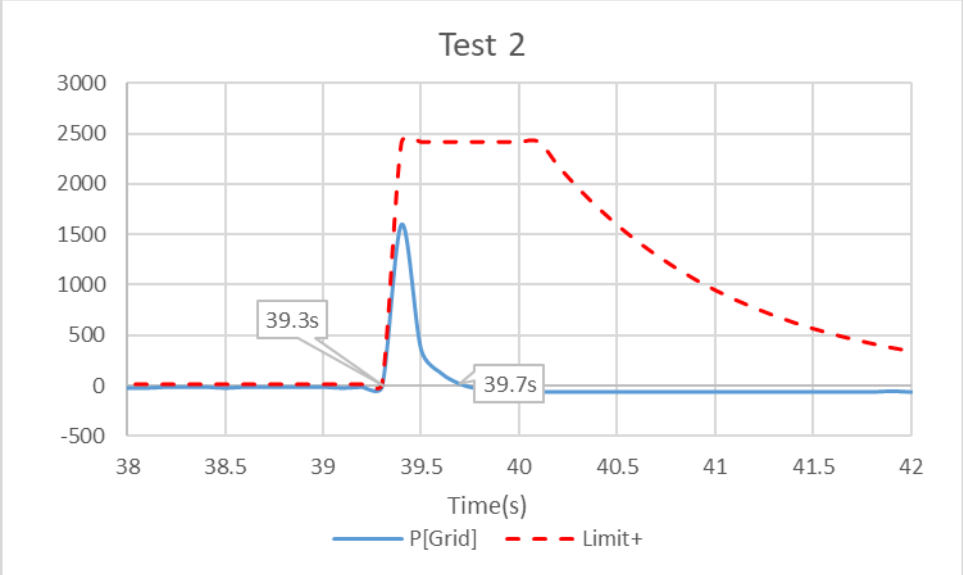
Diagram:





Assessment criterion:

Adjust the test setup with the initial settings as per the table. Change the power consumption of the load at time t0 according to the table.

Parametro	Prova 1	Prova 2
PIR	40%Pmax generatore	0%Pmax generatore
Limite di immissione	PIR – errore massimo ammesso come indicato in L.3	
Potenza generatore	100%Pmax generatore	
Potenza inziale assorbita dal carico	100%Pmax generatore	
Potenza assorbita dal carico all'istante t0	0%Pmax generatore	

The measuring system must record the active power for at least 5s before time t0 and up to 60s after time t0.

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L.4.3	Verification of the SLI system's ability t o comply with the maximum input curve described in L.3 following a power variation of the primary source				
L.4.3	**Test 1**				**P**
Step	P_{Grid} [W]	P_{Load} [W]	Limit [W]	Settling time[s]	Limit [s]
1	35%	5%	P>1kw:2.5% P<=1kw:25W	0,7	3
2	35%	5%			
L.4.3	**Test2**				**P**
Step	P_{Grid} [W]	P_{Load} [W]	Limit [W]	Settling time[s]	Limit [s]
1	0%	5%	P>1kw:2.5% P<=1kw:25W	1,6	3
2	0%	5%			

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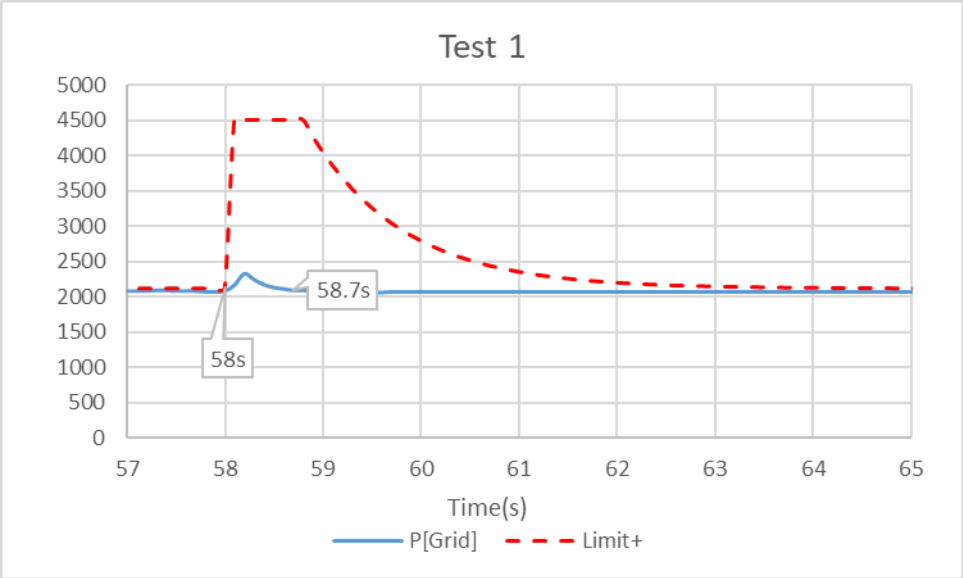
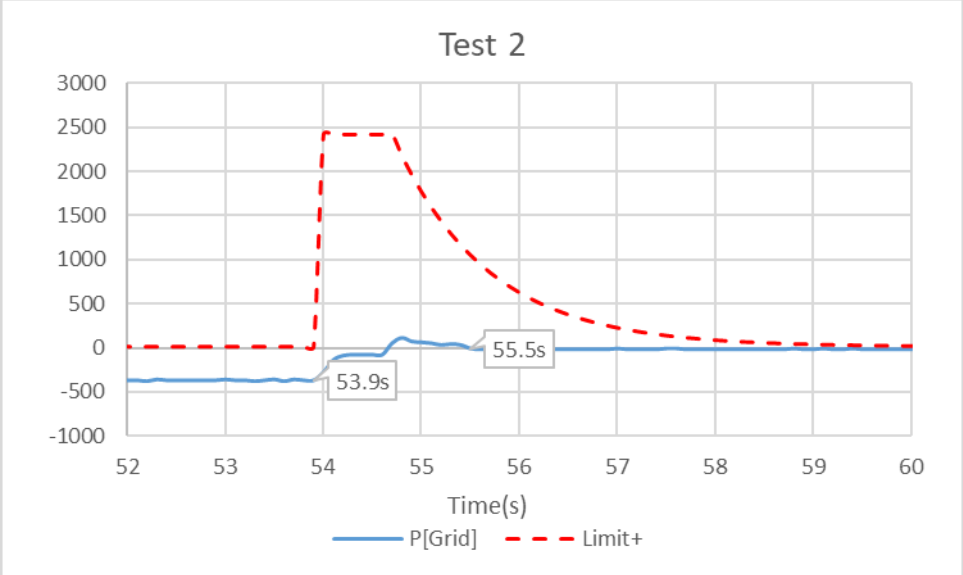
Diagram:





Assessment criterion:

Adjust the test setup with the initial settings as per the table. Change the power consumption of the load at time t0 according to the table.

Parametro	Prova 1	Prova 2
PIR	35%Pmax generatore	0%Pmax generatore
Limite di immissione	PIR – errore massimo ammesso come indicato in L.3	
Potenza iniziale del generatore	40%Pmax generatore	0%Pmax generatore
Potenza assorbita dal carico	5%Pmax generatore	
Potenza disponibile da sorgente primaria all'istante t0	110%Pmax generatore	

The measuring system must record the active power for at least 5s before time t0 and up to 60s after time t0.

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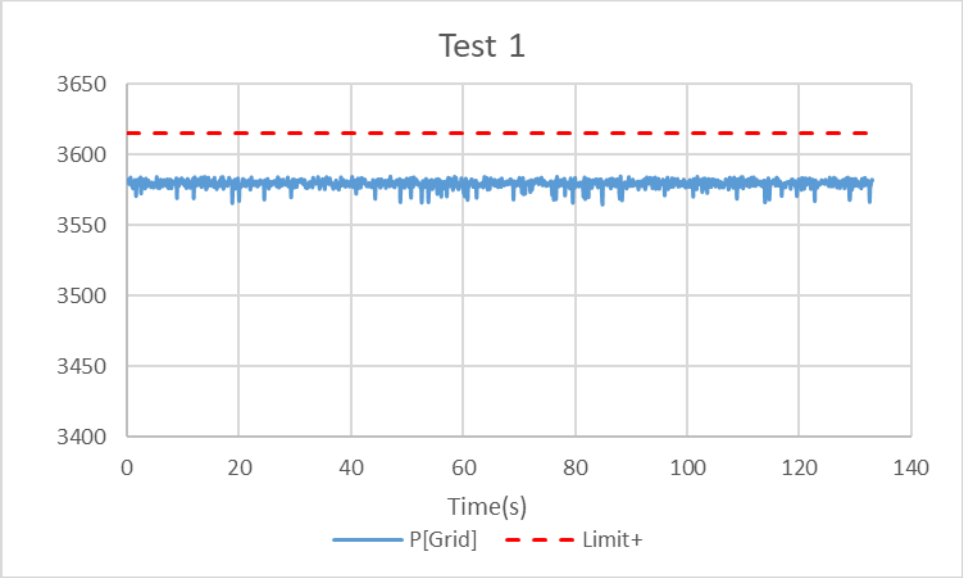
L.4.4	Verification of the SLI system's ability to comply with the limit of the power fed into the grid Under steady-state conditions	
L.4.4	Test 1	P

P_{Grid} [W]	P_{Load} [W]	Limit [W]
0%	100%	P>1kw:2.5% P<=1kw:25W

Diagram:



Assessment criterion:

Adjust the test setup with the settings as shown in the table.

Parametro	Prova
PIR	60%Pmax generatore
Limite di immissione	PIR - errore massimo ammesso come indicato in L.3
Potenza generata	100%Pmax generatore
Potenza assorbita dal carico	20%Pmax generatore

The measurement system must record the active power measurement for at least 15 minutes after the SLI control has limited the power input to a value below the PIR.

The test is passed if, during the detection period, the power fed into the grid by the generator is continuously lower than the PIR with a measurement tolerance of 2.5% for power above 1kW and 25W for power up to 1kW.

The test is passed if during the detection period, the power fed into the grid by the generator does not deviate from the PIR less the accuracy of the measuring system for verification purposes plus the accuracy of the measuring device for SLI purposes.

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Annex Bbis Tests on storage systems		
Clause	**Test**	**Result**
Bbis.3	List of tests and reference conditions	
	a)Harmonic emission	**P**
	b)Harmonic emission exceeding 75A	**N/A**
	c)Flicker emission	**P**
Bbis.4	Verification of the voltage and frequency operating range	**P**
Bbis.5	Conditions for connection, reconnection and phased power supply	**P**
Bbis.5.1	Verification of connection and reconnection conditions	**P**
Bbis.5.2	Verification of gradual output/absorption of active power	**P**
Bbis.6	Reactive Power Exchange	**P**
Bbis.6.1	Verification of construction requirements: reactive power capability	**P**
Bbis.6.2	Method of performing and recording the test	**P**
Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	**P**
Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total power output of more than 11,08 kW	**N/A**
Bbis.6.3	Reactive power exchange according to an assigned level	**N/A**
Bbis.6.4	Method of performing the test and recording the results (Q-setting hypothesis)	**P**
Bbis.6.5	Response time to a step change in the assigned level	**P**
Bbis.6.6	Automatic reactive power output according to a characteristic curve cos φ = f(P)	
Bbis.6.7	Verification of compliance with the application of the standard delivery curve cos φ = f(P)	**P**
Bbis.6.8	Automatic exchange of reactive power according to a characteristic curve Q = f(V)	**N/A**
Bbis.6.9	Verification of compliance with characteristic curve Q = f(V) (greater 11,08kW systems)	**N/A**
Bbis.7	Active Power Control	**P**
Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	**P**
Bbis.7.2	Verification of automatic active power reduction in the presence of over-frequency transients on the grid	**P**
Bbis.7.2.1	Performance of tests	
Bbis.7.2.2	Test Results	**P**
Bbis.7.3	Verification of automatic active power increase in the presence of under-frequency transients on the grid	**P**
Bbis.7.3.1	Performance of tests	
Bbis.7.3.2	Test Results	
Bbis.7.4	Verification of active power control on external control from DSO	**P**
Bbis.7.4.1	Checking the settling time to a power increase/decrease command	**P**
Bbis.8.1	Verification of emission of continuous component	**P**
Bbis.8.2	Verification of Protection against Continuous Component Input	**P**
Bbis.9	Verification of UVRT capability	**N/A**
	Verification of OVRT capability	**N/A**
Bbis.10	Verification of insensitivity to automatic reclosure in phase discordance	**P**
Bbis.10.1	Simulated network test	**P**

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1987,0		4000,8		6060,7		
AC Voltage [V]	230,5		230,7		231,0		
AC Current [A]	8,71		17,43		26,32		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,520		6,921		7,904		
PWHD	1,663		1,193		2,155		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,625	-	17,338	-	26,238	-	-
2nd	0,021	0,082	0,010	0,039	0,006	0,025	8,00
3rd	1,136	4,353	1,553	5,954	1,668	6,395	N/A
4th	0,013	0,051	0,008	0,032	0,007	0,026	4,00
5th	0,284	1,089	0,783	3,003	0,929	3,562	10,70
6th	0,003	0,011	0,006	0,025	0,006	0,024	2,67
7th	0,036	0,136	0,414	1,586	0,586	2,247	7,20
8th	0,004	0,016	0,005	0,020	0,005	0,018	2,00
9th	0,075	0,287	0,221	0,845	0,396	1,520	N/A
10th	0,005	0,019	0,004	0,014	0,004	0,014	1,60
11th	0,038	0,144	0,088	0,336	0,242	0,929	3,10
12th	0,002	0,009	0,002	0,006	0,003	0,013	1,33
13th	0,036	0,137	0,043	0,165	0,164	0,627	2,00
14th	0,003	0,010	0,001	0,004	0,002	0,007	N/A
15th	0,058	0,223	0,025	0,094	0,100	0,382	N/A
16th	0,003	0,013	0,002	0,006	0,001	0,005	N/A
17th	0,057	0,220	0,021	0,081	0,070	0,270	N/A
18th	0,002	0,008	0,002	0,006	0,002	0,006	N/A
19th	0,031	0,119	0,018	0,068	0,042	0,163	N/A
20th	0,001	0,004	0,001	0,005	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,030	0,031	0,117	N/A
22th	0,002	0,008	0,001	0,005	0,001	0,005	N/A
23th	0,016	0,061	0,006	0,024	0,017	0,067	N/A
24th	0,001	0,005	0,001	0,005	0,001	0,004	N/A
25th	0,011	0,042	0,012	0,045	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,003	0,001	0,004	N/A
27th	0,016	0,063	0,017	0,066	0,010	0,037	N/A
28th	0,002	0,008	0,001	0,003	0,001	0,005	N/A
29th	0,022	0,083	0,020	0,077	0,009	0,036	N/A

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
30th	0,002	0,009	0,002	0,006	0,002	0,007	N/A
31th	0,020	0,078	0,020	0,078	0,008	0,032	N/A
32th	0,002	0,006	0,001	0,004	0,001	0,004	N/A
33th	0,013	0,051	0,018	0,071	0,009	0,036	N/A
34th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
35th	0,008	0,030	0,017	0,065	0,008	0,032	N/A
36th	0,001	0,004	0,001	0,003	0,001	0,005	N/A
37th	0,003	0,010	0,014	0,055	0,008	0,029	N/A
38th	0,001	0,003	0,001	0,003	0,001	0,004	N/A
39th	0,002	0,009	0,013	0,051	0,007	0,028	N/A
40th	0,001	0,002	0,000	0,002	0,001	0,004	N/A
41th	0,004	0,016	0,010	0,040	0,008	0,029	N/A
42th	0,001	0,003	0,001	0,002	0,001	0,006	N/A
43th	0,006	0,024	0,008	0,031	0,007	0,027	N/A
44th	0,001	0,004	0,001	0,003	0,001	0,003	N/A
45th	0,006	0,023	0,004	0,016	0,007	0,029	N/A
46th	0,001	0,003	0,001	0,003	0,001	0,002	N/A
47th	0,005	0,020	0,002	0,006	0,008	0,029	N/A
48th	0,001	0,002	0,001	0,004	0,001	0,003	N/A
49th	0,005	0,021	0,004	0,014	0,008	0,030	N/A
50th	0,001	0,003	0,001	0,003	0,001	0,003	N/A
Note For test result (discharge mode $P_{SMAX,}$ P_{NINV}) see B.1 a), b).							

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1963,4		-3966,1		-5989,5		
AC Voltage [V]	230,1		229,6		229,4		
AC Current [A]	8,63		17,38		26,21		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,673		7,115		8,094		
PWHD	1,179		0,996		1,952		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,539	-	17,281	-	26,118	-	-
2nd	0,035	0,134	0,014	0,053	0,006	0,025	8,00
3rd	1,173	4,497	1,605	6,151	1,742	6,676	N/A
4th	0,020	0,078	0,013	0,049	0,007	0,027	4,00
5th	0,301	1,154	0,792	3,034	0,929	3,562	10,70
6th	0,005	0,018	0,009	0,036	0,004	0,017	2,67
7th	0,010	0,039	0,433	1,660	0,584	2,238	7,20
8th	0,006	0,023	0,007	0,026	0,005	0,018	2,00
9th	0,100	0,385	0,206	0,789	0,359	1,376	N/A
10th	0,008	0,032	0,004	0,016	0,004	0,016	1,60
11th	0,044	0,170	0,101	0,389	0,242	0,928	3,10
12th	0,005	0,017	0,002	0,008	0,003	0,013	1,33
13th	0,014	0,054	0,023	0,090	0,139	0,534	2,00
14th	0,003	0,010	0,001	0,005	0,002	0,009	N/A
15th	0,044	0,169	0,019	0,073	0,091	0,348	N/A
16th	0,005	0,018	0,002	0,008	0,002	0,008	N/A
17th	0,039	0,150	0,029	0,109	0,048	0,183	N/A
18th	0,004	0,016	0,002	0,009	0,001	0,005	N/A
19th	0,032	0,122	0,022	0,083	0,032	0,122	N/A
20th	0,002	0,007	0,002	0,008	0,001	0,005	N/A
21th	0,014	0,054	0,021	0,080	0,020	0,078	N/A
22th	0,001	0,006	0,002	0,007	0,001	0,004	N/A
23th	0,009	0,033	0,015	0,056	0,016	0,060	N/A
24th	0,002	0,006	0,001	0,005	0,001	0,004	N/A
25th	0,002	0,007	0,009	0,035	0,017	0,064	N/A
26th	0,001	0,005	0,001	0,003	0,001	0,004	N/A
27th	0,005	0,018	0,009	0,034	0,019	0,072	N/A
28th	0,002	0,006	0,001	0,004	0,001	0,004	N/A
29th	0,009	0,035	0,009	0,036	0,019	0,072	N/A

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
30th	0,002	0,009	0,002	0,006	0,002	0,006	N/A
31th	0,009	0,033	0,010	0,037	0,017	0,066	N/A
32th	0,002	0,008	0,001	0,004	0,001	0,004	N/A
33th	0,009	0,035	0,010	0,038	0,017	0,067	N/A
34th	0,001	0,005	0,001	0,005	0,001	0,003	N/A
35th	0,007	0,028	0,011	0,040	0,015	0,056	N/A
36th	0,001	0,004	0,001	0,005	0,001	0,002	N/A
37th	0,007	0,025	0,011	0,042	0,011	0,042	N/A
38th	0,001	0,003	0,001	0,004	0,001	0,002	N/A
39th	0,004	0,016	0,009	0,034	0,011	0,042	N/A
40th	0,001	0,003	0,001	0,004	0,001	0,003	N/A
41th	0,001	0,005	0,009	0,033	0,007	0,028	N/A
42th	0,001	0,004	0,001	0,002	0,001	0,003	N/A
43th	0,001	0,002	0,007	0,026	0,005	0,019	N/A
44th	0,001	0,004	0,001	0,002	0,001	0,003	N/A
45th	0,002	0,008	0,005	0,021	0,004	0,015	N/A
46th	0,001	0,003	0,000	0,001	0,001	0,003	N/A
47th	0,003	0,013	0,004	0,016	0,002	0,009	N/A
48th	0,001	0,004	0,000	0,001	0,001	0,003	N/A
49th	0,003	0,011	0,005	0,018	0,002	0,006	N/A
50th	0,001	0,002	0,000	0,002	0,001	0,002	N/A
Note							
For test result (discharge mode P_{SMAX}, P_{NINV}) see B.1 a), b).							

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1986,3		4000,4		6059,9		
AC Voltage [V]	230,5		230,7		231,0		
AC Current [A]	8,70		17,43		26,32		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,516		6,919		7,903		
PWHD	1,663		1,193		2,155		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,622	-	17,337	-	26,234	-	-
2nd	0,032	0,121	0,012	0,046	0,008	0,029	8,00
3rd	1,134	4,348	1,553	5,952	1,668	6,394	N/A
4th	0,019	0,072	0,010	0,039	0,008	0,030	4,00
5th	0,284	1,087	0,783	3,002	0,929	3,561	10,70
6th	0,004	0,014	0,007	0,028	0,007	0,026	2,67
7th	0,035	0,136	0,414	1,585	0,586	2,246	7,20
8th	0,006	0,022	0,006	0,023	0,006	0,022	2,00
9th	0,074	0,285	0,221	0,845	0,396	1,519	N/A
10th	0,007	0,027	0,004	0,015	0,005	0,018	1,60
11th	0,037	0,143	0,088	0,336	0,242	0,929	3,10
12th	0,003	0,012	0,002	0,006	0,004	0,014	1,33
13th	0,036	0,137	0,043	0,165	0,164	0,627	2,00
14th	0,003	0,013	0,001	0,005	0,002	0,008	N/A
15th	0,058	0,222	0,025	0,094	0,100	0,382	N/A
16th	0,005	0,018	0,002	0,007	0,001	0,005	N/A
17th	0,057	0,220	0,021	0,081	0,070	0,270	N/A
18th	0,003	0,012	0,002	0,007	0,002	0,006	N/A
19th	0,031	0,119	0,018	0,068	0,043	0,163	N/A
20th	0,001	0,005	0,002	0,006	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,030	0,031	0,117	N/A
22th	0,003	0,010	0,002	0,006	0,002	0,006	N/A
23th	0,016	0,061	0,006	0,024	0,017	0,066	N/A
24th	0,002	0,007	0,001	0,005	0,001	0,004	N/A
25th	0,011	0,042	0,012	0,046	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
27th	0,016	0,063	0,017	0,066	0,010	0,037	N/A
28th	0,003	0,010	0,001	0,003	0,001	0,006	N/A
29th	0,021	0,082	0,020	0,077	0,009	0,036	N/A

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
30th	0,003	0,013	0,002	0,006	0,002	0,007	N/A
31th	0,020	0,078	0,020	0,078	0,008	0,031	N/A
32th	0,002	0,009	0,001	0,004	0,001	0,005	N/A
33th	0,013	0,051	0,018	0,071	0,009	0,036	N/A
34th	0,001	0,004	0,001	0,004	0,001	0,005	N/A
35th	0,008	0,030	0,017	0,065	0,008	0,031	N/A
36th	0,001	0,005	0,001	0,003	0,001	0,005	N/A
37th	0,003	0,010	0,014	0,055	0,008	0,029	N/A
38th	0,001	0,005	0,001	0,003	0,001	0,004	N/A
39th	0,002	0,009	0,013	0,051	0,007	0,028	N/A
40th	0,001	0,002	0,001	0,002	0,001	0,004	N/A
41th	0,004	0,016	0,010	0,040	0,008	0,029	N/A
42th	0,001	0,004	0,001	0,002	0,001	0,006	N/A
43th	0,006	0,024	0,008	0,031	0,007	0,027	N/A
44th	0,001	0,005	0,001	0,003	0,001	0,003	N/A
45th	0,006	0,022	0,004	0,016	0,007	0,029	N/A
46th	0,001	0,003	0,001	0,003	0,001	0,003	N/A
47th	0,005	0,019	0,002	0,006	0,008	0,029	N/A
48th	0,001	0,004	0,001	0,004	0,001	0,003	N/A
49th	0,005	0,021	0,004	0,014	0,008	0,030	N/A
50th	0,001	0,004	0,001	0,004	0,001	0,003	N/A
Note							
For test result (discharge mode $P_{SMAX,}$ P_{NINV}) see B.1 a), b).							

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Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1963,4		-3966,1		-5990,7		
AC Voltage [V]	230,1		229,6		229,4		
AC Current [A]	8,63		17,38		26,21		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,678		7,121		8,094		
PWHD	1,182		0,998		1,953		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,539	-	17,281	-	26,123	-	-
2nd	0,033	0,125	0,012	0,047	0,004	0,017	8,00
3rd	1,174	4,502	1,606	6,156	1,741	6,675	N/A
4th	0,019	0,073	0,012	0,044	0,005	0,020	4,00
5th	0,301	1,154	0,792	3,036	0,929	3,563	10,70
6th	0,004	0,017	0,008	0,032	0,003	0,011	2,67
7th	0,011	0,041	0,433	1,660	0,584	2,238	7,20
8th	0,006	0,022	0,006	0,023	0,003	0,013	2,00
9th	0,101	0,385	0,206	0,788	0,359	1,377	N/A
10th	0,008	0,031	0,004	0,014	0,003	0,012	1,60
11th	0,044	0,170	0,101	0,388	0,242	0,928	3,10
12th	0,004	0,016	0,002	0,007	0,004	0,014	1,33
13th	0,014	0,055	0,023	0,089	0,139	0,535	2,00
14th	0,003	0,010	0,001	0,005	0,002	0,007	N/A
15th	0,044	0,170	0,019	0,073	0,091	0,348	N/A
16th	0,004	0,017	0,002	0,007	0,002	0,007	N/A
17th	0,039	0,151	0,029	0,110	0,048	0,183	N/A
18th	0,004	0,015	0,002	0,008	0,001	0,005	N/A
19th	0,032	0,122	0,022	0,084	0,032	0,122	N/A
20th	0,002	0,007	0,002	0,007	0,001	0,005	N/A
21th	0,014	0,054	0,021	0,080	0,020	0,078	N/A
22th	0,001	0,005	0,002	0,007	0,001	0,004	N/A
23th	0,009	0,033	0,015	0,056	0,016	0,060	N/A
24th	0,002	0,006	0,001	0,005	0,001	0,004	N/A
25th	0,002	0,007	0,009	0,035	0,017	0,064	N/A
26th	0,001	0,005	0,001	0,003	0,001	0,004	N/A
27th	0,005	0,018	0,009	0,034	0,019	0,072	N/A
28th	0,002	0,006	0,001	0,004	0,001	0,003	N/A
29th	0,009	0,036	0,009	0,036	0,019	0,072	N/A

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TEMP-0058-TG-EAW-ES-V01

Bbis.3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
30th	0,002	0,008	0,001	0,006	0,002	0,006	N/A
31th	0,009	0,034	0,010	0,038	0,017	0,066	N/A
32th	0,002	0,008	0,001	0,004	0,001	0,003	N/A
33th	0,009	0,035	0,010	0,038	0,017	0,067	N/A
34th	0,001	0,005	0,001	0,004	0,001	0,003	N/A
35th	0,007	0,028	0,011	0,041	0,015	0,056	N/A
36th	0,001	0,004	0,001	0,005	0,001	0,002	N/A
37th	0,007	0,025	0,011	0,042	0,011	0,042	N/A
38th	0,001	0,003	0,001	0,004	0,001	0,002	N/A
39th	0,004	0,016	0,009	0,034	0,011	0,042	N/A
40th	0,001	0,003	0,001	0,003	0,001	0,003	N/A
41th	0,001	0,005	0,009	0,033	0,007	0,028	N/A
42th	0,001	0,004	0,001	0,002	0,001	0,002	N/A
43th	0,001	0,002	0,007	0,026	0,005	0,019	N/A
44th	0,001	0,004	0,000	0,002	0,001	0,003	N/A
45th	0,002	0,008	0,005	0,021	0,004	0,015	N/A
46th	0,001	0,003	0,000	0,001	0,001	0,002	N/A
47th	0,004	0,014	0,004	0,017	0,002	0,009	N/A
48th	0,001	0,004	0,000	0,001	0,001	0,002	N/A
49th	0,003	0,011	0,005	0,018	0,002	0,006	N/A
50th	0,001	0,002	0,000	0,002	0,001	0,002	N/A
Note							
For test result (discharge mode P_{SMAX}, P_{NINV}) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1986,4		3999,9		6060,4		
AC Voltage [V]	230,5		230,7		231,0		
AC Current [A]	8,70		17,43		26,32		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,510		6,918		7,902		
PWHD	1,663		1,192		2,157		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	8,622	-	17,334	-	26,236	-	-
2nd	0,032	0,123	0,014	0,054	0,006	0,024	8,00
3rd	1,133	4,342	1,553	5,952	1,668	6,393	N/A
4th	0,019	0,074	0,012	0,047	0,006	0,023	4,00
5th	0,284	1,088	0,783	3,002	0,929	3,562	10,70
6th	0,004	0,014	0,009	0,035	0,006	0,025	2,67
7th	0,035	0,133	0,413	1,585	0,586	2,245	7,20
8th	0,006	0,023	0,007	0,027	0,004	0,017	2,00
9th	0,074	0,283	0,220	0,845	0,396	1,520	N/A
10th	0,007	0,028	0,004	0,017	0,003	0,012	1,60
11th	0,037	0,144	0,088	0,335	0,242	0,928	3,10
12th	0,003	0,013	0,002	0,007	0,003	0,013	1,33
13th	0,035	0,136	0,043	0,165	0,164	0,628	2,00
14th	0,003	0,013	0,001	0,005	0,002	0,008	N/A
15th	0,058	0,222	0,024	0,094	0,100	0,382	N/A
16th	0,005	0,018	0,002	0,009	0,001	0,005	N/A
17th	0,057	0,220	0,021	0,081	0,071	0,270	N/A
18th	0,003	0,012	0,002	0,009	0,001	0,005	N/A
19th	0,031	0,120	0,018	0,068	0,043	0,163	N/A
20th	0,001	0,006	0,002	0,007	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,030	0,031	0,117	N/A
22th	0,003	0,010	0,002	0,007	0,001	0,005	N/A
23th	0,016	0,061	0,006	0,024	0,017	0,067	N/A
24th	0,002	0,007	0,002	0,006	0,001	0,004	N/A
25th	0,011	0,042	0,012	0,046	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,003	0,001	0,004	N/A
27th	0,016	0,062	0,017	0,066	0,010	0,037	N/A
28th	0,003	0,010	0,001	0,004	0,001	0,005	N/A
29th	0,021	0,082	0,020	0,076	0,009	0,036	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmax battery							
30th	0,003	0,013	0,002	0,007	0,002	0,007	N/A
31th	0,020	0,078	0,020	0,078	0,008	0,031	N/A
32th	0,002	0,009	0,001	0,005	0,001	0,004	N/A
33th	0,013	0,051	0,018	0,071	0,009	0,036	N/A
34th	0,001	0,004	0,001	0,004	0,001	0,005	N/A
35th	0,008	0,030	0,017	0,064	0,008	0,031	N/A
36th	0,001	0,005	0,001	0,004	0,001	0,004	N/A
37th	0,003	0,010	0,014	0,055	0,008	0,029	N/A
38th	0,001	0,005	0,001	0,003	0,001	0,004	N/A
39th	0,002	0,009	0,013	0,051	0,007	0,028	N/A
40th	0,001	0,003	0,001	0,002	0,001	0,004	N/A
41th	0,004	0,016	0,010	0,040	0,008	0,029	N/A
42th	0,001	0,004	0,000	0,002	0,001	0,005	N/A
43th	0,006	0,024	0,008	0,030	0,007	0,027	N/A
44th	0,001	0,005	0,001	0,003	0,001	0,003	N/A
45th	0,006	0,023	0,004	0,016	0,007	0,029	N/A
46th	0,001	0,003	0,001	0,003	0,001	0,002	N/A
47th	0,005	0,019	0,002	0,006	0,008	0,029	N/A
48th	0,001	0,004	0,001	0,004	0,001	0,003	N/A
49th	0,005	0,021	0,004	0,013	0,008	0,030	N/A
50th	0,001	0,004	0,001	0,004	0,001	0,003	N/A
Note For test result (discharge mode $P_{SMAX,}$ P_{NINV}) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1964,5		-3981,1		-5993,3		
AC Voltage [V]	230,1		229,9		229,4		
AC Current [A]	8,63		17,42		26,22		
Frequency [Hz]	50,00		50,00		50,00		
THD [%]	4,689		7,123		8,093		
PWHD	1,189		0,997		1,955		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,544	-	17,323	-	26,135	-	-
2nd	0,022	0,085	0,007	0,028	0,005	0,019	8,00
3rd	1,178	4,514	1,605	6,152	1,740	6,671	N/A
4th	0,013	0,050	0,007	0,028	0,002	0,008	4,00
5th	0,302	1,157	0,794	3,044	0,930	3,566	10,70
6th	0,003	0,011	0,005	0,020	0,003	0,010	2,67
7th	0,011	0,043	0,434	1,665	0,584	2,240	7,20
8th	0,004	0,015	0,004	0,016	0,002	0,007	2,00
9th	0,101	0,388	0,208	0,796	0,360	1,379	N/A
10th	0,006	0,022	0,003	0,010	0,002	0,006	1,60
11th	0,045	0,171	0,102	0,391	0,242	0,929	3,10
12th	0,003	0,011	0,002	0,007	0,001	0,005	1,33
13th	0,014	0,055	0,024	0,093	0,140	0,536	2,00
14th	0,002	0,008	0,001	0,005	0,001	0,005	N/A
15th	0,045	0,172	0,019	0,073	0,091	0,348	N/A
16th	0,003	0,013	0,001	0,005	0,002	0,007	N/A
17th	0,040	0,152	0,029	0,109	0,048	0,183	N/A
18th	0,003	0,011	0,001	0,006	0,002	0,007	N/A
19th	0,032	0,122	0,022	0,084	0,032	0,121	N/A
20th	0,001	0,005	0,001	0,005	0,001	0,004	N/A
21th	0,014	0,054	0,021	0,081	0,020	0,078	N/A
22th	0,001	0,004	0,001	0,004	0,001	0,005	N/A
23th	0,009	0,034	0,015	0,056	0,016	0,061	N/A
24th	0,001	0,004	0,001	0,004	0,001	0,004	N/A
25th	0,002	0,007	0,009	0,035	0,017	0,065	N/A
26th	0,001	0,004	0,001	0,002	0,001	0,004	N/A
27th	0,005	0,018	0,009	0,034	0,019	0,072	N/A
28th	0,001	0,004	0,001	0,003	0,001	0,003	N/A
29th	0,009	0,036	0,009	0,035	0,019	0,073	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmax battery							
30th	0,002	0,007	0,001	0,005	0,002	0,006	N/A
31th	0,009	0,034	0,010	0,038	0,017	0,066	N/A
32th	0,002	0,006	0,001	0,003	0,001	0,004	N/A
33th	0,009	0,035	0,010	0,038	0,018	0,067	N/A
34th	0,001	0,004	0,001	0,003	0,001	0,003	N/A
35th	0,008	0,029	0,011	0,041	0,015	0,057	N/A
36th	0,001	0,003	0,001	0,004	0,001	0,003	N/A
37th	0,007	0,026	0,011	0,043	0,011	0,042	N/A
38th	0,001	0,002	0,001	0,003	0,001	0,003	N/A
39th	0,004	0,016	0,009	0,034	0,011	0,042	N/A
40th	0,001	0,002	0,001	0,002	0,001	0,003	N/A
41th	0,001	0,005	0,009	0,034	0,007	0,028	N/A
42th	0,001	0,003	0,000	0,002	0,001	0,002	N/A
43th	0,001	0,002	0,007	0,027	0,005	0,019	N/A
44th	0,001	0,003	0,000	0,002	0,001	0,002	N/A
45th	0,002	0,009	0,006	0,021	0,004	0,014	N/A
46th	0,001	0,002	0,000	0,001	0,001	0,002	N/A
47th	0,004	0,014	0,004	0,017	0,002	0,009	N/A
48th	0,001	0,003	0,000	0,001	0,000	0,002	N/A
49th	0,003	0,011	0,005	0,018	0,002	0,006	N/A
50th	0,000	0,002	0,000	0,001	0,000	0,002	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1986,2		4040,6		6059,4		
AC Voltage [V]	230,5		230,7		230,9		
AC Current [A]	8,7		17,6		26,3		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	4,506		6,940		7,899		
PWHD	1,662		1,180		2,156		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,621	-	17,510	-	26,231	-	-
2nd	0,032	0,123	0,014	0,054	0,009	0,033	8,00
3rd	1,132	4,338	1,555	5,960	1,667	6,391	N/A
4th	0,019	0,073	0,013	0,052	0,009	0,033	4,00
5th	0,284	1,088	0,787	3,018	0,929	3,559	10,70
6th	0,004	0,014	0,011	0,042	0,007	0,025	2,67
7th	0,034	0,132	0,419	1,607	0,586	2,245	7,20
8th	0,006	0,022	0,008	0,029	0,006	0,025	2,00
9th	0,074	0,282	0,225	0,864	0,396	1,518	N/A
10th	0,007	0,027	0,005	0,017	0,005	0,020	1,60
11th	0,037	0,144	0,092	0,351	0,242	0,929	3,10
12th	0,003	0,012	0,002	0,008	0,004	0,015	1,33
13th	0,035	0,136	0,046	0,175	0,164	0,627	2,00
14th	0,003	0,013	0,001	0,005	0,002	0,009	N/A
15th	0,058	0,221	0,024	0,094	0,100	0,382	N/A
16th	0,005	0,018	0,002	0,008	0,001	0,005	N/A
17th	0,057	0,220	0,021	0,080	0,070	0,270	N/A
18th	0,003	0,012	0,002	0,009	0,001	0,005	N/A
19th	0,031	0,120	0,018	0,070	0,043	0,163	N/A
20th	0,001	0,006	0,002	0,008	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,033	0,031	0,117	N/A
22th	0,003	0,010	0,002	0,007	0,002	0,006	N/A
23th	0,016	0,061	0,006	0,022	0,017	0,066	N/A
24th	0,002	0,007	0,002	0,006	0,001	0,004	N/A
25th	0,011	0,042	0,011	0,041	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,004	0,001	0,005	N/A
27th	0,016	0,062	0,016	0,062	0,010	0,037	N/A
28th	0,002	0,009	0,001	0,004	0,002	0,006	N/A
29th	0,021	0,082	0,019	0,074	0,009	0,036	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
30th	0,003	0,013	0,002	0,007	0,002	0,008	N/A
31th	0,020	0,078	0,020	0,076	0,008	0,031	N/A
32th	0,002	0,009	0,001	0,005	0,001	0,005	N/A
33th	0,013	0,051	0,018	0,070	0,009	0,035	N/A
34th	0,001	0,004	0,001	0,005	0,001	0,005	N/A
35th	0,008	0,031	0,017	0,065	0,008	0,031	N/A
36th	0,001	0,005	0,001	0,004	0,001	0,005	N/A
37th	0,003	0,010	0,014	0,056	0,008	0,030	N/A
38th	0,001	0,005	0,001	0,004	0,001	0,004	N/A
39th	0,002	0,009	0,014	0,052	0,007	0,028	N/A
40th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
41th	0,004	0,016	0,011	0,041	0,008	0,029	N/A
42th	0,001	0,004	0,000	0,002	0,002	0,006	N/A
43th	0,006	0,024	0,009	0,033	0,007	0,027	N/A
44th	0,001	0,005	0,001	0,002	0,001	0,003	N/A
45th	0,006	0,023	0,005	0,019	0,007	0,029	N/A
46th	0,001	0,003	0,001	0,003	0,001	0,002	N/A
47th	0,005	0,019	0,002	0,007	0,008	0,029	N/A
48th	0,001	0,004	0,001	0,004	0,001	0,003	N/A
49th	0,005	0,021	0,003	0,013	0,008	0,030	N/A
50th	0,001	0,004	0,001	0,005	0,001	0,004	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1961,9		-3963,1		-5996,7		
AC Voltage [V]	230,1		229,9		229,7		
AC Current [A]	8,6		17,3		26,2		
Frequency [Hz]	50,1		49,9		49,9		
THD [%]	4,663		7,084		8,095		
PWHD	1,167		0,980		1,944		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,533	-	17,244	-	26,114	-	-
2nd	0,052	0,199	0,026	0,099	0,013	0,048	8,00
3rd	1,170	4,484	1,598	6,125	1,742	6,679	N/A
4th	0,030	0,115	0,020	0,077	0,009	0,036	4,00
5th	0,300	1,151	0,787	3,019	0,929	3,562	10,70
6th	0,007	0,027	0,014	0,055	0,006	0,023	2,67
7th	0,010	0,038	0,430	1,650	0,583	2,235	7,20
8th	0,009	0,034	0,011	0,044	0,006	0,022	2,00
9th	0,099	0,381	0,205	0,785	0,359	1,375	N/A
10th	0,012	0,047	0,007	0,025	0,005	0,020	1,60
11th	0,044	0,168	0,102	0,391	0,242	0,926	3,10
12th	0,007	0,026	0,003	0,010	0,004	0,016	1,33
13th	0,014	0,054	0,024	0,092	0,139	0,533	2,00
14th	0,004	0,014	0,001	0,005	0,003	0,011	N/A
15th	0,044	0,167	0,019	0,072	0,091	0,347	N/A
16th	0,006	0,024	0,003	0,011	0,002	0,009	N/A
17th	0,039	0,148	0,028	0,107	0,048	0,182	N/A
18th	0,006	0,022	0,004	0,014	0,002	0,006	N/A
19th	0,032	0,121	0,021	0,081	0,032	0,121	N/A
20th	0,003	0,010	0,003	0,013	0,002	0,007	N/A
21th	0,014	0,053	0,021	0,079	0,020	0,078	N/A
22th	0,002	0,008	0,003	0,012	0,001	0,005	N/A
23th	0,008	0,033	0,014	0,055	0,016	0,060	N/A
24th	0,002	0,009	0,002	0,008	0,001	0,005	N/A
25th	0,002	0,007	0,009	0,035	0,017	0,064	N/A
26th	0,002	0,007	0,001	0,005	0,001	0,005	N/A
27th	0,005	0,017	0,009	0,034	0,019	0,071	N/A
28th	0,002	0,008	0,002	0,006	0,001	0,005	N/A
29th	0,009	0,034	0,009	0,035	0,019	0,072	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
30th	0,003	0,011	0,002	0,007	0,002	0,007	N/A
31th	0,008	0,032	0,009	0,036	0,017	0,065	N/A
32th	0,003	0,011	0,002	0,006	0,001	0,004	N/A
33th	0,009	0,033	0,010	0,037	0,017	0,066	N/A
34th	0,002	0,007	0,002	0,007	0,001	0,003	N/A
35th	0,007	0,027	0,010	0,039	0,015	0,056	N/A
36th	0,002	0,006	0,002	0,007	0,001	0,003	N/A
37th	0,006	0,024	0,011	0,040	0,011	0,041	N/A
38th	0,001	0,005	0,002	0,006	0,001	0,003	N/A
39th	0,004	0,015	0,009	0,033	0,011	0,042	N/A
40th	0,001	0,004	0,001	0,006	0,001	0,003	N/A
41th	0,001	0,005	0,008	0,032	0,007	0,027	N/A
42th	0,001	0,005	0,001	0,004	0,001	0,003	N/A
43th	0,001	0,002	0,007	0,025	0,005	0,019	N/A
44th	0,001	0,005	0,001	0,004	0,001	0,003	N/A
45th	0,002	0,007	0,005	0,020	0,004	0,014	N/A
46th	0,001	0,004	0,001	0,002	0,001	0,003	N/A
47th	0,003	0,012	0,004	0,016	0,002	0,009	N/A
48th	0,002	0,006	0,001	0,002	0,001	0,003	N/A
49th	0,003	0,010	0,004	0,017	0,002	0,006	N/A
50th	0,001	0,003	0,001	0,003	0,001	0,003	N/A

Note

For test result (discharge mode PSMAX, PNINV) see B.1 a), b).

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1986,2		3989,7		6059,2		
AC Voltage [V]	230,5		230,7		230,9		
AC Current [A]	8,7		17,3		26,3		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	4,502		6,894		7,899		
PWHD	1,661		1,186		2,156		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	8,621	-	17,290	-	26,231	-	-
2nd	0,036	0,136	0,015	0,058	0,010	0,037	8,00
3rd	1,130	4,333	1,547	5,932	1,667	6,390	N/A
4th	0,021	0,080	0,013	0,049	0,009	0,035	4,00
5th	0,284	1,089	0,780	2,990	0,928	3,559	10,70
6th	0,004	0,016	0,010	0,039	0,007	0,026	2,67
7th	0,034	0,129	0,412	1,578	0,586	2,245	7,20
8th	0,006	0,025	0,007	0,028	0,007	0,027	2,00
9th	0,073	0,281	0,220	0,842	0,396	1,518	N/A
10th	0,008	0,030	0,004	0,016	0,005	0,021	1,60
11th	0,038	0,144	0,087	0,335	0,242	0,929	3,10
12th	0,004	0,013	0,002	0,007	0,004	0,017	1,33
13th	0,035	0,135	0,043	0,166	0,164	0,628	2,00
14th	0,004	0,014	0,001	0,005	0,002	0,009	N/A
15th	0,057	0,220	0,024	0,093	0,100	0,382	N/A
16th	0,005	0,020	0,002	0,009	0,001	0,006	N/A
17th	0,057	0,220	0,021	0,080	0,070	0,270	N/A
18th	0,003	0,013	0,002	0,009	0,001	0,005	N/A
19th	0,031	0,121	0,018	0,067	0,043	0,163	N/A
20th	0,002	0,006	0,002	0,008	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,029	0,031	0,117	N/A
22th	0,003	0,011	0,002	0,007	0,002	0,006	N/A
23th	0,016	0,061	0,006	0,024	0,017	0,066	N/A
24th	0,002	0,008	0,002	0,006	0,001	0,005	N/A
25th	0,011	0,042	0,012	0,045	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
27th	0,016	0,061	0,017	0,065	0,010	0,037	N/A
28th	0,003	0,010	0,001	0,004	0,002	0,006	N/A
29th	0,021	0,081	0,020	0,076	0,009	0,036	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
30th	0,004	0,014	0,002	0,007	0,002	0,008	N/A
31th	0,020	0,077	0,020	0,078	0,008	0,032	N/A
32th	0,003	0,010	0,001	0,005	0,001	0,005	N/A
33th	0,013	0,051	0,018	0,070	0,009	0,035	N/A
34th	0,001	0,004	0,001	0,005	0,001	0,006	N/A
35th	0,008	0,031	0,017	0,064	0,008	0,032	N/A
36th	0,001	0,006	0,001	0,004	0,001	0,005	N/A
37th	0,003	0,010	0,014	0,054	0,008	0,029	N/A
38th	0,001	0,005	0,001	0,004	0,001	0,005	N/A
39th	0,002	0,009	0,013	0,050	0,007	0,028	N/A
40th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
41th	0,004	0,015	0,010	0,039	0,008	0,029	N/A
42th	0,001	0,004	0,000	0,002	0,002	0,006	N/A
43th	0,006	0,023	0,008	0,030	0,007	0,027	N/A
44th	0,001	0,006	0,001	0,003	0,001	0,004	N/A
45th	0,006	0,022	0,004	0,016	0,007	0,029	N/A
46th	0,001	0,004	0,001	0,003	0,001	0,003	N/A
47th	0,005	0,019	0,002	0,006	0,008	0,029	N/A
48th	0,001	0,004	0,001	0,005	0,001	0,003	N/A
49th	0,005	0,021	0,003	0,013	0,008	0,030	N/A
50th	0,001	0,004	0,001	0,004	0,001	0,004	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1961,7		-3959,4		-5996,7		
AC Voltage [V]	230,1		229,9		229,7		
AC Current [A]	8,6		17,3		26,2		
Frequency [Hz]	49,9		49,9		49,9		
THD [%]	4,663		7,100		8,098		
PWHD	1,172		0,990		1,944		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	8,532	-	17,229	-	26,115	-	-
2nd	0,053	0,203	0,023	0,090	0,012	0,046	8,00
3rd	1,170	4,484	1,602	6,140	1,743	6,680	N/A
4th	0,031	0,117	0,018	0,070	0,009	0,035	4,00
5th	0,300	1,151	0,789	3,026	0,930	3,564	10,70
6th	0,007	0,027	0,013	0,050	0,006	0,023	2,67
7th	0,010	0,038	0,431	1,651	0,583	2,236	7,20
8th	0,009	0,034	0,010	0,040	0,005	0,020	2,00
9th	0,099	0,381	0,204	0,783	0,359	1,376	N/A
10th	0,013	0,048	0,006	0,023	0,005	0,019	1,60
11th	0,044	0,168	0,101	0,386	0,242	0,927	3,10
12th	0,007	0,026	0,002	0,009	0,004	0,015	1,33
13th	0,014	0,054	0,023	0,088	0,139	0,533	2,00
14th	0,004	0,014	0,001	0,005	0,003	0,010	N/A
15th	0,044	0,168	0,019	0,073	0,090	0,347	N/A
16th	0,007	0,025	0,003	0,011	0,002	0,009	N/A
17th	0,039	0,148	0,028	0,109	0,047	0,182	N/A
18th	0,006	0,023	0,003	0,013	0,001	0,006	N/A
19th	0,032	0,121	0,022	0,082	0,031	0,121	N/A
20th	0,003	0,010	0,003	0,012	0,002	0,006	N/A
21th	0,014	0,054	0,021	0,079	0,020	0,078	N/A
22th	0,002	0,008	0,003	0,011	0,001	0,004	N/A
23th	0,009	0,033	0,014	0,055	0,016	0,060	N/A
24th	0,002	0,009	0,002	0,008	0,001	0,005	N/A
25th	0,002	0,007	0,009	0,034	0,017	0,065	N/A
26th	0,002	0,007	0,001	0,005	0,001	0,005	N/A
27th	0,005	0,017	0,009	0,034	0,019	0,072	N/A
28th	0,002	0,008	0,001	0,006	0,001	0,004	N/A
29th	0,009	0,035	0,009	0,035	0,019	0,072	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
30th	0,003	0,012	0,002	0,006	0,002	0,007	N/A
31th	0,008	0,032	0,010	0,037	0,017	0,065	N/A
32th	0,003	0,011	0,002	0,006	0,001	0,004	N/A
33th	0,009	0,034	0,010	0,038	0,017	0,067	N/A
34th	0,002	0,007	0,002	0,006	0,001	0,003	N/A
35th	0,007	0,027	0,010	0,040	0,015	0,056	N/A
36th	0,002	0,006	0,002	0,007	0,001	0,003	N/A
37th	0,006	0,025	0,011	0,041	0,011	0,041	N/A
38th	0,001	0,005	0,002	0,006	0,001	0,002	N/A
39th	0,004	0,016	0,009	0,033	0,011	0,042	N/A
40th	0,001	0,004	0,001	0,005	0,001	0,003	N/A
41th	0,001	0,005	0,008	0,032	0,007	0,027	N/A
42th	0,001	0,005	0,001	0,003	0,001	0,003	N/A
43th	0,001	0,002	0,007	0,026	0,005	0,018	N/A
44th	0,001	0,005	0,001	0,003	0,001	0,003	N/A
45th	0,002	0,008	0,005	0,020	0,004	0,014	N/A
46th	0,001	0,004	0,001	0,002	0,001	0,003	N/A
47th	0,003	0,012	0,004	0,016	0,002	0,009	N/A
48th	0,002	0,006	0,000	0,002	0,001	0,003	N/A
49th	0,003	0,010	0,005	0,017	0,002	0,006	N/A
50th	0,001	0,003	0,001	0,002	0,001	0,003	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1985,8		3999,7		6059,3		
AC Voltage [V]	230,5		230,7		230,9		
AC Current [A]	8,7		17,4		26,3		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	4,504		6,917		7,900		
PWHD	1,662		1,192		2,155		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	8,620	-	17,333	-	26,231	-	-
2nd	0,036	0,137	0,016	0,060	0,009	0,033	8,00
3rd	1,131	4,335	1,552	5,950	1,668	6,392	N/A
4th	0,021	0,080	0,014	0,053	0,009	0,033	4,00
5th	0,284	1,088	0,783	3,002	0,929	3,560	10,70
6th	0,004	0,016	0,011	0,043	0,007	0,027	2,67
7th	0,034	0,131	0,413	1,585	0,586	2,246	7,20
8th	0,006	0,025	0,008	0,030	0,006	0,025	2,00
9th	0,073	0,281	0,220	0,844	0,396	1,519	N/A
10th	0,008	0,030	0,004	0,017	0,005	0,020	1,60
11th	0,037	0,143	0,088	0,336	0,242	0,929	3,10
12th	0,004	0,013	0,002	0,007	0,004	0,016	1,33
13th	0,035	0,135	0,043	0,165	0,164	0,627	2,00
14th	0,004	0,014	0,001	0,005	0,002	0,008	N/A
15th	0,058	0,221	0,024	0,094	0,100	0,382	N/A
16th	0,005	0,020	0,002	0,009	0,002	0,007	N/A
17th	0,057	0,220	0,021	0,081	0,070	0,270	N/A
18th	0,004	0,014	0,003	0,010	0,001	0,005	N/A
19th	0,031	0,120	0,018	0,068	0,043	0,163	N/A
20th	0,002	0,006	0,002	0,009	0,001	0,004	N/A
21th	0,023	0,088	0,008	0,030	0,031	0,117	N/A
22th	0,003	0,011	0,002	0,008	0,002	0,006	N/A
23th	0,016	0,061	0,006	0,024	0,017	0,066	N/A
24th	0,002	0,008	0,002	0,007	0,001	0,004	N/A
25th	0,011	0,042	0,012	0,046	0,014	0,054	N/A
26th	0,001	0,003	0,001	0,004	0,001	0,005	N/A
27th	0,016	0,062	0,017	0,065	0,010	0,037	N/A
28th	0,003	0,010	0,001	0,004	0,002	0,006	N/A
29th	0,021	0,081	0,020	0,076	0,009	0,036	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-6KLP1G01 with Cmin battery							
30th	0,004	0,014	0,002	0,007	0,002	0,008	N/A
31th	0,020	0,078	0,020	0,078	0,008	0,031	N/A
32th	0,003	0,010	0,001	0,005	0,001	0,005	N/A
33th	0,013	0,051	0,018	0,071	0,009	0,035	N/A
34th	0,001	0,004	0,001	0,005	0,001	0,005	N/A
35th	0,008	0,031	0,017	0,064	0,008	0,031	N/A
36th	0,001	0,006	0,001	0,004	0,001	0,005	N/A
37th	0,003	0,010	0,014	0,055	0,008	0,029	N/A
38th	0,001	0,005	0,001	0,004	0,001	0,004	N/A
39th	0,002	0,009	0,013	0,051	0,007	0,028	N/A
40th	0,001	0,003	0,001	0,003	0,001	0,005	N/A
41th	0,004	0,016	0,010	0,040	0,008	0,029	N/A
42th	0,001	0,004	0,000	0,002	0,002	0,006	N/A
43th	0,006	0,024	0,008	0,031	0,007	0,027	N/A
44th	0,001	0,005	0,001	0,003	0,001	0,004	N/A
45th	0,006	0,022	0,004	0,016	0,007	0,029	N/A
46th	0,001	0,003	0,001	0,003	0,001	0,003	N/A
47th	0,005	0,019	0,002	0,006	0,008	0,029	N/A
48th	0,001	0,004	0,001	0,005	0,001	0,003	N/A
49th	0,005	0,021	0,004	0,013	0,008	0,030	N/A
50th	0,001	0,004	0,001	0,005	0,001	0,004	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-1962,6		-3960,3		-6003,3		
AC Voltage [V]	230,1		229,9		229,6		
AC Current [A]	8,6		17,3		26,2		
Frequency [Hz]	49,9		49,9		49,9		
THD [%]	4,670		7,107		8,103		
PWHD	1,176		0,994		1,950		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	8,536	-	17,232	-	26,144	-	-
2nd	0,043	0,164	0,020	0,075	0,012	0,048	8,00
3rd	1,172	4,492	1,603	6,146	1,743	6,683	N/A
4th	0,025	0,096	0,017	0,064	0,010	0,037	4,00
5th	0,301	1,152	0,790	3,029	0,930	3,566	10,70
6th	0,006	0,022	0,012	0,044	0,006	0,023	2,67
7th	0,010	0,038	0,431	1,653	0,584	2,239	7,20
8th	0,007	0,028	0,009	0,033	0,006	0,022	2,00
9th	0,100	0,383	0,204	0,784	0,359	1,377	N/A
10th	0,010	0,040	0,005	0,020	0,005	0,020	1,60
11th	0,044	0,169	0,100	0,385	0,242	0,929	3,10
12th	0,006	0,021	0,002	0,008	0,004	0,017	1,33
13th	0,014	0,054	0,023	0,087	0,139	0,534	2,00
14th	0,003	0,012	0,001	0,005	0,003	0,011	N/A
15th	0,044	0,169	0,019	0,074	0,091	0,348	N/A
16th	0,005	0,021	0,002	0,009	0,002	0,009	N/A
17th	0,039	0,150	0,029	0,110	0,047	0,182	N/A
18th	0,005	0,019	0,003	0,011	0,002	0,006	N/A
19th	0,032	0,122	0,022	0,083	0,032	0,121	N/A
20th	0,002	0,009	0,003	0,010	0,002	0,006	N/A
21th	0,014	0,054	0,021	0,079	0,021	0,079	N/A
22th	0,002	0,007	0,002	0,009	0,001	0,004	N/A
23th	0,009	0,033	0,014	0,055	0,016	0,061	N/A
24th	0,002	0,007	0,002	0,007	0,001	0,005	N/A
25th	0,002	0,007	0,009	0,034	0,017	0,065	N/A
26th	0,002	0,006	0,001	0,004	0,001	0,005	N/A
27th	0,005	0,018	0,009	0,034	0,019	0,072	N/A
28th	0,002	0,007	0,001	0,005	0,001	0,005	N/A
29th	0,009	0,035	0,009	0,035	0,019	0,073	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-6KLP1G01 with Cmin battery							
30th	0,003	0,010	0,002	0,006	0,002	0,006	N/A
31th	0,009	0,033	0,010	0,037	0,017	0,065	N/A
32th	0,002	0,009	0,001	0,005	0,001	0,004	N/A
33th	0,009	0,034	0,010	0,038	0,017	0,067	N/A
34th	0,002	0,006	0,001	0,006	0,001	0,003	N/A
35th	0,007	0,028	0,010	0,040	0,015	0,056	N/A
36th	0,001	0,005	0,002	0,006	0,001	0,003	N/A
37th	0,007	0,025	0,011	0,042	0,011	0,041	N/A
38th	0,001	0,004	0,001	0,005	0,001	0,003	N/A
39th	0,004	0,016	0,009	0,034	0,011	0,042	N/A
40th	0,001	0,003	0,001	0,004	0,001	0,004	N/A
41th	0,001	0,005	0,009	0,033	0,007	0,027	N/A
42th	0,001	0,004	0,001	0,003	0,001	0,003	N/A
43th	0,001	0,002	0,007	0,026	0,005	0,018	N/A
44th	0,001	0,005	0,001	0,003	0,001	0,003	N/A
45th	0,002	0,008	0,005	0,020	0,004	0,014	N/A
46th	0,001	0,003	0,000	0,002	0,001	0,003	N/A
47th	0,003	0,013	0,004	0,016	0,002	0,009	N/A
48th	0,001	0,005	0,000	0,002	0,001	0,003	N/A
49th	0,003	0,011	0,005	0,017	0,002	0,006	N/A
50th	0,001	0,003	0,001	0,002	0,001	0,003	N/A
Note For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1023,3		2006,3		3043,1		
AC Voltage [V]	230,4		230,5		230,6		
AC Current [A]	4,4		8,7		13,2		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	3,281		9,084		12,179		
PWHD	2,607		3,325		2,705		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	4,455	-	8,708	-	13,196	-	-
2nd	0,037	0,281	0,033	0,253	0,023	0,176	8,00
3rd	0,293	2,249	1,139	8,733	1,432	10,981	N/A
4th	0,005	0,040	0,019	0,149	0,019	0,144	4,00
5th	0,253	1,936	0,294	2,251	0,627	4,808	10,70
6th	0,016	0,124	0,004	0,032	0,013	0,097	2,67
7th	0,037	0,287	0,028	0,218	0,251	1,923	7,20
8th	0,003	0,026	0,006	0,044	0,005	0,042	2,00
9th	0,139	1,069	0,072	0,554	0,084	0,642	N/A
10th	0,009	0,067	0,007	0,056	0,001	0,010	1,60
11th	0,064	0,489	0,040	0,308	0,033	0,254	3,10
12th	0,002	0,015	0,004	0,027	0,003	0,025	1,33
13th	0,024	0,186	0,032	0,247	0,036	0,276	2,00
14th	0,002	0,013	0,003	0,025	0,004	0,030	N/A
15th	0,028	0,217	0,056	0,429	0,027	0,209	N/A
16th	0,006	0,049	0,005	0,037	0,003	0,021	N/A
17th	0,056	0,431	0,058	0,444	0,002	0,014	N/A
18th	0,006	0,049	0,003	0,026	0,002	0,016	N/A
19th	0,026	0,203	0,033	0,251	0,015	0,115	N/A
20th	0,002	0,012	0,001	0,010	0,002	0,018	N/A
21th	0,006	0,048	0,024	0,182	0,029	0,222	N/A
22th	0,004	0,028	0,003	0,021	0,002	0,017	N/A
23th	0,007	0,051	0,016	0,126	0,032	0,242	N/A
24th	0,002	0,014	0,002	0,016	0,002	0,018	N/A
25th	0,022	0,170	0,011	0,083	0,031	0,239	N/A
26th	0,005	0,037	0,001	0,006	0,002	0,014	N/A
27th	0,019	0,146	0,015	0,114	0,026	0,200	N/A
28th	0,001	0,008	0,002	0,017	0,002	0,012	N/A
29th	0,007	0,051	0,020	0,156	0,020	0,150	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,017	0,003	0,025	0,002	0,013	N/A
31th	0,004	0,031	0,020	0,157	0,015	0,117	N/A
32th	0,001	0,004	0,003	0,020	0,002	0,014	N/A
33th	0,008	0,065	0,014	0,109	0,010	0,079	N/A
34th	0,002	0,019	0,001	0,009	0,001	0,011	N/A
35th	0,010	0,080	0,009	0,067	0,006	0,046	N/A
36th	0,002	0,012	0,001	0,009	0,001	0,007	N/A
37th	0,005	0,042	0,003	0,023	0,003	0,023	N/A
38th	0,001	0,007	0,001	0,010	0,001	0,005	N/A
39th	0,004	0,031	0,003	0,020	0,005	0,039	N/A
40th	0,001	0,008	0,001	0,006	0,001	0,008	N/A
41th	0,004	0,033	0,003	0,027	0,007	0,054	N/A
42th	0,001	0,007	0,001	0,008	0,002	0,012	N/A
43th	0,004	0,034	0,006	0,044	0,008	0,058	N/A
44th	0,001	0,005	0,001	0,010	0,001	0,011	N/A
45th	0,003	0,024	0,006	0,045	0,007	0,050	N/A
46th	0,001	0,004	0,001	0,007	0,001	0,007	N/A
47th	0,003	0,021	0,005	0,038	0,007	0,050	N/A
48th	0,001	0,011	0,001	0,007	0,001	0,007	N/A
49th	0,004	0,029	0,006	0,044	0,008	0,059	N/A
50th	0,001	0,009	0,001	0,008	0,001	0,009	N/A

Note

For test result (discharge mode PSMAX, PNINV) see B.1 a), b).

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-972,6		-1963,5		-2987,2		
AC Voltage [V]	230,4		230,2		230,0		
AC Current [A]	4,2		8,6		13,1		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	3,254		9,374		12,525		
PWHD	1,515		2,373		2,125		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	4,238	-	8,540	-	12,993	-	-
2nd	0,050	0,380	0,036	0,273	0,026	0,199	8,00
3rd	0,286	2,196	1,177	9,022	1,476	11,315	N/A
4th	0,009	0,069	0,021	0,157	0,020	0,154	4,00
5th	0,273	2,096	0,301	2,304	0,636	4,879	10,70
6th	0,021	0,160	0,004	0,034	0,012	0,094	2,67
7th	0,036	0,277	0,012	0,089	0,273	2,094	7,20
8th	0,005	0,042	0,006	0,047	0,006	0,047	2,00
9th	0,109	0,834	0,101	0,776	0,063	0,485	N/A
10th	0,014	0,110	0,008	0,065	0,001	0,009	1,60
11th	0,069	0,530	0,044	0,339	0,013	0,102	3,10
12th	0,002	0,014	0,005	0,035	0,003	0,027	1,33
13th	0,011	0,087	0,014	0,110	0,047	0,363	2,00
14th	0,002	0,013	0,003	0,021	0,005	0,036	N/A
15th	0,019	0,144	0,045	0,344	0,032	0,248	N/A
16th	0,007	0,057	0,005	0,036	0,004	0,033	N/A
17th	0,030	0,230	0,039	0,302	0,024	0,181	N/A
18th	0,008	0,060	0,004	0,032	0,003	0,019	N/A
19th	0,013	0,098	0,032	0,244	0,009	0,070	N/A
20th	0,001	0,009	0,002	0,014	0,002	0,015	N/A
21th	0,012	0,093	0,014	0,108	0,015	0,116	N/A
22th	0,003	0,025	0,001	0,011	0,002	0,014	N/A
23th	0,002	0,012	0,009	0,066	0,022	0,167	N/A
24th	0,003	0,020	0,002	0,012	0,002	0,018	N/A
25th	0,012	0,088	0,002	0,013	0,021	0,163	N/A
26th	0,004	0,034	0,001	0,010	0,002	0,018	N/A
27th	0,007	0,053	0,005	0,037	0,017	0,130	N/A
28th	0,001	0,010	0,002	0,012	0,002	0,015	N/A
29th	0,005	0,040	0,009	0,072	0,015	0,112	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (Ambient)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,016	0,002	0,018	0,002	0,012	N/A
31th	0,003	0,021	0,009	0,067	0,010	0,078	N/A
32th	0,001	0,010	0,002	0,016	0,001	0,008	N/A
33th	0,006	0,046	0,009	0,069	0,008	0,063	N/A
34th	0,003	0,023	0,001	0,010	0,001	0,007	N/A
35th	0,004	0,033	0,007	0,057	0,006	0,048	N/A
36th	0,001	0,006	0,001	0,008	0,001	0,006	N/A
37th	0,005	0,036	0,007	0,051	0,004	0,031	N/A
38th	0,001	0,009	0,001	0,007	0,001	0,007	N/A
39th	0,003	0,023	0,004	0,032	0,003	0,020	N/A
40th	0,001	0,007	0,001	0,005	0,001	0,007	N/A
41th	0,003	0,021	0,001	0,009	0,001	0,007	N/A
42th	0,001	0,011	0,001	0,008	0,001	0,007	N/A
43th	0,003	0,024	0,001	0,005	0,001	0,010	N/A
44th	0,001	0,006	0,001	0,008	0,001	0,007	N/A
45th	0,002	0,018	0,002	0,017	0,002	0,012	N/A
46th	0,001	0,004	0,001	0,006	0,001	0,006	N/A
47th	0,001	0,011	0,004	0,027	0,003	0,026	N/A
48th	0,001	0,009	0,001	0,008	0,001	0,007	N/A
49th	0,001	0,005	0,003	0,022	0,004	0,030	N/A
50th	0,001	0,005	0,001	0,004	0,001	0,009	N/A
Note For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1023,2		2006,3		3043,2		
AC Voltage [V]	230,4		230,5		230,6		
AC Current [A]	4,5		8,7		13,2		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	3,280		9,093		12,168		
PWHD	2,606		3,326		2,701		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	4,454	-	8,709	-	13,196	-	-
2nd	0,038	0,288	0,033	0,253	0,024	0,180	8,00
3rd	0,293	2,247	1,140	8,742	1,431	10,970	N/A
4th	0,005	0,041	0,020	0,151	0,020	0,151	4,00
5th	0,253	1,936	0,293	2,249	0,627	4,805	10,70
6th	0,017	0,127	0,004	0,032	0,013	0,103	2,67
7th	0,037	0,287	0,029	0,222	0,251	1,925	7,20
8th	0,003	0,027	0,006	0,045	0,006	0,042	2,00
9th	0,139	1,069	0,073	0,557	0,084	0,646	N/A
10th	0,009	0,068	0,007	0,056	0,001	0,011	1,60
11th	0,064	0,489	0,040	0,308	0,033	0,253	3,10
12th	0,002	0,016	0,004	0,027	0,003	0,026	1,33
13th	0,024	0,186	0,032	0,248	0,036	0,275	2,00
14th	0,002	0,014	0,003	0,025	0,004	0,032	N/A
15th	0,028	0,217	0,056	0,430	0,027	0,208	N/A
16th	0,007	0,050	0,005	0,037	0,003	0,022	N/A
17th	0,056	0,430	0,058	0,444	0,002	0,014	N/A
18th	0,007	0,050	0,003	0,026	0,002	0,017	N/A
19th	0,026	0,203	0,033	0,250	0,015	0,114	N/A
20th	0,002	0,013	0,001	0,011	0,002	0,019	N/A
21th	0,006	0,048	0,024	0,182	0,029	0,221	N/A
22th	0,004	0,029	0,003	0,021	0,002	0,018	N/A
23th	0,007	0,051	0,016	0,126	0,031	0,241	N/A
24th	0,002	0,014	0,002	0,016	0,002	0,019	N/A
25th	0,022	0,169	0,011	0,083	0,031	0,239	N/A
26th	0,005	0,037	0,001	0,006	0,002	0,015	N/A
27th	0,019	0,146	0,015	0,115	0,026	0,201	N/A
28th	0,001	0,009	0,002	0,018	0,002	0,012	N/A
29th	0,007	0,051	0,020	0,157	0,020	0,150	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,018	0,003	0,025	0,002	0,014	N/A
31th	0,004	0,031	0,020	0,157	0,015	0,118	N/A
32th	0,001	0,004	0,003	0,020	0,002	0,015	N/A
33th	0,008	0,065	0,014	0,108	0,010	0,079	N/A
34th	0,002	0,019	0,001	0,009	0,001	0,011	N/A
35th	0,010	0,080	0,009	0,067	0,006	0,046	N/A
36th	0,002	0,012	0,001	0,009	0,001	0,007	N/A
37th	0,005	0,042	0,003	0,023	0,003	0,023	N/A
38th	0,001	0,007	0,001	0,010	0,001	0,005	N/A
39th	0,004	0,031	0,003	0,020	0,005	0,038	N/A
40th	0,001	0,008	0,001	0,006	0,001	0,008	N/A
41th	0,004	0,033	0,004	0,027	0,007	0,054	N/A
42th	0,001	0,007	0,001	0,008	0,002	0,012	N/A
43th	0,005	0,035	0,006	0,044	0,007	0,057	N/A
44th	0,001	0,006	0,001	0,010	0,001	0,011	N/A
45th	0,003	0,024	0,006	0,045	0,007	0,050	N/A
46th	0,001	0,004	0,001	0,007	0,001	0,007	N/A
47th	0,003	0,021	0,005	0,038	0,007	0,050	N/A
48th	0,001	0,010	0,001	0,007	0,001	0,007	N/A
49th	0,004	0,029	0,006	0,044	0,008	0,059	N/A
50th	0,001	0,009	0,001	0,008	0,001	0,010	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-978,7		-1962,7		-2987		
AC Voltage [V]	230,2		230,1		230,0		
AC Current [A]	4,3		8,6		12,9		
Frequency [Hz]	50		50		50		
THD [%]	3,305		9,367		12,526		
PWHD	1,510		2,371		2,114		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	4,264	-	8,536	-	12,992	-	-
2nd	0,046	0,353	0,042	0,324	0,028	0,216	8,00
3rd	0,299	2,290	1,176	9,014	1,476	11,316	N/A
4th	0,008	0,062	0,024	0,187	0,022	0,166	4,00
5th	0,271	2,075	0,300	2,301	0,636	4,879	10,70
6th	0,020	0,150	0,005	0,042	0,013	0,102	2,67
7th	0,039	0,299	0,011	0,088	0,273	2,091	7,20
8th	0,005	0,036	0,007	0,056	0,007	0,050	2,00
9th	0,109	0,835	0,101	0,774	0,063	0,484	N/A
10th	0,014	0,104	0,010	0,077	0,001	0,009	1,60
11th	0,071	0,548	0,044	0,338	0,013	0,102	3,10
12th	0,002	0,015	0,005	0,041	0,004	0,028	1,33
13th	0,011	0,086	0,014	0,110	0,047	0,362	2,00
14th	0,002	0,013	0,003	0,024	0,005	0,039	N/A
15th	0,018	0,136	0,045	0,343	0,032	0,247	N/A
16th	0,007	0,052	0,005	0,042	0,004	0,034	N/A
17th	0,030	0,230	0,039	0,301	0,023	0,179	N/A
18th	0,007	0,057	0,005	0,037	0,003	0,021	N/A
19th	0,014	0,106	0,032	0,243	0,009	0,069	N/A
20th	0,001	0,007	0,002	0,017	0,002	0,016	N/A
21th	0,012	0,094	0,014	0,107	0,015	0,116	N/A
22th	0,003	0,024	0,002	0,013	0,002	0,015	N/A
23th	0,002	0,014	0,009	0,066	0,022	0,166	N/A
24th	0,002	0,017	0,002	0,014	0,002	0,019	N/A
25th	0,011	0,086	0,002	0,013	0,021	0,162	N/A
26th	0,004	0,032	0,001	0,011	0,002	0,019	N/A
27th	0,007	0,057	0,005	0,037	0,017	0,129	N/A
28th	0,001	0,011	0,002	0,015	0,002	0,016	N/A
29th	0,005	0,041	0,009	0,072	0,014	0,111	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (-10°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,014	0,003	0,020	0,002	0,013	N/A
31th	0,003	0,024	0,009	0,067	0,010	0,078	N/A
32th	0,001	0,009	0,002	0,019	0,001	0,009	N/A
33th	0,006	0,044	0,009	0,069	0,008	0,062	N/A
34th	0,003	0,022	0,002	0,012	0,001	0,008	N/A
35th	0,004	0,034	0,007	0,056	0,006	0,047	N/A
36th	0,001	0,007	0,001	0,010	0,001	0,006	N/A
37th	0,005	0,038	0,007	0,050	0,004	0,030	N/A
38th	0,001	0,008	0,001	0,008	0,001	0,007	N/A
39th	0,003	0,025	0,004	0,031	0,003	0,019	N/A
40th	0,001	0,006	0,001	0,006	0,001	0,007	N/A
41th	0,003	0,021	0,001	0,010	0,001	0,007	N/A
42th	0,001	0,011	0,001	0,008	0,001	0,007	N/A
43th	0,003	0,024	0,001	0,005	0,001	0,010	N/A
44th	0,001	0,005	0,001	0,009	0,001	0,007	N/A
45th	0,003	0,019	0,002	0,017	0,002	0,012	N/A
46th	0,000	0,003	0,001	0,007	0,001	0,006	N/A
47th	0,002	0,012	0,003	0,027	0,003	0,025	N/A
48th	0,001	0,009	0,001	0,010	0,001	0,008	N/A
49th	0,001	0,005	0,003	0,021	0,004	0,029	N/A
50th	0,001	0,006	0,001	0,005	0,001	0,009	N/A

Note

For test result (discharge mode PSMAX, PNINV) see B.1 a), b).

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	1023,5		2006		3042,7		
AC Voltage [V]	230,4		230,5		230,6		
AC Current [A]	4,4		8,8		13,3		
Frequency [Hz]	50,0		50,0		50,0		
THD [%]	3,281		9,077		12,139		
PWHD	2,607		3,323		2,693		
Harmonic	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Current Magnitude [A]**	**% of Funda-mental**	**Harmonic Current Limits [%]**
1st	4,456	-	8,707	-	13,194	-	-
2nd	0,034	0,263	0,037	0,284	0,028	0,213	8,00
3rd	0,294	2,253	1,138	8,724	1,427	10,939	N/A
4th	0,005	0,037	0,022	0,169	0,023	0,174	4,00
5th	0,252	1,936	0,294	2,251	0,625	4,795	10,70
6th	0,015	0,117	0,005	0,037	0,015	0,117	2,67
7th	0,038	0,289	0,028	0,215	0,252	1,929	7,20
8th	0,003	0,025	0,007	0,051	0,007	0,050	2,00
9th	0,139	1,069	0,072	0,552	0,085	0,654	N/A
10th	0,008	0,063	0,008	0,064	0,001	0,011	1,60
11th	0,064	0,490	0,040	0,308	0,032	0,247	3,10
12th	0,002	0,014	0,004	0,030	0,004	0,030	1,33
13th	0,024	0,186	0,032	0,246	0,035	0,271	2,00
14th	0,002	0,012	0,004	0,028	0,005	0,036	N/A
15th	0,028	0,217	0,056	0,428	0,027	0,207	N/A
16th	0,006	0,047	0,005	0,041	0,003	0,027	N/A
17th	0,056	0,431	0,058	0,443	0,002	0,014	N/A
18th	0,006	0,046	0,004	0,030	0,003	0,020	N/A
19th	0,027	0,204	0,033	0,251	0,014	0,111	N/A
20th	0,002	0,012	0,002	0,012	0,003	0,021	N/A
21th	0,006	0,048	0,024	0,182	0,028	0,218	N/A
22th	0,003	0,027	0,003	0,023	0,003	0,020	N/A
23th	0,006	0,050	0,016	0,126	0,031	0,239	N/A
24th	0,002	0,013	0,002	0,018	0,003	0,022	N/A
25th	0,022	0,170	0,011	0,083	0,031	0,238	N/A
26th	0,005	0,035	0,001	0,006	0,002	0,018	N/A
27th	0,019	0,147	0,015	0,113	0,026	0,201	N/A
28th	0,001	0,008	0,002	0,019	0,002	0,014	N/A
29th	0,007	0,051	0,020	0,155	0,020	0,151	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (P_{SMAX}, or P_{NINV} for integrated EESS)							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,016	0,004	0,028	0,002	0,015	N/A
31th	0,004	0,031	0,020	0,156	0,015	0,118	N/A
32th	0,001	0,004	0,003	0,022	0,002	0,017	N/A
33th	0,008	0,065	0,014	0,109	0,010	0,080	N/A
34th	0,002	0,018	0,001	0,010	0,002	0,013	N/A
35th	0,010	0,080	0,009	0,068	0,006	0,047	N/A
36th	0,001	0,011	0,001	0,010	0,001	0,009	N/A
37th	0,005	0,042	0,003	0,024	0,003	0,023	N/A
38th	0,001	0,006	0,001	0,011	0,001	0,006	N/A
39th	0,004	0,031	0,003	0,020	0,005	0,038	N/A
40th	0,001	0,007	0,001	0,007	0,001	0,009	N/A
41th	0,004	0,032	0,003	0,027	0,007	0,053	N/A
42th	0,001	0,006	0,001	0,008	0,002	0,013	N/A
43th	0,004	0,034	0,006	0,044	0,007	0,056	N/A
44th	0,001	0,005	0,001	0,011	0,002	0,012	N/A
45th	0,003	0,024	0,006	0,044	0,006	0,050	N/A
46th	0,000	0,004	0,001	0,008	0,001	0,008	N/A
47th	0,003	0,020	0,005	0,038	0,006	0,049	N/A
48th	0,001	0,010	0,001	0,008	0,001	0,009	N/A
49th	0,004	0,029	0,006	0,044	0,008	0,058	N/A
50th	0,001	0,008	0,001	0,009	0,001	0,011	N/A
Note For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
Phase 1							
Power Level	**33%**		**66%**		**100%**		
AC Power [W]	-976,1		-1962,8		-2987		
AC Voltage [V]	230,1		230,2		299,9		
AC Current [A]	4,4		8,7		13,1		
Frequency [Hz]	50		50		50		
THD [%]	3,253		9,358		12,527		
PWHD	1,512		2,364		2,115		
Harmonic	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Current Magnitude [A]**	**% of Fundamental**	**Harmonic Current Limits [%]**
1st	4,238	-	8,536	-	12,993	-	-
2nd	0,048	0,365	0,042	0,324	0,028	0,214	8,00
3rd	0,287	2,199	1,174	9,004	1,476	11,317	N/A
4th	0,009	0,066	0,024	0,187	0,022	0,167	4,00
5th	0,273	2,096	0,300	2,302	0,636	4,879	10,70
6th	0,020	0,153	0,005	0,042	0,014	0,106	2,67
7th	0,037	0,281	0,011	0,085	0,273	2,091	7,20
8th	0,005	0,040	0,007	0,056	0,006	0,049	2,00
9th	0,109	0,833	0,101	0,771	0,063	0,485	N/A
10th	0,014	0,106	0,010	0,077	0,001	0,009	1,60
11th	0,069	0,530	0,044	0,338	0,013	0,102	3,10
12th	0,002	0,014	0,005	0,042	0,004	0,029	1,33
13th	0,011	0,087	0,014	0,109	0,047	0,362	2,00
14th	0,002	0,012	0,003	0,024	0,005	0,039	N/A
15th	0,019	0,143	0,045	0,341	0,032	0,248	N/A
16th	0,007	0,055	0,005	0,042	0,004	0,034	N/A
17th	0,030	0,230	0,039	0,300	0,023	0,179	N/A
18th	0,008	0,058	0,005	0,037	0,003	0,021	N/A
19th	0,013	0,099	0,032	0,243	0,009	0,070	N/A
20th	0,001	0,008	0,002	0,017	0,002	0,016	N/A
21th	0,012	0,094	0,014	0,108	0,015	0,116	N/A
22th	0,003	0,024	0,002	0,013	0,002	0,015	N/A
23th	0,002	0,012	0,009	0,066	0,022	0,166	N/A
24th	0,002	0,019	0,002	0,015	0,003	0,019	N/A
25th	0,012	0,088	0,002	0,013	0,021	0,162	N/A
26th	0,004	0,032	0,001	0,011	0,002	0,019	N/A
27th	0,007	0,053	0,005	0,036	0,017	0,129	N/A
28th	0,001	0,010	0,002	0,015	0,002	0,016	N/A
29th	0,005	0,040	0,009	0,071	0,014	0,111	N/A

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Bbis,3 a) / b)	Emission Test Harmonics DIN EN 61000-3-12 (≥ 16 A and ≤ 75 A per Phase) (+55°C)						P
Bidirectional converters (charge mode P_{CMAX})							
T-REX-3KLP1G01with Cmin battery							
30th	0,002	0,015	0,003	0,020	0,002	0,013	N/A
31th	0,003	0,022	0,009	0,067	0,010	0,078	N/A
32th	0,001	0,010	0,002	0,019	0,001	0,009	N/A
33th	0,006	0,046	0,009	0,068	0,008	0,062	N/A
34th	0,003	0,022	0,002	0,012	0,001	0,008	N/A
35th	0,004	0,034	0,007	0,056	0,006	0,047	N/A
36th	0,001	0,006	0,001	0,010	0,001	0,006	N/A
37th	0,005	0,036	0,007	0,050	0,004	0,030	N/A
38th	0,001	0,008	0,001	0,008	0,001	0,007	N/A
39th	0,003	0,023	0,004	0,031	0,003	0,019	N/A
40th	0,001	0,006	0,001	0,006	0,001	0,007	N/A
41th	0,003	0,022	0,001	0,010	0,001	0,006	N/A
42th	0,001	0,011	0,001	0,008	0,001	0,007	N/A
43th	0,003	0,024	0,001	0,005	0,001	0,009	N/A
44th	0,001	0,005	0,001	0,009	0,001	0,007	N/A
45th	0,002	0,018	0,002	0,017	0,002	0,012	N/A
46th	0,000	0,004	0,001	0,007	0,001	0,006	N/A
47th	0,001	0,011	0,003	0,026	0,003	0,025	N/A
48th	0,001	0,009	0,001	0,010	0,001	0,007	N/A
49th	0,001	0,005	0,003	0,021	0,004	0,029	N/A
50th	0,001	0,005	0,001	0,005	0,001	0,009	N/A
Note							
For test result (discharge mode PSMAX, PNINV) see B.1 a), b).							

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Bbis.3 c)	Flicker emission	P

Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmax battery

Ambient

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,176	0,164	0,002
66%	EN 61000-3-11	0,162	0,126	0,001
100%*	EN 61000-3-11	0,38	0,292	-0,005

-10°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,168	0,156	-0,001
66%	EN 61000-3-11	0,137	0,105	0,020
100%*	EN 61000-3-11	0,463	0,304	-0,008

+55°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,171	0,161	0,005
66%	EN 61000-3-11	0,111	0,095	0,003
100%*	EN 61000-3-11	0,486	0,402	0,001

Bidirectional converters (charge mode P_{CMAX})

Ambient

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,166	0,167	-0,085
66%	EN 61000-3-11	0,178	0,145	0,064
100%*	EN 61000-3-11	0,138	0,138	-0,025

-10°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,165	0,161	-0,184
66%	EN 61000-3-11	0,181	0,154	0,004
100%*	EN 61000-3-11	0,140	0,139	0,026

+55°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,163	0,163	-0,09
66%	EN 61000-3-11	0,167	0,138	0,012
100%*	EN 61000-3-11	0,137	0,136	-0,002

Note

Mains Impedance according EN61000-3-3 / EN61000-3-11:

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Bbis.3 c)	Flicker emission	P
R_{max} = 0,24Ω; jX_{max}= 0,15Ω @50Hz ($\|Z_{max}\|$ = 0,283 Ω)		
Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:		
$Z_{max} = Z_{ref} * 3,3\% / d_c(P_n)$		
The tests are based on the limits of the EN61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.		

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Bbis.3 c)	Flicker emission	P

Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmin battery

Ambient

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,154	0,153	0,018
66%	EN 61000-3-11	0,138	0,137	0,018
100%*	EN 61000-3-11	0,137	0,138	0,050

-10°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,183	0,186	0,005
66%	EN 61000-3-11	0,151	0,142	0,041
100%*	EN 61000-3-11	0,160	0,145	0,049

+55°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,221	0,252	0,002
66%	EN 61000-3-11	0,226	0,253	0,009
100%*	EN 61000-3-11	0,212	0,212	0,002

Bidirectional converters (charge mode P_{CMAX})

Ambient

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,129	0,130	0,013
66%	EN 61000-3-11	0,183	0,186	0,005
100%*	EN 61000-3-11	0,152	0,141	-0,001

-10°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,129	0,130	0,011
66%	EN 61000-3-11	0,131	0,132	0,061
100%*	EN 61000-3-11	0,129	0,126	0,013

+55°C

Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,206	0,193	0,009
66%	EN 61000-3-11	0,137	0,124	0,001
100%*	EN 61000-3-11	0,129	0,127	0,018

Note

Mains Impedance according EN61000-3-3 / EN61000-3-11:

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Bbis.3 c)	Flicker emission	P

R_{max} = 0,24Ω; jX_{max}= 0,15Ω @50Hz (|Z_{max}| = 0,283 Ω)

Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:

$Z_{max} = Z_{ref} * 3,3\% / d_c(P_n)$

The tests are based on the limits of the EN61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.

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Bbis.3 c)	Flicker emission			P
Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)				
T-REX-3KLP1G01with Cmin battery				
Ambient				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,140	0,142	0,045
66%	EN 61000-3-11	0,148	0,147	-0,017
100%*	EN 61000-3-11	0,139	0,140	0,017
-10°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,144	0,145	0,019
66%	EN 61000-3-11	0,162	0,161	0,028
100%*	EN 61000-3-11	0,139	0,139	0,010
+55°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,133	0,134	-0,105
66%	EN 61000-3-11	0,144	0,145	0,009
100%*	EN 61000-3-11	0,158	0,160	0,018
Bidirectional converters (charge mode P_{CMAX})				
Ambient				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,145	0,147	0,074
66%	EN 61000-3-11	0,150	0,149	0,022
100%*	EN 61000-3-11	0,133	0,133	0,012
-10°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,139	0,138	-0,023
66%	EN 61000-3-11	0,183	0,188	0,015
100%*	EN 61000-3-11	0,177	0,179	-0,001
+55°C				
Location	Test voltage	Result		
		Plt	Pst	dc%
33%	EN 61000-3-11	0,154	0,157	0,001
66%	EN 61000-3-11	0,145	0,145	0,009
100%*	EN 61000-3-11	0,130	0,128	0,038
Note				
Mains Impedance according EN61000-3-3 / EN61000-3-11:				

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Bbis.3 c)	Flicker emission	P
R_{max} = 0,24Ω; jX_{max}= 0,15Ω @50Hz (|Z_{max}| = 0,283 Ω)		
Calculation of the maximum permissible grid impedance at the point of common coupling based on d_c:		
$Z_{max} = Z_{ref} * 3,3\% / d_c(P_n)$		
The tests are based on the limits of the EN61000-3-3 for less than 16A and on EN 61000-3-11 for more than 16A.		

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Bbis.4	Verification of the voltage and frequency operating range			P
Test results				
	Conditions			
Test 1(*)	V = 85% * V_n; f = 47,5 Hz; P = 100% * P_{SMAX} (P_{NINV} for integrated EESS); cos φ = 1 for at least 300 s			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	196,42	47,50	6007,25	0,9990
Limit	no disconnection allowed			
Test 2(**)	V = 110% * V_n; f = 51,5 Hz; P = 100% * P_{SMAX} (P_{NINV} for integrated EESS); cos φ = 1 for at least 300 s			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	253,67	51,50	6004,13	0,9990
Limit	no disconnection allowed			
Test 3	V = 85% * V_n; f = 47,5 Hz; P = 100% * P_{CMAX}; cos φ = 1 for at least 300 s			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	195,46	47,50	-6018,65	0,9990
Limit	no disconnection allowed			
Test 4	V = 110% * V_n; f = 51,5 Hz; P = 100% * P_{CMAX}; cos φ = 1 for at least 300 s			
Connection	Voltage [V]	Frequency [Hz]	Output power [W]	cos φ [1]
	252,18	51,50	-6001,11	0,9990
Limit	no disconnection allowed			

Test

(*) Unit can operate at reduced power of $P_{SMAX} \geq 85\% * S_n$

(**) Over frequency reduction function must be deactivated

Supplied power must remain stable within ±5% S_n at the entire duration

Only Test 1 and Test 2 apply to storage systems connected to one-way converters

Assessment criterion

The test is intended to check the capacity of the generator to maintain the connection with the grid for an indefinite time in the field of voltage and frequency

85% V_n = V = 110% V_n

47,5 Hz = f = 51,5 Hz

The test should provide for the test of stable operation at the extreme limits of voltage and frequency for a minimum time of 5 minutes, for each working point (limited to 3 minutes in the field of tensions between 85% V_n = V = 90% V_n for only wind power generators).

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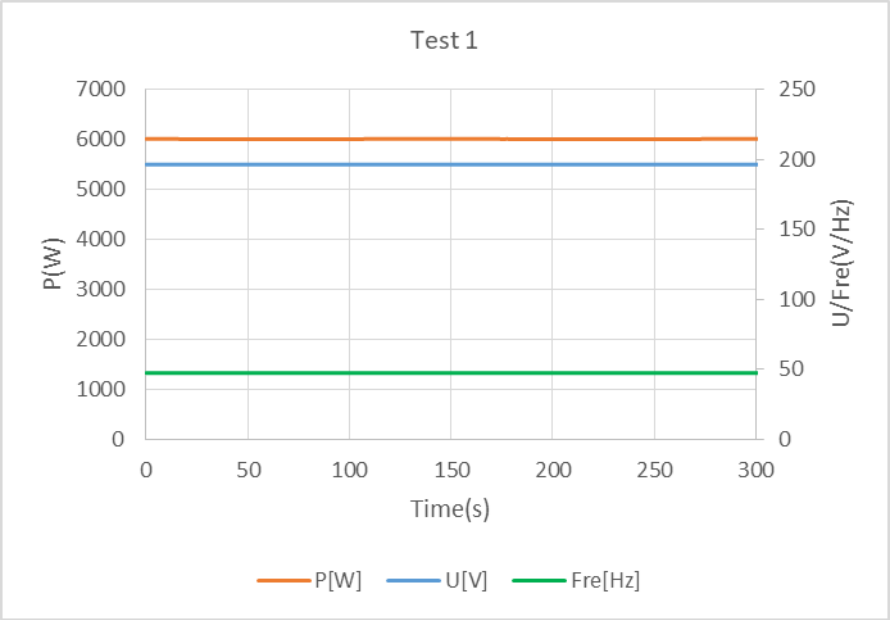
Bbis.4	Verification of the voltage and frequency operating range	P

Graph of conditions of test 1



Graph of conditions of test 2

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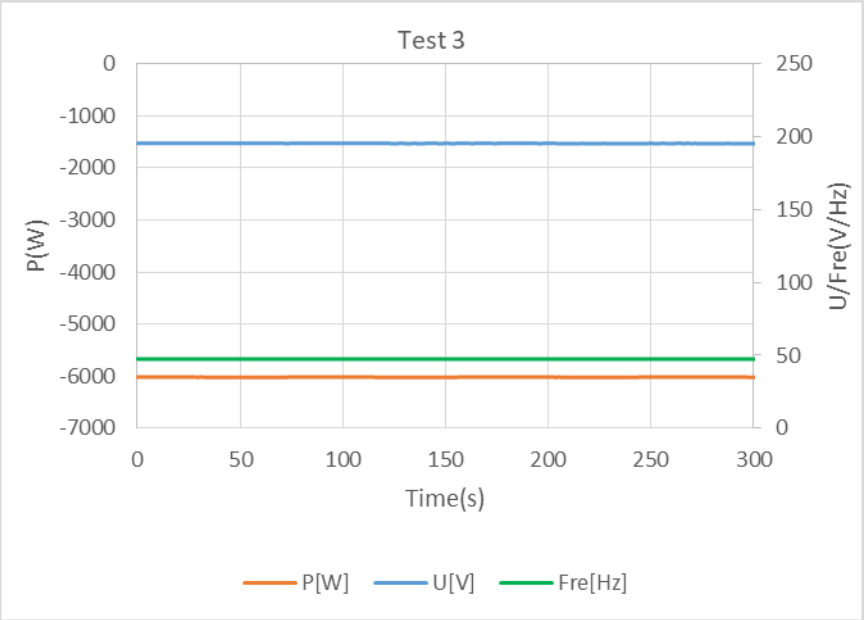
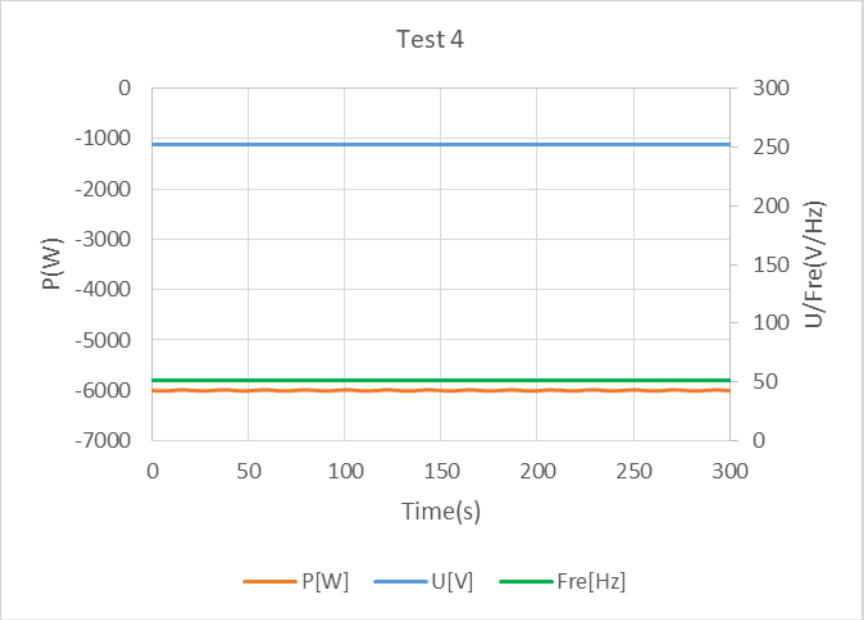
Bbis.4	Verification of the voltage and frequency operating range	P

Graph of conditions of test 3



Graph of conditions of test 4



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TEMP-0058-TG-EAW-ES-V01

Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters / Unidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmax battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	110% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	42,2	36,0
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	306,6	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	41,2	35,4
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	308,2	305,8
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

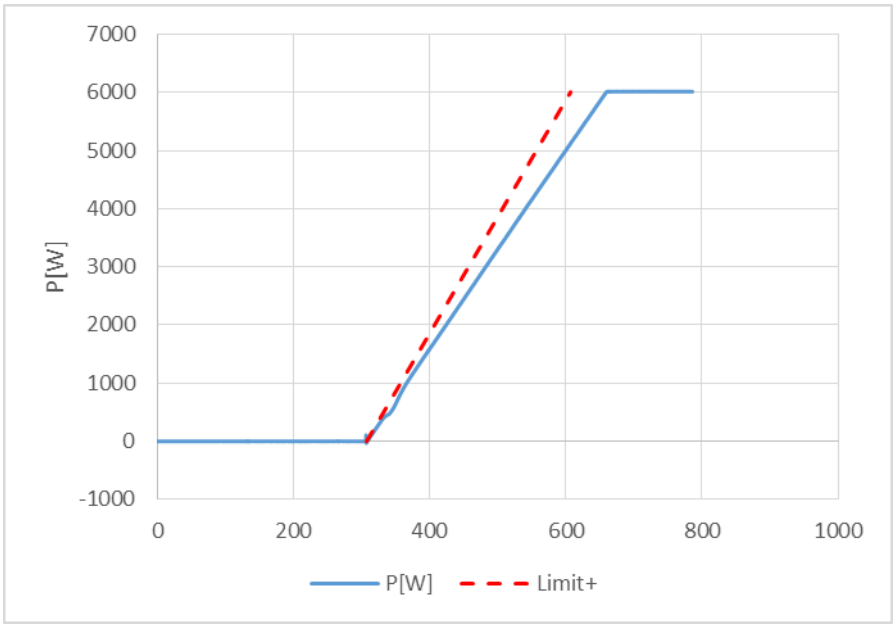
Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range between 49 Hz and 51 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters (charge mode P_{CMAX})

T-REX-6KLP1G01 with Cmax battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	111% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	38,8	38,0
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	305,2	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	37,8	39,6
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	305,0	305,6
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range

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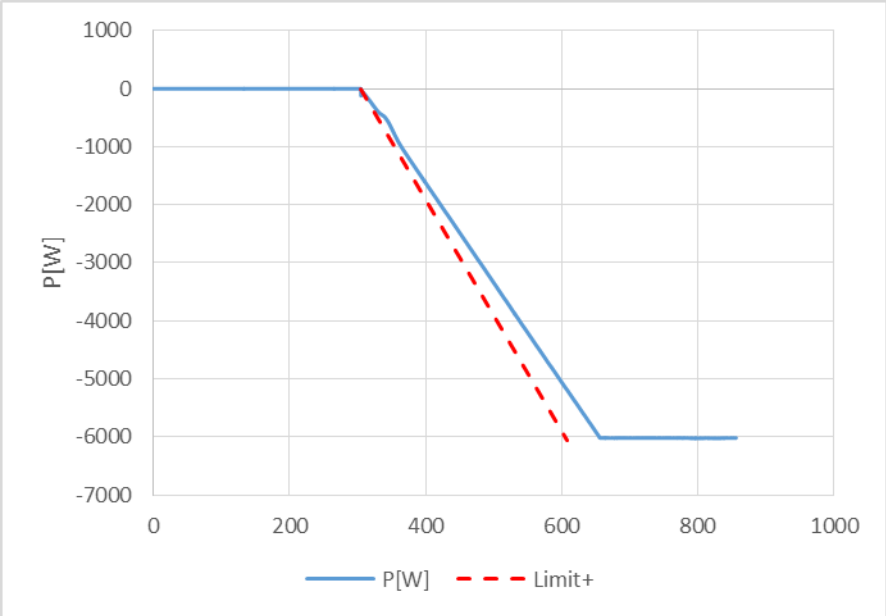
Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

between 49,00 Hz and 51,00 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters / Unidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmin battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	110% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	36,3	35,2
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	304,1	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	41,2	38,2
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	304,8	305,8
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

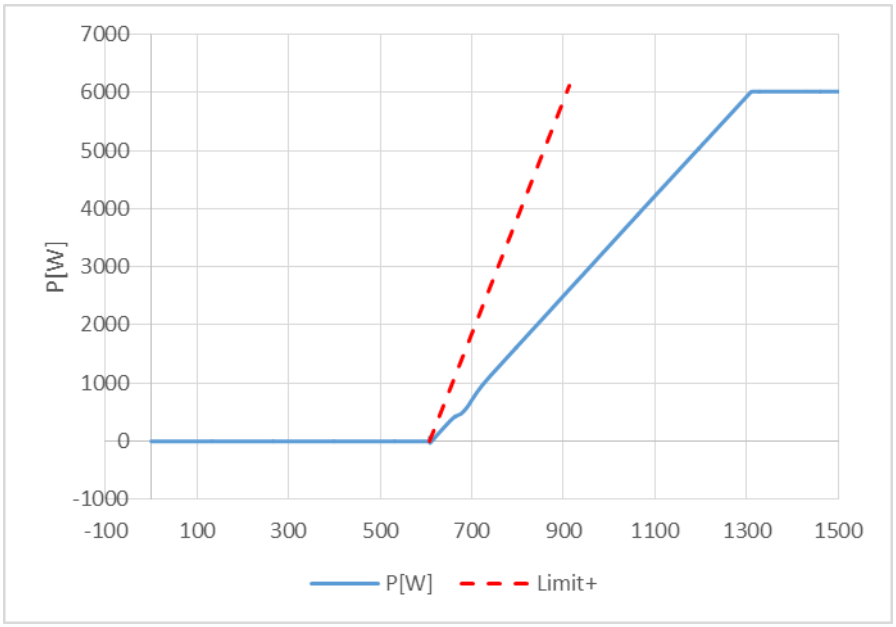
Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range between 49 Hz and 51 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters (charge mode P_{CMAX})

T-REX-6KLP1G01 with Cmin battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	111% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	36,6	35,2
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	305,2	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	35,8	35,4
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	305,2	305,6
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range

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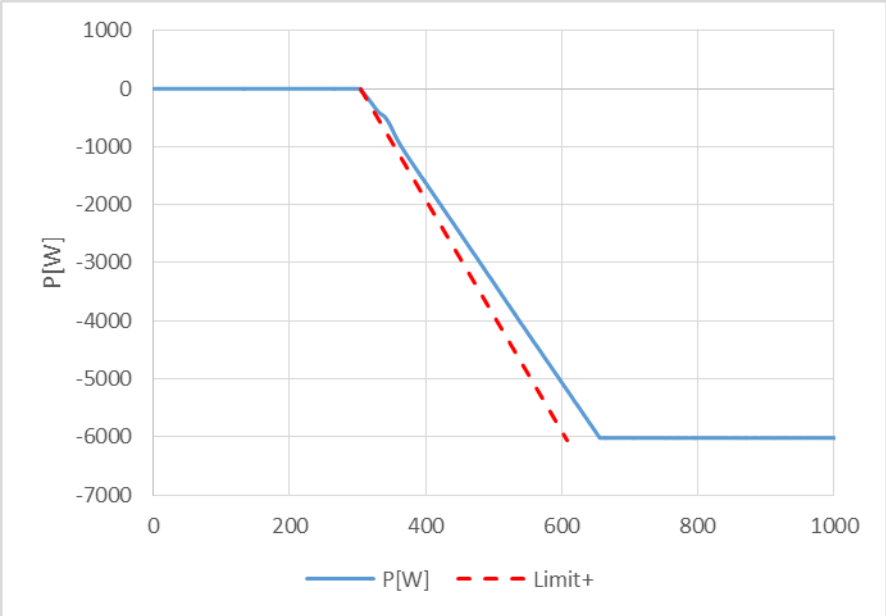
Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

between 49,00 Hz and 51,00 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters / Unidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-3KLP1G01 with Cmin battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	110% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	36,4	40,0
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	305,0	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	37,2
Reconnection time [s]	38,8	35,4
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	305,0	305,6
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

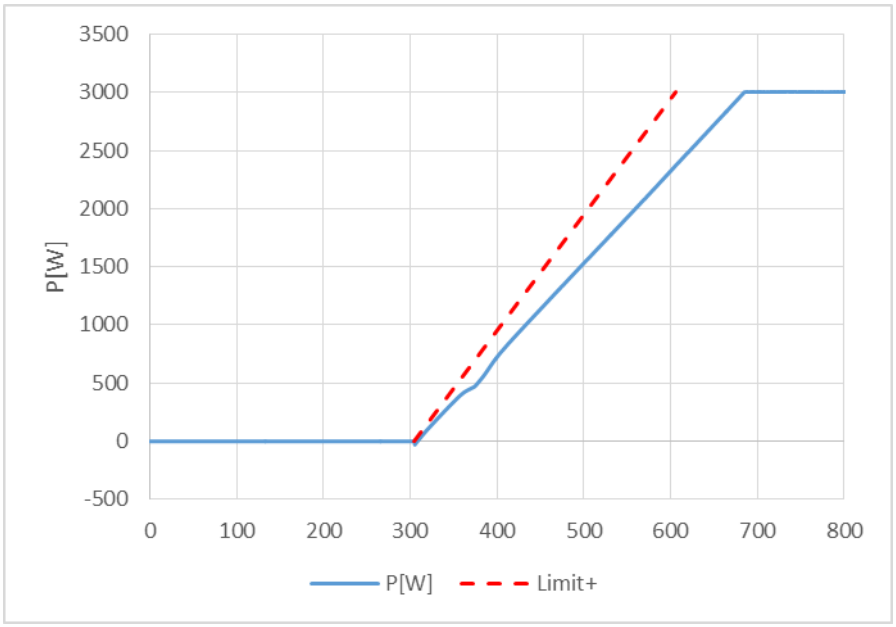
Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range between 49 Hz and 51 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

Test: Bidirectional converters (charge mode P_{CMAX})

T-REX-3KLP1G01 with Cmin battery	**Voltage conditions**	
a) Out of voltage range	84% V_n for 30 s	111% V_n for 30 s
Connection	No connection	No connection
Limit	No connection allowed	
b) In voltage range at start-up	85% V_n < V	V <110% V_n
Reconnection time [s]	36,8	36,2
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
c) In voltage range after voltage failure	85% V_n < V	V <110% V_n
Reconnection time [s]	305,4	305,2
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
	Frequency conditions	
d) Out of frequency range	49,88 Hz ± 0,01 Hz	49,88 Hz ± 0,01 Hz
Connection	No connection	No connection
Limit	No connection allowed	
e) In frequency range at start-up	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	36,0	43,0
Limit	Reconnection after 30 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	
f) In frequency range after frequency failure	49,90 Hz < f	f < 50,10 Hz
Reconnection time [s]	313,8	305,8
Limit	Reconnection after 300 s	
Gradient	Gradient should be recorded for at least 300 s until the inverter has the full output power. Max gradient: 20% P_n / min For recorded gradient see diagram underneath	

Test

Test condition b) and c): voltage within the limits of 85% to 110%

Test condition e) and f): frequency within the limits of 49,90 Hz to 50,10 Hz

Assessment criterion

In order to prevent network disruptions, operation in parallel of generators of any kind must take place ONLY when the frequency and voltage detected at the output terminals remain within the following limits for 300 s (or not less than 30 s, in accordance with the specifications in 8.4.1.3, letter a):

- voltage between 85% and 110% of V_n; frequency between 49,90 Hz and 50,10 Hz (default setting, adjustment range

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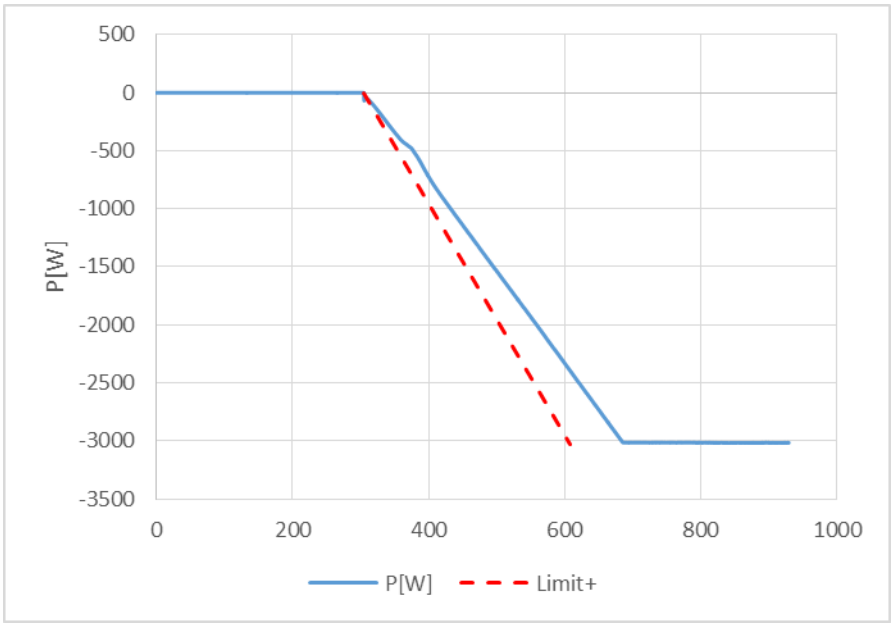
Bbis.5	**Connection conditions, reconnection and gradual power supply**	**P**
Bbis.5.1 **Bbis.5.2**	**Verification of connection and reconnection conditions** **Verification of gradual output/absorption of active power**	**P**

between 49,00 Hz and 51,00 Hz).

In addition, the power supply for indirectly connected production systems should be gradual, with a transition from the initial "no-load" conditions at the time of parallel, to the power value available with a maximum positive ramp of 20% of the maximum load per minute.

Graph of gradual power supply



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Bbis.6	Reactive Power Exchange
Bbis.6.1	Verification of construction requirements: reactive power capability

As stipulated in 8.4.4.2, storage systems used in plants designed for continuous operation in parallel with the DSO's grid must be able to operate with a power factor other than 1. The exchange of reactive power with the grid may take place at the request of the DSO in the following cases

- if there are network management requirements, in particular to help limit the voltage at the output terminals or on the LV line to which other EESS and/or GD sources may also be connected;
- with the purpose of providing a network service; requirement applicable only for plants with a total power output of more than 11,08 kW and under the conditions that will be regulated by ARERA.

The purpose of the tests referred to in this paragraph is to verify the reactive power capability of the storage systems as the active power varies, in order to ensure compliance with the minimum construction requirements set out in 8.4.4.2, at least equal to

a) for all storage systems in installations with a total capacity of up to 11.08 kW an instantaneous power factor between cos f = 0,90 in reactive absorption (inductive behaviour) and cos f = 0.90 in reactive output (capacitive behaviour), according to the "triangular" capability curve shown in the example in Figure 62 (valid for a storage system with bidirectional inverter). In this case, the reactive exchange is aimed at limiting grid overvoltage or undervoltage caused by its own active power input/output,

b) for all storage systems in plants with a total power greater than 11.08 kW an instantaneous power factor between cos f = 0,90 in reactive absorption (inductive behaviour) and cos f = 0.90 in reactive supply (capacitive behaviour), according to the "rectangular" capability curve shown in the example in Figure 62 aimed at the supply of a grid service requested by the DSO, under the conditions subject to regulation by ARERA.

For the purposes of this test (minimum requirements), the manufacturer must indicate and set the maximum available reactive power regulation as the active power output varies, in order to make it possible to characterise the maximum capabilities of the storage system (as smaller machines can also be used on systems with a total power output of more than 11,08 kW).

This paragraph and its sub-sections do not apply to static converters for installations with a power output of less than 800 W.

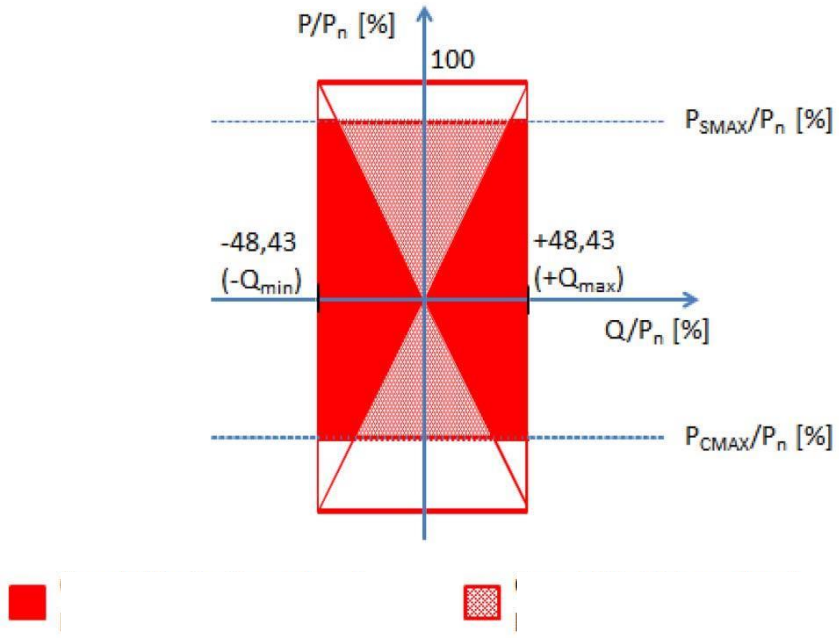

Figure 62 - Capability for a storage system with bidirectional inverter

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Bbis.6.2	Method of performing and recording the test

The following requirements are given for the execution of the test.

- The storage system must be set so that it can absorb respectively (inductive behaviour) and deliver (capacitive behaviour) the maximum reactive power available to each of the active power level output / consumption according to its capability.
- It regulates at this point the EESS (and the eventual source DC) in order to make available the full power injection / withdrawal available: P_{SMAX} (for accumulation of integrated systems, P_{NINV}), or, in the case of systems of accumulation associated with bidirectional converters, P_{CMAX}.
- They regulate (via the control logic of EESS and / or via the source control), the active power for values in 5 intervals [10-20]%; [30-40]%; ...; [90-100]% of P_{SMAX} (for integrated storage systems, P_{NINV}) and, if the system is connected to a bidirectional converter, in 5 intervals the power take intervals [10-20]%; ...; [90-100]% of P_{CMAX}. It carries out the measurement of the active power in stationary conditions, after 1 min. approximately from the execution of adjustment (to 1 min average values calculated on the basis of the measured values at the fundamental frequency of 200 ms) window.
- For each of the active power levels (equal to 10 levels, in the case of executing at full power tests with bi-directional storage systems) you will have to record a value of the inductive reactive power and one for the capacitive, as average values for 1 min calculated on the basis of measurements at the fundamental frequency of 1 s window. Even the power factor must be detected and reported as average to 1 min.
- In addition to measurements of reactive power limit values, the measured values should be recorded by setting the reactive power supplied to 0 ($\cos \varphi = 1$).

The maximum capability in absorption capability (Q_{min}) and delivery (Q_{max}) of reactive power resulting from the sequence of the above measures and that for Q = 0 must be documented in tabular form below, in each of active power output level ranging between 0% and power of the maximum available discharge and, if required, between 0% and power of maximum charge available, the corresponding level of reactive power consumption (and delivered), expressed both in absolute terms and as a p.u. the rated power of the converter and cos φ terms. The test is passed successfully under the conditions expressed herein.

- Storage systems in plants with a total power output of up to 11,08 kW: the value of the instantaneous power factor at each of the 5 (or 10) measurement points is equal to or less than 0,90 in both reactive power absorption (inductive behaviour) and delivery (capacitive behaviour) modes.
- storage in total power plants greater than 11,08 kW systems: the value of the absorbed reactive power (inductive behaviour) and delivered (capacitive behaviour) resulting in each of the 5 (or 10) measurement points is at least equal in absolute value to 48,43% of the rated active power of the inverter.

The maximum value of the absorbed reactive power (inductive behaviour) and delivered (capacitive behaviour) resulting in each of the measuring points to be reported in a table similar to Table. 4BBIS - capacitive reactive power distribution follows, which refers, for example, to the case of the test at full power on a non-integrated system of accumulation. It will then generate tables 3, for the cases of maximum inductive reactive power, maximum capacitive and the behaviour with the set-point Q = 0. For each measured point is allowed a maximum deviation of reactive power $\Delta Q = \pm 5\% * S_n$.

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Test result: Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmax battery

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	593,2	285,5	0,9011	668,7
10 - 20	1194,0	560,3	0,9053	1289,8
20 - 30	1793,5	827,0	0,9081	1915,4
30 - 40	2394,5	1193,3	0,8950	2546,8
40 - 50	2994,7	1471,2	0,8975	3183,5
50 - 60	3596,2	1815,5	0,8927	3826,4
60 - 70	4196,3	2090,9	0,8950	4471,3
70 - 80	4796,7	2367,2	0,8967	5122,1
80 - 90	5396,1	2642,7	0,8981	5777,8
90 - 100	5496,8	2689,0	0,8983	5833,2

Limit	$\Delta Q \leq \pm 5$ % of S_n

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	597,5	-288,3	0,9007	668,7
10 - 20	1200,0	-582,2	0,8997	1289,9
20 - 30	1801,6	-860,4	0,9024	1915,1
30 - 40	2404,2	-1142,8	0,9032	2547,0
40 - 50	3006,9	-1469,7	0,8984	3184,1
50 - 60	3610,0	-1773,1	0,8976	3826,5
60 - 70	4211,5	-2017,4	0,9019	4471,2
70 - 80	4813,6	-2253,9	0,9056	5122,0
80 - 90	5414,6	-2555,8	0,9043	5777,3
90 - 100	5515,8	-2596,9	0,9047	5834,0

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	607,2	72,1	0,9930	678,2
10 - 20	1197,2	163,3	0,9908	1285,3
20 - 30	1796,7	166,5	0,9957	1906,4
30 - 40	2398,1	167,3	0,9976	2533,4
40 - 50	2999,5	170,1	0,9984	3165,3
50 - 60	3600,5	169,4	0,9989	3801,6
60 - 70	4202,0	168,7	0,9992	4442,9
70 - 80	4804,3	168,0	0,9994	5090,6
80 - 90	5404,5	171,0	0,9995	5741,3
90 - 100	6004,8	169,9	0,9996	6392,2

Limit	$\Delta Q \leq \pm 5$ % of S_n

Test result: Bidirectional converters (charge mode P_{CMAX})

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-598,1	286,1	-0,9021	368,8
10 - 20	-1198,7	598,4	-0,8947	989,9
20 - 30	-1798,5	876,1	-0,8990	1515,1
30 - 40	-2409,4	1202,2	-0,8948	2146,2
40 - 50	-2852,4	1392,8	-0,8986	2533,6
50 - 60	-3599,0	1809,8	-0,8934	3427,7
60 - 70	-4172,9	2023,3	-0,8968	4121,6
70 - 80	-4799,5	2356,4	-0,8976	4592,5
80 - 90	-5399,0	2621,0	-0,8989	5157,6
90 - 100	-5449,3	2647,1	-0,8995	5281,7

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-599,8	-293,2	-0,8984	368,7
10 - 20	-1248,9	-585,8	-0,9053	989,9
20 - 30	-1844,3	-868,9	-0,9046	1515,3
30 - 40	-2442,0	-1147,2	-0,9051	2146,9
40 - 50	-3041,6	-1446,3	-0,9031	2533,8
50 - 60	-3641,6	-1741,6	-0,9021	3426,3
60 - 70	-4243,4	-2004,0	-0,9042	4121,3
70 - 80	-4844,5	-2334,3	-0,9009	4592,2
80 - 90	-5401,2	-2602,2	-0,9009	5157,6
90 - 100	-5459,1	-2648,4	-0,8997	5332,5
Limit	$\Delta Q \leq \pm 5$ % of S_n			

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-609,8	-161,7	-0,9961	531,2
10 - 20	-1254,9	-158,7	-0,9921	1157,4
20 - 30	-1850,0	-155,2	-0,9965	1731,4
30 - 40	-2449,5	-155,2	-0,9980	2305,8
40 - 50	-3047,6	-161,4	-0,9986	2875,1
50 - 60	-3649,1	-154,9	-0,9991	3443,4
60 - 70	-4253,2	-159,2	-0,9993	4009,6
70 - 80	-4856,6	-153,6	-0,9995	4571,9
80 - 90	-5405,8	-152,9	-0,9996	5079,8
90 - 100	-6012,2	-147,3	-0,9997	5638,3
Limit	$\Delta Q \leq \pm 5$ % of S_n			

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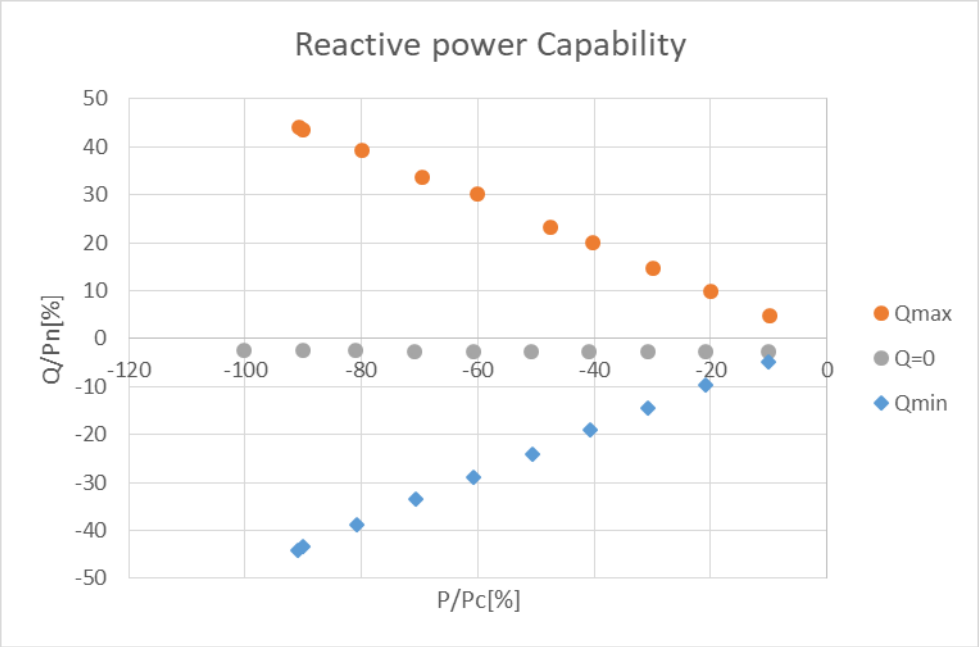
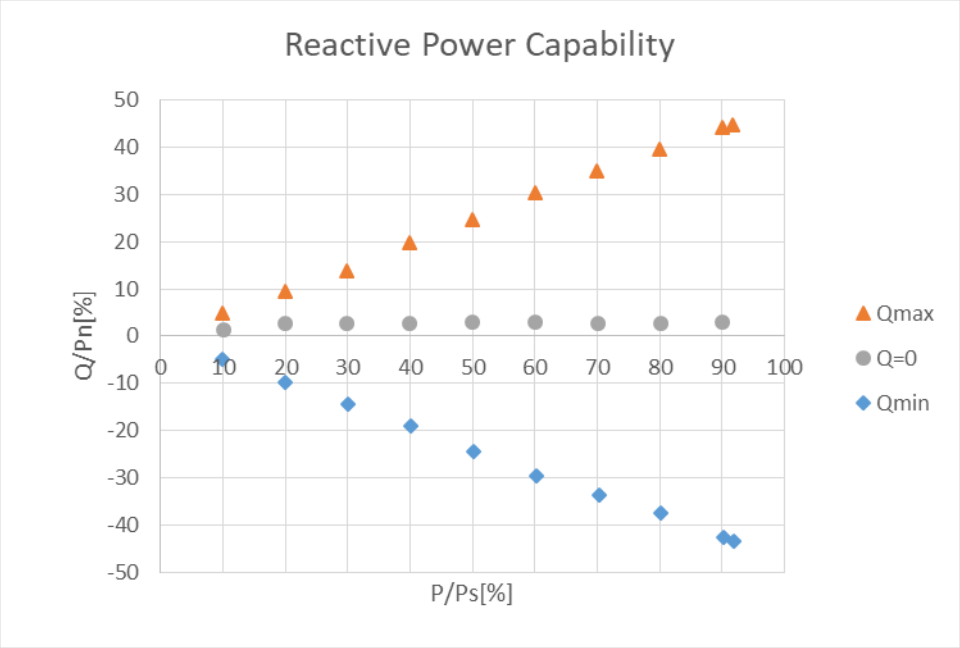
Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Graph of capability curves valid for inverter Charge mode P_{CMAX}



Graph of capability curves valid for inverter Discharge mode P_{SMAX}



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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Note

The inverter produces reactive power according to the circular characteristic. The priority is always given by the reactive power.

Maximum inductive and capacitive reactive power delivered as a function of active power (here the case of a power storage system up to 11,08 kW is represented, which must be able to deliver with a cos φ = 0,95, i.e. Q_{min}/P_n = 0,3286 %/P_n)

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Test result: Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-6KLP1G01 with Cmin battery

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	593,2	285,5	0,9011	-668,7
10 - 20	1194,0	560,3	0,9053	-1289,9
20 - 30	1793,6	842,0	0,9052	-1915,1
30 - 40	2394,3	1195,5	0,8947	-2546,9
40 - 50	2994,9	1451,7	0,8998	-3184,1
50 - 60	3595,8	1815,5	0,8927	-3825,8
60 - 70	4194,0	2090,3	0,8950	-4471,2
70 - 80	4795,6	2367,1	0,8967	-5120,3
80 - 90	5396,2	2576,1	0,9024	-5777,2
90 - 100	5483,1	2592,6	0,9040	-5826,8

Limit	$\Delta Q \leq \pm 5$ % of S_n

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	595,5	-288,7	-0,9006	-668,7
10 - 20	1197,8	-586,7	-0,8997	-1289,8
20 - 30	1799,6	-902,1	-0,9024	-1915,1
30 - 40	2402,1	-1212,8	-0,9032	-2546,9
40 - 50	3005,1	-1503,1	-0,8989	-3184,2
50 - 60	3607,4	-1792,3	-0,8973	-3825,8
60 - 70	4209,4	-2077,9	-0,9020	-4465,2
70 - 80	4810,5	-2359,6	-0,9059	-5121,3
80 - 90	5413,1	-2649,4	-0,9049	-5777,5
90 - 100	5504,4	-2692,7	-0,9045	-5828,6

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	603,8	69,9	0,9934	-671,4
10 - 20	1200,4	160,1	0,9912	-1285,5
20 - 30	1800,0	166,8	0,9957	-1906,6
30 - 40	2401,2	167,6	0,9976	-2533,6
40 - 50	3002,6	170,4	0,9984	-3165,3
50 - 60	3603,6	169,7	0,9989	-3801,7
60 - 70	4205,1	169,0	0,9992	-4443,1
70 - 80	4807,4	168,2	0,9994	-5090,7
80 - 90	5407,5	171,2	0,9995	-5741,3
90 - 100	6007,8	170,0	0,9996	-6392,2

Limit	$\Delta Q \leq \pm 5$ % of S_n

Test result: Bidirectional converters (charge mode P_{CMAX})

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-593,5	284,5	-0,9017	368,4
10 - 20	-1193,7	601,5	-0,8930	990,1
20 - 30	-1791,7	879,5	-0,8977	1515,5
30 - 40	-2391,9	1213,9	-0,8917	2146,7
40 - 50	-2993,8	1450,6	-0,8999	2533,2
50 - 60	-3594,2	1812,5	-0,8929	3425,9
60 - 70	-4196,8	2090,1	-0,8951	4121,0
70 - 80	-4797,8	2368,5	-0,8967	4592,2
80 - 90	-5394,8	2642,4	-0,8981	5157,8
90 - 100	-5450,6	2662,6	-0,8985	5281,5

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-600,1	-294,4	-0,8978	368,9
10 - 20	-1248,6	-594,8	-0,9028	989,9
20 - 30	-1845,4	-877,5	-0,9031	1515,3
30 - 40	-2442,5	-1158,6	-0,9035	2147,5
40 - 50	-3041,9	-1454,3	-0,9022	2533,6
50 - 60	-3640,1	-1759,9	-0,9003	3426,3
60 - 70	-4243,7	-1955,7	-0,9082	4121,8
70 - 80	-4846,7	-2348,7	-0,8999	4592,4
80 - 90	-5396,6	-2621,3	-0,8995	5156,8
90 - 100	-5493,4	-2680,7	-0,8987	5334,2
Limit	$\Delta Q \leq \pm 5$ % of S_n			

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-609,5	-160,8	-0,9906	533,8
10 - 20	-1251,4	-159,2	-0,9920	1157,0
20 - 30	-1846,7	-157,1	-0,9964	1730,9
30 - 40	-2445,9	-154,9	-0,9980	2305,1
40 - 50	-3045,3	-155,4	-0,9987	2875,3
50 - 60	-3646,7	-154,8	-0,9991	3444,2
60 - 70	-4249,7	-159,1	-0,9993	4009,9
70 - 80	-4853,2	-153,5	-0,9995	4571,3
80 - 90	-5402,3	-152,8	-0,9996	5079,4
90 - 100	-6009,5	-147,2	-0,9997	5638,3
Limit	$\Delta Q \leq \pm 5$ % of S_n			

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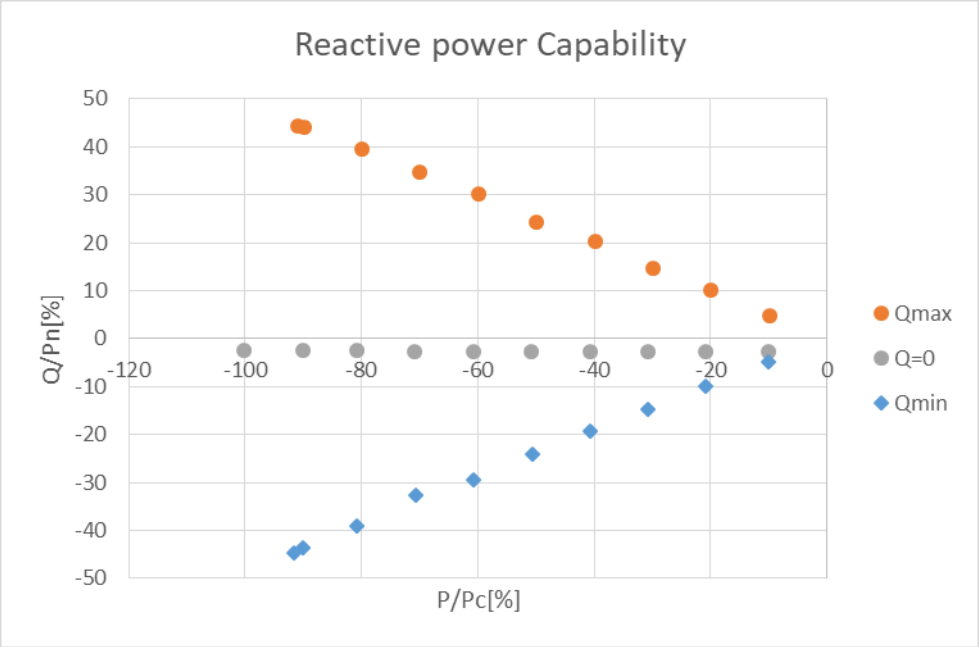
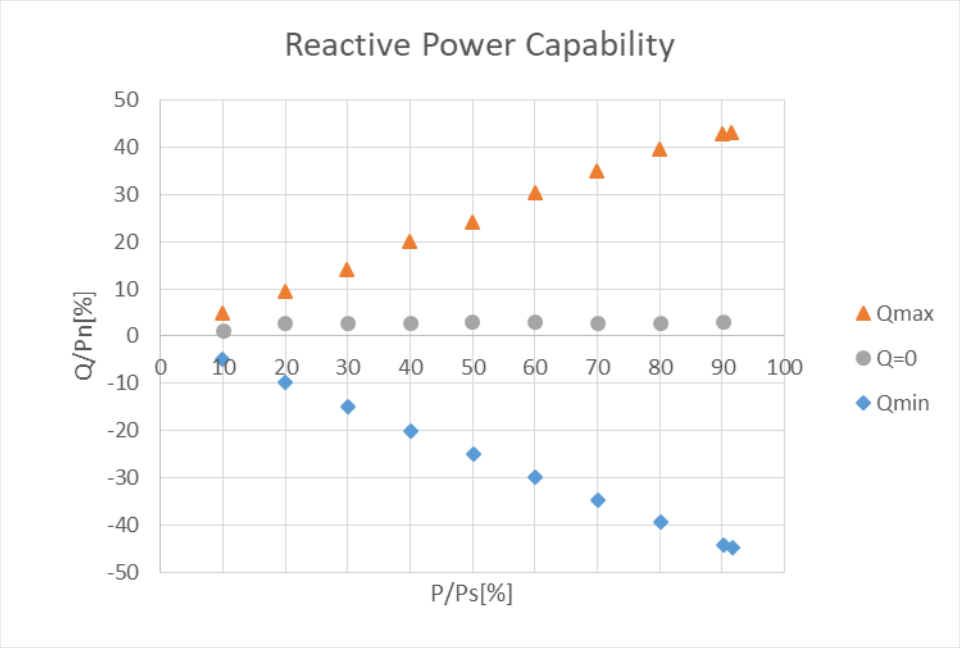
Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Graph of capability curves valid for inverter Charge mode P_{CMAX}



Graph of capability curves valid for inverter Discharge mode P_{SMAX}



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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Note

The inverter produces reactive power according to the circular characteristic. The priority is always given by the reactive power.

Maximum inductive and capacitive reactive power delivered as a function of active power (here the case of a power storage system up to 11,08 kW is represented, which must be able to deliver with a cos φ = 0,95, i.e. Q_{min}/P_n = 0,3286 %/P_n)

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Test result: Bidirectional converters (Discharge mode P_{SMAX}, or P_{NINV} for integrated EESS)

T-REX-3KLP1G01with Cmin battery

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	291,7	129,1	0,8928	-356,8
10 - 20	592,8	285,5	0,9009	-664,5
20 - 30	893,4	427,4	0,9021	-974,0
30 - 40	1193,1	563,4	0,9042	-1283,7
40 - 50	1492,2	717,1	0,9013	-1594,2
50 - 60	1793,4	878,8	0,8980	-1908,0
60 - 70	2094,3	998,7	0,9026	-2223,3
70 - 80	2393,1	1126,1	0,9048	-2536,7
80 - 90	2693,4	1320,6	0,8979	-2853,8
90 - 100	2740,9	1339,6	0,8984	-2904,0

Limit	$\Delta Q \leq \pm 5$ % of S_n

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	292,4	-143,7	0,8974	-358,2
10 - 20	594,5	-288,0	0,9000	-667,7
20 - 30	896,3	-441,8	0,8970	-978,6
30 - 40	1196,7	-580,8	0,8996	-1289,0
40 - 50	1496,7	-706,9	0,9042	-1601,0
50 - 60	1798,1	-856,6	0,9028	-1915,1
60 - 70	2098,5	-970,3	0,9077	-2228,9
70 - 80	2399,2	-1132,5	0,9043	-2544,8
80 - 90	2695,4	-1292,2	0,9017	-2857,1
90 - 100	2748,3	-1320,2	0,9014	-2913,1

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	292,6	36,2	0,9923	-357,8
10 - 20	601,1	75,0	0,9923	-672,1
20 - 30	896,0	100,1	0,9938	-974,9
30 - 40	1195,3	145,6	0,9908	-1283,4
40 - 50	1495,3	147,2	0,9940	-1594,0
50 - 60	1795,8	148,3	0,9957	-1906,1
60 - 70	2096,2	148,2	0,9969	-2219,1
70 - 80	2397,0	148,6	0,9976	-2533,4
80 - 90	2697,1	148,7	0,9981	-2848,1
90 - 100	2996,9	149,3	0,9984	-3163,6

Limit	$\Delta Q \leq \pm 5$ % of S_n

Test result: Bidirectional converters (charge mode P_{CMAX})

Inductive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-291,7	129,1	-0,8929	-356,8
10 - 20	-592,8	285,5	-0,9009	-664,5
20 - 30	-893,4	427,3	-0,9021	-974,0
30 - 40	-1193,1	563,3	-0,9043	-1283,7
40 - 50	-1492,2	716,8	-0,9014	-1594,2
50 - 60	-1793,4	878,8	-0,8980	-1908,0
60 - 70	-2094,3	998,7	-0,9026	-2223,3
70 - 80	-2393,1	1126,0	-0,9048	-2536,8
80 - 90	-2693,4	1320,5	-0,8979	-2853,8
90 - 100	-2743,3	1340,6	-0,8985	-2906,7

Limit	$\Delta Q \leq \pm 5$ % of S_n

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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Capacitive reactive power absorption

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-308,8	-153,7	-0,8952	239,5
10 - 20	-608,6	-291,3	-0,9020	531,0
20 - 30	-909,4	-424,0	-0,9063	822,8
30 - 40	-1209,8	-586,5	-0,8998	1112,8
40 - 50	-1510,5	-733,8	-0,8995	1402,4
50 - 60	-1811,3	-865,0	-0,9024	1689,9
60 - 70	-2113,3	-1035,8	-0,8979	1978,2
70 - 80	-2414,2	-1143,1	-0,9038	2265,3
80 - 90	-2710,7	-1303,0	-0,9013	2546,6
90 - 100	-2764,4	-1332,0	-0,9009	2597,4
Limit	$\Delta Q \leq \pm 5$ % of S_n			

Q = 0

Power-BIN [%P_n]	Active power [W]	Reactive power [Var]	Power factor (cos φ) [1]	DC power [W]
0 - 10	-309,7	-26,1	-0,9965	240,8
10 - 20	-617,5	-50,0	-0,9967	542,3
20 - 30	-912,6	-88,4	-0,9953	829,4
30 - 40	-1082,5	-141,5	-0,9916	1120,1
40 - 50	-1383,3	-144,2	-0,9946	1410,8
50 - 60	-1683,9	-146,7	-0,9962	1700,4
60 - 70	-1985,2	-147,7	-0,9972	1989,8
70 - 80	-2287,3	-147,8	-0,9979	2278,7
80 - 90	-2588,1	-143,5	-0,9985	2565,4
90 - 100	-2889,7	-145,5	-0,9987	2852,4
Limit	$\Delta Q \leq \pm 5$ % of S_n			

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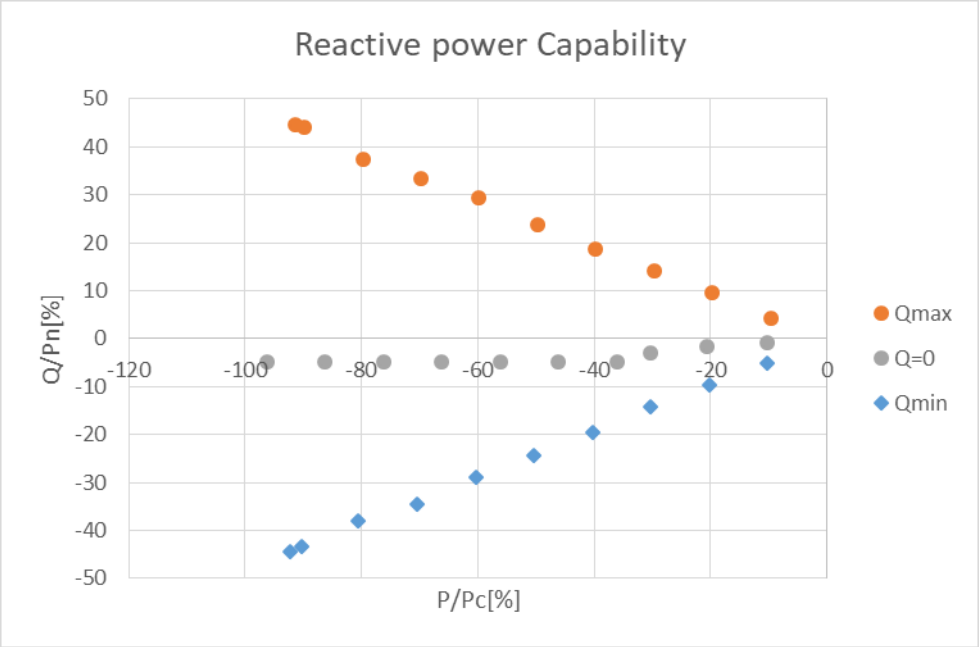
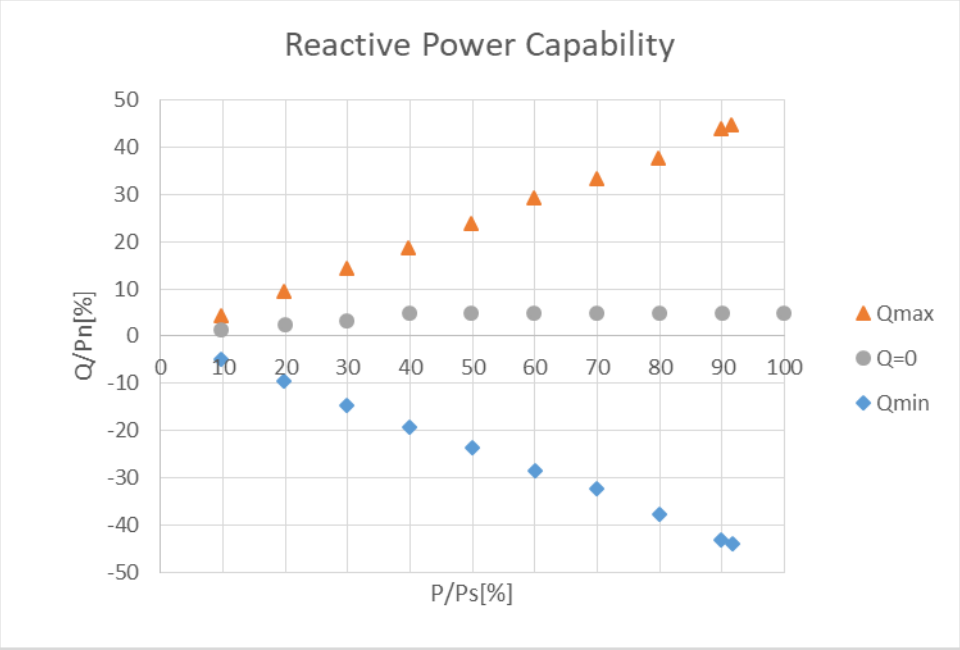
Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Graph of capability curves valid for inverter Charge mode P_{CMAX}



Graph of capability curves valid for inverter Discharge mode P_{SMAX}



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Bbis.6.2	Test performance and recording mode for Storage systems in installations with a total capacity of up to 11,08 kW	P

Note

The inverter produces reactive power according to the circular characteristic. The priority is always given by the reactive power.

Maximum inductive and capacitive reactive power delivered as a function of active power (here the case of a power storage system up to 11,08 kW is represented, which must be able to deliver with a cos φ = 0,95, i.e. Q_{min}/P_n = 0,3286 %/P_n)

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Bbis.6.4	Method of performing the test and recording the results (Q-setting hypothesis)	P
Bidirectional converters		
Test: 50% P_{SMAX}		
1-min mean value	50% P_{SMAX} Q = 0% S_n to Q_{ind} = 40% S_n	
Q_{E60} [%]:	40,0	
Limit ΔQ_{E60} [%]:	Q_{ind} = 40% S_n ± 5 % of S_n	
Settling time [s]:	15,6	
Limit settling time [s]:	30	
Test: 50% P_{CMAX}		
1-min mean value	50% P_{CMAX} Q = 0% S_n to Q_{ind} = 40% S_n	
Q_{E60} [%]:	40,0	
Limit ΔQ_{E60} [%]:	Q_{ind} = 40% S_n ± 5 % of S_n	
Settling time [s]:	14,6	
Limit settling time [s]:	30	

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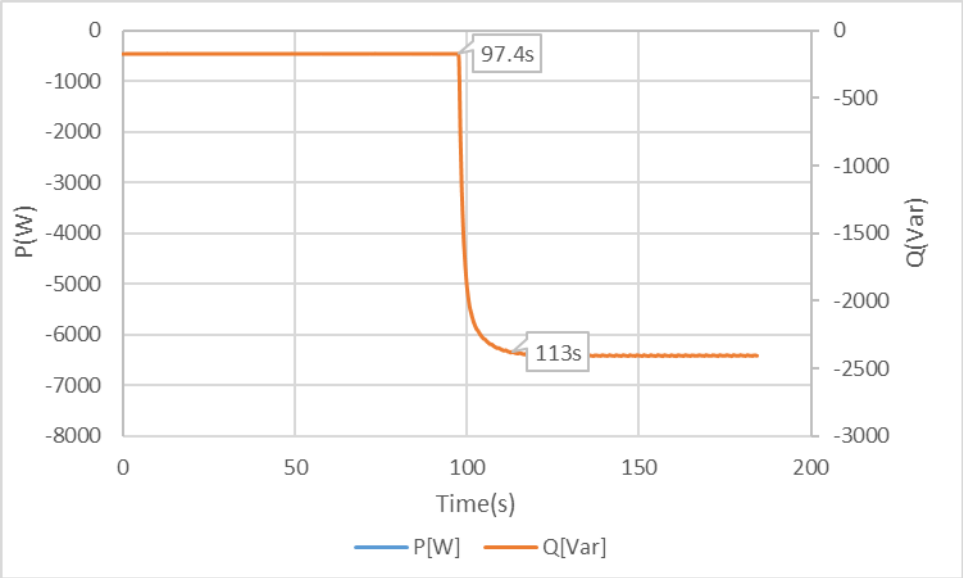
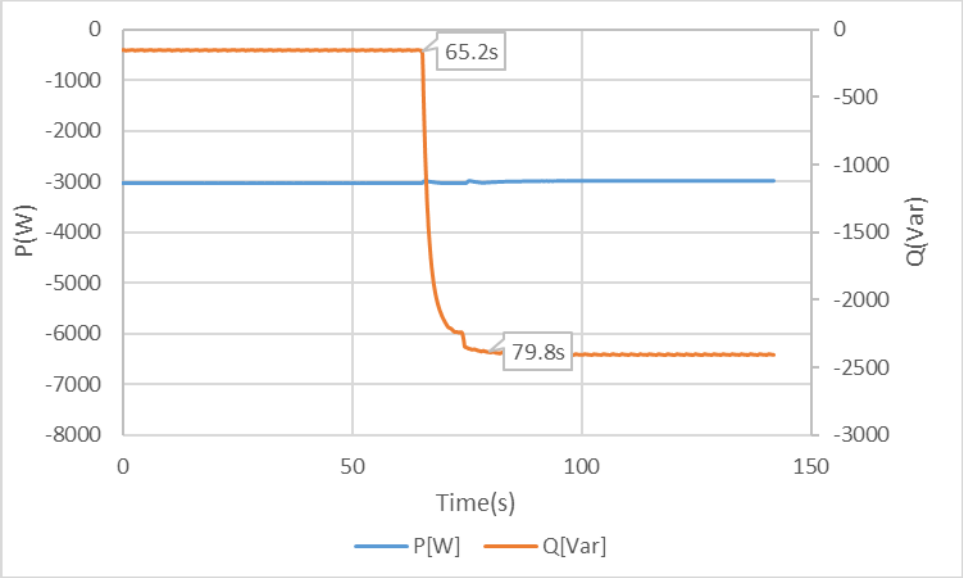
Bbis.6.4	Method of performing the test and recording the results (Q-setting hypothesis)	P

Graph



Graph



Note:

- ΔQ ≤ ± 2,5%
- Δcosφ ≤ ± 0,01

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Bbis.6.6	Automatic reactive power output according to a characteristic curve cos φ = f(P)

Storage systems in plants must be able to absorb reactive power automatically and autonomously (local control logic) according to a power factor characteristic curve as a function of active power = f(P).

For integrated storage systems, the test must be carried out with the photovoltaic field delivering such a power that, together with the nominal power of the storage, the nominal power of the inverter is obtained.

The purpose of the test is to verify that the storage system, through its converter, follows the automatic reactive power delivery mode according to the standard characteristic curve cos φ = f (P) given in E.2, according to method a).

A: P = 20%*P_{SMAX}; cos φ = 1

B: P = 50%*P_{SMAX}; cos φ = 1

C: P = P_{SMAX}; cos φ = cos $\varphi_{\_min}$ = 0,9

Where cos φ_{min} is 0,90 (inductive/capacitive)

Adjustment along the characteristic curve is enabled when the voltage detected at the output terminals exceeds the "critical" lock-in value (e.g. set to V_n = 1,05 V_n, see paragraph E.2).

The lock-in voltage value that enables the automatic supply of reactive power and that during testing must be set to 1,05 V_n (default setting also for production), must be adjustable in the range between V_n and 1,1 V_n at intervals of 0,01 V_n.

The Distributor shall specify the required lock-in voltage value in the Operating Regulations.

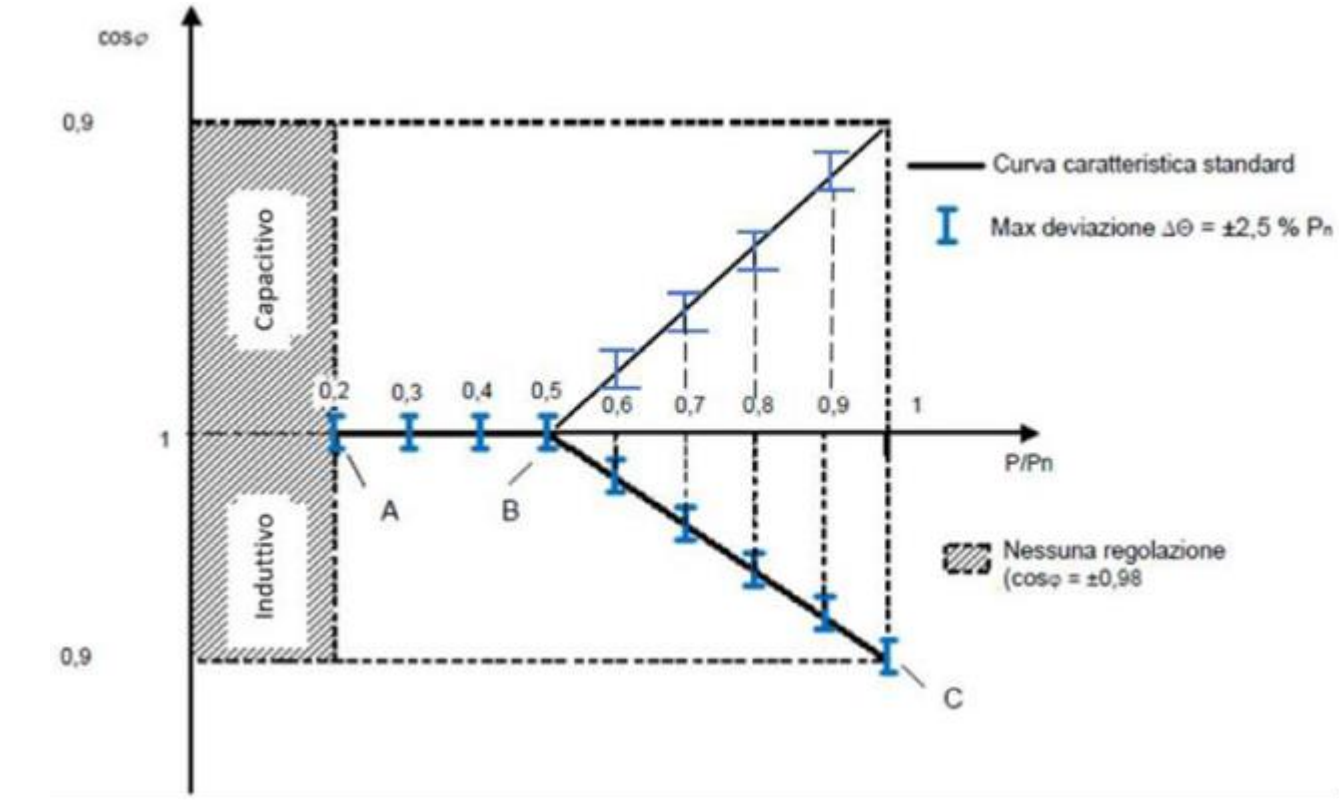

Figure 66 - Standard characteristic curve cosφ= f(P)

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Bbis.6.7	Verification of compliance with the application of the standard delivery curve cos φ = f(P)	P

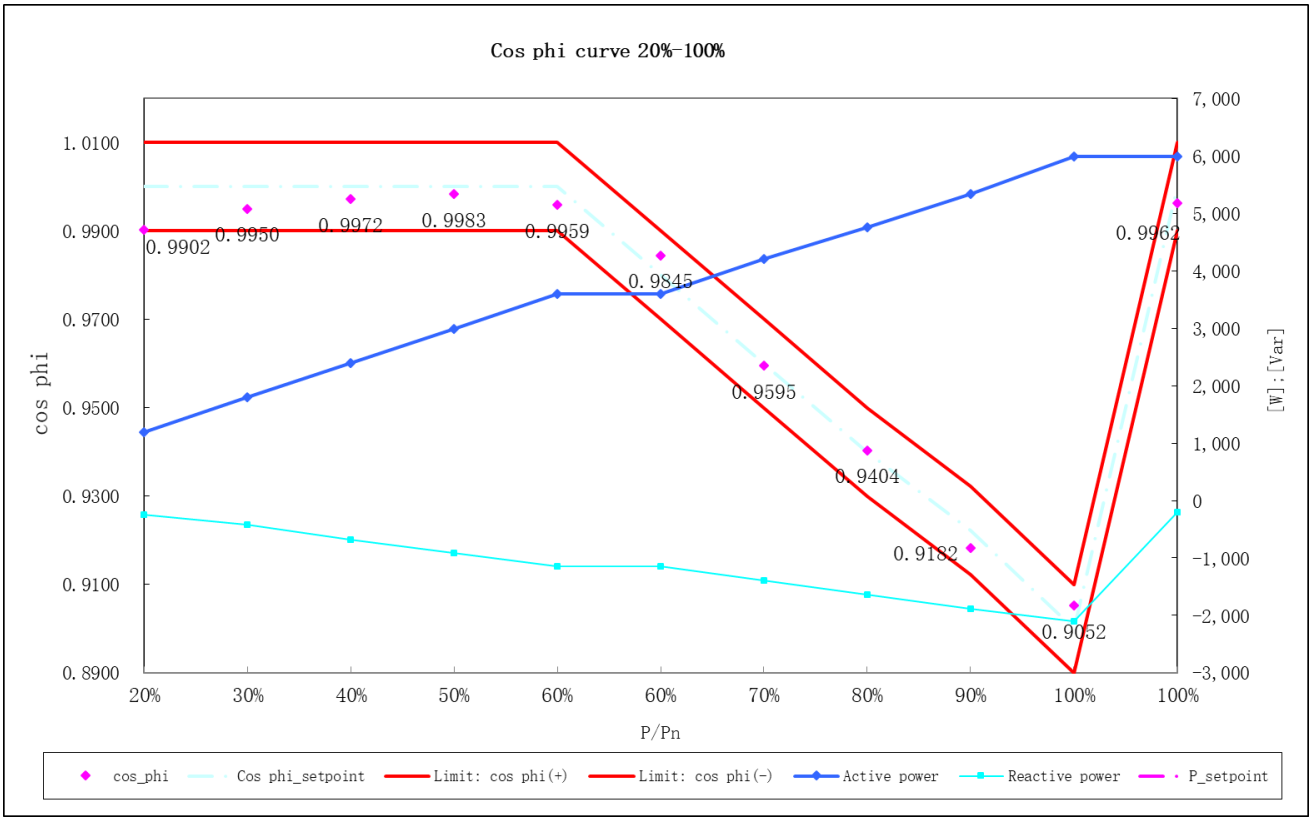
Test result

T-REX-6KLP1G01 with Cmax battery

Inductive reactive power absorption

Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	1194,1	-240,6	0,9902	1,0000	-0,0098
30	1792,5	-418,6	0,9950	1,0000	-0,0050
40	2394,7	-676,5	0,9972	1,0000	-0,0028
50	2991,7	-908,6	0,9983	1,0000	-0,0017
60	3598,1	-1138,5	0,9959	1,0000	-0,0041
60	3594,1	-1151,6	0,9845	0,9800	0,0045
70	4202,3	-1391,9	0,9595	0,9600	-0,0005
80	4760,1	-1631,7	0,9404	0,9400	0,0004
90	5336,0	-1889,0	0,9182	0,9200	-0,0018
100	5994,6	-2105,0	0,9052	0,9000	0,0052
100	5986,3	-199,5	0,9962	1,0000	-0,0038

Graph of cos φ(P) 20% to 100%



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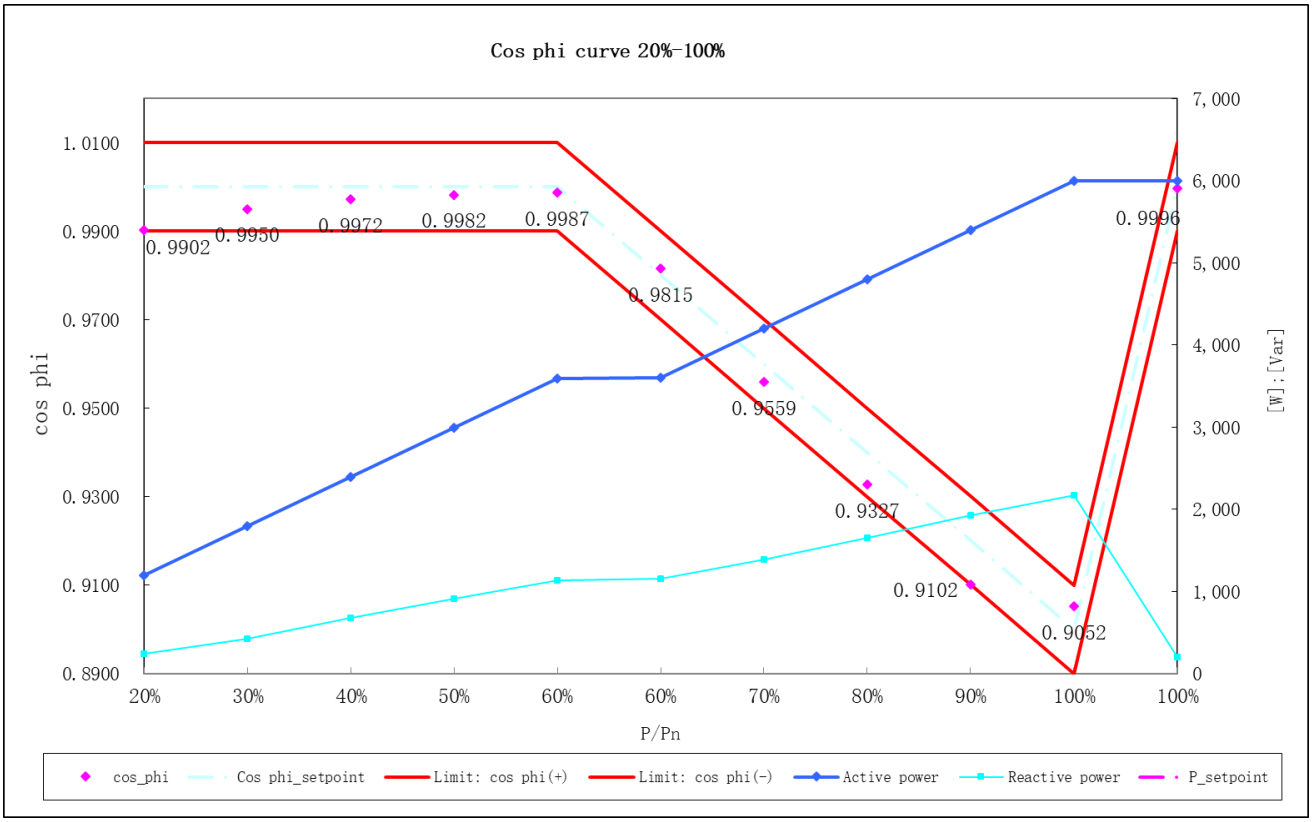
Capacitive reactive power absorption					
Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	1193,6	242,2	0,9902	1,0000	-0,0098
30	1792,5	422,6	0,9950	1,0000	-0,0050
40	2394,1	675,6	0,9972	1,0000	-0,0028
50	2995,0	914,6	0,9982	1,0000	-0,0018
60	3596,6	1132,5	0,9987	1,0000	-0,0013
60	3598,2	1154,3	0,9815	0,9800	0,0015
70	4196,2	1394,4	0,9559	0,9600	-0,0041
80	4797,1	1658,4	0,9327	0,9400	-0,0073
90	5397,8	1925,1	0,9102	0,9200	-0,0098
100	5994,1	2173,6	0,9052	0,9000	0,0052
100	6001,9	197,8	0,9996	1,0000	-0,0004

Graph of cos φ(P) 20% to 100%



Note

The lock-in value is adjustable between V_n and $1.1V_n$ and the lock-out value between V_n and $0.9V_n$ in 0,01V steps.

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Bbis.6.7	Verification of compliance with the application of the standard delivery curve cos φ = f(P)	P

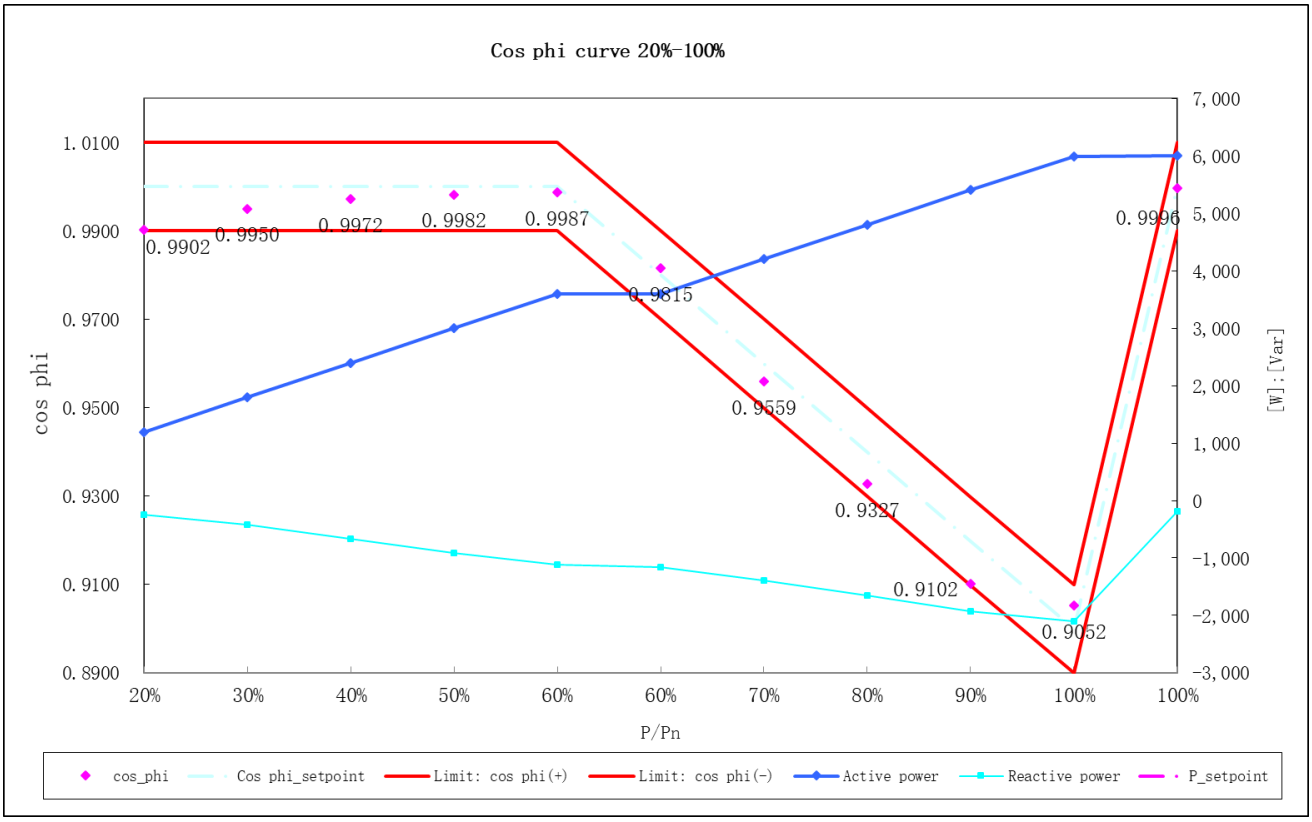
Test result

T-REX-6KLP1G01 with Cmin battery

Inductive reactive power absorption

Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	1193,5	-241,8	0,9902	1,0000	-0,0098
30	1793,1	-422,4	0,9950	1,0000	-0,0050
40	2394,3	-671,3	0,9972	1,0000	-0,0028
50	2995,4	-906,8	0,9982	1,0000	-0,0018
60	3597,2	-1118,8	0,9987	1,0000	-0,0013
60	3598,8	-1161,8	0,9809	0,9800	0,0009
70	4200,3	-1392,6	0,9600	0,9600	0,0000
80	4803,1	-1654,3	0,9372	0,9400	-0,0028
90	5406,5	-1922,6	0,9141	0,9200	-0,0059
100	5993,8	-2105,4	0,9052	0,9000	0,0052
100	6001,8	-187,6	0,9996	1,0000	-0,0004

Graph of cos φ(P) 20% to 100%



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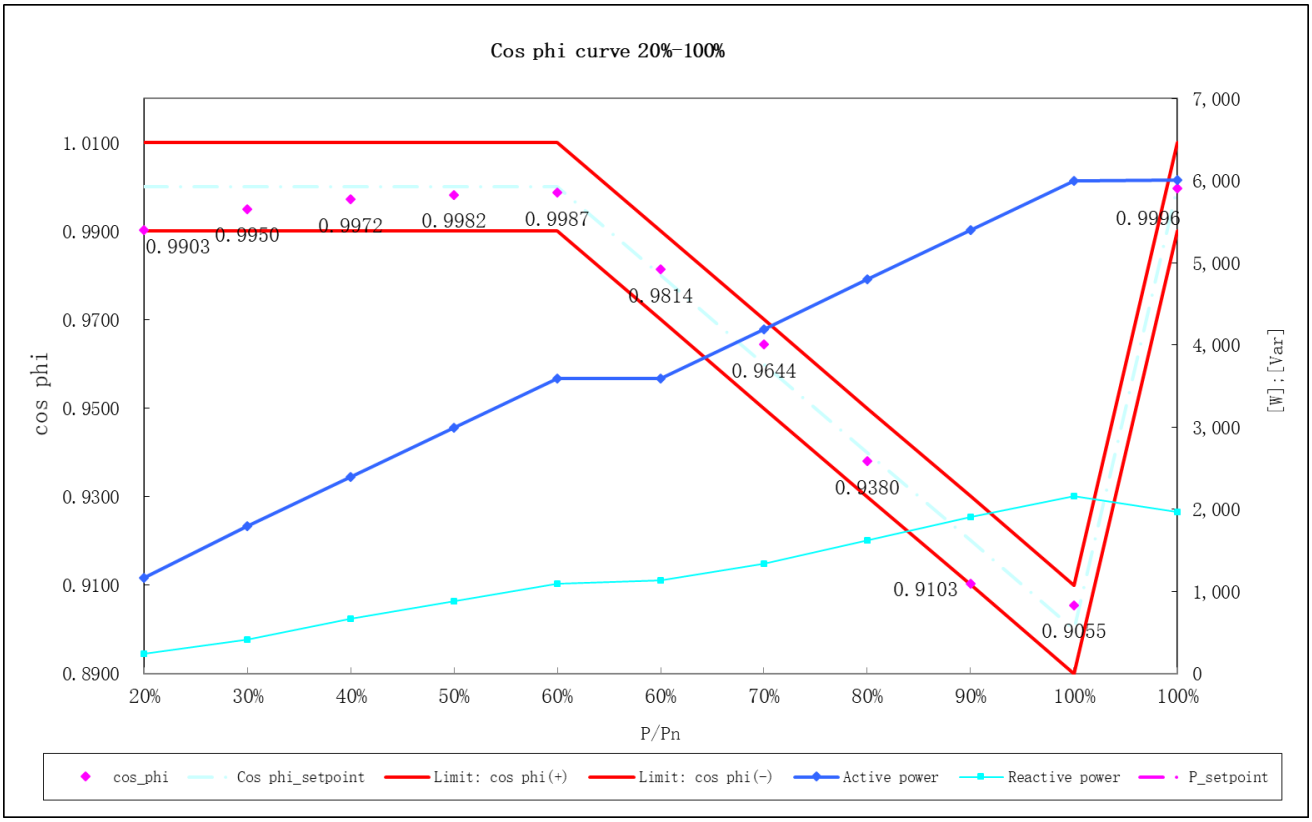
Capacitive reactive power absorption					
Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	1169,3	241,2	0,9903	1,0000	-0,0097
30	1792,2	415,0	0,9950	1,0000	-0,0050
40	2394,2	666,4	0,9972	1,0000	-0,0028
50	2992,7	884,9	0,9982	1,0000	-0,0018
60	3596,2	1099,9	0,9987	1,0000	-0,0013
60	3595,0	1138,9	0,9814	0,9800	0,0014
70	4194,9	1343,9	0,9644	0,9600	0,0044
80	4797,0	1625,2	0,9380	0,9400	-0,0020
90	5395,2	1909,9	0,9103	0,9200	-0,0097
100	5995,6	2161,7	0,9055	0,9000	0,0055
100	6002,5	194,7	0,9996	1,0000	-0,0004

Graph of cos φ(P) 20% to 100%



Note

The lock-in value is adjustable between V_n and $1.1V_n$ and the lock-out value between V_n and $0.9V_n$ in 0,01V steps.

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Bbis.6.7	Verification of compliance with the application of the standard delivery curve cos φ = f(P)	P

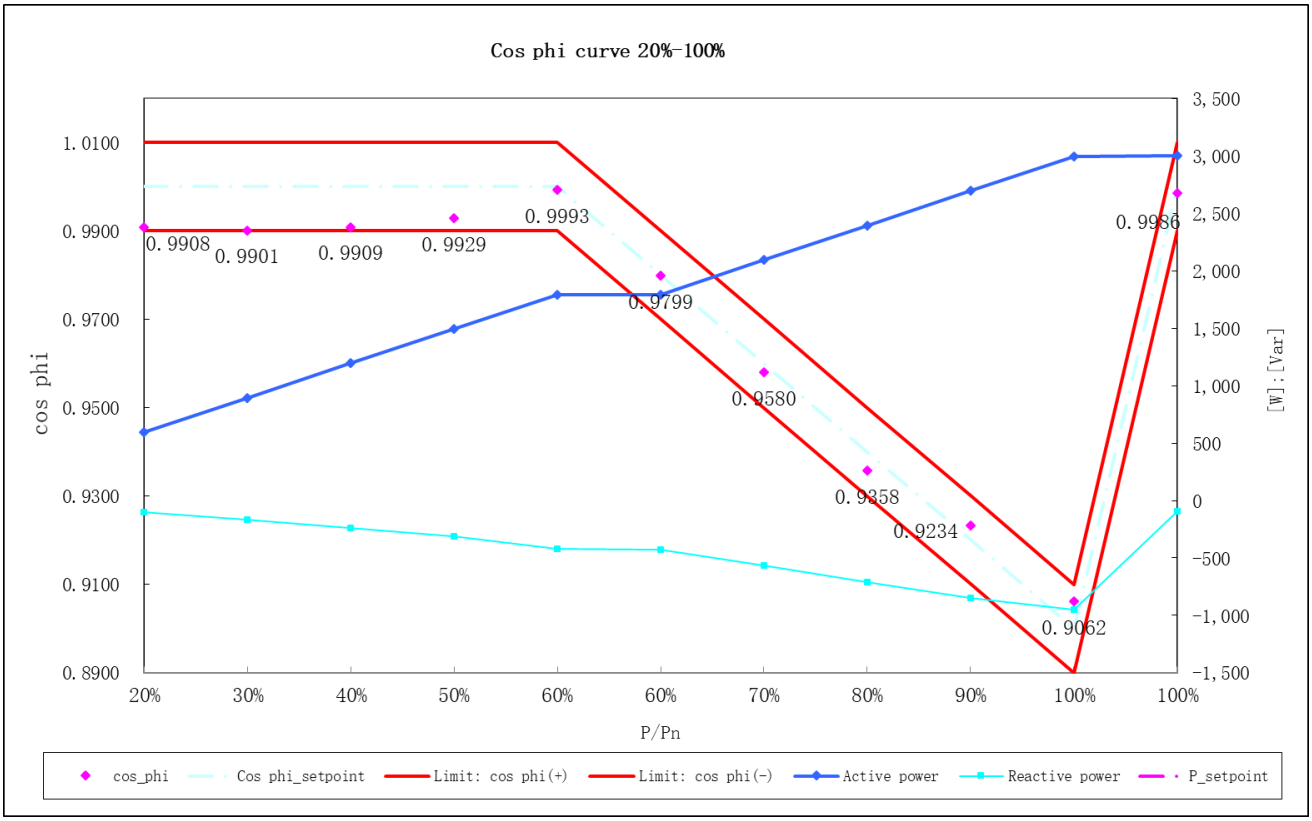
Test result

T-REX-3KLP1G01 with Cmin battery

Inductive reactive power absorption

Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	595,5	-101,3	0,9908	1,0000	-0,0092
30	893,8	-169,8	0,9901	1,0000	-0,0099
40	1193,5	-240,4	0,9909	1,0000	-0,0091
50	1492,2	-313,2	0,9929	1,0000	-0,0071
60	1791,3	-418,3	0,9993	1,0000	-0,0007
60	1794,1	-425,0	0,9799	0,9800	-0,0001
70	2095,6	-562,5	0,9580	0,9600	-0,0020
80	2395,7	-708,2	0,9358	0,9400	-0,0042
90	2697,3	-846,0	0,9234	0,9200	0,0034
100	2997,5	-952,2	0,9062	0,9000	0,0062
100	2998,3	-91,3	0,9986	1,0000	-0,0014

Graph of cos φ(P) 20% to 100%



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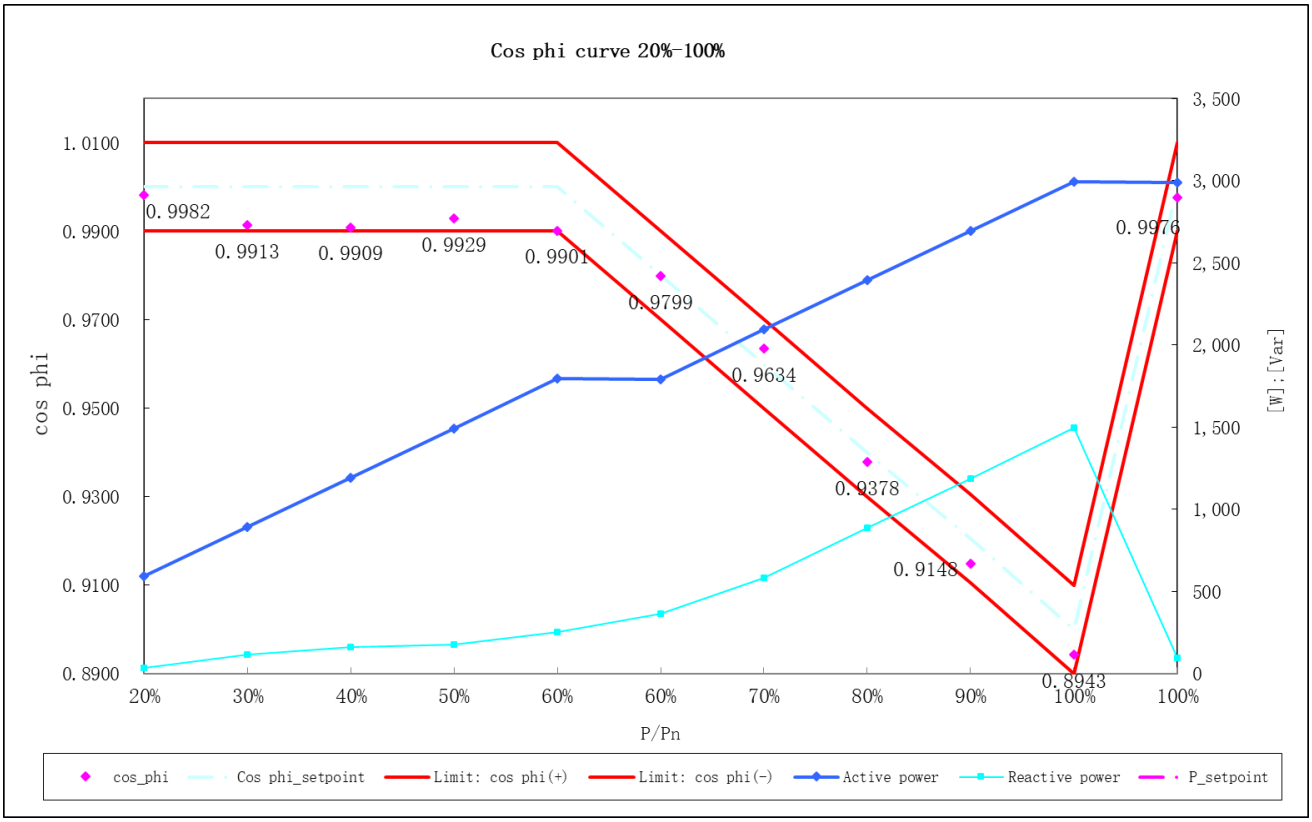
Capacitive reactive power absorption					
Power-BIN [%]	Active power P [W]	Reactive power Q [Var]	cos φ measured [1]	cos φ expected [1]	Δcos φ [1]
20	592,8	35,2	0,9982	1,0000	-0,0018
30	893,9	118,6	0,9913	1,0000	-0,0087
40	1193,5	162,0	0,9909	1,0000	-0,0091
50	1493,5	178,8	0,9929	1,0000	-0,0071
60	1794,6	254,8	0,9901	1,0000	-0,0099
60	1792,1	365,1	0,9799	0,9800	-0,0001
70	2093,8	583,0	0,9634	0,9600	0,0034
80	2393,9	886,1	0,9378	0,9400	-0,0022
90	2693,2	1189,2	0,9148	0,9200	-0,0052
100	2993,8	1498,0	0,8943	0,9000	-0,0057
100	2988,7	94,6	0,9976	1,0000	-0,0024

Graph of cos φ(P) 20% to 100%



Note

The lock-in value is adjustable between V_n and $1.1V_n$ and the lock-out value between V_n and $0.9V_n$ in 0,01V steps.

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Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P

The purpose of the test is to verify the automatic reduction function of the active power output when the voltage read at the terminals of the storage system is close to 110 % of V_n.

Test result

T-REX-6KLP1G01 with Cmax battery

setpoint	Activation threshold -2 % of V_n	Activation threshold +2 % of V_n	Activation threshold -2 % of V_n
Voltage [V]	248,8	257,3	248,8
P_{E60} [% P_N]	100,1	-80,7	100,1
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,1	-0,7	0,1
Settling time [s]	N/A	52,5	N/A
Limit settling time [s]	300		

Test:

1. the active power reduction function P(V) is enabled, according to the manufacturer's instructions (which must be stated in the test report):
2. adjust the voltage read at the converter's output terminals to -2 % of the manufacturer's declared activation threshold and the DC source so that the active power delivered at the output is equal to the maximum power available at the input;
3. adjust the voltage read at the output terminals of the converter to +2 % of the activation threshold stated by the manufacturer;
4. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
5. within 5 min from the instant of application of the voltage 2 % of the activation threshold declared by the manufacturer (compatible with the energy capacity of the storage system) it is verified that, in the case of storage systems connected to unidirectional converters the active power supplied by the inverter has been reduced to a value no greater than 20 % * P_{SMAX} (20 % * P_{NINV}, in the case of integrated EESS), while in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX} is also verified that the equipment signals the power reduction in progress (recording the modalities in the test report);
6. adjust the voltage read at the output terminals of the converter to -2 % of the activation threshold stated by the manufacturer;
7. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
8. check that the active power delivered by the inverter returns to the value congruent with the power
9. made available by the DC-side accumulators and, if used, of the primary or simulated source.

Assessment criterion

for adjustable PGUs:

- no network disconnection
- in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX}
- the setting time determined is equal or less than 300s
- the active power delivered by the inverter returns to the value congruent with the power made available by the DC-side accumulators

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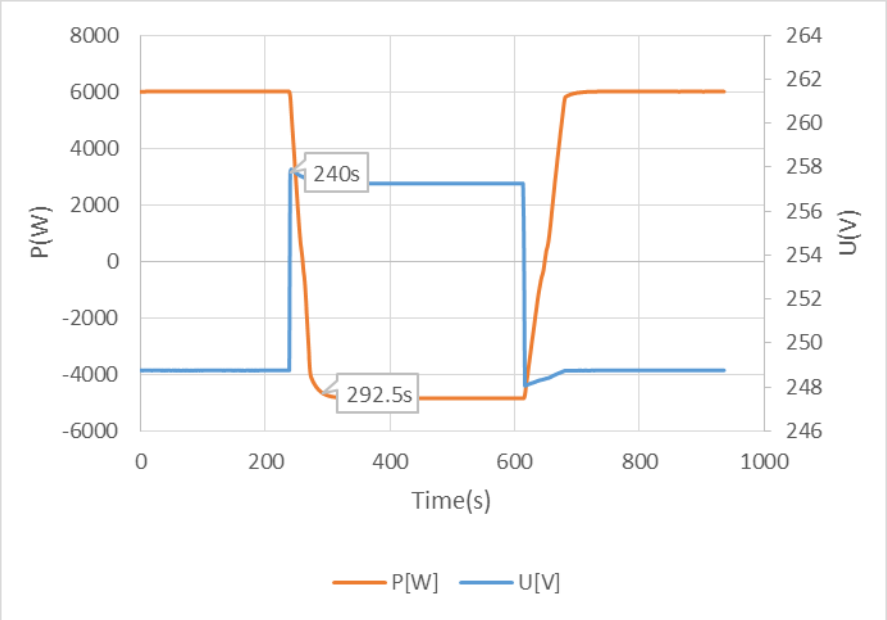
Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P

Graph



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Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P

The purpose of the test is to verify the automatic reduction function of the active power output when the voltage read at the terminals of the storage system is close to 110 % of V_n.

Test result

T-REX-6KLP1G01 with Cmin battery

setpoint	Activation threshold -2 % of V_n	Activation threshold +2 % of V_n	Activation threshold -2 % of V_n
Voltage [V]	248,8	257,3	248,8
P_{E60} [% P_N]	100,2	-80,5	100,2
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,2	-0,5	0,2
Settling time [s]	N/A	58,5	N/A
Limit settling time [s]	300		

Test:

10. the active power reduction function P(V) is enabled, according to the manufacturer's instructions (which must be stated in the test report):
11. adjust the voltage read at the converter's output terminals to -2 % of the manufacturer's declared activation threshold and the DC source so that the active power delivered at the output is equal to the maximum power available at the input;
12. adjust the voltage read at the output terminals of the converter to +2 % of the activation threshold stated by the manufacturer;
13. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
14. within 5 min from the instant of application of the voltage 2 % of the activation threshold declared by the manufacturer (compatible with the energy capacity of the storage system) it is verified that, in the case of storage systems connected to unidirectional converters the active power supplied by the inverter has been reduced to a value no greater than 20 % * P_{SMAX} (20 % * P_{NINV}, in the case of integrated EESS), while in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX} is also verified that the equipment signals the power reduction in progress (recording the modalities in the test report);
15. adjust the voltage read at the output terminals of the converter to -2 % of the activation threshold stated by the manufacturer;
16. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
17. check that the active power delivered by the inverter returns to the value congruent with the power
18. made available by the DC-side accumulators and, if used, of the primary or simulated source.

Assessment criterion

for adjustable PGUs:

- no network disconnection
- in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX}
- the setting time determined is equal or less than 300s
- the active power delivered by the inverter returns to the value congruent with the power made available by the DC-side accumulators

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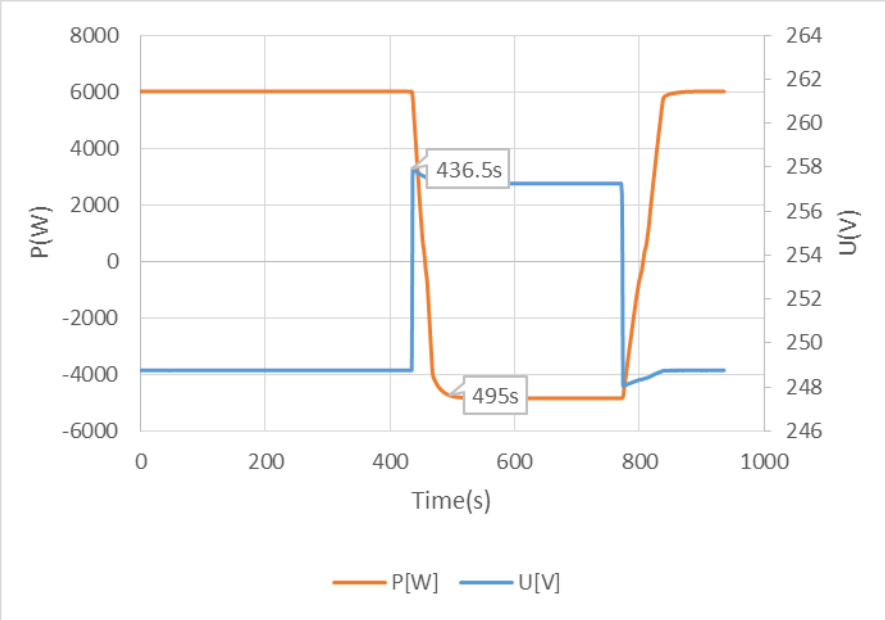
Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P

Graph



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Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P

The purpose of the test is to verify the automatic reduction function of the active power output when the voltage read at the terminals of the storage system is close to 110 % of V_n.

Test result

T-REX-3KLP1G01 with Cmin battery

setpoint	Activation threshold -2 % of V_n	Activation threshold +2 % of V_n	Activation threshold -2 % of V_n
Voltage [V]	248,6	257,4	248,6
P_{E60} [% P_N]	100,0	-80,7	100,0
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,0	-0,7	0,0
Settling time [s]	N/A	69,0	40,0
Limit settling time [s]	300		

Test:

19. the active power reduction function P(V) is enabled, according to the manufacturer's instructions (which must be stated in the test report):
20. adjust the voltage read at the converter's output terminals to -2 % of the manufacturer's declared activation threshold and the DC source so that the active power delivered at the output is equal to the maximum power available at the input;
21. adjust the voltage read at the output terminals of the converter to +2 % of the activation threshold stated by the manufacturer;
22. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
23. within 5 min from the instant of application of the voltage 2 % of the activation threshold declared by the manufacturer (compatible with the energy capacity of the storage system) it is verified that, in the case of storage systems connected to unidirectional converters the active power supplied by the inverter has been reduced to a value no greater than 20 % * P_{SMAX} (20 % * P_{NINV}, in the case of integrated EESS), while in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX} is also verified that the equipment signals the power reduction in progress (recording the modalities in the test report);
24. adjust the voltage read at the output terminals of the converter to -2 % of the activation threshold stated by the manufacturer;
25. measure the active power as 1 s averages and plot the values obtained in a time-dependent graph;
26. check that the active power delivered by the inverter returns to the value congruent with the power
27. made available by the DC-side accumulators and, if used, of the primary or simulated source.

Assessment criterion

for adjustable PGUs:

- no network disconnection
- in the case of bi-directional converters, the EESS has switched to absorb, compatibly with the constraints given by its own capacity, an active power of at least 80 % * P_{CMAX}
- the setting time determined is equal or less than 300s
- the active power delivered by the inverter returns to the value congruent with the power made available by the DC-side accumulators

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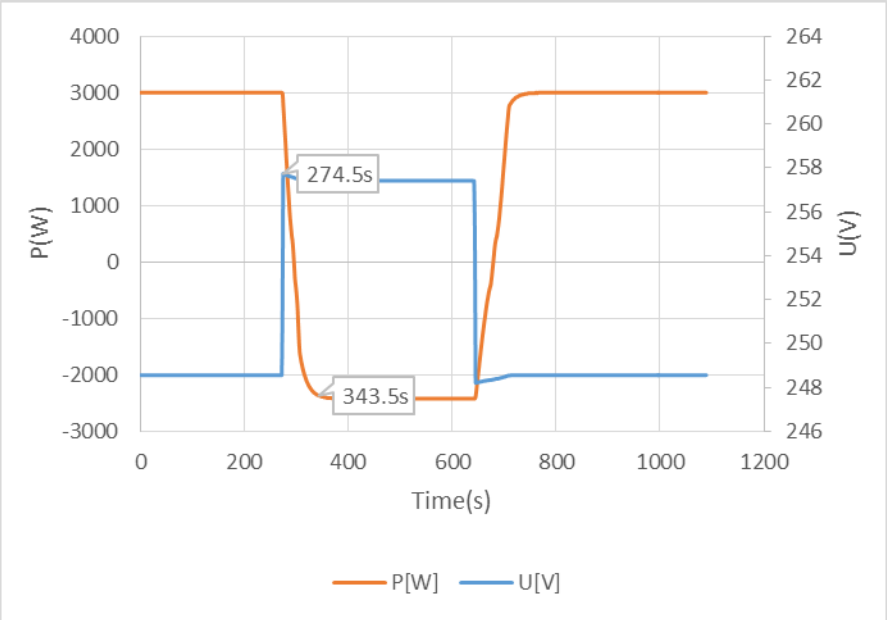
Bbis.7.1	Automatic active power limitation for voltage values close to 110 % of nominal voltage	P
Graph		



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Bbis.7.2	Verification of automatic reduction of active power in presence of Over-frequency transitions on the network	P
Bbis.7.2.1	Performance of tests	

- Connect the test object following the manufacturer's instructions.
- Set all parameters of the simulated network to the respective normal operation values.
- Set all the parameters of the test object to the respective normal operation values, so that the output AC power of the inverter is equal to the maximum AC output for sequence A, and 50% in the case of sequence B.
- Take measurements at 7 points (the frequency value should have a maximum uncertainty of ± 10 mHz) consecutively over time:

1) f = 47,51 Hz (t1 for sequence A, t'1 for sequence B)

2) f =50 Hz + 0,15 Hz (t2 for sequence A, t'2 for sequence B)

3) f =50 Hz + 0,40 Hz (t3 for sequence A, t'3 for sequence B)

4) f =50 Hz + 0,60 Hz (t4 for sequence A, t'4 for sequence B)

5) f =50 Hz + 1,49 Hz (t5 for sequence A, t'5 for sequence B)

6) f =50 Hz + 0,11 Hz (t6 for sequence A, t'6 for sequence B)

At this point, perform step 7 bringing the frequency back to the nominal value in order to check the conditions for a gradual recovery of the maximum supply (sequence A), or 50% of the maximum power (sequence B):

7) f = 50 Hz (t7 for sequence A, t'7 for sequence B)

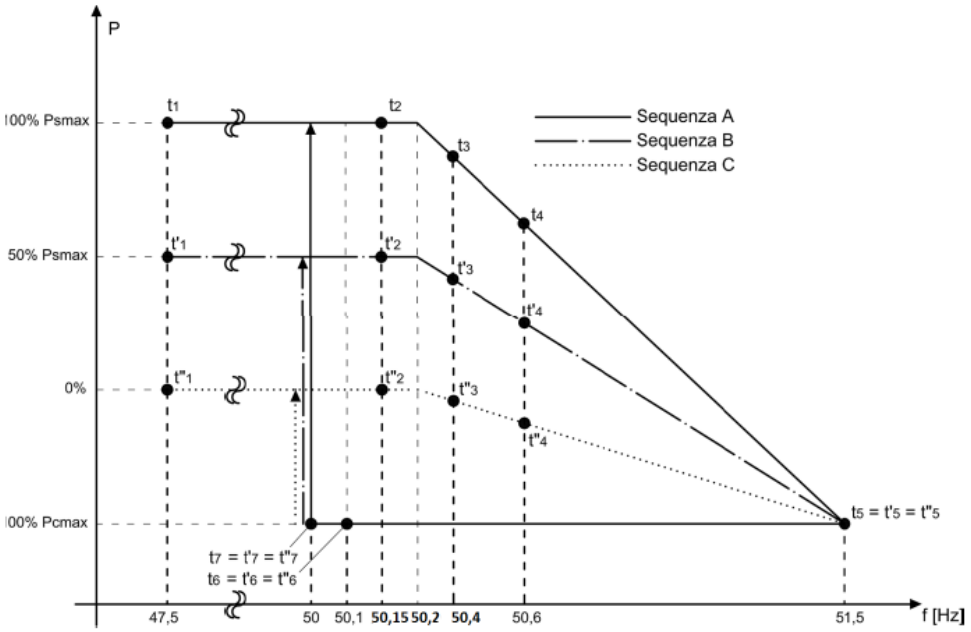

Figura 9Bbis – Curve di limitazione della potenza attiva per convertitori bidirezionali

Note:

The inverter is able to set a delay for the activation of the curve from 0s - 1s.
(in 50ms steps / default setting: 0)

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Bbis.7.2.2	Test results							P
Test result								
T-REX-6KLP1G01 with Cmax battery								
1-min mean value [Hz]	1) 47,51	2) 50,15	3) 50,20	4) 50,40	5) 50,60	6) 51,49	7) 50,11	8) 50,00
1. Measurement 1) to 7): Active power output 100%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	6000	6000	6000	4159,0	2310,8	-5907,7	-5907,7	6000,0
P_{E60} [W]	6016,8	6001,1	6007,0	4219,6	2352,8	-5843,0	-5976,8	6008,7
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,28	0,02	0,12	1,01	0,70	1,08	-1,15	0,15
2. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	3000	3000	3000	1621,0	235,3	-5930,8	-5930,8	3000,0
PE60 [W]	3010,0	2995,3	3000,0	1683,4	248,1	-5919,4	-5924,5	3000,2
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,17	-0,08	0,00	1,04	0,21	0,19	0,11	0,00
3. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	47,51	50,15	50,20	50,40	50,60	51,49	50,11	50,00
$P_{setpoint}$ [W]	0	0	0	-920,6	-1843,8	-5953,8	-5953,8	0,0
PE60 [W]	-10,0	-10,0	-10,0	-970,0	-1874,5	-5987,7	-5987,4	-9,8
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,17	-0,17	-0,17	-0,82	-0,51	-0,56	-0,56	-0,16
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							
Note								

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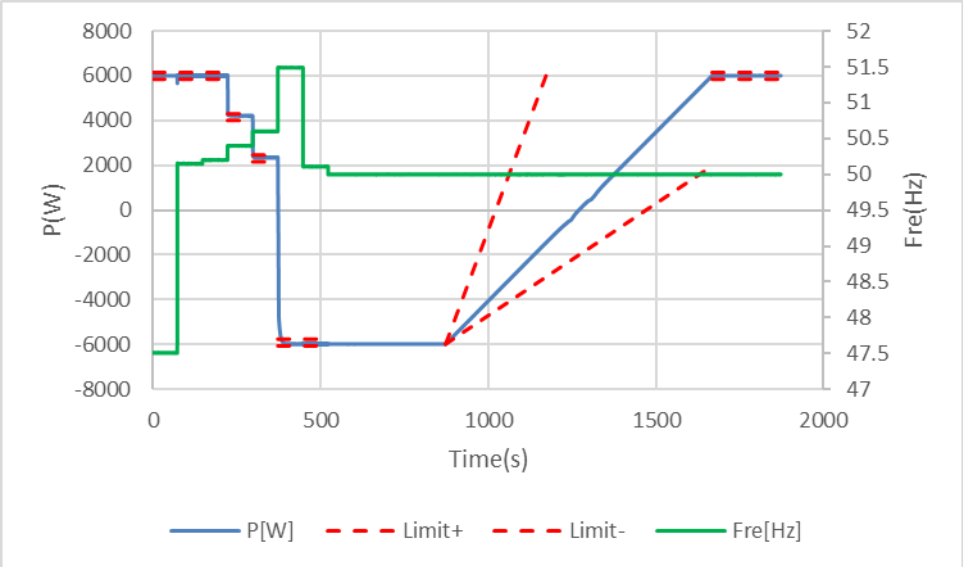
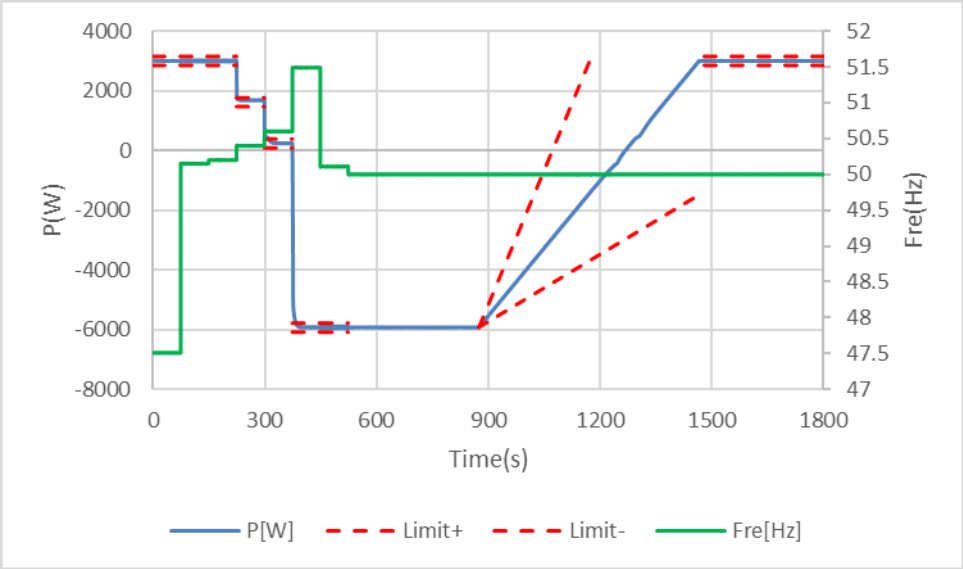
Graph of Measurement 1.: Active power output reduction 100%P_{Smax}



Graph of Measurement 2.: Active power output reduction 50%P_{Smax}



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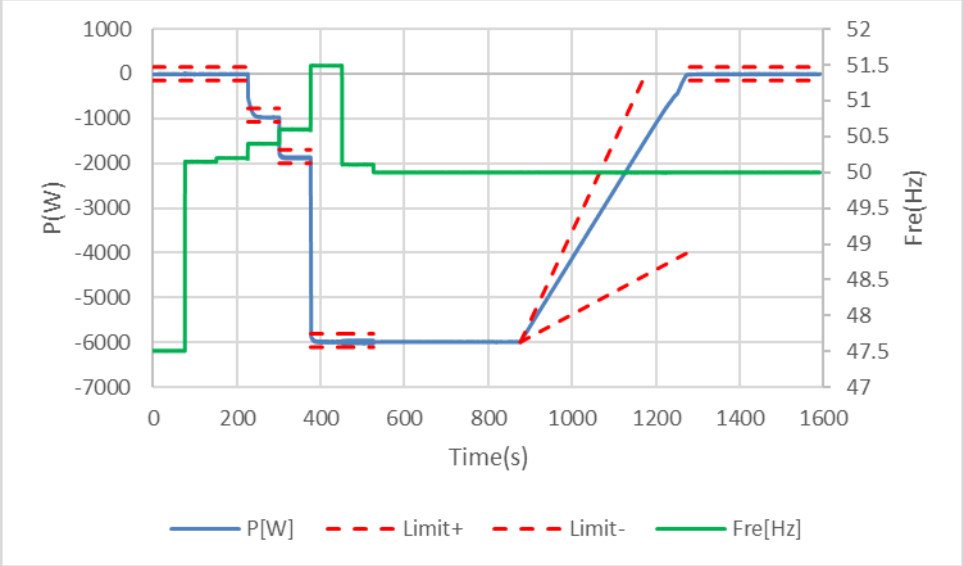
Graph of Measurement 3.: Active power output reduction 0%P_{Smax}



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Bbis.7.2.2	Test results							P
Test result								
T-REX-6KLP1G01 with Cmin battery								
1-min mean value [Hz]	1) 47,51	2) 50,15	3) 50,20	4) 50,40	5) 50,60	6) 51,49	7) 50,11	8) 50,00
1. Measurement 1) to 7): Active power output 100%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	6000	6000	6000	4157,2	2314,4	-5907,7	-5907,7	6000,0
P_{E60} [W]	6019,4	6001,1	6006,6	4224,9	2359,8	-5668,1	-5975,3	6006,4
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,32	0,02	0,11	1,13	0,76	3,99	-1,13	0,11
2. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	3000	3000	3000	1618,5	234,0	-5930,8	-5930,8	3000,0
PE60 [W]	3008,9	2997,4	3000,4	1687,2	252,8	-5917,9	-5924,7	3000,6
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,15	-0,04	0,01	1,15	0,31	0,21	0,10	0,01
3. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	0	0	0	-920,9	-1841,3	-5953,8	-5953,8	0,0
PE60 [W]	-11,5	-9,6	-9,8	-970,6	-1877,0	-5990,0	-5988,9	-9,6
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,19	-0,16	-0,16	-0,83	-0,59	-0,60	-0,58	-0,16
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							
Note								

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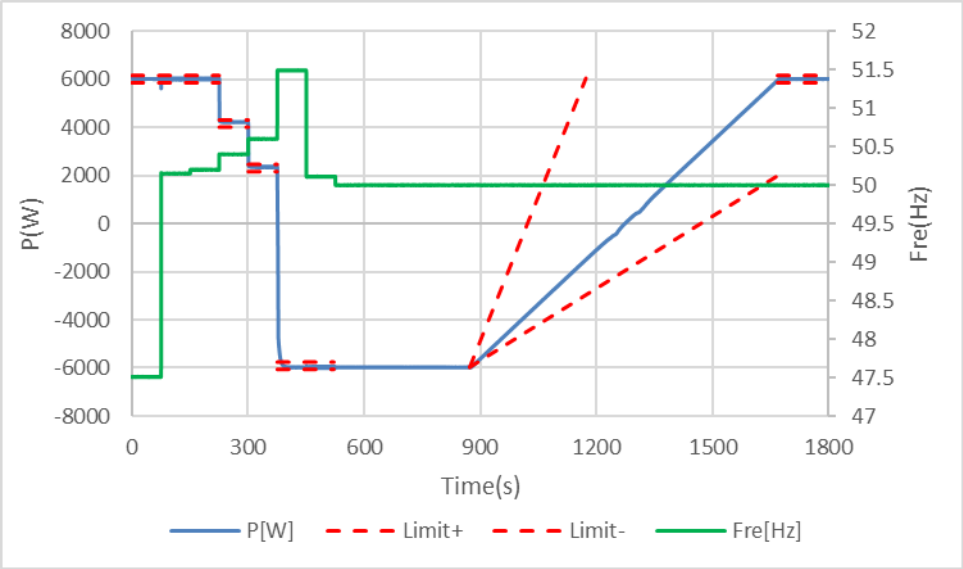
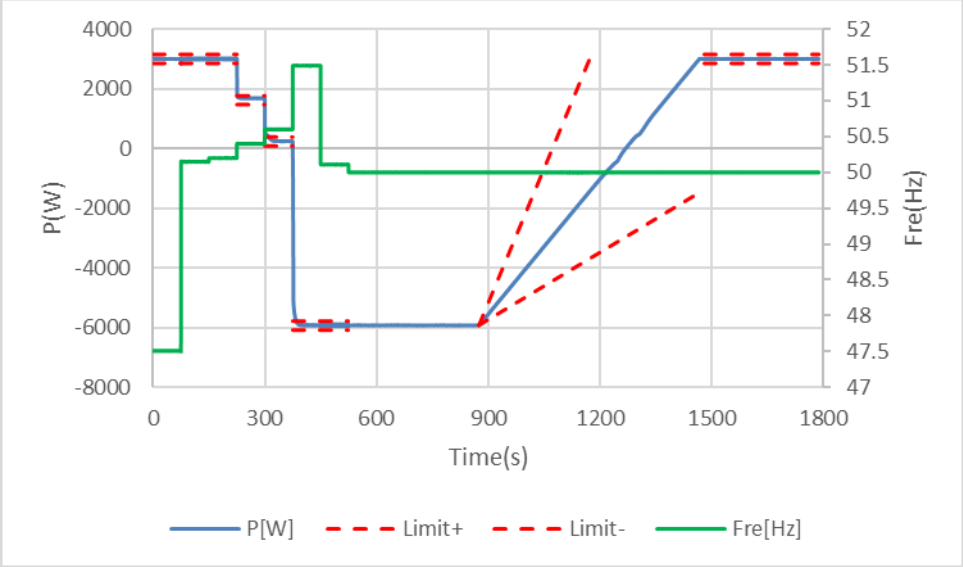
Graph of Measurement 1.: Active power output reduction 100%P_{Smax}



Graph of Measurement 2.: Active power output reduction 50%P_{Smax}



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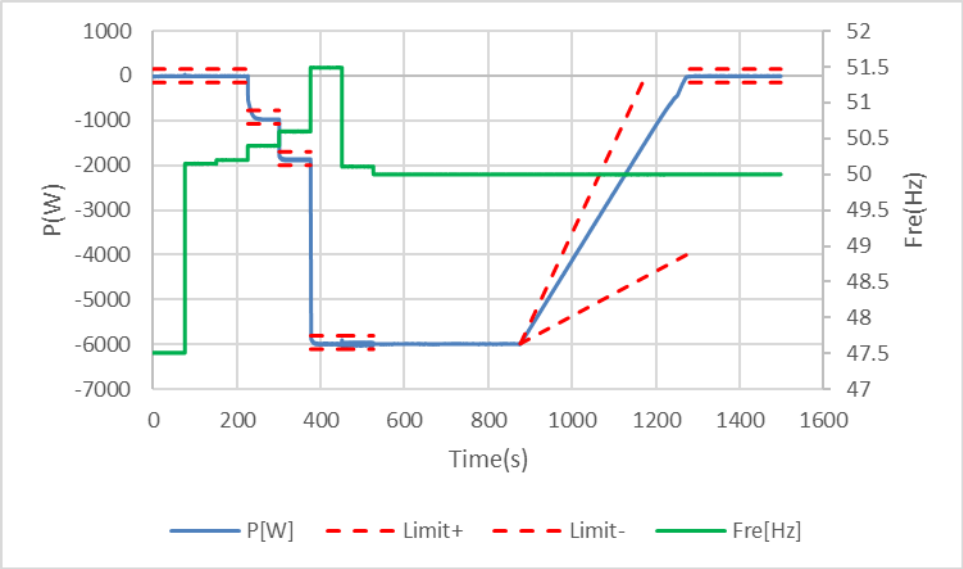
Graph of Measurement 3.: Active power output reduction 0%P_{Smax}



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Bbis.7.2.2	Test results							P
Test result								
T-REX-3KLP1G01 with Cmin battery								
1-min mean value [Hz]	1) 47,51	2) 50,15	3) 50,20	4) 50,40	5) 50,60	6) 51,49	7) 50,11	8) 50,00
1. Measurement 1) to 7): Active power output 100%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	3000	3000	3000	2080,6	1157,6	-2953,8	-2953,8	3000,0
P_{E60} [W]	3008,1	2996,2	2999,4	2108,3	1180,4	-2807,2	-2986,0	3000,4
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,27	-0,13	-0,02	0,92	0,76	4,89	-1,07	0,01
2. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	1500	1500	1500	810,1	117,3	-2965,4	-2965,4	1500,0
PE60 [W]	1500,2	1497,2	1497,9	840,0	118,5	-2957,4	-2957,0	1498,5
$\Delta P_{E60}/P_{Setpoint}$ [%]	0,01	-0,09	-0,07	1,00	0,04	0,26	0,28	-0,05
3. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	47.51	50.15	50.20	50.40	50.60	51.49	50.11	50.00
$P_{setpoint}$ [W]	0	0	0	-461,2	-920,3	-2976,9	-2976,9	0,0
PE60 [W]	-10,0	-9,6	-9,1	-480,0	-940,0	-2990,4	-2990,2	-9,8
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,33	-0,32	-0,30	-0,63	-0,66	-0,45	-0,44	-0,33
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							
Note								

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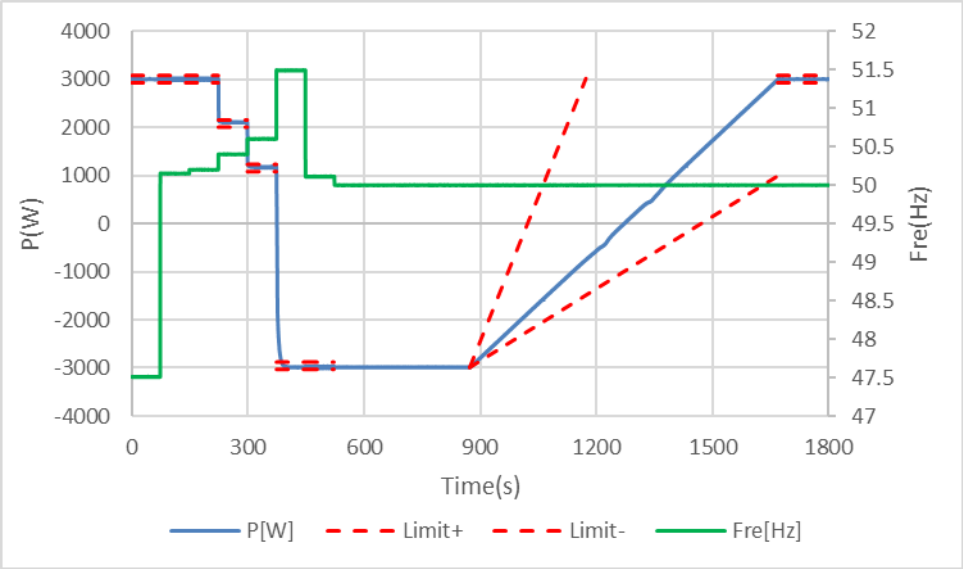
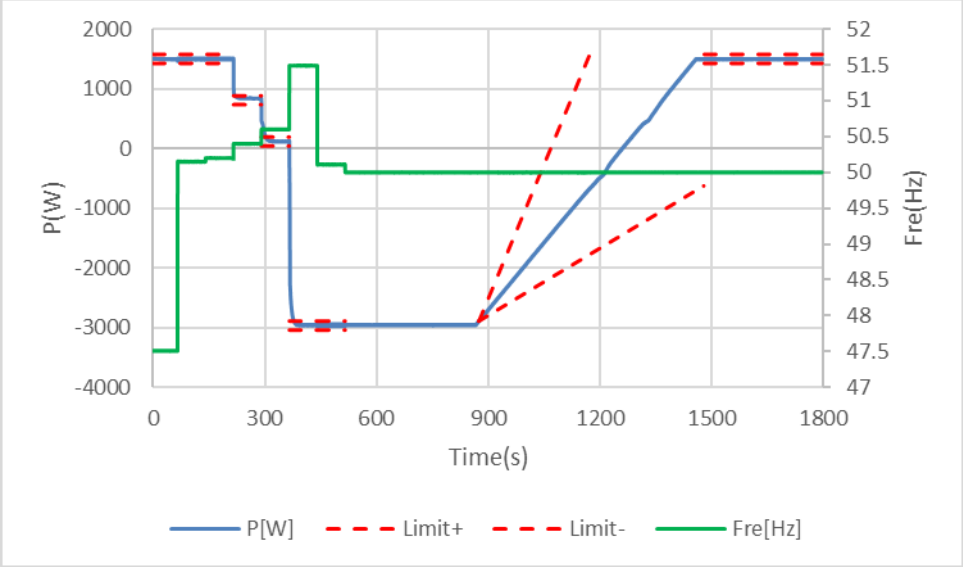
Graph of Measurement 1.: Active power output reduction 100%P_{Smax}



Graph of Measurement 2.: Active power output reduction 50%P_{Smax}



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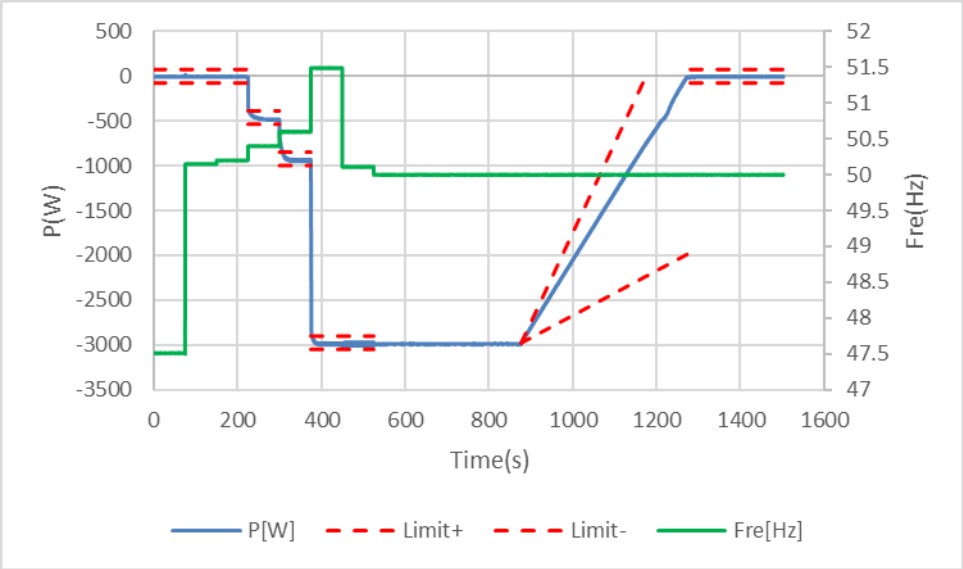
Graph of Measurement 3.: Active power output reduction 0%P_{Smax}



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Bbis.7.3	Verification of automatic active power increase in the presence of under-frequency transients on the grid	P
Bbis.7.3.1	Performance of tests	

- Connect the test object following the manufacturer's instructions.
- Set all parameters of the simulated network to the respective normal operation values.
- Set all the parameters of the test object to the respective normal operation values, so that the output AC power of the inverter is equal to the maximum AC output for sequence A, and 50% in the case of sequence B.
- Take measurements at 7 points (the frequency value should have a maximum uncertainty of ± 10 mHz) consecutively over time:

1) f = 51,49 Hz (t1 for sequence A, t'1 for sequence B)

2) f = 50,00 Hz - 0,15 Hz (t2 for sequence A, t'2 for sequence B)

3) f = 50,00 Hz - 0,40 Hz (t3 for sequence A, t'3 for sequence B)

4) f = 50,00 Hz - 0,60 Hz (t4 for sequence A, t'4 for sequence B)

5) f = 50,00 Hz - 0,89 Hz (t5 for sequence A, t'5 for sequence B)

6) f = 50,00 Hz - 0,11 Hz (t6 for sequence A, t'6 for sequence B)

At this point, perform step 7 bringing the frequency back to the nominal value in order to check the conditions for a gradual recovery of the maximum supply (sequence A), or 50% of the maximum power (sequence B)

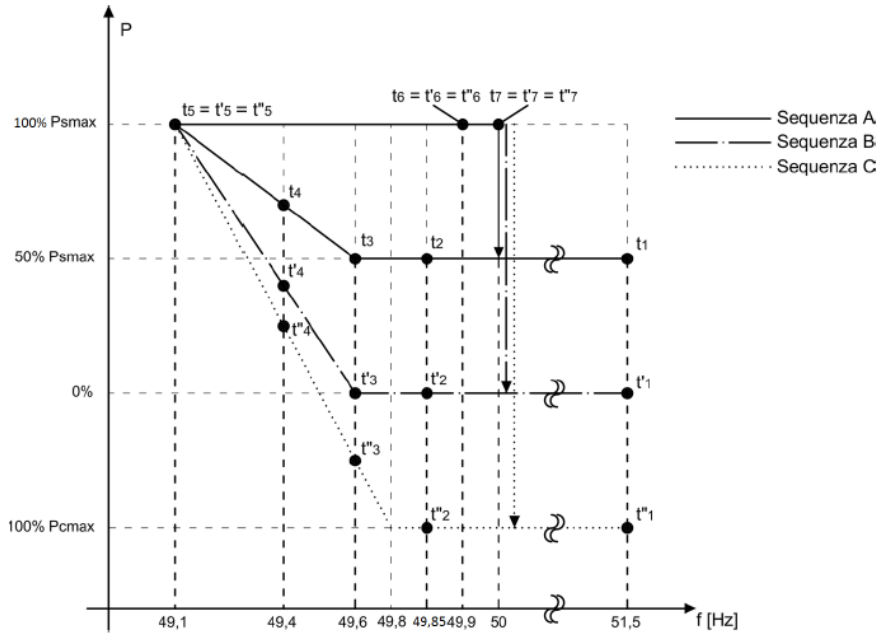

Figura 11Bbis – Curve di limitazione della potenza attiva

:

7) f = 50,00 Hz (t7 for sequence A, t'7 for sequence B)

Note

The inverter is able to set a delay for the activation of the curve from 0 s – 1 s.
(in 50 ms steps / default setting: 0 s)

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Bbis.7.3.2	Test results							P
Test result								
T-REX-6KLP1G01 with Cmax battery								
1-min mean value [Hz]	1) 51,49	3) 49,85	4) 49,80	4) 49,60	5) 49,40	5) 49,11	3) 49,89	8) 50,00
1. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	3000,0	3000,0	3000,0	3000,0	4200,0	5940,0	5940,0	3000,0
P_{E60} [W]	2999,1	3001,7	3000,2	2999,1	4268,1	6020,0	6020,9	3000,2
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,01	0,03	0,00	-0,01	1,13	1,33	1,35	0,00
2. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	0,0	0,0	0,0	0,0	2400,0	5880,0	5880,0	0,0
P_{E60} [W]	-9,6	-9,4	-10,0	-9,4	2341,1	6013,6	6021,3	-8,5
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,16	-0,16	-0,17	-0,16	-0,98	2,23	2,35	-0,14
3. Measurement 1) to 7): Active power output 100%P_{Cmax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	-6000,0	-6000,0	-6000,0	-2571,4	857,1	5828,6	5828,6	-6000,0
P_{E60} [W]	-6046,8	-6057,0	-6047,7	-2548,9	872,3	5912,9	5939,6	-5926,3
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,78	-0,95	-0,79	0,37	0,25	1,41	1,85	1,23
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * S_n from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

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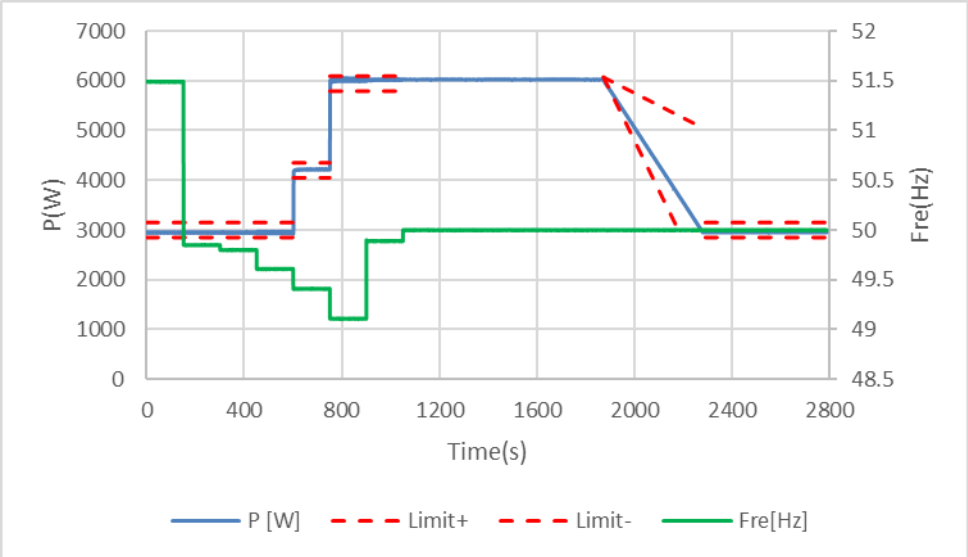
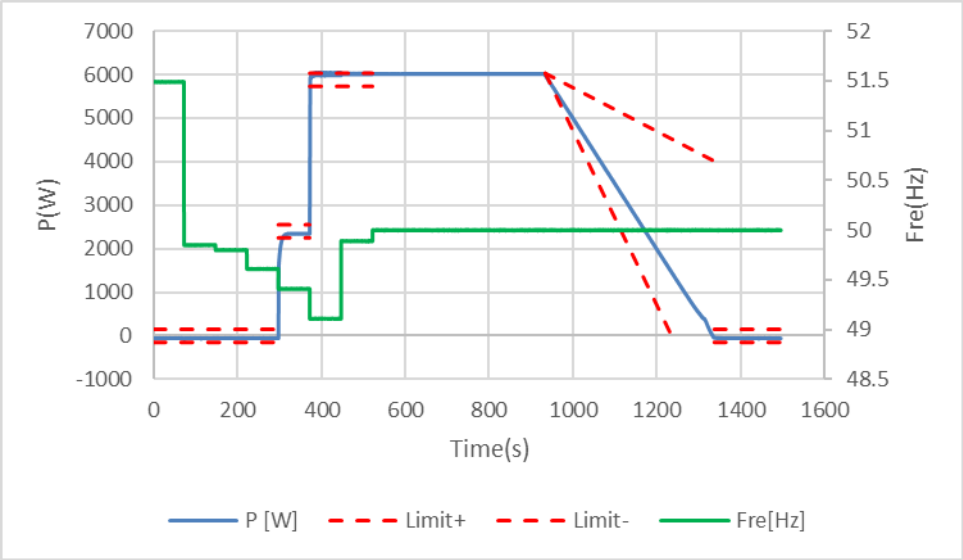
Graph of Measurement 1.: Active power output reduction 50%P_{Smax}



Graph of Measurement 2.: Active power output reduction 0%P_{Smax}



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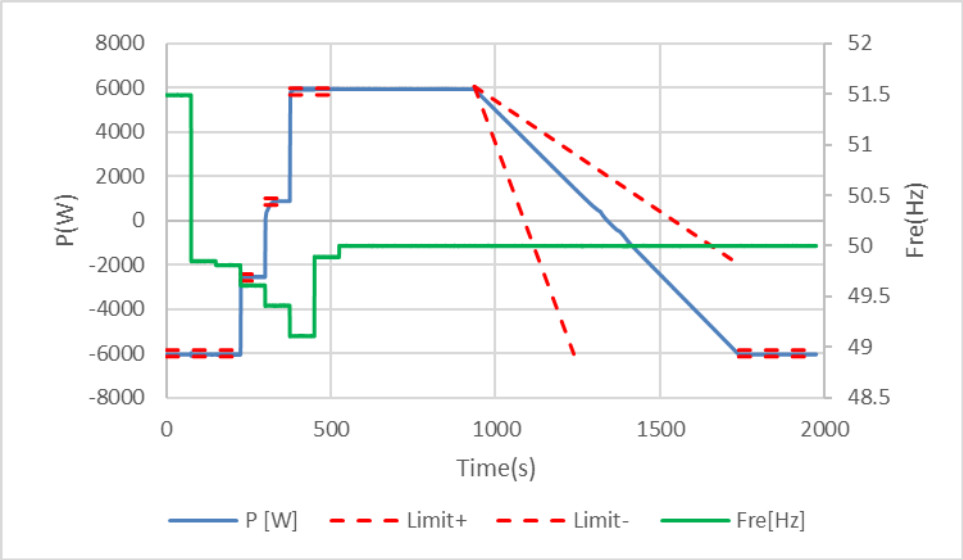
Graph of Measurement 3.: Active power output reduction 100%P_{Cmax}



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Bbis.7.3.2	Test results							P
Test result								
T-REX-6KLP1G01 with Cmin battery								
1-min mean value [Hz]	1) 51,49	3) 49,85	4) 49,80	4) 49,60	5) 49,40	5) 49,11	3) 49,89	8) 50,00
1. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	3000	3000	3000	3000,0	4200,0	5940,0	5940,0	3000,0
P_{E60} [W]	2998,7	3002,8	3000,0	3001,1	4217,2	6022,6	6019,8	3000,2
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,02	0,05	0,00	0,02	0,29	1,38	1,33	0,00
2. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	0	0	0	0,0	2400,0	5880,0	5880,0	0,0
P_{E60} [W]	-16,4	-9,6	-9,8	-9,6	2345,1	6008,9	6009,8	-8,9
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,27	-0,16	-0,16	-0,16	-0,91	2,15	2,16	-0,15
3. Measurement 1) to 7): Active power output 100%P_{Cmax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	-6000	-6000	-6000	-2571,4	857,1	5828,6	5828,6	-6000,0
P_{E60} [W]	-6046,8	-6057,0	-6047,7	-2548,9	873,0	5912,9	5939,6	-5926,3
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,78	-0,95	-0,79	0,37	0,26	1,41	1,85	1,23
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * S_n from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

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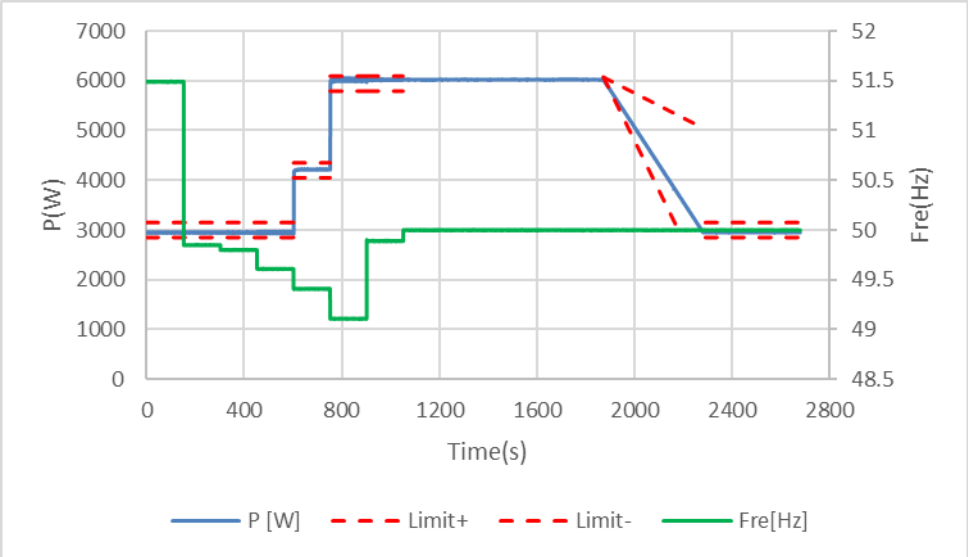
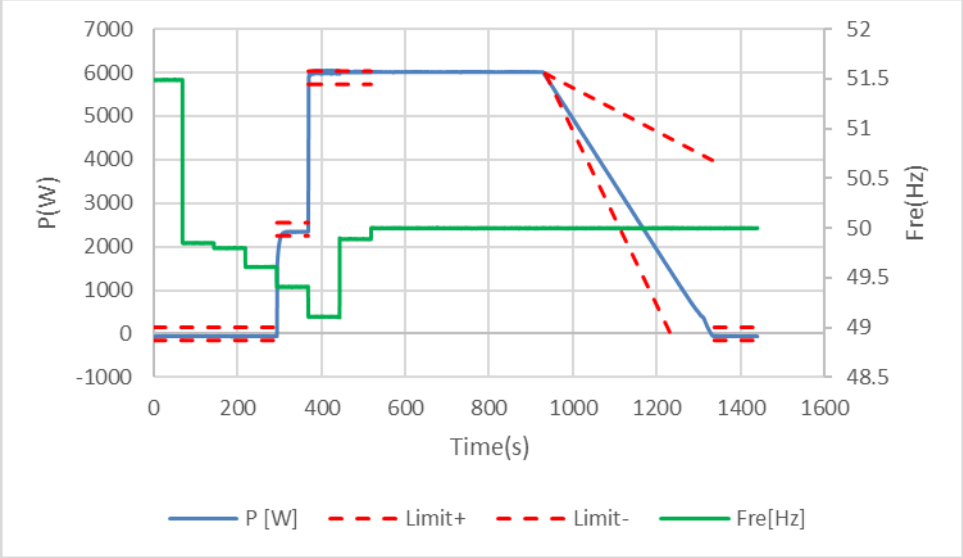
Graph of Measurement 1.: Active power output reduction 50%P_{Smax}



Graph of Measurement 2.: Active power output reduction 0%P_{Smax}



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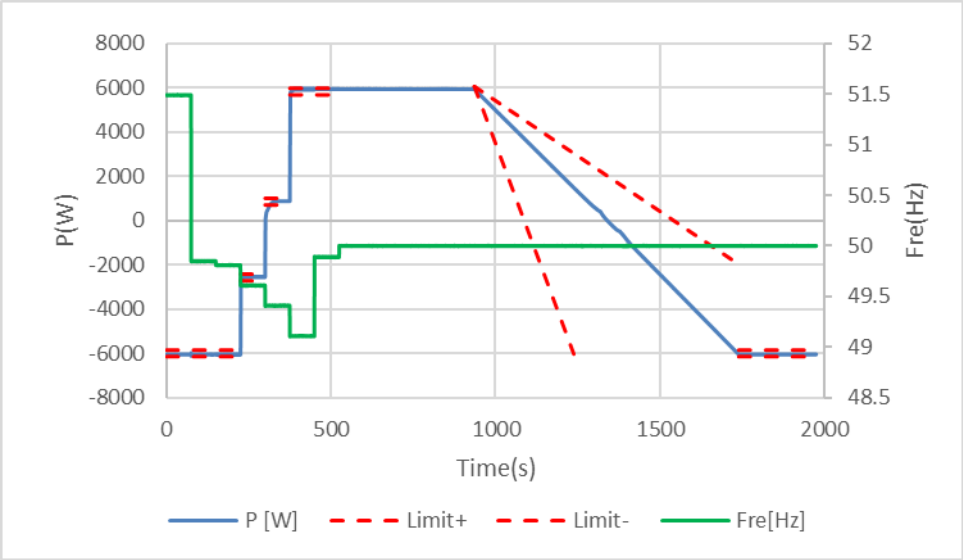
Graph of Measurement 3.: Active power output reduction 100%P_{Cmax}



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Bbis.7.3.2	Test results							P
Test result								
T-REX-3KLP1G01 with Cmin battery								
1-min mean value [Hz]	1) 51,49	3) 49,85	4) 49,80	4) 49,60	5) 49,40	5) 49,11	3) 49,89	8) 50,00
1. Measurement 1) to 7): Active power output 50%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	1500	1500	1500	1500,0	2100,0	2970,0	2970,0	1500,0
P_{E60} [W]	1496,4	1496,8	1496,2	1525,5	2153,4	3028,1	3027,0	1498,9
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,12	-0,11	-0,13	0,85	1,78	1,94	1,90	-0,04
2. Measurement 1) to 7): Active power output 0%P_{Smax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	0	0	0	0,0	1200,0	2940,0	2940,0	0,0
P_{E60} [W]	-8,9	-9,6	-10,0	49,6	1205,1	2969,8	2978,9	-10,0
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,30	-0,32	-0,33	1,65	0,17	0,99	1,30	-0,33
3. Measurement 1) to 7): Active power output 100%P_{Cmax}								
Frequency [Hz]	51,49	49,85	49,80	49,60	49,40	49,11	49,89	50,00
$P_{setpoint}$ [W]	-3000	-3000	-3000	-1285,7	428,6	2914,3	2914,3	-3000,0
P_{E60} [W]	-3021,1	-3027,9	-3021,9	-1286,6	429,8	2889,3	2961,9	-3021,3
$\Delta P_{E60}/P_{Setpoint}$ [%]	-0,70	-0,93	-0,73	-0,03	0,04	-0,83	1,59	-0,71
Limit $\Delta P_{E60}/P_{Setpoint}$	± 2,5% % of S_n							

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * S_n from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

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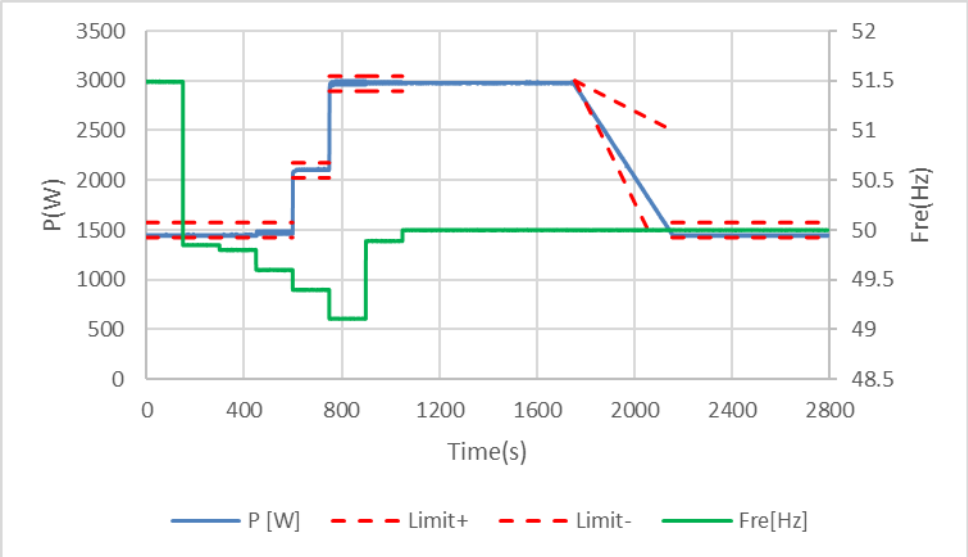
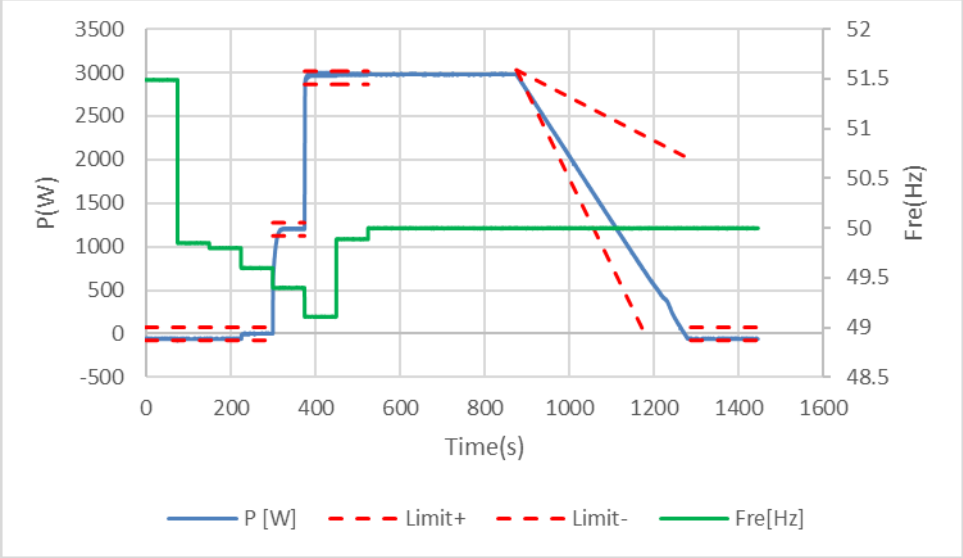
Graph of Measurement 1.: Active power output reduction 50%P_{Smax}



Graph of Measurement 2.: Active power output reduction 0%P_{Smax}



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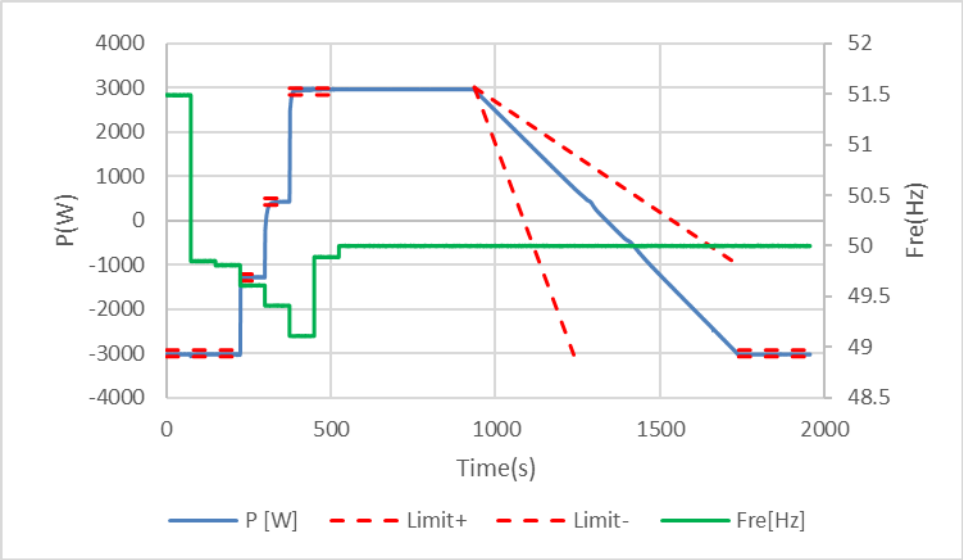
Graph of Measurement 3.: Active power output reduction 100%P_{Cmax}



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TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P
Bidirectional converters		
T-REX-6KLP1G01 with Cmax battery		
1-min mean value	50% P_{SMAX} to 30% P_{CMAX}	
P_{E60} [%]	30,3	
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	
Settling time [s]	8,8	
Limit settling time [s]	30	

The ability to increase/decrease the active power input/output as a result of a remote signal must be tested by agreeing with the manufacturer of the storage system how the signal will be received and processed.

The test must be carried out according to the following steps:

- Bring the storage system up to 50 % of the available active feed-in power.
- Send the generator an active power set-point of 30 % of the P_{SMAX}.
- Maintain the set-point for a time of 60 s, consistent with the energy capacity of the storage system.
- Measure the active power delivered by the inverter, at least 30 s after the command for the new active power control set-point has been sent (this is to ensure that the system has reached a steady state).

The test is considered successful if the maximum deviation between the assigned level and the actual measured value (average value with 1 min. window) for the active power is less than ± 2,5 % of them S_n.

In the case of storage systems connected to bidirectional converters, repeat the test at 30 % P_{CMAX}.

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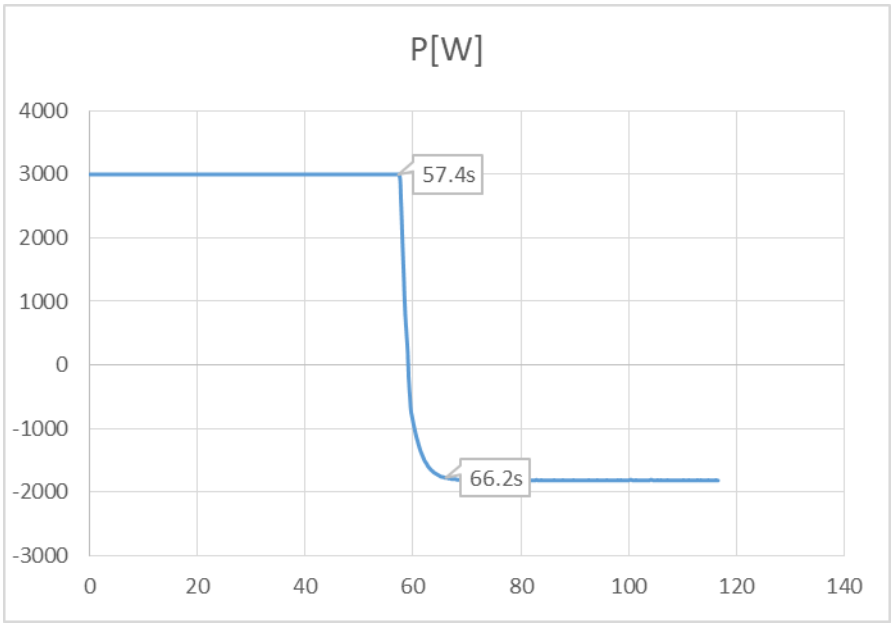
TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P

Graph: 50% P_{SMAX} to 30% P_{CMAX}



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TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P
Bidirectional converters		
T-REX-6KLP1G01 with Cmin battery		
1-min mean value	50% P_{SMAX} to 30% P_{CMAX}	
P_{E60} [%]	30,3	
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	
Settling time [s]	9,0	
Limit settling time [s]	30	

The ability to increase/decrease the active power input/output as a result of a remote signal must be tested by agreeing with the manufacturer of the storage system how the signal will be received and processed.

The test must be carried out according to the following steps:

- Bring the storage system up to 50 % of the available active feed-in power.
- Send the generator an active power set-point of 30 % of the P_{SMAX}.
- Maintain the set-point for a time of 60 s, consistent with the energy capacity of the storage system.
- Measure the active power delivered by the inverter, at least 30 s after the command for the new active power control set-point has been sent (this is to ensure that the system has reached a steady state).

The test is considered successful if the maximum deviation between the assigned level and the actual measured value (average value with 1 min. window) for the active power is less than ± 2,5 % of them S_n.

In the case of storage systems connected to bidirectional converters, repeat the test at 30 % P_{CMAX}.

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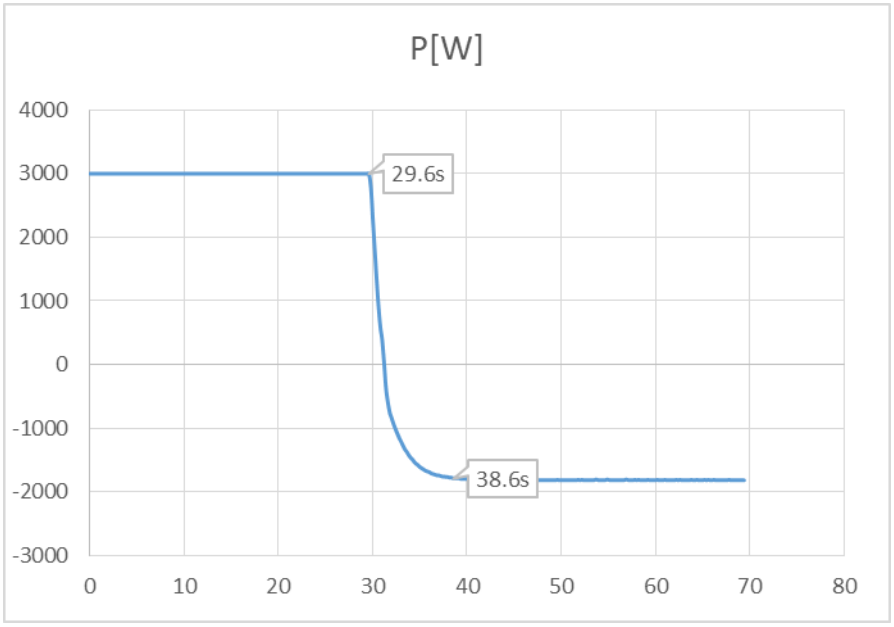
TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P

Graph: 50% P_{SMAX} to 30% P_{CMAX}



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TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P
Bidirectional converters		
T-REX-3KLP1G01with Cmin battery		
1-min mean value	50% P_{SMAX} to 30% P_{CMAX}	
P_{E60} [%]	30,3	
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	
Settling time [s]	0,8	
Limit settling time [s]	63,8	

The ability to increase/decrease the active power input/output as a result of a remote signal must be tested by agreeing with the manufacturer of the storage system how the signal will be received and processed.

The test must be carried out according to the following steps:

- Bring the storage system up to 50 % of the available active feed-in power.
- Send the generator an active power set-point of 30 % of the P_{SMAX}.
- Maintain the set-point for a time of 60 s, consistent with the energy capacity of the storage system.
- Measure the active power delivered by the inverter, at least 30 s after the command for the new active power control set-point has been sent (this is to ensure that the system has reached a steady state).

The test is considered successful if the maximum deviation between the assigned level and the actual measured value (average value with 1 min. window) for the active power is less than ± 2,5 % of them S_n.

In the case of storage systems connected to bidirectional converters, repeat the test at 30 % P_{CMAX}.

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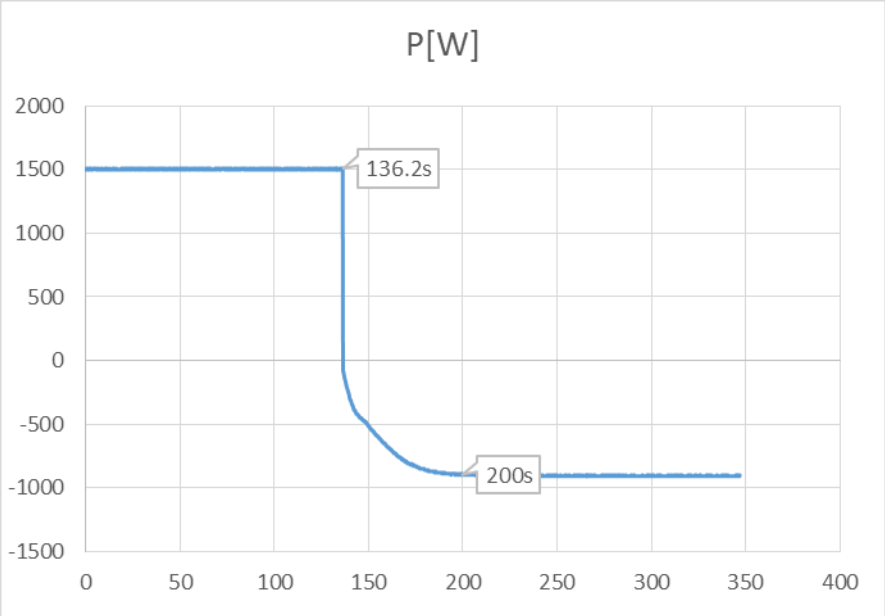
TEMP-0058-TG-EAW-ES-V01

Bbis.7.4	Verification of active power control on external control from DSO	P

Graph: 50% P_{SMAX} to 30% P_{CMAX}



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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P
Bidirectional converters		
T-REX-6KLP1G01 with Cmax battery		
1-min mean value	100% P_{SMAX} to 30% P_{CMAX}	100% P_{CMAX} to 50% P_{SMAX}
P_{E60} [%]	30,3	50,1
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	50% P_{SMAX} ± 2,5 % of S_n
Settling time [s]	12,0	10,4
Limit settling time [s]	50	50
1-min mean value	100% S_n to 15% S_n	
P_{E60} [%]	N/A	
Limit ΔP_{E60} [%]	S_n ± 2,5 % of S_n	
Settling time [s]	N/A	
Limit settling time [s]	60	

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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

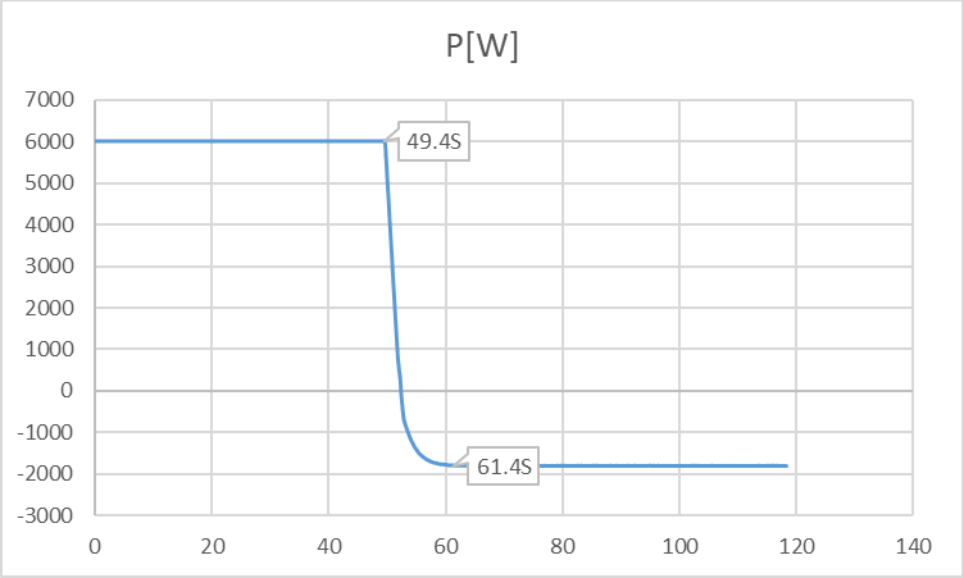
- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * Sn from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

Graph: 100%P_{SMAX} to 30%P_{CMAX}



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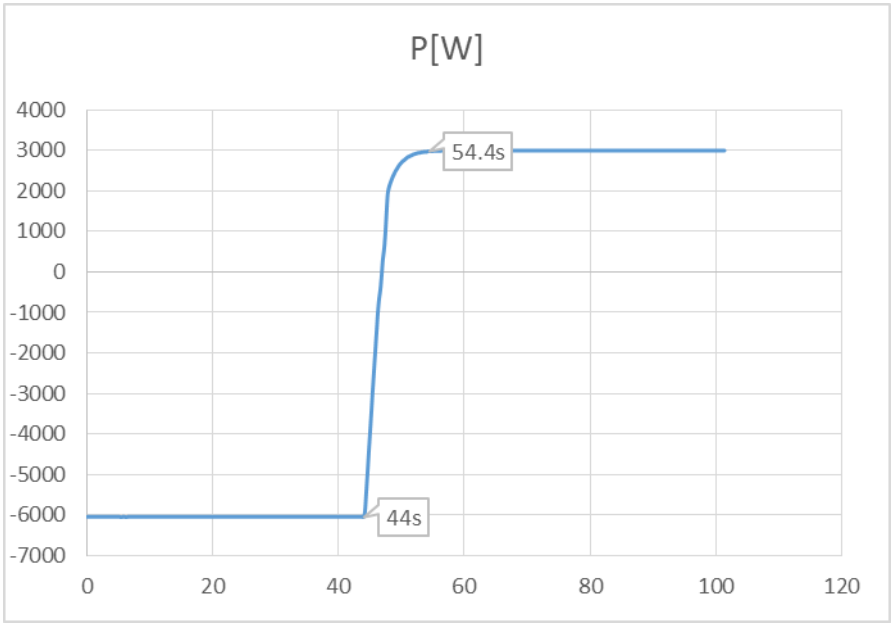
Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Graph: 100% P_{CMAX} to 50% P_{SMAX}



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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P
Bidirectional converters		
T-REX-6KLP1G01 with Cmin battery		
1-min mean value	100% P_{SMAX} to 30% P_{CMAX}	100% P_{CMAX} to 50% P_{SMAX}
P_{E60} [%]	30,3	50,0
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	50% P_{SMAX} ± 2,5 % of S_n
Settling time [s]	9,4	8,6
Limit settling time [s]	50	50
1-min mean value	100% S_n to 15% S_n	
P_{E60} [%]	N/A	
Limit ΔP_{E60} [%]	S_n ± 2,5 % of S_n	
Settling time [s]	N/A	
Limit settling time [s]	60	

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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

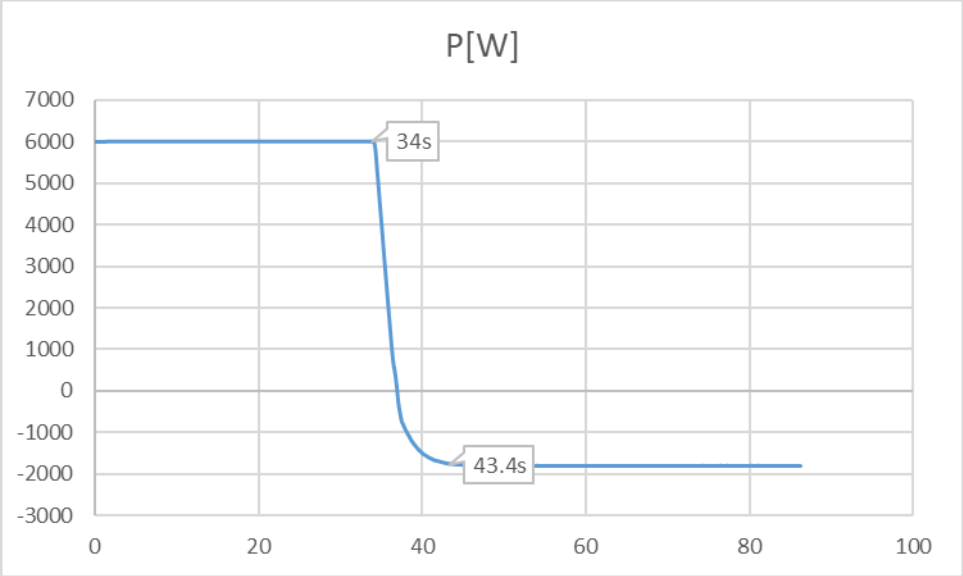
- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * Sn from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

Graph: 100%P_{SMAX} to 30%P_{CMAX}



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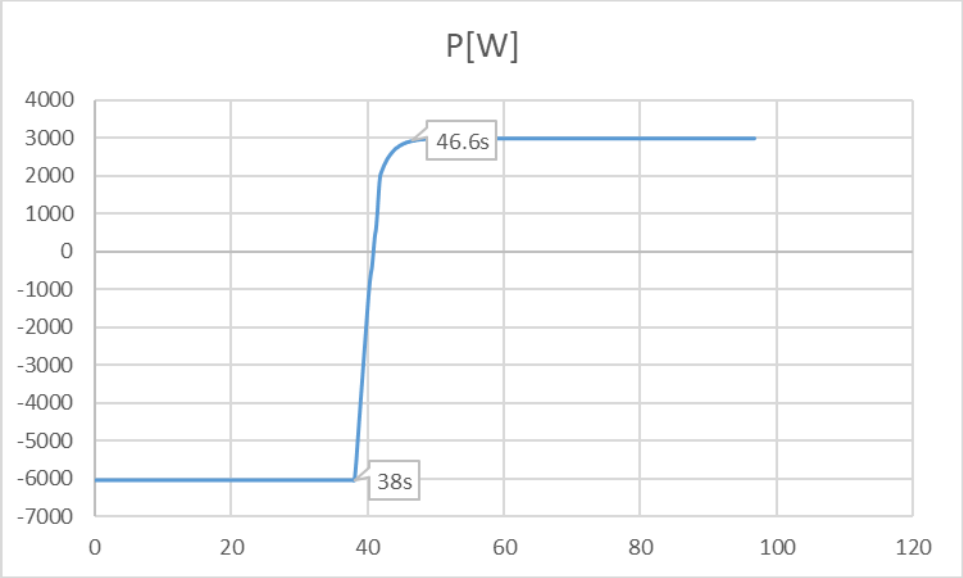
Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Graph: 100% P_{CMAX} to 50% P_{SMAX}



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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P
Bidirectional converters		
T-REX-3KLP1G01with Cmin battery		
1-min mean value	100% P_{SMAX} to 30% P_{CMAX}	100% P_{CMAX} to 50% P_{SMAX}
P_{E60} [%]	30,3	50,1
Limit ΔP_{E60} [%]	30% P_{CMAX} ± 2,5 % of S_n	50% P_{SMAX} ± 2,5 % of S_n
Settling time [s]	54,6	42,4
Limit settling time [s]	50	50
1-min mean value	100% S_n to 15% S_n	
P_{E60} [%]	N/A	
Limit ΔP_{E60} [%]	S_n ± 2,5 % of S_n	
Settling time [s]	N/A	
Limit settling time [s]	60	

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Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Test

For checking the settling time at a command to reduce the active power output, or increase the active power input, the test is carried out:

- for storage systems connected to bidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{CMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting the control parameter from 100 % * P_{SMAX} to 30 % * P_{SMAX} at time t0.

For testing the settling time to a command to increase active power, or reduce the active power absorbed, the test is carried out:

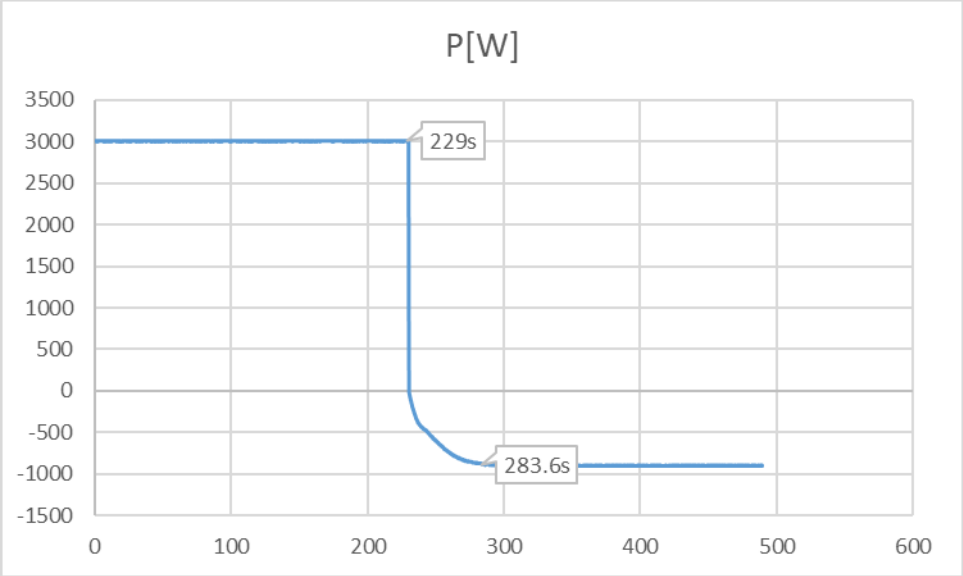
- for storage systems connected to bi-directional converters, adjusting the control parameter from 100 % * P_{CMAX} to 50 % * P_{SMAX} at time t0;
- for storage systems connected to unidirectional converters, adjusting parameter from 0 % * P_{SMAX} to 50 % * P_{SMAX} at time t0.

Assessment criterion

The settling time (or settling time) is the time interval from the instant t0 of application of the active power increment/limitation step (e.g. 100 % * P_{SMAX} 30 % * P_{SMAX}) to the instant in which the power falls stably within a tolerance band equal to ±2,5 % * Sn from new set value.

The maximum measured settling time must be less than 50 s, and in any case no more than 60 s in the case of the limitation command from 100 % * S_n to 15 % * S_n.

Graph: 100%P_{SMAX} to 30%P_{CMAX}



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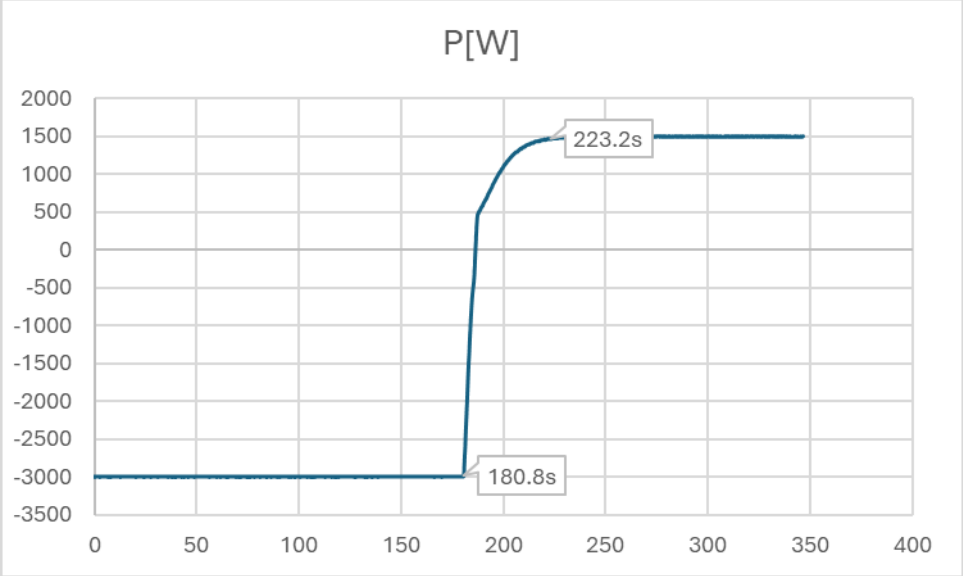
Bbis.7.4.1	Verification of the settling time to a power increase/reduction in command	P

Graph: 100% P_{CMAX} to 50% P_{SMAX}



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Bbis.8.1	Verification of emission of continuous component		P
T-REX-6KLP1G01 with Cmax battery (P_{SMAX})			
Phase 1 (Ambient)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1877,9	3900,1	5935,2
AC Voltage [V]	230,2	230,4	230,5
AC Current [A]	9,8	17,7	26,1
PF [1]	0,8324	0,9598	0,9851
Cosφ [1]	0,8324	0,9598	0,9851
DC Current in AC [mA]	2,398	3,196	7,408
DC Current in AC [% of I_n]	0,009	0,012	0,028
Phase 1 (-10°C)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1879,2	3899,6	5933,3
AC Voltage [V]	230,2	230,4	230,5
AC Current [A]	9,8	17,6	26,1
PF [1]	0,8327	0,9598	0,9851
Cosφ [1]	0,8327	0,9598	0,9851
DC Current in AC [mA]	1,467	4,089	6,439
DC Current in AC [% of I_n]	0,006	0,016	0,025
Phase 1 (+55°C)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	1879,1	3900,1	5934,8
AC Voltage [V]	230,2	230,4	230,5
AC Current [A]	9,8	17,7	26,1
PF [1]	0,8327	0,9599	0,9850
Cosφ [1]	0,8327	0,9599	0,9850
DC Current in AC [mA]	2,368	2,964	5,457
DC Current in AC [% of I_n]	0,009	0,011	0,021

Note

Limits of clause 8.4.4.1

The measurement is be performed by averaging the measured quantity of a maximum time window of 1 sec., by recording the performance for a minimum period of 5 minutes and acquiring a minimum number of samples equal to the reciprocal of the time window in which the quantity was averaged (for 1 sec, at least 300 samples). The output rms current and rms voltage of the inverter are measured and recorded in the same manner.

Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

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Bbis.8.1	Verification of emission of continuous component		P
T-REX-6KLP1G01 with Cmax battery (P_{CMAX})			
Phase 1 (Ambient)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	-1946,5	-3961,6	-6012,3
AC Voltage [V]	229,8	229,6	229,4
AC Current [A]	9,6	17,5	26,3
PF [1]	-0,8849	-0,9855	-0,9985
Cosφ [1]	-0,8849	-0,9855	-0,9985
DC Current in AC [mA]	6,588	6,036	8,545
DC Current in AC [% of I_n]	0,025	0,023	0,033
Phase 1 (-10°C)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	-1945,7	-3962,4	-6012,7
AC Voltage [V]	229,8	229,6	229,4
AC Current [A]	9,6	17,5	26,3
PF [1]	-0,8848	-0,9855	-0,9985
Cosφ [1]	-0,8848	-0,9855	-0,9985
DC Current in AC [mA]	4,798	7,590	8,267
DC Current in AC [% of I_n]	0,018	0,029	0,032
Phase 1 (+55°C)			
Power Level [% of VA]	33 ± 5	66 ± 5	100 ± 5
AC Power [W]	-1946,5	-3961,6	-6011,5
AC Voltage [V]	229,8	229,6	229,4
AC Current [A]	9,6	17,5	26,3
PF [1]	-0,8849	-0,9855	-0,9985
Cosφ [1]	-0,8849	-0,9855	-0,9985
DC Current in AC [mA]	6,911	6,640	7,961
DC Current in AC [% of I_n]	0,026	0,025	0,031

Note

Limits of clause 8.4.4.1

The measurement is be performed by averaging the measured quantity of a maximum time window of 1 sec., by recording the performance for a minimum period of 5 minutes and acquiring a minimum number of samples equal to the reciprocal of the time window in which the quantity was averaged (for 1 sec, at least 300 samples). The output rms current and rms voltage of the inverter are measured and recorded in the same manner.

Testing must be performed according to WI 10.4.-03.doc rev D. The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

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Bbis.8.2	Verification of Protection against Continuous Component Input			P
Test result				
Actual Power	Limits	Measurement [mA]	Limiting value [mA]	Disconnection time [s]
I_{dc} = 0,5% of I_n (Positive)				
33%	0,5% I_n / 1 s	805,2	130,5	0,363
66%	0,5% I_n / 1 s	464,0	130,5	0,302
100%	0,5% I_n / 1 s	306,7	130,5	0,462
I_{dc} = 0,5% of I_n (Negative)				
33%	0,5% I_n / 1 s	-827,8	130,5	0,993
66%	0,5% I_n / 1 s	-199,8	130,5	0,853
100%	0,5% I_n / 1 s	-846,0	130,5	0,988
I_{dc} = >1 A (Positive)				
33%	1 A / 0,2 s	3249	1000	0,125
66%	1 A / 0,2 s	5288	1000	0,145
100%	1 A / 0,2 s	1514	1000	0,103
I_{dc} = >1 A (Negative)				
33%	1 A / 0,2 s	-3257	1000	0,184
66%	1 A / 0,2 s	-1217	1000	0,195
100%	1 A / 0,2 s	-1151	1000	0,179

Note

Checking the switch-off of the converter, if the first protection threshold Idc > (> 0,5 % In; in the case of systems with a power of less than 800 W: > 20 mA)

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Bbis.10	**Verification of insensitivity to automatic reclosure in phase discordance**	**P**
Bbis.10.1	**Simulated network test**	**P**

Referring to the diagram in Figure 75 - simulated network utilization:

- the grid simulator must be able to produce voltage phase jumps at the inverter output terminals of 90° and 180° respectively;
- storage system shall operate at a power level compatible with the characteristics of the test circuit and with unity power factor (cos φ = 1);

VR: simulated mains voltage.

- The storage system is to be brought into operation at full discharge power. Let the system operate under the set conditions for at least 5 min, consistent with the energy capacity of the EESS, or the time required for the temperature inside the converter to stabilize.

At the end of the stabilization period, two tests are to be carried out in sequence, inducing a transient that abruptly produces a phase-shift angle on the simulated VR mains voltage of 90° and 180°.

The test report should indicate for each of the two test sequences:

- the angle between the voltage before and after the phase jump, with an instrument having an error of 1°;
- the storage system current over a time window running from 20 ms before to at least 200 ms after the phase jump of the simulated mains voltage.

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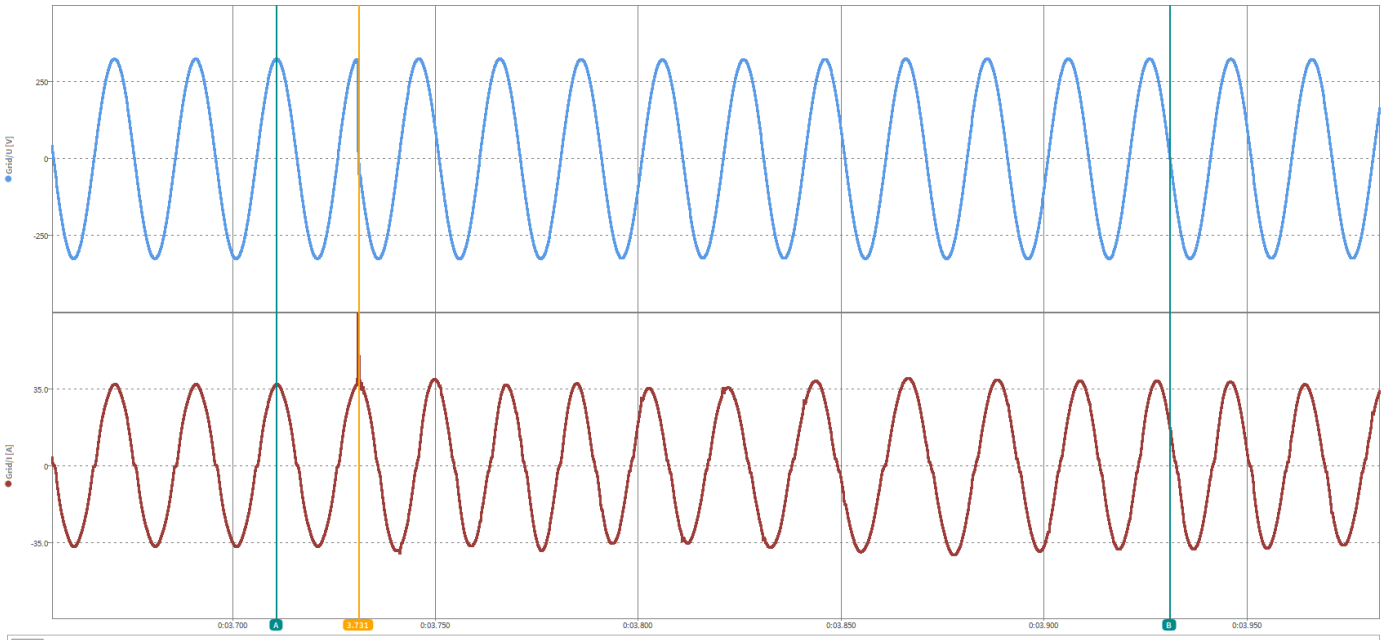
90° phase shift



	A	B	间隔	有效值
时间 [s]	3.71100000	3.93100000	0.22000000	
Grid/U [V]	326.0871	11.87712	-314.2100	230.7463
Grid/I [A]	37.26658	18.26624	-19.00034	26.72088

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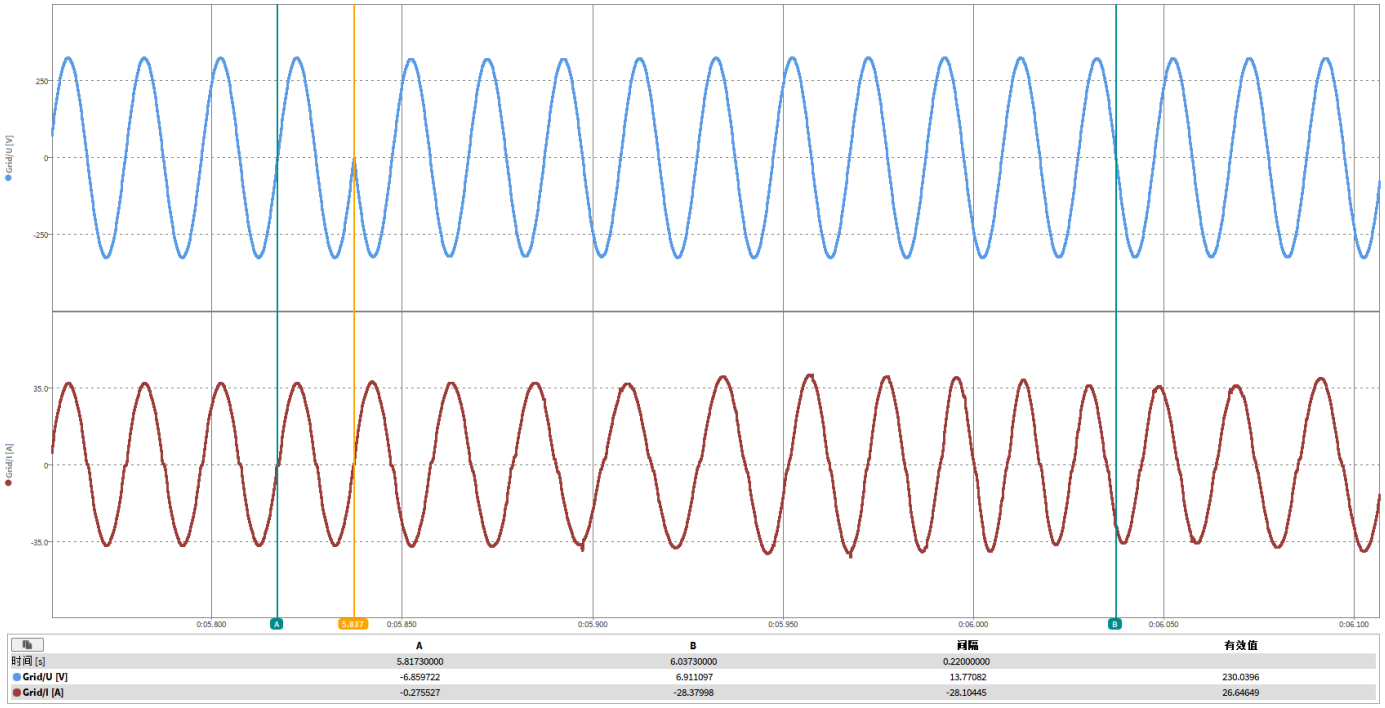
180° phase shift



	A	B	间隔	有效值
时间 [s]	5.81730000	6.03730000	0.22000000	
Grid/U [V]	-6.859722	6.911097	13.77082	230.0396
Grid/I [A]	-0.275527	-28.37998	-28.10445	26.64649

This type of test can be performed in two ways:

with the inverter connected to a simulated network (Bbis.10.1)

with the inverter connected to the distribution network (Bbis.10.2 and alternatively Bbis.10.3).

The generator/storage must not be damaged as a result of the tests. Protective devices may be switched off or released.

With reference to the diagram in Figure 16B.bis – Using the simulated network:

- The network simulator should be able to produce phase shifts in of the output voltage at the inverter terminals of 90° and 180°, respectively.
- Generator: inverter operating at nominal power with unity power factor (cos φ = 1)
- VR: simulated network voltage
- The generator/storage system must start operating at nominal power. Let the system operate under the conditions set for at least 5 minutes or the time needed to stabilise the internal temperature of the converter.

After the stabilisation period two tests should be performed in sequence, by inducing the transient that produces a phase shift angle on the simulated network voltage VR of 180° and 90°.

In the test report the following data for each of the two test sequences shall be indicated:

- the angle between the voltage before and after the phase shift, with an instrument with a 1° error;

the generator current on a time window starting from 20 ms before until at least 200 ms after the phase shift of the simulated network voltage.

Note

The inverter was restarted after the test has been performed. There are no damages on the complete system.

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Annex No. 1
ISO 9001 certificate

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中之鉴认证

Guangdong Zhongzhijian Certification Co., Ltd.

CERTIFICATE OF CONFORMITY OF QUALITY MANAGEMENT SYSTEM CERTIFICATION

No: 2070024Q10027R0M

This is to certify that the QUALITY MANAGEMENT SYSTEM of

GUANGDONG FELICITY ESS COMPANY LIMITED

REGISTERED ADDRESS: NO. 6 A04-101, HUAYE ROAD, DONGHUA, RENHE TOWN, BAIYUN DISTRICT, GUANGZHOU, CHINA;
PRODUCTION ADDRESS: NO. 2, 4, 6, 8, 10, AND 12 HUAYE ROAD, DONGHUA, RENHE TOWN, BAIYUN DISTRICT, GUANGZHOU, CHINA

Organization Code:91440100MACYCNNR51

is in conformity with

GB/T19001-2016/ISO9001:2015 Standard

This system is valid for the

R& D AND MANUFACTURING OF SOLAR POWER GENERATION SYSTEM (INVERTER, CONTROLLER, LITHIUM BATTERY PACK, SOLAR PANEL) AND SOLAR STREET LAMP

Date of issue:2024-01-23

Term of validity of this certificate:from January.23,2024 to January.22,2027 inclusive

This certificate remains valid only if the certified organization accepts and passes regular surveillance audits.

Representative of The Company

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

CNAS 中国认可 国际互认 管理体系 MANAGEMENT SYSTEM CNAS C207- M

The validity of this certificate could be confirmed via official Website Of CNCA (www.cnca.gov.cn)
Further to the certificate applicability, please enquire the certified organization: visitwww.isozcc.com or contact ZCC 020-37889183
15I, Fuxing Business Building, Huang Pu Avenue (E.)163, Guangzhou City, Guangdong, China (510620) Guangdong ZhongzhijianCertification Co., Ltd.

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Annex No. 2
EMC Test Report

The complete EMC test report is stored at Bureau Veritas Consumer Products Services Germany GmbH in project CQEY-ESH-P25071524.

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Shenzhen Nore Testing Center Co.,Ltd.
Report No.: SZNTC2408233EV00

EMC TEST REPORT

Applicant	:	Guangdong Felicity New Energy Co.,Ltd.
Address	:	(KongGangBaiYun)No.2, Donghua Huaye Road, Renhe Town, Baiyun Area, Guangzhou Guangdong P.R.China
Manufacturer	:	Guangdong Felicity New Energy Co.,Ltd.
Address	:	(KongGangBaiYun)No.2, Donghua Huaye Road, Renhe Town, Baiyun Area, Guangzhou Guangdong P.R.China
Factory	:	Guangdong Felicity New Energy Co.,Ltd.
Address	:	(KongGangBaiYun)No.2, Donghua Huaye Road, Renhe Town, Baiyun Area, Guangzhou Guangdong P.R.China
E.U.T.	:	Hybrid Inverter
Brand Name	:	Felicity ESS
Model No.	:	T-REX-6KLP1G01, T-REX-5KLP1G01,T-REX-4K6LP1G01 T-REX-4KLP1G01, T-REX-3K6LP1G01, T-REX-3KLP1G01
Standard	:	EN IEC 61000-6-1:2019 / IEC 61000-6-1:2016 EN IEC 61000-6-2:2019 / IEC 61000-6-2:2016 EN IEC 61000-6-3:2021 / IEC 61000-6-3:2020 EN IEC 61000-6-4:2019 / IEC 61000-6-4:2018
Date of Receiving Samples	:	September 06, 2024
Date of Test	:	September 06, 2024 to September 13, 2024
Date of Report	:	September 13, 2024

This Test Report is Issued Under the Authority of :

Prepared by

Jason Liu / Engineer

Approved & Authorized Signer

Han Song / Authorized Signatory

This report shows that above equipment is technically compliant with the requirements of the standards above. All test results in this report apply only to the tested sample(s). Without prior written approval of Shenzhen Nore Testing Center Co., Ltd, this report shall not be reproduced except in full.

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Address: South, No. 1, Building 10, Maqueling Industrial Zone, Nanshan Shenzhen, Guangdong, 518057, China

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Annex No. 3
Datasheet of the relay

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Power Relays (Over 2 A)

LF-G RELAYS

Load for solar inverter, Compact size, 1 Form A 22 A/33 A, Power relays

Protective construction : Flux-resistant type

(Unit : mm)

FEATURES

- High capacity control possible at 22 A/33 A (High capacity type) 250 V AC rating in compact size
- Contact GAP: 1.5 mm, 1.8 mm Compliant with photovoltaic standard (IEC62109 and VDE0126)
- Coil holding voltage contributes to saving energy of equipment
- Conforms to various safety standards: UL/C-UL and VDE

TYPICAL APPLICATIONS

- Photovoltaic power generation systems (Solar inverter)
- Uninterruptible Power Supplies (UPS)
- Home appliances
- Office equipment

DETAILS FEATURES

■ Contact GAP: 1.5 mm, 1.8 mm*1

Compliant with European photovoltaic standard (IEC62109*2 and VDE0126*3) .
EN61810-1 certified: 2.5 kV surge withstand voltage (between contacts)

*1: Safety standard of PV power inverter
*2: German safety standard of PV power inverter
*3: Due to addition of altitude stipulation (Min. 2,000 m) to IEC62109.

■ Coil holding voltage*1 contributes to saving energy of equipment

The coil holding voltage can be reduced up to 35 % V of the rated coil voltage (Ambient temperature: 20 ℃*2) .
Operating power at the lowest coil holding voltage: 170 mW equivalent

*1: Coil holding voltage is the coil voltage after 100 ms from the applied rated coil voltage.
*2: When the ambient temperature during use is 85 ℃, make the coil holding voltage between 45 to 80 % V of the rated coil voltage.

■ High capacity control possible at 22 A/33 A (High capacity type) 250 V AC rating in compact size (W: 15.7 × L: 30.1 × H: 23.3 mm)

■ High insulation

Creepage distance between contact and coil terminal: Min. 9.5 mm
Clearance distance between contact and coil terminal: Min. 6.5 mm
Surge withstand voltage: 6 kV

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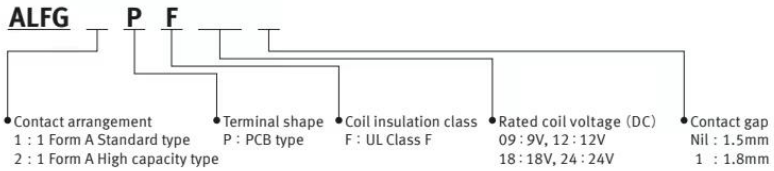
Power Relays (Over 2 A) LF-G RELAYS

ORDERING INFORMATION (PART NO.)



TYPES

Contact arrangement	Rated coil voltage	Part No.				Standard packing	
		Contact GAP 1.5 mm		Contact GAP 1.8 mm		Inner carton	Outer carton
		Standard type	High capacity type	Standard type	High capacity type		
1 Form A	9 V DC	ALFG1PF09	ALFG2PF09	ALFG1PF091	ALFG2PF091	50 pcs.	200 pcs.
	12 V DC	ALFG1PF12	ALFG2PF12	ALFG1PF121	ALFG2PF121		
	18 V DC	ALFG1PF18	ALFG2PF18	ALFG1PF181	ALFG2PF181		
	24 V DC	ALFG1PF24	ALFG2PF24	ALFG1PF241	ALFG2PF241		

RATING

■ Coil data

- Operating characteristics such as " Operate voltage " and " Release voltage " are influenced by mounting conditions or ambient temperature, etc.
  Therefore, please use the relay within ±5 % of rated coil voltage.
- " Initial " means the condition of products at the time of delivery.

Rated coil voltage	Operate voltage* (at 20 ℃)	Release voltage* (at 20 ℃)	Rated operating current (±10 %, at 20 ℃)	Coil resistance (±10 %, at 20 ℃)	Rated operating power	Max. allowable voltage (at 20 ℃)
9 V DC	Max. 70 % V of rated coil voltage (Initial)	Min. 10 % V of rated coil voltage (Initial)	155 mA	58 Ω	1,400 mW	120 % V of rated coil voltage
12 V DC			117 mA	103 Ω		
18 V DC			78 mA	230 Ω		
24 V DC			59 mA	410 Ω		

* square, pulse drive

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Power Relays (Over 2 A) LF-G RELAYS

■ Specifications

Item		Specifications		
		Standard type	High capacity type	
		Contact GAP 1.5 mm, 1.8 mm	Contact GAP 1.5 mm	Contact GAP 1.8 mm
Contact data	Contact arrangement	1 Form A		
	Contact resistance (initial)	Max. 100 mΩ (by voltage drop 6 V DC 1 A)		
	Contact material	$AgSnO_2$ type		
	Contact rating (resistive)	22 A 250 V AC	31 A 250 V AC	33 A 250 V AC
	Max. switching power (resistive)	5,500 VA	7,750 VA	8,250 VA
	Max. switching voltage	250 V AC		
	Max. switching current	22 A (AC)	31 A (AC)	33 A (AC)
	Min. switching load (reference value) *1	100 mA 5 V DC		
Insulation resistance (initial)		Min. 1,000 MΩ (at 500 V DC, Measured portion is the same as the case of dielectric strength.)		
Dielectric strength (initial)	Between open contacts	2,500 V rms for 1 min (detection current: 10 mA)		
	Between contact and coil	4,000 V rms for 1 min (detection current: 10 mA)		
Surge withstand voltage (initial) *2	Between contact and coil	6,000 V		
Coil holding voltage*3		35 to 120 % V (at 20 ℃, contact carrying current 22 A) 45 to 80 % V (at 85 ℃, contact carrying current 22 A)	35 to 120 % V (at 20 ℃, contact carrying current 31 A) 45 to 80 % V (at 85 ℃, contact carrying current 31 A)	35 to 120 % V (at 20 ℃, contact carrying current 33 A) 45 to 80 % V (at 85 ℃, contact carrying current 33 A)
Time characteristics (initial)	Operate time	Max. 20 ms at rated coil voltage (at 20 ℃, without bounce)		
	Release time	Max. 10 ms at rated coil voltage (at 20 ℃, without bounce, without diode)		
Shock resistance	Functional	100 m/s² (half-sine shock pulse: 11 ms, detection time: 10 μs)		
	Destructive	1,000 m/s² (half-sine shock pulse: 6 ms)		
Vibration resistance	Functional	10 to 55 Hz (at double amplitude of 1.5 mm, detection time: 10 μs)		
	Destructive	10 to 55 Hz (at double amplitude of 1.5 mm)		
Expected life	Mechanical life	Contact GAP 1.5 mm: Min. 10^6 ope. (switching frequency: at 180 times /min) Contact GAP 1.8 mm: Min. 500 × 10^3 ope. (switching frequency: at 180 times/min)		
Conditions	Conditions for usage, transport and storage*4	Ambient temperature: −40 to +60 ℃ (When rated coil voltage applied) −40 to +85 ℃ (Coil holding voltage is when 45 to 80 % V of rated coil voltage is applied.) Humidity: 5 to 85 % RH (Avoid icing and condensation)		
Unit weight		Approx. 23 g		

*1: This value can change due to the switching frequency, environmental conditions, and desired reliability level, therefore it is recommended to check this with the actual load.
*2: Wave is standard shock voltage of ±1.2 × 50 μs according to JEC-212-1981
*3: Coil holding voltage is the coil voltage after 100 ms from the applied rated coil voltage.
*4: For ambient temperature, please read " GUIDELINES FOR RELAY USAGE ".

■ Expected electrical life

Type	Contact GAP	Load	Switching capacity	Number of operations
Standard type	1.5 mm/1.8 mm	Resistive load	22 A 250 V AC	Min. 30 × 10^3 ope. (switching frequency at 20 times/min)
		Destructive	22 A 250 V AC (cosϕ = 0.8)	Min. 30 × 10^3 ope. (switching frequency ON : OFF = 0.1 s : 10 s)
		Over load	35 A 250 V AC (cosϕ = 0.8)	Min. 50 ope. (switching frequency ON : OFF = 0.1 s : 10 s)
High capacity type	1.5 mm	Destructive	31 A 250 V AC (cosϕ = 0.8)	Min. 30 × 10^3 ope. (switching frequency ON : OFF = 0.1 s : 10 s)
		Over load	47 A 250 V AC (cosϕ = 0.8)	Min. 50 ope. (switching frequency ON : OFF = 0.1 s : 10 s)
	1.8 mm	Destructive	33 A 250 V AC (cosϕ = 0.8)	Min. 30 × 10^3 ope. (switching frequency ON : OFF = 0.1 s : 10 s)
		Over load	50 A 250 V AC (cosϕ = 0.8)	Min. 50 ope. (switching frequency ON : OFF = 0.1 s : 10 s)

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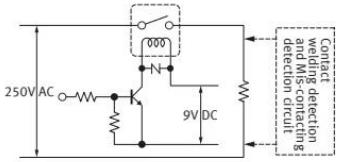
Power Relays (Over 2 A) LF-G RELAYS

REFERENCE DATA

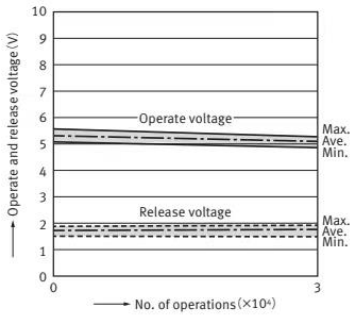
■ Standard type (Contact GAP 1.5 mm, 1.8 mm)

1-1. Electrical life test (22 A 250 V AC Resistive load)

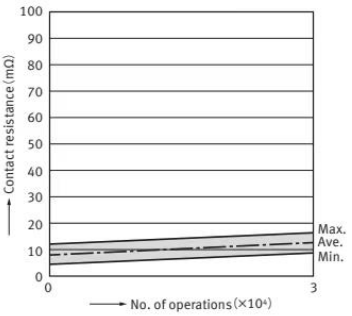
Tested sample : ALFG1PF09, ALFG1PF091, 6 pcs.
Operation frequency : ON : OFF = 1.5s : 1.5s
Ambient temperature : 85°C
Circuit :



Change of operate and release voltage

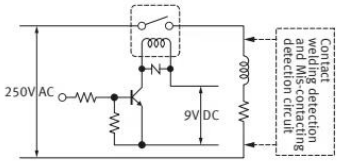


Change of contact resistance

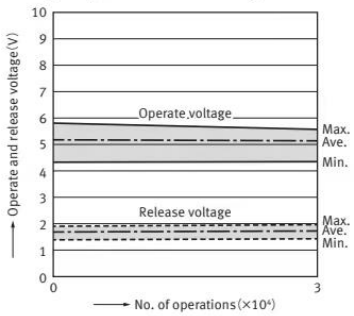


1-2. Electrical life test (22 A 250 V AC cosϕ = 0.8 Inductive load)

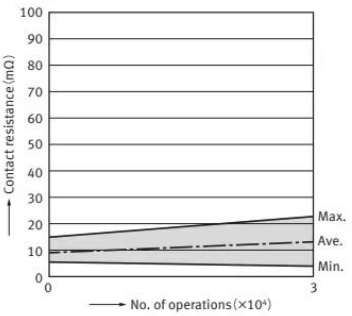
Tested sample : ALFG1PF09, ALFG1PF091, 6 pcs.
Operation frequency : ON : OFF = 0.1s : 10s
Ambient temperature : 85°C
Circuit :



Change of operate and release voltage

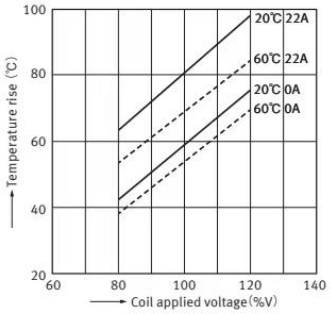


Change of contact resistance

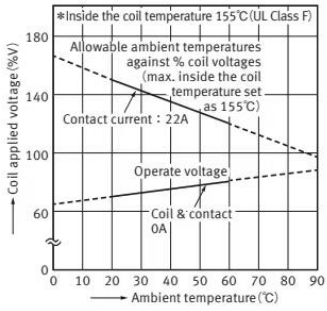


2. Coil temperature characteristics (Average)

Tested sample : ALFG1PF09, ALFG1PF091, 6 pcs.
Measured portion : Coil inside
Contact current : 22A
Ambient temperature : 20℃, 60℃



3. Ambient temperature characteristics



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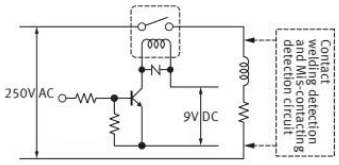
Power Relays (Over 2 A) LF-G RELAYS

■ High capacity type

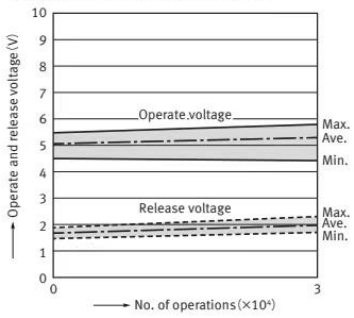
● Contact GAP 1.5 mm

1. Electrical life test (31 A 250 V AC cosϕ = 0.8 Inductive load)

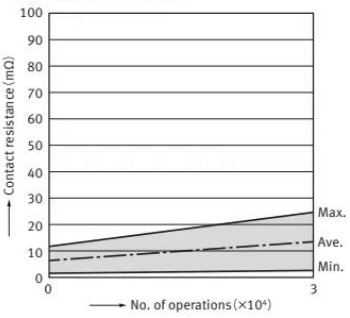
Tested sample : ALFG2PF09, 6 pcs.
Operation frequency : ON : OFF = 0.1s : 10s
Ambient temperature : 85℃



Change of operate and release voltage

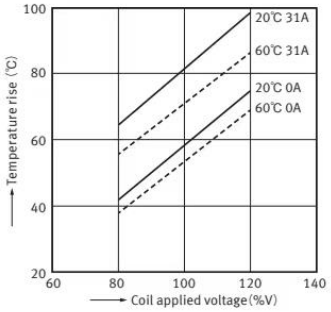


Change of contact resistance

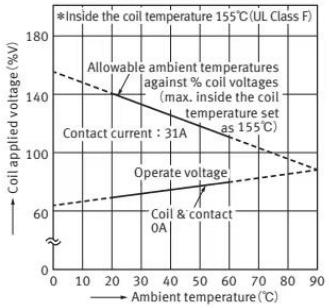


2. Coil temperature characteristics (Average)

Tested sample : ALFG2PF09, 6 pcs.
Measured portion : Coil inside
Contact current : 31A
Ambient temperature : 20℃, 60℃



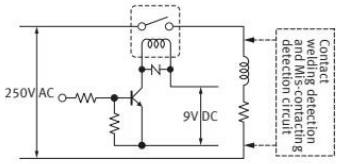
3. Ambient temperature characteristics



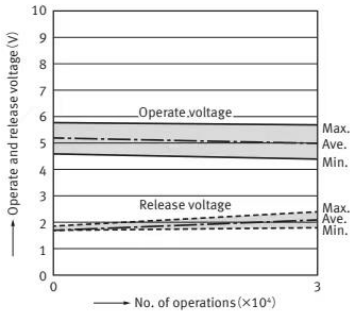
● Contact GAP 1.8 mm

1. Electrical life test (33 A 250 V AC cosϕ = 0.8 Inductive load)

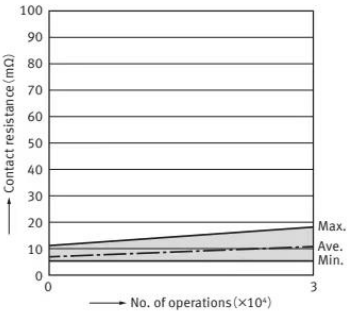
Tested sample : ALFG2PF091, 6 pcs.
Operation frequency : ON : OFF = 0.1s : 10s
Ambient temperature : 85℃
Circuit :



Change of operate and release voltage



Change of contact resistance



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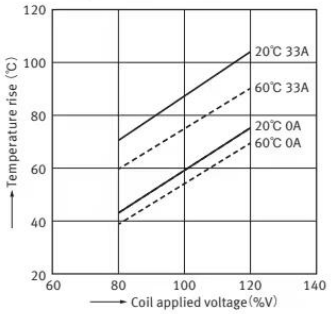
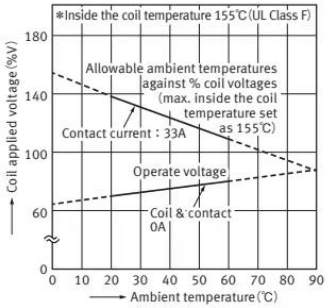
Power Relays (Over 2 A) LF-G RELAYS

2. Coil temperature characteristics (Average)

Tested sample : ALFG2PF091, 6 pcs.
Measured portion : Coil inside
Contact current : 33A
Ambient temperature : 20℃, 60℃

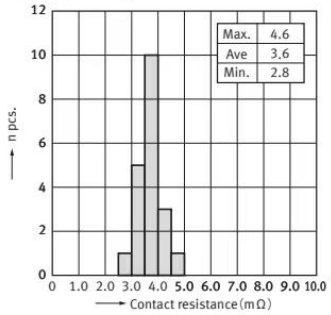


3. Ambient temperature characteristics



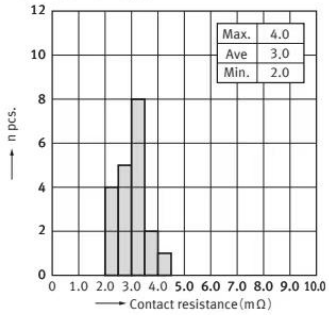
4-1. Contact resistance (6 V DC, 20 A)

Tested sample : ALFG2PF121, 20pcs.
Conditions : 6 V DC, 20 A



4-2. Contact resistance (6 V DC, 33 A)

Tested sample : ALFG2PF121, 20pcs.
Conditions : 6 V DC, 33 A

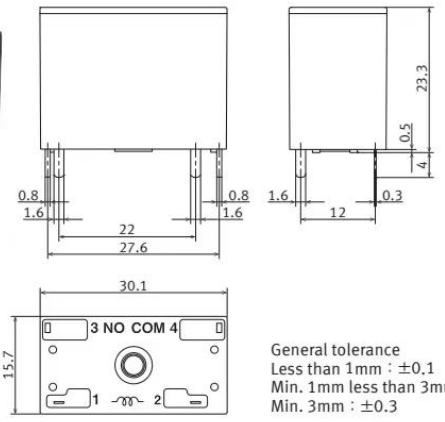


DIMENSIONS (Unit: mm)

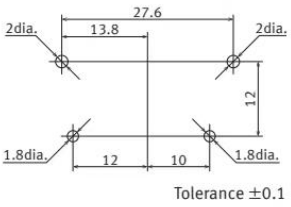
CAD The CAD data of the products with a " CAD " mark can be downloaded from our Website.

CAD

External dimensions

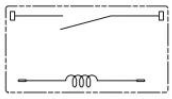


Recommended PC board pattern (BOTTOM VIEW)



Tolerance ±0.1

Schematic (BOTTOM VIEW)



General tolerance
Less than 1mm : ±0.1
Min. 1mm less than 3mm : ±0.2
Min. 3mm : ±0.3

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AZSR143

50 AMP MINIATURE POWER RELAY

FEATURES

- 50 Amp switching capability
- Contact gap: 1.8mm standard / 2.0mm available
- Dielectric strength 4.5 kV_{RMS}
- 10kV Surge
- UL class F insulation
- UL / CUR E365652
- TÜV B0887930015
- CQC 19002227975

CONTACTS

Arrangement	SPST-N.O. (1 Form A)
Ratings (max.) switched power switched current continuous current switched voltage	(resistive load) 13850 VA 50 A 50 A 277 VAC
Rated Loads **UL/CUR/TÜV/CQC**	43 A at 277 VAC, resistive, 85°C, 30k cycles 33 A at 277 VAC, resistive, 105°C, 30k cycles 50 A at 277 VAC, resistive, 85°C, 6k cycles 20 A at 277 VAC on, carry 50A, 20A 277VAC off, resistive, 85°C, 50k cycles
Contact material	$AgSnO_2$ (silver tin oxide)
Contact gap standard version option (103) version	 1.8 mm 2.0 mm
Contact resistance initial typical	(load contact) ≤ 100 mΩ < 3 mΩ

COIL

Nominal coil DC voltages	5, 9, 12, 18, 24, 48
Dropout voltage	> 5% of nominal coil voltage
Holding voltage	> 35% of nominal coil voltage
Coil power nominal holding power at pickup voltage	(at 23 °C) 1.6 W 196 mW 900 mW
Temperature Rise	70 K (126°F) at nom. coil voltage, 85°C
Max. temperature	Class F insulation - 155°C (311°F)

GENERAL DATA

Life Expectancy mechanical electrical	(minimum operations) 1 x 10^6 see UL/CUR/TÜV/CQC ratings
Operate Time	20 ms (max.) at nominal coil voltage
Release Time	10 ms (max.) at nominal coil voltage, without coil suppression
Dielectric Strength coil to load contacts open load contacts	(at sea level for 1 min.) 4500 V_{RMS} 2500 V_{RMS}
Surge Voltage	10kV @1.2/50µs (coil to contacts)
Insulation Resistance	1000 MΩ (min.) at 23°C, 500 VDC, 50% RH
Temperature Range operating	(at nominal coil voltage) -40°C (-40°F) to 85°C (185°F)
Vibration resistance	0.062" (1.5 mm) DA at 10–55 Hz
Shock	20 g
Enclosure protection category material group flammability	P.B.T. polyester RT II, flux proof IIIa UL94 V-0
Terminals	Tinned copper alloy, P. C.
Soldering max. temperature max. time	 270 °C 5 s
Dimensions length width height	 35.0 mm (1.38") 16.0 mm (0.63") 27.9 mm (1.10")
Weight	25 grams (approx.)
Compliance	UL 508, IEC 61810-1, RoHS, REACH
Packing unit in pcs	50 per plastic tray / 500 per carton box

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AZSR131

35 AMP MINIATURE POWER RELAY

FEATURES

- 35 Amp switching capability
- Contact gap: 1.8 mm / 2.3 mm
- Dielectric strength 4500V_{RMS}, 10kV Surge
- UL class F insulation
- GWT(IEC60335-1) version available
- UL / CUR E365652
- TÜV B0887930015
- CQC 17002168255

CONTACTS

Arrangement	SPST-N.O. (1 Form A)
Ratings (max.) switched power switched current continuous current switched voltage	(resistive load) 9695 VA 35 A 35 A 277 VAC
Rated Loads UL/CUR/TÜV/CQC	26A at 277 VAC, resistive, 85°C, 50k cycles 35A at 277 VAC, resistive, 85°C, 30k cycles 22A at 277 VAC, resistive, 70°C, 100k cycles 33A at 277 VAC, cosphi 0.8, 85°C, 50k cycles 35A at 277 VAC, cosphi 0.8, 85°C, 30k cycles
Contact material	$AgSnO_2$ (silver tin oxide)
Contact gap standard version option (200) version	 1.8 mm 2.3 mm
Contact resistance initial typical	(load contact) ≤ 100 mΩ < 3 mΩ

COIL

Nominal coil DC voltages	5, 9, 12, 18, 24, 48
Dropout voltage	> 5% of nominal coil voltage
Holding voltage	> 35% of nominal coil voltage
Coil power nominal holding power at pickup voltage	(at 23 °C) 1.4 W 172 mW 790 mW
Temperature Rise	70 K at nom. coil voltage, 35A, 85°C
Max. temperature	Class F insulation - 155°C (311°F)

GENERAL DATA

Life Expectancy Mechanical electrical	(minimum operations) 1 x 10^5(2.3mm gap) 3 x 10^5(1.8mm gap) see UL/CUR/TÜV/CQC ratings
Operate Time	20 ms (max.) at nominal coil voltage
Release Time	10 ms (max.) at nominal coil voltage, without coil suppression
Dielectric Strength coil to load contacts open load contacts	(at sea level for 1 min.) 4500 V_{RMS} 2500 V_{RMS} 3500 V_{RMS} (200 version)
Surge Voltage	10kV @1.2/50µs (coil to contacts)
Insulation Resistance	1000 MΩ (min.) at 23°C, 500 VDC, 50% RH
Temperature Range Operating storage	(at nominal coil voltage) -40°C (-40°F) to 85°C (185°F) -40°C (-40°F) to 105°C (221°F)
Vibration resistance	0.062" (1.5 mm) DA at 10–55 Hz
Shock	20 g
Enclosure protection category material group flammability	P.B.T. polyester RT II, flux proof IIIa UL94 V-0
Terminals	Tinned copper alloy, P. C.
Soldering max. temperature max. time	 270 °C 5 s
Dimensions length width height	 30.4 mm (1.20") 15.9 mm (0.63") 25.15 mm (1.00")
Weight	25 grams (approx.)
Compliance	UL 508, IEC 61810-1, RoHS, REACH
Packing unit in pcs	50 per plastic tray / 500 per carton box

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AZSR131

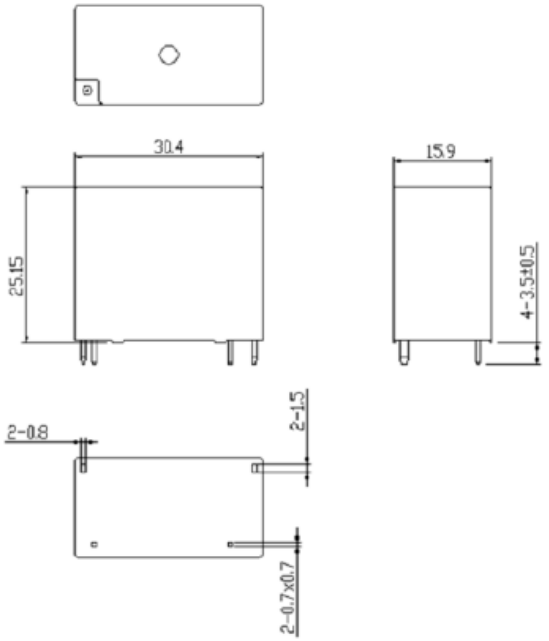
COIL VOLTAGE SPECIFICATIONS

Nominal Coil VDC	Must Operate VDC	Min. Holding VDC	Max. Cont. VDC	Resistance Ohm ± 10%
5	3.75	1.75	6.0	18
9	6.75	3.2	10.8	58
12	9.0	4.2	14.4	103
18	13.5	6.3	21.6	230
24	18.0	8.4	28.8	410
48	36.0	16.8	57.6	1650

Note: All values at 23°C (73°F), upright position, terminals downward.

MECHANICAL DATA

Dimensions in mm. Tolerance: ±0.3mm



ORDERING DATA

AZSR131-1AE-□□DGW□□□

Options
nil: standard version
(200): 2.3 mm contact gap version

Glow wire degree
blank: without glow wire
GW: with glow wire

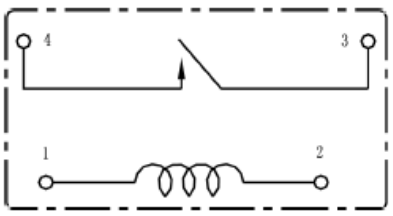
Nominal coil voltage
see coil voltage specifications table

Example ordering data

AZSR131-1AE-12D	12 VDC nominal coil voltage, 1.8 mm contact gap, without glow wire
AZSR131-1AE-12DGW	12 VDC nominal coil voltage, 1.8 mm contact gap, with glow wire
AZSR131-1AE-12D(200)	12 VDC nominal coil voltage, 2.3 mm contact gap, without glow wire

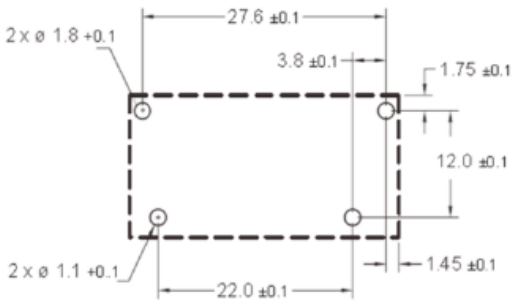
WIRING DIAGRAMS

Viewed towards terminals



PC BOARD LAYOUT

Viewed towards terminals. Dimensions in mm.



NOTES

1. All values at 23°C (73°F).
2. Relay may pull in with less than "Must Operate" value.
3. Provide sufficient PCB cross section as heat spreader on terminals.
4. Specifications subject to change without notice.

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Churod Electronics
东莞市中汇瑞德电子股份有限公司
DongGuan Churod Electronics Co., Ltd.

RELAY SPECIFICATION

继电器规格书

(File No.: 001411/ Version: 03 / Issued Date: Dec. 30th, 2021/Updated Date: Jun. 1st, 2023)

Product Description（品名）	**CHFN-V-112H1A2F(50A)**
Part Number（编码）	
Customer（客户）	

Customer Approval （客户批准）

STAMPING AREA （盖章处）

Issued（发行）	Checked（审核）	Approved（承认）
Qingwu Feng	**Simon Fu**	**Saso.San**

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Churod Electronics
东莞市中汇瑞德电子股份有限公司
DongGuan Churod Electronics Co., Ltd.

CHANGE RESUME 变更记录			
序号	更改内容	更改原因	更改时间
00	首版发行	/	20211230
01	增加安规认证	增加安规认证编号	20220817
02	触点间隙变更为 2.0mm 以上	客户要求	20220913
03	增加波峰焊耐温条件	客户要求	20230601

SAFETY STANDARD 安全标准	
UL certificate UL 证书	E341422
TUV certificate TUV 证书	R50220099
CQC certificate CQC 证书	CQC11002066606

COIL CHARACTERISTICS 线圈特性

Coil resistance 线圈电阻	90±10% Ω
Rated voltage 额定电压	12VDC
Max. allowable voltage 最大允许电压	130% 额定电压
Rated power 额定功率	1.6W
Operate voltage 吸合电压	≤9.0VDC 23℃ ≤10.8VDC 85℃
Hold Voltage (See Notes 4) 保持电压	4.8~6.0 VDC 23℃ 5.4~6.6VDC 85℃
Release voltage 释放电压	≥0.6VDC

CONTACT RATINGS 触点规格

Contact configuration 触点结构	1 Form A (SPST)
Contact material 触点材料	Ag Alloy
Initial contact resistance 初始接触电阻	≤100mΩ at 6VDC/1A
Rated switching voltage (Normally Open)	277VAC

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额定切换电压（常开触点） Rated switching voltage (Normally Close)	-
额定切换电压（常闭触点） Rated current (Normally Open)	50A
额定电流（常开触点） Rated current (Normally Close)	-
额定电流（常闭触点） Rated switching power (Normally Open)	13850VA
额定切换功率（常开触点） Rated switching power (Normally Close)	-
额定切换功率（常闭触点） Minimum applicable load (Normally Open)	5VDC 100mA
最小使用负载（常开触点） Minimum applicable load (Normally Close)	-
最小使用负载（常闭触点） Operate time	≤20ms, excluding bounce time
吸合时间	≤20ms，不含触点抖动时间
Release time	≤10ms, excluding bounce time
释放时间	≤10ms，不含触点抖动时间
Mechanical endurance	100K cycles, 120 cycles/minute
机械寿命	
Electrical endurance (Resistive Load)	43A 1s/9s ON/OFF 30K cycles
电气寿命（阻性负载）	线圈通电 1 秒(12V/0.1 秒→下降 5.4~6.6V/0.9S) / 9 秒 OFF 50A 1s/9s ON/OFF 6K cycles 线圈通电 1 秒(12V/0.1 秒→下降 5.4~6.6V/0.9S) / 9 秒 OFF 20A-50A-20A 1s(0.15/0.7/0.15)/9s ON/OFF 30K cycles 线圈通电 1 秒(12V/0.1 秒→下降 5.4~6.6V/0.9S) / 9 秒 OFF
Contact Gap	2.0mm 以上
接点间隙	

INSULATION PERFORMANCE 绝缘性能

Dielectric strength	2800VAC 1minute, between open contacts
介电强度	2800VAC 1 分钟（断开触点间） 4,500VAC 1minute, between coil to contacts 4,500VAC 1 分钟（线圈与触点间）
Impulse withstand voltage	10KV (1.2/50 μs), between coil to contacts
耐浪涌电压	10KV（线圈与触点间）
Insulation resistance	1000MΩ at 500VDC, between open contacts and coil to contacts
绝缘电阻	

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	1000MΩ（断开触点间及线圈与触点间）
Insulation systems (UL) 绝缘系统	155℃(F)
Insulation type 绝缘类型	Basic insulation 基本绝缘

ENVIRONMENT PERFORMANCE 环境性能

Category of protection (IEC61810-1) 密封类型	RT II (Flux proof) 防助焊剂渗入型
Operating temperature 工作温度	-40~85℃
Operating humidity 工作湿度	20~85%RH
Storage temperature 储藏温度	-40~85℃
Storage humidity 储藏湿度	20~85%RH
Vibration resistance 耐振动	(1) Capability to function during vibration No opening or closing of any closed or opened contact circuit respectively exceed 10μs when the relay is subjected to vibration of 10~55Hz and 1.5mm dual amplitude in each of three mutually perpendicular axes for 10 minutes respectively, while it is in operate condition and in release condition. 抗误动作能力 动作/释放状态下，继电器在三个轴向耐受频率10~55Hz及振幅1.5mm的振动各10分钟，触点误动作不超过10微秒。 (2) Capability to function after vibration No trouble on structure and characteristics after the relay is subjected to vibration of 10~55Hz and 1.5mm dual amplitude in each of three mutually perpendicular axes for 2 hours respectively. 振动耐久能力 继电器在三个轴向耐受振幅1.5mm及频率10~55Hz的振动各2小时，产品构造和性能无异常发生。
Shock resistance 耐冲击	(1) Capability to function during shock No opening or closing of any closed or opened contact circuit respectively exceed 10μs when the

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	relay is subjected to shock of 98.1m/s^2 for 11ms in both directions of each of three mutually perpendicular axes for 3 times respectively, while it is in operate condition and in release condition. 抗误动作能力 动作/释放状态下，继电器在三轴六方向耐受加速度98.1m/s^{2}及作用时间11毫秒的冲击各3次，触点误动作不超过10微秒。 (2) Capability to function after shock No trouble on structure and characteristics after the relay is subjected to shock of 981m/s^2 for 6ms in both directions of each of three mutually perpendicular axes for 3 times respectively. 冲击耐久能力 继电器在三轴六方向耐受加速度981m/s^{2}及作用时间6毫秒的冲击各3次，产品构造和性能无异常发生。
Cold resistance 耐低温	No trouble on structure and characteristics after placed at -40℃ for 240 hours and 2 hours recovery in standard atmospheric conditions. -40℃中放置240小时并在标准大气条件中恢复2小时后继电器构造和特性无异常。
Thermal resistance 耐高温	No trouble on structure and characteristics after placed at 85℃ for 240 hours and 2 hours recovery in standard atmospheric conditions. 85℃中放置 240 小时并在标准大气条件中恢复 2 小时后继电器构造和特性无异常。
Humidity resistance 耐湿度	No trouble on structure and characteristics after placed at 40℃&95%RH for 240 hours and 2 hours recovery in standard atmospheric conditions. 40℃及95%相对湿度中放置240小时并在标准大气条件中恢复2小时后继电器构造和特性无异常。
Thermal shock resistance 耐冷热冲击	No trouble on structure and characteristics after endure 100 cycles of cyclic temperature and 2 hours recovery in standard atmospheric conditions, which the temperature cycle consists of -40℃ for 0.5 hour and 85℃ for 0.5 hour. -40℃和85℃中各放置0.5小时为一个温度周期，循环100次，在标准大气条件中恢复2小时后继电器构造和

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	特性无异常。
Terminal robustness 引出端强度	No trouble on structure and characteristics after endure axial pushing/pulling force of 10N for 10 seconds. 继电器引出端承受 10 牛顿的轴向压入、拔出力，延时 10 秒，构造和性能无异常。

MARKING 产品标识

Position of marking 标识位置	Side of relay cover 外壳侧面
Cover color 外壳颜色	Black 黑色
Marking type 标记类型	Laser 激光
Trade mark 商标	Churod

MOUNTING INFORMANTION 安装信息

Solderability 可焊性	260±5℃ for 5±0.5 seconds
Resistance to soldering heat 耐焊接热	260±5℃ for 10±1 seconds 350±10℃ for 3.5±0.5 seconds
Standard direction 标准方向	Relay PCB terminals downward 继电器 PCB 型引出端朝下
Terminals assignment and outline dimensions 引出端脚位和外形尺寸	Refer to APPENDIX 请参考附件
Wave soldering Condition 波峰焊条件	Refer the following Curve 280℃±5℃ for 10±1 seconds

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ENGINEERING NOTES 注意事项

Unless otherwise explicitly stated, the standard environment conditions for measurement or testing are listed as followings:

除非特别申明，测量或试验的标准环境条件如下：

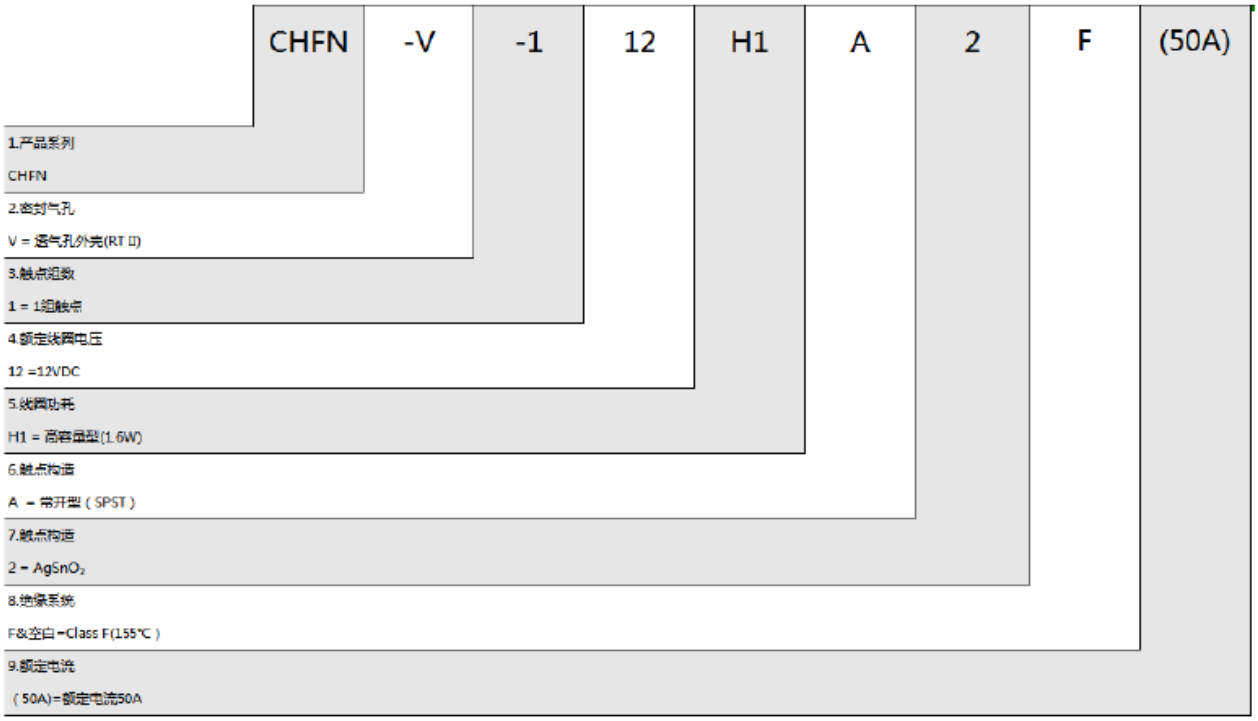
(1) Ambient temperature is 23±5℃;
环境温度为 23±5℃;

(2) Atmospheric pressure is 96±10% kPa;
大气压力为 96±10% kPa;

(3) Relative humidity is 50%±25% RH.
相对湿度为 50%±25% RH.

(4) When the ambient temperature > 23°C,coil voltage requires reduction to 5.4 to <6.6V after applying rate voltage for 100ms~200ms
当环境温度>23℃时，线圈施加额定电压 100ms~200ms 以后,电压需下降到 5.4~6.6V

Nomenclature
命名规则



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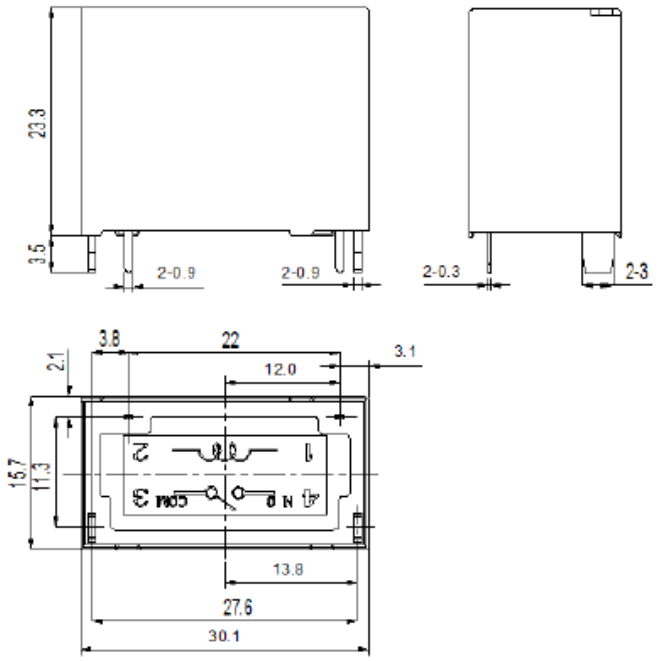
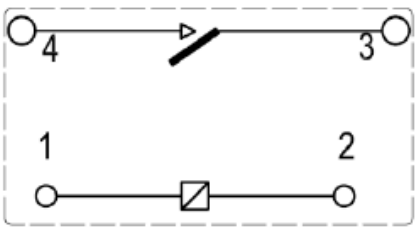
OUTLINE DIMENSION

外形尺寸图



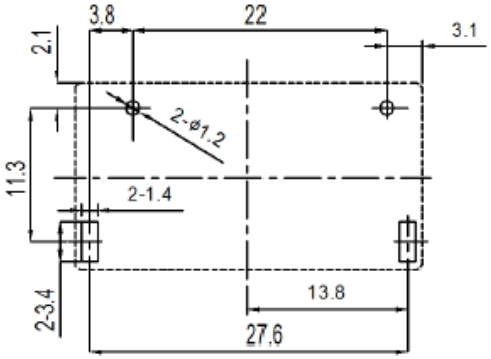
Wiring diagram (Bottom View)

接线图（底视图）



Mounting dimensions (Bottom View)

安装孔尺寸图（底视图）



Note: All unspecified tolerance (including outline dimension and PC board dimension) according to following listing

备注：产品外形尺寸未标注尺寸公差及 PC 板未注尺寸公差按下表执行。

产品外形尺寸未注尺寸公差 Outline dimensions hadn't specified tolerance		PC 板未注尺寸公差 PC board dimensions hadn't specified tolerance
外形尺寸 Outline dimensions	公差 Tolerance	±0.1
≤0.3	±0.1	
≤1	±0.25	
≤5	±0.3	
>5	±0.5	

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RELAY SPECIFICATION

继电器规格书

(File No.: 001000 / Version: 00 / Issued Date: Jun. 6th, 2023)

Product Description（品名）	**CHFN-V-112HA2F(31A)**
Part Number（编码）	
Customer（客户）	

Customer Approval （客户批准）

STAMPING AREA （盖章处）

Issued（发行）	Checked（审核）	Approved（承认）
Helena.Gong	**===**	**Nathan.Chen**

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SAFETY STANDARD 安全标准	
UL certificate UL 证书	E341422
TUV certificate TUV 证书	R50220099
CQC certificate CQC 证书	CQC11002066606

COIL CHARACTERISTICS 线圈特性

Coil resistance 线圈电阻	103±10% Ω
Rated voltage 额定电压	12VDC
Max. allowable voltage 最大允许电压	130% of rated coil voltage
Rated power 额定功率	1.4W
Operate voltage 吸合电压	≤9.0VDC
Release voltage 释放电压	≥0.6VDC
Hold Voltage(See Notes 4) 保持电压	≤4.2VDC(@23℃) at0.17W ≤5.4VDC(@85℃) at0.28W

NOTES 备注

吸合电压≤9.0 是指产品性能，使用时，吸合电压则需≥9.0V，保持电压亦同，使用时需≥5.4V

The operate voltage is less than 9.0V, which means that the product performance meets the requirements. When using, the operate voltage should be greater than 9.0V, as the same, the hold voltage should be greater than 5.4V

CONTACT RATINGS 触点规格

Contact configuration 触点结构	1 Form A (SPST)
Contact material 触点材料	Ag Alloy
Initial contact resistance 初始接触电阻	≤100mΩ at 6VDC/1A
Rated switching voltage (Normally Open) 额定切换电压（常开触点）	277VAC
Rated switching voltage (Normally Close) 额定切换电压（常闭触点）	-
Rated current (Normally Open)	31A

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额定电流（常开触点） Rated current (Normally Close)	-
额定电流（常闭触点） Rated switching power (Normally Open)	8587VA
额定切换功率（常开触点） Rated switching power (Normally Close)	-
额定切换功率（常闭触点） Minimum applicable load (Normally Open)	5VDC 100mA
最小使用负载（常开触点） Minimum applicable load (Normally Close)	-
最小使用负载（常闭触点） Operate time	≤20ms, excluding bounce time
吸合时间	≤20ms，不含触点抖动时间
Release time	≤10ms, excluding bounce time
释放时间	≤10ms，不含触点抖动时间
Mechanical endurance	300K cycles, 180 cycles/minute
机械寿命	
Electrical endurance (Resistive Load)	31A, 277VAC, 30K cycles, 1s on/9s off
电气寿命（阻性负载）	线圈通电 1 秒(24V/0.1 秒→下降 10.8~13.2V/0.9S) / 9 秒 OFF，（ @85℃）
Contact Gap	2.0mm 以上
接点间隙	

INSULATION PERFORMANCE 绝缘性能

Dielectric strength	2800VAC 1minute, between open contacts
介电强度	2800VAC 1 分钟（断开触点间）
	4,500VAC 1minute, between coil to contacts
	4,500VAC 1 分钟（线圈与触点间）
Impulse withstand voltage	10KV (1.2/50 μ s), between coil to contacts
耐浪涌电压	10KV（线圈与触点间）
Insulation resistance	1000MΩ at 500VDC, between open contacts and coil to contacts
绝缘电阻	1000MΩ（断开触点间及线圈与触点间）
Insulation systems (UL)	155℃(F)
绝缘系统	
Case admit temperature	130℃
外壳容许温度	
Insulation type	Basic insulation
绝缘类型	基本绝缘

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ENVIRONMENT PERFORMANCE 环境性能

Category of protection (IEC61810-1) 密封类型	RT II (Flux Tight) 防助焊剂渗入型
Operating temperature 工作温度	-40~85℃
Operating humidity 工作湿度	20~85%RH
Storage temperature 储藏温度	-40~85℃
Storage humidity 储藏湿度	20~85%RH
Vibration resistance 耐振动	(1) Capability to function during vibration No opening or closing of any closed or opened contact circuit respectively exceed 10μs when the relay is subjected to vibration of 10~55Hz and 1.5mm dual amplitude in each of three mutually perpendicular axes for 10 minutes respectively, while it is in operate condition and in release condition. 抗误动作能力 动作/释放状态下，继电器在三个轴向耐受频率10~55Hz及振幅1.5mm的振动各10分钟，触点误动作不超过10微秒。 (2) Capability to function after vibration No trouble on structure and characteristics after the relay is subjected to vibration of 10~55Hz and 1.5mm dual amplitude in each of three mutually perpendicular axes for 2 hours respectively. 振动耐久能力 继电器在三个轴向耐受振幅1.5mm及频率10~55Hz的振动各2小时，产品构造和性能无异常发生。
Shock resistance 耐冲击	(1) Capability to function during shock No opening or closing of any closed or opened contact circuit respectively exceed 10μs when the relay is subjected to shock of 98.1m/s^2 for 11ms in both directions of each of three mutually perpendicular axes for 3 times respectively, while it is in operate condition and in release condition. 抗误动作能力 动作/释放状态下，继电器在三轴六方向耐受加速度

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	98.1m/s^{2}及作用时间11毫秒的冲击各3次，触点误动作不超过10微秒。 (2) Capability to function after shock No trouble on structure and characteristics after the relay is subjected to shock of 981m/s^2 for 6ms in both directions of each of three mutually perpendicular axes for 3 times respectively. 冲击耐久能力 继电器在三轴六方向耐受加速度981m/s^{2}及作用时间6毫秒的冲击各3次，产品构造和性能无异常发生。
Cold resistance 耐低温	No trouble on structure and characteristics after placed at -40℃ for 240 hours and 2 hours recovery in standard atmospheric conditions. -40℃中放置240小时并在标准大气条件中恢复2小时后继电器构造和特性无异常。
Thermal resistance 耐高温	No trouble on structure and characteristics after placed at 85℃ for 240 hours and 2 hours recovery in standard atmospheric conditions. 85℃中放置 240 小时并在标准大气条件中恢复 2 小时后继电器构造和特性无异常。
Humidity resistance 耐湿度	No trouble on structure and characteristics after placed at 40℃&95%RH for 240 hours and 2 hours recovery in standard atmospheric conditions. 40℃及95%相对湿度中放置240小时并在标准大气条件中恢复2小时后继电器构造和特性无异常。
Thermal shock resistance 耐冷热冲击	No trouble on structure and characteristics after endure 100 cycles of cyclic temperature and 2 hours recovery in standard atmospheric conditions, which the temperature cycle consists of -40℃ for 0.5 hour and 85℃ for 0.5 hour. -40℃和85℃中各放置0.5小时为一个温度周期，循环100次，在标准大气条件中恢复2小时后继电器构造和特性无异常。
Terminal robustness 引出端强度	No trouble on structure and characteristics after endure axial pushing/pulling force of 10N for 10 seconds. 继电器引出端承受 10 牛顿的轴向压入、拔出力，延时 10 秒，构造和性能无异常。

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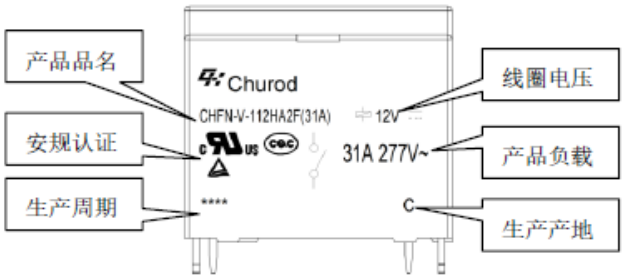
Terminal temperature rise 端子温升	65K(Under the condition of 85 ℃) 65K（85℃条件下）
Coil temperature rise 线圈温升	65K(Under the condition of 85 ℃) 65K（85℃条件下）

MARKING 产品标识

Position of marking 标识位置	Side of relay cover 外壳侧面
Cover color 外壳颜色	Black 黑色
Marking type 标记类型	Laser 激光
Trade mark 商标	Churod



范例：2319, 23 表示 2023 年，19 表示第 19 周

MOUNTING INFORMANTION 安装信息

Solderability 可焊性	260±5℃ for 5±0.5 seconds
Resistance to soldering heat 耐焊接热	260±5℃ for 10±1 seconds 350±10℃ for 3.5±0.5 seconds
Standard direction 标准方向	Relay PCB terminals downward 继电器 PCB 型引出端朝下
Terminals assignment and outline dimensions 引出端脚位和外形尺寸	Refer to APPENDIX 请参考附件
Weight **产品单重**	Approx. 23g 约 23 克

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Unless otherwise explicitly stated, the standard environment conditions for measurement or testing are listed as followings:

除非特别申明，测量或试验的标准环境条件如下：

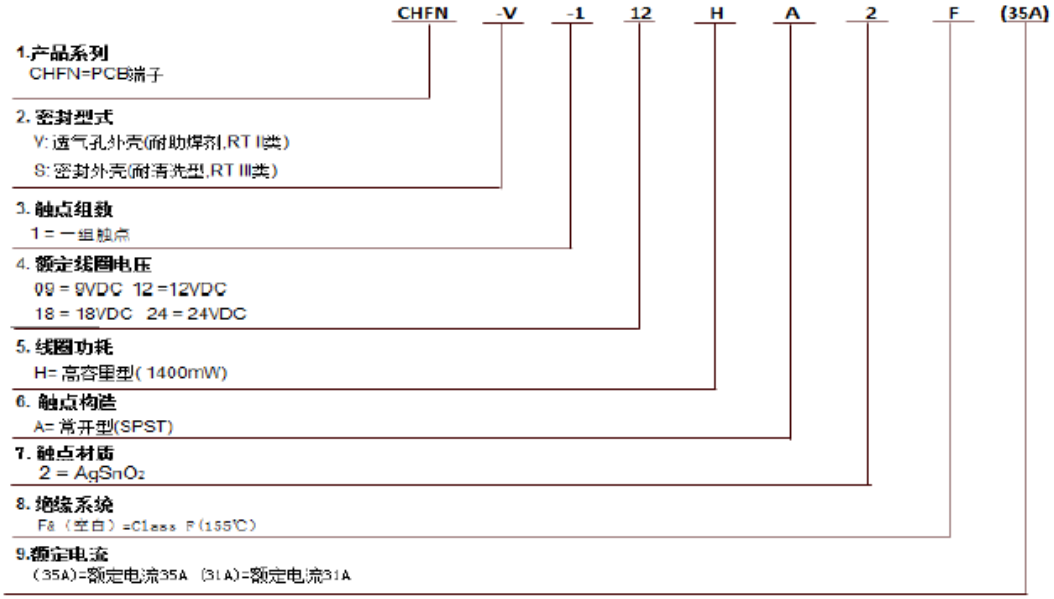
(1) Ambient temperature is 23±5℃;
环境温度为 23±5℃;

(2) Atmospheric pressure is 96±10% kPa;
大气压力为 96±10% kPa;

(3) Relative humidity is 50%±25% RH.
相对湿度为 50%±25% RH.

(4) When the ambient temperature > 23°C,coil voltage requires reduction to 10.8 to <13.2V after applying rate voltage for 100ms~200ms
当环境温度＞23℃时，线圈施加额定电压 100ms~200ms 以后,电压需下降到 10.8~13.2V

Nomenclature
命名规则



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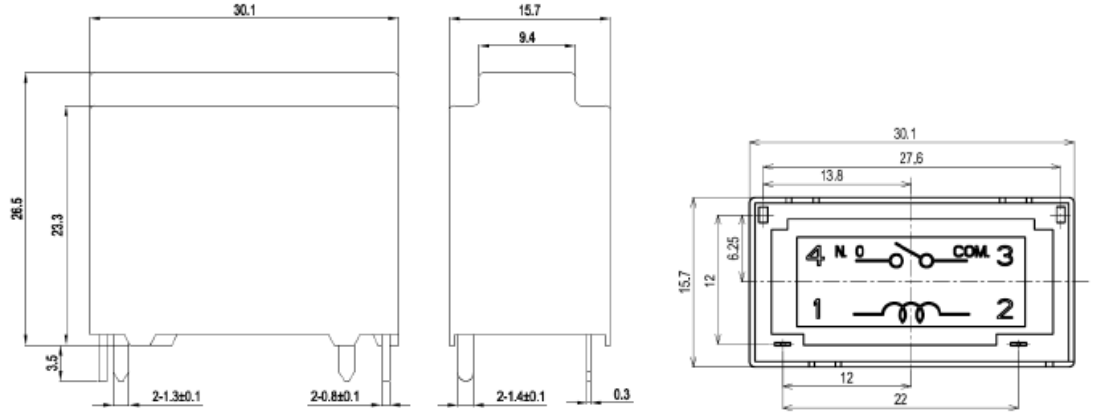
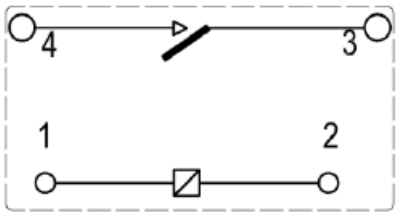
Churod Electronics
东莞市中汇瑞德电子股份有限公司
Churod Electronics Co., Ltd.

OUTLINE DIMENSION

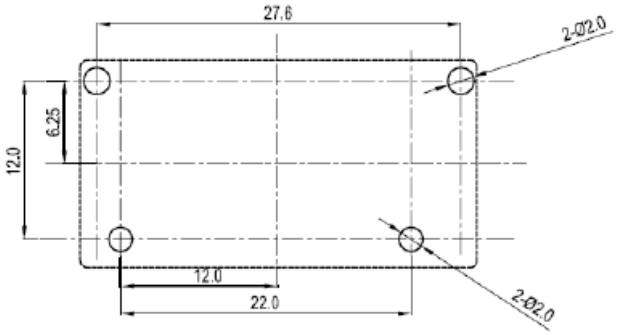
外形尺寸图



Wiring diagram (Bottom View)
接线图（底视图）



Mounting dimensions (Bottom View)
安装孔尺寸图（底视图）



Note: All unspecified tolerance (including outline dimension and PC board dimension) according to following listing

备注：产品外形尺寸未标注尺寸公差及 PC 板未注尺寸公差按下表执行。

产品外形尺寸未注尺寸公差 Outline dimensions hadn't specified tolerance		PC 板未注尺寸公差 PC board dimensions hadn't specified tolerance
外形尺寸 Outline dimensions	公差 Tolerance	
≤0.3	±0.1	±0.1
≤1	±0.2	
≤5	±0.3	
>5	±0.5	

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TEMP-0058-TG-EAW-ES-V01

HF161F-40 MINIATURE HIGH POWER RELAY

c UL us
File No.: E134517

File No.:R 50475730

CQC
File No.:CQC20002246447

Features

- Applicable to variable frequency air conditioning used for soft start
- 40 A 277 VAC loading current capability
- Class F insulation system

RoHS compliant

CONTACT DATA

Contact arrangement	1A
Contact resistance	10mΩ max.(6VDC 20A)
Contact material	$AgSnO_2$
Contact rating (Res. load)	Making 20A Loading 40A Breaking 20A, 277VAC
Max. switching voltage	277VAC
Max. switching current	40A
Max. continuous current	40A at 85℃
Max. switching power	11080VA
Mechanical endurance	2×10^6OPS
Electrical endurance(1)	1×10^5 OPS MIN (85℃,1s on 9s off,Making 20A Loading 40A Breaking 20A, 277VAC, Resistive load) 1×10^4 OPS MIN (85℃,1s on 9s off, 30A24VDC,Resistive load)

Notes: 1) For plastic sealed type, the venting-hole should be opened in electrical endurance test.

CHARACTERISTICS

Insulation resistance		1000MΩ (at 500VDC)
Dielectric strength	Between coil & contacts	4500VAC 1min
	Between open contacts	1000VAC 1min
Surge voltage (between coil & contacts)		10kV (1.2 / 50μs)
Operate time (at nomi. volt.)		20ms max.
Release time (at nomi. volt.)		10ms max.
Temperature rise (at nomi. volt.)		70K max (Contact load current 40A, rated voltage excitation, at 85℃)
Shock resistance	Functional	196m/s²
	Destructive	980m/s²

CHARACTERISTICS

Vibration resistance	10Hz to 55Hz 1.5mm DA
Humidity	5% to 85% RH
Ambient temperature	-40℃ to 85℃
Termination	PCB
Unit weight	Approx. 25g
Construction	Flux proofed Plastic sealed

Notes: The data shown above are initial values.

COIL

Coil power	Approx. 900mW

COIL DATA at 23℃

Nominal Voltage VDC	Pick-up Voltage VDC max.1)	Drop-out Voltage VDC min.1)	Max. Voltage VDC*2)	Coil Resistance Ω
5	3.75	0.5	6.0	27.8 x (1±10%)
12	9	1.2	14.4	160 x (1±10%)
24	18	2.4	28.8	640 x (1±10%)
48	36	4.8	57.6	2560 x (1±10%)

Notes: 1)The data shown above are initial values.
2) Maximum voltage refers to the maximum voltage which relay coil could endure in a short period of time.

SAFETY APPROVAL RATINGS

UL/CUL	Making 20A, Loading 40 A,Breaking 20 A 277V a.c., Resistive,85℃
TÜV	40 A, 277V a.c., Resistive,85℃
CQC	30 A, 24V d.c., Resistive,85℃

Notes: 1)All values unspecified are at room temperature.
2) Only typical loads are listed above. Other load specifications can be available upon request.

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ORDERING INFORMATION

	HF161F-40 /	12	-H	S	T	F	(XXX)
Type							
Coil voltage	5, 12, 24, 48VDC						
Contact arrangement	**H:** 1 Form A						
Construction(1)	**S:** Plastic sealed		Nil: Flux proofed				
Contact matcrial	**T:** $AgSnO_2$						
Insulation standard	**F:** Class F						
Special code	**XXX:** Customer special requirement			**Nil:** Standard			

Notes: 1) Please avoid using the relay in an environment containing organic silicon,otherwise the entry of organic silicon into the relay may acceleration contact failure.If there are harmful substances and elements such as water vapor,H_2S,SO_2,NO_2,Cl,P,dust,etc.,as well as unknown harmful substances and elements,In the use of environmental gases,it may lead to increased contact resistance and poor contact during the use of relays.In the above situations,please control the materials that produce harmful substances and elements or use plastic sealed type,and arrange relevant tests to confirm that it meet the requirements for actual use.

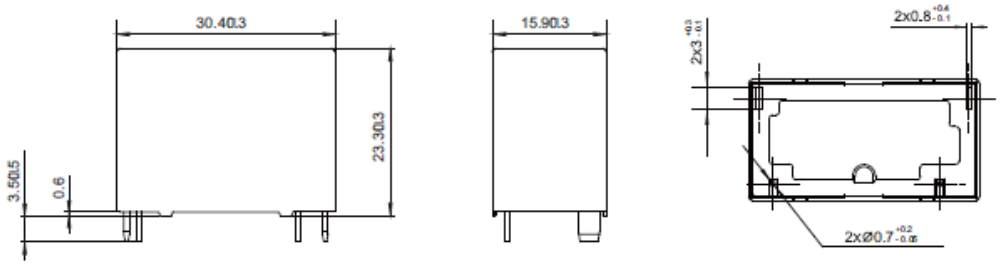
2) Water cleaning or surface process is not suggested after the flux-proofed relays are assembled on PCB.

3) The customer special requirement express as special code after evaluating by Hongfa.e.g.(335) stands for product in accordance to IEC 60335-1(GWT).

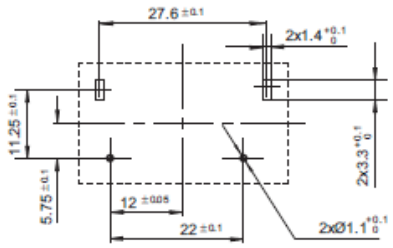
OUTLINE DIMENSIONS, WIRING DIAGRAM AND PC BOARD LAYOUT

Unit: mm

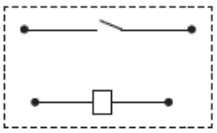
Outline Dimensions



PCB Layout
(Bottom view)



Wiring Diagram
(Bottom view)



Remark: 1) In case of no tolerance shown in outline dimension: outline dimension ≤1mm, tolerance should be ±0.2mm; outline dimension >1mm and ≤5mm, tolerance should be ±0.3mm; outline dimension >5mm, tolerance should be ±0.4mm.

2) The tolerance without indicating for PCB layout is always ±0.1mm.

Disclaimer

The specification is for reference only. See to "Terminology and Guidelines" for more information. Specifications subject to change without notice. We could not evaluate all the performance and all the parameters for every possible application. Thus the user should be in a right position to choose the suitable product for their own application. If there is any query, please contact Hongfa for the technical service. However, it is the user's responsibility to determine which product should be used only.

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TEMP-0058-TG-EAW-ES-V01

HF161F-W SOLAR RELAY

File No.:E134517

File No.:40031410

File No.:CQC10002050943
CQC18002203499

Features

- 31A switching capacity
- Applicable to inverter used for photovoltaic power generation systems
- Ideal for UPS
- 1.5mm contact gap (compliant to European Photovoltaic Standard VDE0126)
  1.8mm contact gap (compliant to IEC 62109-2-2011)
- The clearance distance between contact and coil is bigger than 6.4mm, the creepage distance is bigger than 8mm. (special code 477:7.5mm)
- Low coil holding voltage contributes to saving energy of equipment.
- UL insulation system: Class F

RoHS compliant

CONTACT DATA

Contact gap	1.5mm	1.8mm	2.0mm	2.3mm	2.3mm
Contact arrangement	1A				
Contact resistance[1)]	100mΩ max.(1A 6VDC)				
Contact material	$AgSnO_2$				
Contact rating	Resistive: 26A 250VAC Inductive:31A 250VAC (cosø=0.8) 0.1s:10s	Resistive: 26A 250VAC Inductive:33A 250VAC (cosø=0.8) 0.1s:10s	Resistive: 26A 250VAC Inductive:31A 250VAC (cosø=0.8) 0.1s:10s	Resistive: 26A 250VAC	Resistive: 35A 277VAC
Max. switching voltage	277VAC				400VAC
Max. switching current	31A	33A	31A	26A	35A
Max. switching power	7750VA	8250VA	7750VA	7202VA	14000VA
Mechanical endurance	1 x 10^6 OPS	1 x 10^5 OPS	1 x 10^5 OPS	1 x 10^5 OPS	1 x 10^5 OPS
Electrical endurance	HT type: 3 x 10^4 OPS (26A 250VAC Resistive 75°C 1.5s on 1.5s off)	HT type: 3 x 10^4 OPS (26A 250VAC Resistive 75°C 1.5s on 1.5s off)	HT type: 3 x 10^4 OPS (26A 250VAC Resistive 75°C 1.5s on 1.5s off)	HT type: 3 x 10^4 OPS (26A 250VAC Resistive Room temp. 1.5s on 1.5s off)	HT type: 3 x 10^4 OPS (35A 277VAC Resistive 85°C 1s on 9s off)

Notes: 1)The data shown above are initial values.

CHARACTERISTICS

Insulation resistance		1000MΩ (at 500VDC)
Dielectric strength	Between coil & contacts	4500VAC 1min
	Between open contacts	2500VAC 1min
Surge voltage (between coil & contacts)		10kV (1.2/50μs)
Operate time (at rated. volt.)		20ms max.
Release time (at rated. volt.)		10ms max.
Temperature rise (at rated. volt.)		95K max. (Contact load current 31A, rated voltage excitation, at 60°C)
		70K max. (Contact load current 31A, 80% of rated voltage excitation, at 85°C)
Shock resistance	Functional	196m/s²
	Destructive	980m/s²
Vibration resistance		10Hz to 55Hz 1.5mm DA
Ambient temperature		-40°C to 85°C (Apply holding voltage to coil, which is 45% to 80% that of rated voltage)
Humidity		5% to 85% RH
Termination		PCB
Unit weight		Approx. 21g
Construction		Flux proofed

Notes: The data shown above are initial values.

COIL

Coil power	Approx. 1.4W
Holding voltage	35% to 120%UN (at 23°C) 45% to 80%UN (at 85°C)

Notes: 1)The coil holding voltage is the voltage of coil after being applied rated voltage for 100ms
2)The relay col does not allow applied more than maximum of holding voltage values for a long time (Eg: 120% Un at 23°C; 80% Un at 85°C) , prevent overheating burned.

COIL DATA at 23°C

Nominal Voltage VDC	Pick-up Voltage VDC max.[1)]	Drop-out Voltage VDC min.[1)]	Max. Voltage VDC*[2)]	Coil Resistance Ω
9	6.3	0.9	10.8	58 x (1±10%)
12	8.4	1.2	14.4	103 x (1±10%)
18	12.6	1.8	21.6	230 x (1±10%)
24	16.8	2.4	28.8	410 x (1±10%)

Notes: 1)The data shown above are initial values.
2)*Maximum voltage refers to the maximum voltage which relay coil could endure in a short period of time.

HONGFA RELAY
ISO9001, IATF16949 , ISO14001, ISO45001, IECQ QC 080000, ISO/IEC 27001 CERTIFIED 2024 Rev. 1.00

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SAFETY APPROVAL RATINGS

UL/CUL	$AgSnO_2$	26A 277VAC at 75˚C 22A 277VAC at 85˚C 35A 400VAC at 85˚C(A27)
VDE	$AgSnO_2$	26A 277VAC at 75˚C 22A 277VAC at 85˚C 31A 250VAC COSØ =0.8 0.1s:10s 33A 250VAC COSØ =0.8 0.1s:10s (477)
TÜV	$AgSnO_2$	35A 400VAC at 85˚C(A27)

Notes: 1) All values unspecified are at room temperature.
2) Only typical loads are listed above. Other load specifications can be available upon request.

ORDERING INFORMATION

	HF161F-W /	12	-H	T	(XXX)
Type					
Coil voltage	9, 12, 18, 24VDC				
Contact arrangement	**H:** 1 Form A				
Contact matcrial	**T:** $AgSnO_2$				
Special code[3]	**XXX:** Customer special requirement		**Nil:** Standard		

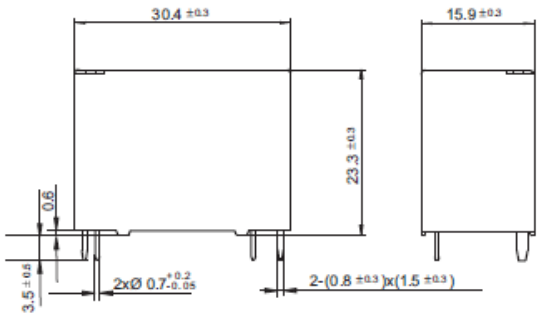
Notes: 1) Water cleaning or surface process is not suggested after the flux-proofed relays are assembled on PCB.
2) Please avoid using the relay in an environment containing organic silicon,otherwise the entry of organic silicon into the relay may acceleration contact failure.If there are harmful substances and elements such as water vapor,H_2S, SO_2, NO_2,Cl,P,etc.In the use of environmental gases,it may lead to increased contact resistance and poor contact during the use of relays.In the above situations,please control the materials or use plastic sealed type and arrange relevant tests to confirm.
3) The customer special requirement express as special code after evaluating by Hongfa. e.g. (414) stands for product with coil terminal of 1.4X0.4; e.g. (477) stands for Contact gap: 1.8mm.(456) stands for Contact gap: 2.0mm.(704)stands for Contact gap: 2.3mm.(A27) stands for Contact gap: 2.3mm, Contact rating 35A.
4) The product has two packaging options: suction tray packaging and tube packaging. Among them, the standard size of tube packaging is 592 mm. If you need special customization, please contact us.

OUTLINE DIMENSIONS, WIRING DIAGRAM AND PC BOARD LAYOUT

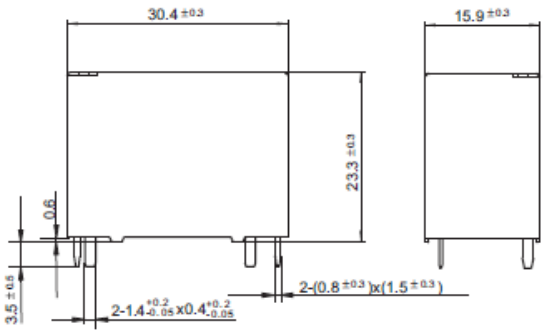
Unit: mm

Outline Dimensions

Standard type



(414) special code version



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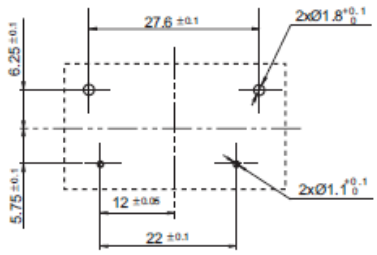
OUTLINE DIMENSIONS, WIRING DIAGRAM AND PC BOARD LAYOUT

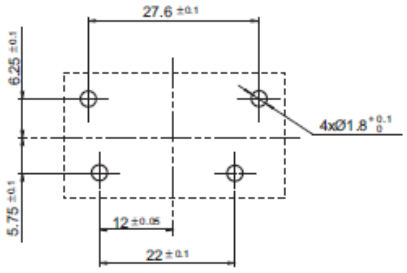
Unit: mm

PCB Layout (Bottom view)

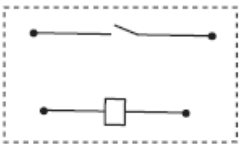
Standard type



(414) special code version



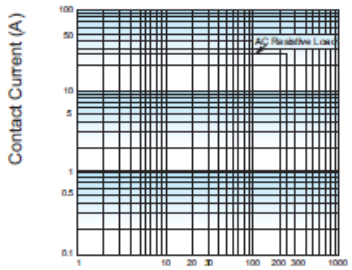
Wiring Diagram



Remark: 1) In case of no tolerance shown in outline dimension: outline dimension ≤1mm, tolerance should be ±0.2mm; outline dimension >1mm and ≤5mm, tolerance should be ±0.3mm; outline dimension >5mm, tolerance should be ±0.4mm.
2) The tolerance without indicating for PCB layout is always ±0.1mm.

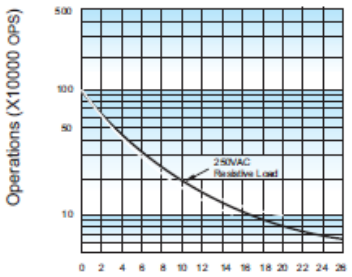
CHARACTERISTIC CURVES

MAXIMUM SWITCHING POWER



Contact Voltage (V)

ENDURANCE CURVE



Contact Current (A)

Test conditions:
at 75°C, 1.5s on 1.5s off.

Disclaimer

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Annex No. 4
Datasheet of the Batterie

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HFIE

Product Name : Lithium-ion battery pack
Battery Type : LiFePO4 (LFP)
Battery Designation : IFpP/51/161/119/[2P16S]E/-10+50/80
Model No : LFPWall-10K-V2
Rated Capacity : 204Ah
Nominal Voltage : 51.2V
Nominal Energy: 10.44kWh
Recommended Charge : 90A charge to 57.6V CC
Ingress Protection : IP65
Operation Temperature : Charge 0-55℃ / Discharge -10-55℃
Storage Temperature : -20-35℃

BEWARE OF FIRE HAZARD! DISPOSAL ACC.TO LOCAL REGULATIONS!
Hefei Hefu Intelligent Energy Co., Ltd

Tel: +860551-82666766 Email:hfiepower@hfiepower.com
Web:www.hfiepower.com
Add:Room 601, Building G3, Phase II, Hefei Software Park,
High-tech Zone, Hefei City

SN :

Made in China

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Annex No. 5
Pictures of the unit

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Enclosure front


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Enclosure (connectors)

Enclosure top side


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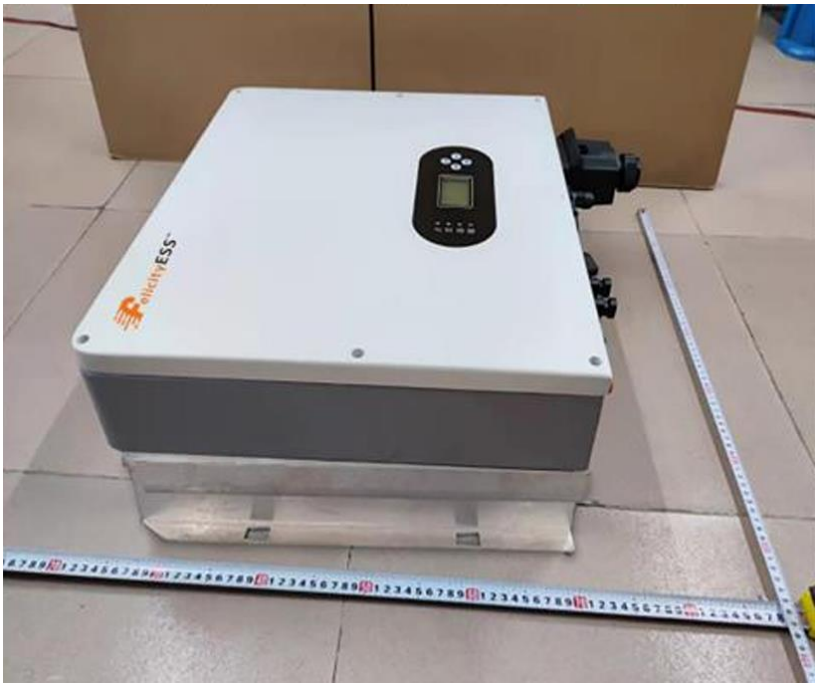
Enclosure left side

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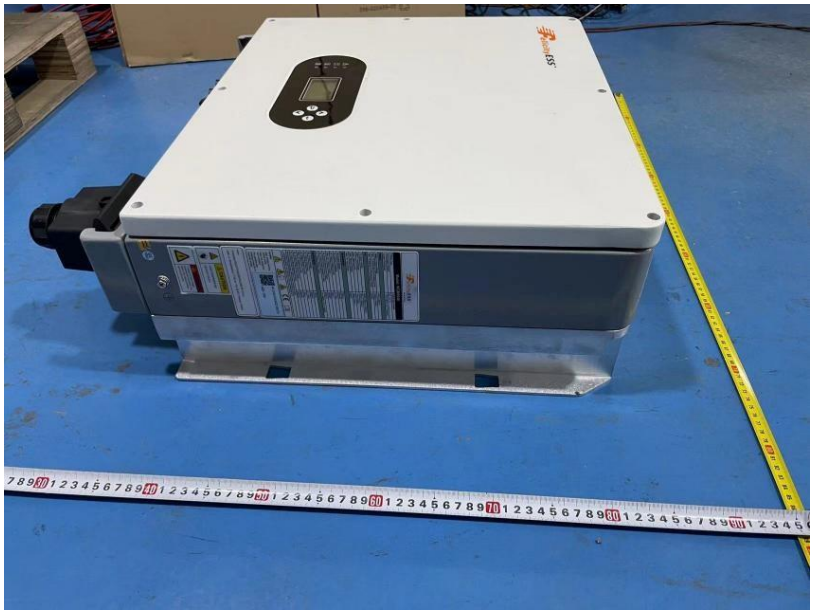

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Enclosure back


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Enclosure open


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Enclosure front


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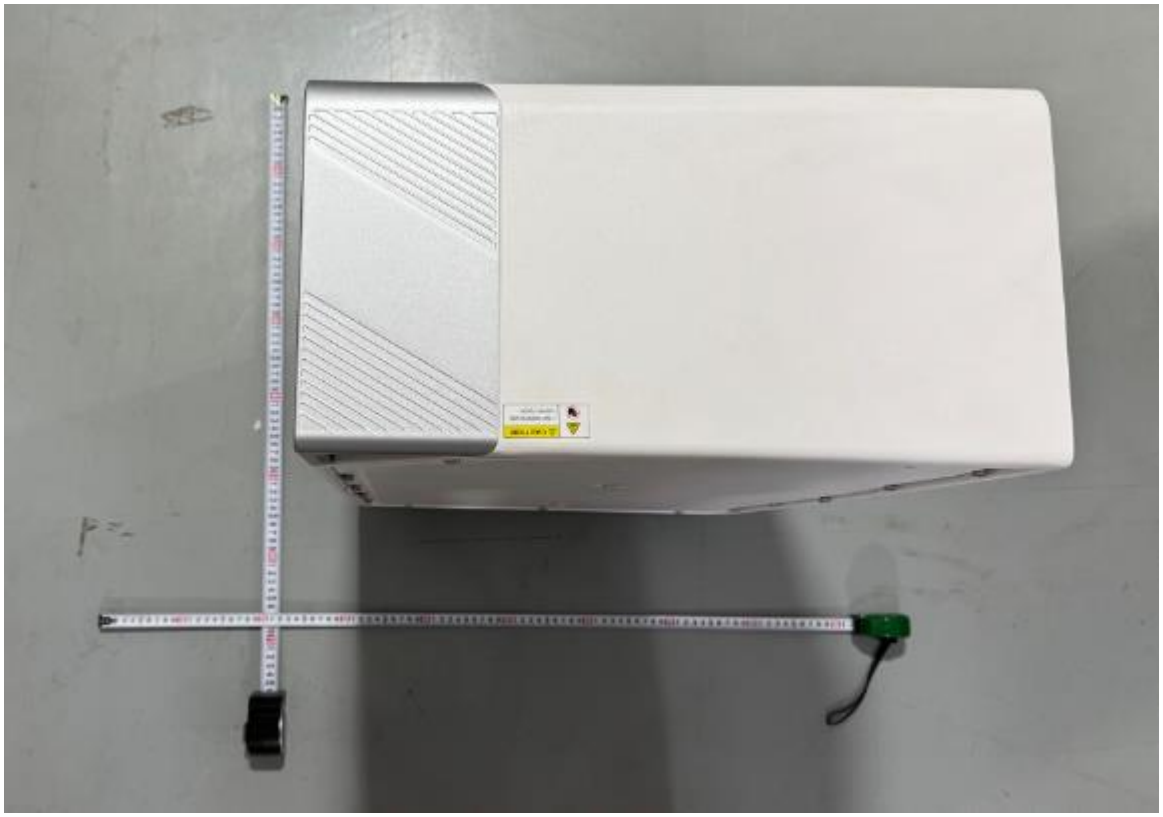
Enclosure

Enclosure top side



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Enclosure left side

Enclosure right side


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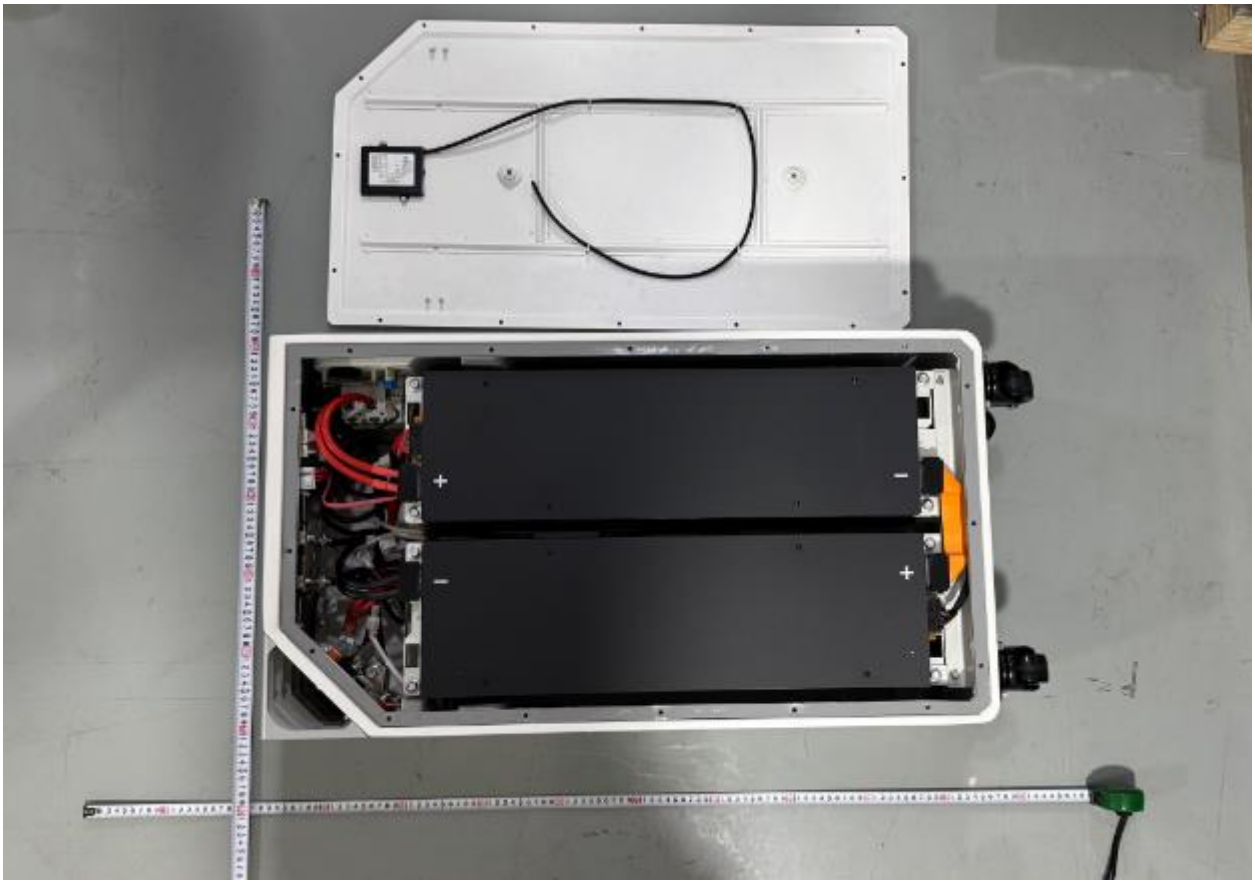
Enclosure open


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Annex No. 6
Test Equipment list

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No.	Equipment	Internal No.	Type	Manufacturer	Last Calibration	Due Date
1	Oscilloscope	A4089036SH	DL850	YOKOGAWA	07/May/25	06/May/26
2	Voltage probe	A4089059SH	DP6150A	CYBERTEK	05/Jun/25	04/Jun/26
3	Current probe	A4089037SH	960 30	YOKOGAWA	19/Aug/25	18/Aug/26
4	Current probe	A4089038SH	960 30	YOKOGAWA	19/Aug/25	18/Aug/26
5	Current probe	A4089039SH	960 30	YOKOGAWA	19/Aug/25	18/Aug/26
6	AC power supply	A7040071SH	61512	Chroma	Monitored by Power Analyzer	
7	AC power supply	A7040077SH	MX-30	AMETEK		
8	Programmable DC source	A7040058SH	62150H-1000S	Chroma		
9	Programmable DC source	A7040059SH	62150H-1000S	Chroma		
10	Programmable DC source	A7040069SH	62150H-1000S	Chroma		
11	Programmable DC source	A7040074SH	62150H-1000S	Chroma		
12	Programmable DC source	A7040075SH	62150H-1000S	Chroma		
13	Programmable DC source	A7040076SH	62150H-1000S	Chroma		
14	Programmable DC source	A7040070SH	62150H-1000S	Chroma		
15	Power Analyzer	A1240096SH	WT3000	YOKOGAWA	19/Aug/24	18/Aug/26
16	Power Analyzer	A1240097SH	WT3000	YOKOGAWA	07/May/25	06/May/26
17	Temperature & humidity meter	B4200046SH	polyma	W302M2A	16/Dec/24	15/Dec/25
18	Temperature & humidity meter	B4200078SH	314	center	03/Jun/24	09/Jun/26
19	Power Analyzer	A1240132SH	DEWE2-A4	DEWETRON	09/May/25	08/May/26

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End of Test Report

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