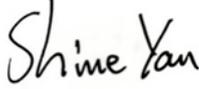


<p><b>TEST REPORT</b>  <b>EN 50549-1:2019</b>  <b>Requirements for generating plants to be connected in parallel with distribution networks</b>  <b>- Part 10: Tests for conformity assessment of generating units</b></p>	
<b>Report</b>	
Report Number.....	6209657.50B
Date of issue .....	2025-02-23
Total number of pages .....	39
<b>Testing Laboratory</b> ..... DEKRA Testing and Certification (Suzhou) Co., Ltd.	
Address .....	No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
<b>Applicant's name</b> ..... Solenso electronic materials Co., LTD.	
Address .....	4F., No. 56, Zili 5th St., Zhongli Dist., Taoyuan City 320, Taiwan
<b>Test specification:</b>	
Standard.....	EN 50549-10:2022, NF EN 50549-10:2022 EN 50549-1:2019; EN 50549-1:2019/A1:2023, NF EN 50549-1:2019, NF EN 50549-1:2019/A1:2023 COMMISSION REGULATION (EU) 2016/631 (NC RfG)
Test procedure .....	Type test
Non-standard test method.....	N/A
<b>Test Report Form No.</b> ..... TRF No. EN 50549-1_V2.1	
Test Report Form(s) Originator .....	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Master TRF .....	Dated 2021-10-28
<b>Test item description</b> ..... Microinverter	
Trade Mark.....	
Manufacturer .....	Solenso electronic materials Co., LTD. 4F., No. 56, Zili 5th St., Zhongli Dist., Taoyuan City 320, Taiwan
Model/Type reference .....	SG1600, SG2000
Ratings .....	Operating temperature range: - 40°C to + 65°C Protective class: IP67 Power factor range (adjustable): -0.8(lagging)~0.8(leading) SG1600: DC: Voltage range:25-55 Vdc, Max Current: 4*14 A, AC: Max. Output Power: 1.6kVA, rated voltage: 230 Vac, Max. current: 6.96 A, 50 Hz, LN-PE SG2000: DC: Voltage range:25-55 Vdc, Max Current: 4*16 A, AC: Max. Output Power: 2kVA, rated voltage: 230 Vac, Max. current: 8.7 A, 50 Hz, LN-PE

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input checked="" type="checkbox"/>	Testing Laboratory:	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Testing location/ address:		No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
Tested by (name, function, signature) :		Shine Yan (ENG) 
Approved by (name, function, signature):		Sandy Qian (REW) 
<input type="checkbox"/>	Testing procedure: CTF Stage 1:	
Testing location/ address.....:		
Tested by (name, function, signature).....:		
Approved by (name, function, signature).....:		
<input type="checkbox"/>	Testing procedure: CTF Stage 2:	
Testing location/ address.....:		
Tested by (name + signature).....:		
Witnessed by (name, function, signature).....:		
Approved by (name, function, signature).....:		
<input type="checkbox"/>	Testing procedure: CTF Stage 3:	
<input type="checkbox"/>	Testing procedure: CTF Stage 4:	
Testing location/ address.....:		
Tested by (name, function, signature).....:		
Witnessed by (name, function, signature).....:		
Approved by (name, function, signature).....:		
Supervised by (name, function, signature).....:		

<b>List of Attachments (including a total number of pages in each attachment):</b> N/A	
<b>Summary of testing:</b>	
<b>Tests performed (name of test and test clause):</b>	<b>Testing location:</b>
<b>Original report 6196342.50B:</b>  All applicable tests were performed.	DEKRA Testing and Certification (Suzhou) Co., Ltd. No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
<b>Amendment 1 Report 6209657.50B:</b>  No testing.	
4.8 EMC and power quality – EMC test (The EMC test report provided by the customer) EMC Test report No.: 6196552.50, Issued by DEKRA Testing and Certification (Shanghai) Co., Ltd.	DEKRA Testing and Certification (Shanghai) Co., Ltd. No.250, Jiangchangsan Road, Jing'an District, Shanghai 200436, China

## Copy of marking plate:

**Solenso** PV Microinverter  
Model: SG1600

Max.Input Voltage	65V d.c.	Nominal Output Frequency	50Hz
Max. Continuous Input Current	14A*4 d.c.	Over Voltage Category	PV: II ,Mains: III
Range of MPPT Voltage	25-55(V)d.c.	MPPT Efficiency	99.9%
Min./Max. Start Voltage	22-60(V)d.c.	Peak Conversion Efficiency	96.5%
Max.Short-circuit Current	25A*4 d.c.	Protective Rating(IP)	IP67
Max. Continuous Output Power	1600VA	Protective Class	I
Max. Continuous Output Current	6.96A a.c	Pollution Degree	PD3
Output Power Factor	>0.99(Default)	Operating Ambient Temp	-40°C~+65°C
Nominal Output Voltage	230V a.c.		



 Solenso electronic materials Co., Ltd

**Solenso** PV Microinverter  
Model: SG2000

Max.Input Voltage	65V d.c.	Nominal Output Frequency	50Hz
Max. Continuous Input Current	16A*4 d.c.	Over Voltage Category	PV: II ,Mains: III
Range of MPPT Voltage	25-55(V)d.c.	MPPT Efficiency	99.9%
Min./Max. Start Voltage	22-60(V)d.c.	Peak Conversion Efficiency	96.5%
Max.Short-circuit Current	25A*4 d.c.	Protective Rating(IP)	IP67
Max. Continuous Output Power	2000VA	Protective Class	I
Max. Continuous Output Current	8.7A a.c	Pollution Degree	PD3
Output Power Factor	>0.99(Default)	Operating Ambient Temp	-40°C~+65°C
Nominal Output Voltage	230V a.c.		



 Solenso electronic materials Co., Ltd

## Remark:

According to customer's and market requirement, these models were evaluated under the grid voltage 230Vac and frequency of 50 Hz.

<b>Test item particulars:</b>				
Equipment mobility.....	: movable <u>fixed</u>	hand-held transportable	stationary for building-in	
Connection to the mains.....	: <u>pluggable equipment</u> permanent connection		direct plug-in for building-in	
Environmental category.....	: <u>outdoor</u>	indoor unconditional	indoor conditional	
Over voltage category Mains.....	: OVC I	OVC II	<u>OVC III</u>	OVC IV
Over voltage category PV.....	: OVC I	<u>OVC II</u>	OVC III	OVC IV
Mains supply tolerance (%).....	: -90 / +110 %			
Tested for power systems.....	: TN			
IT testing, phase-phase voltage (V).....	: N/A			
Class of equipment.....	: <u>Class I</u> Not classified	Class II	Class III	
Mass of equipment (kg).....	: 5.4 kg			
Pollution degree.....	: Outside PD3; Inside PD2			
IP protection class.....	: IP67			
<b>Possible test case verdicts:</b>				
- test case does not apply to the test object.....	: N/A			
- test object does meet the requirement.....	: P (Pass)			
- test object does not meet the requirement.....	: F (Fail)			
- this clause is information reference for installation....	: Info.			
<b>Testing:</b>				
Date of receipt of test item.....	: 2024-12-01 (samples provided by applicant)			
Date (s) of performance of tests.....	: 2024-12-01 to 2024-12-06			
<b>General remarks:</b>				
The test results presented in this report relate only to the object tested.				
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.				
Determination of the test result includes consideration of measurement uncertainty from the test equipment and methods.				
"(see Enclosure #)" refers to additional information appended to the report.				
"(see appended table)" refers to a table appended to the report.				
The unit under test complies with the following standards and regulations:				
EN 50549-10:2022, NF EN 50549-10:2022;				
EN 50549-1:2019; EN 50549-1:2019/A1:2023, NF EN 50549-1:2019, NF EN 50549-1:2019/A1:2023;				
COMMISSION REGULATION (EU) 2016/631 (NC RfG).				
The clause 4.8 EMC and power quality – EMC test is not in the IAS scope of DEKRA Testing and Certification (Suzhou) Co., Ltd.				
This test reports contains 4 parts listed as below:				
- 6209657.50A according to EN 50549-10:2022 (258 pages)				
- 6209657.50B according to EN 50549-1:2019 (Requirements for type A Generating Units) (39 pages)				
Throughout this report a 0 comma / 1 point is used as the decimal separator.				

**Name and address of factory (ies):**

Zhejiang Wellsun Intelligent Technology Co.,Ltd  
109 Yongchang Road, Shifeng Street, Tiantai County, Taizhou City, Zhejiang Province

**General product information:**

See test report No. 6209657.50A for reference

**Amendment 1**

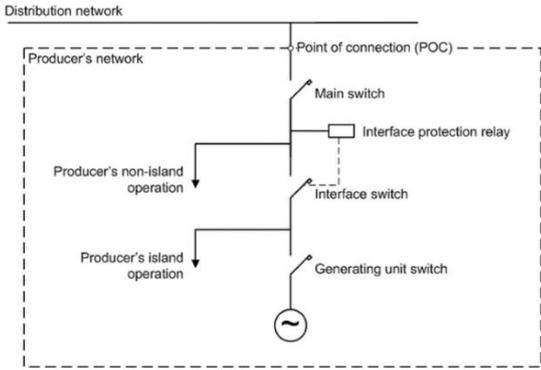
The report 6209657.50B was based on the report 6196342.50B issued by DEKRA Testing and Certification (Suzhou) Co., Ltd., issued on 2024-11-11, and COC No.: 6196342.01, COC No.: 6196342.02 issued by DEKRA Testing and Certification (Shanghai) Ltd., issued on 2024-11-11. It was issued due to below modifications:

---Update the the applicant, trade mark, model names and the marking plate.

After technical review, tests were not considered necessary.

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
<b>4</b>	<b>REQUIREMENTS ON GENERATING PLANTS</b>		P
<b>4.1</b>	<b>General</b>		P
	This clause defines the requirements on generating plants to be operated in parallel with the distribution network. Where settings or a range of configurability is provided and respecting the legal framework the configurations and settings may be provided by the DSO. Where no settings are provided by the DSO, the specified default settings shall be used; if no default settings are provided, the producer shall propose settings and inform the DSO.		P
	The requirements of Clause 4 apply during normal operation of the generating units and do not apply in case of maintenance or units out of operation. The provisions apply to ESS in generation mode. In charging mode EESS should have the same characteristics, unless stated otherwise in the clauses of this European Standard.		Info.
	The applicability is independent of the duration the generating unit operates in parallel with the distribution network. It is the responsibility of the DSO to relax, if deemed appropriate, the requirements for an individual generating unit or plant whose operation in parallel only lasts for a short time (temporary operation in parallel). The relaxed requirements shall be agreed between the DSO and the producer, along with the maximum allowable duration of the temporary operation in parallel.		P
	If different requirements on the generating plant interfere with each other, the following hierarchy in descending order shall be applied:		P
	<ol style="list-style-type: none"> <li>1. Generating unit protection, including regarding the prime mover;</li> <li>2. interface protection (see 4.9) and protection against faults within the generating plant;</li> <li>3. voltage support during faults and voltage steps (see 4.7.4);</li> <li>4. the lower value of: remote control command on active power limitation for distribution grid security (see 4.11) and local response to overfrequency (see 4.6.1);</li> <li>5. local response to underfrequency if applicable (see 4.6.2);</li> <li>6. reactive power (see 4.7.2) and active power (P(U) see 4.7.2) controls;</li> <li>7. other control commands on active power set point for e.g. market, economic reasons, self-consumption optimization.</li> </ol>		P
	The system shall be so designed that under foreseeable conditions no self-protection trips prior to the fulfilment of the requirements of this European Standard and all settings provided by the DSO or responsible party.		P

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	For cogeneration plants embedded in industrial sites, active power requirements shall be agreed between the responsible party and the producer. In such a case the priority list is adapted accordingly.		P
	Besides the requirements of Clause 4, additional requirements apply for connecting a generating plant to the distribution network, e.g. assessment of the point of connection. However, this is excluded from the scope of this European Standard but some guidance is provided in the informative Annex A.		P
	<p>“EN 50549-10 provides technical guidance for tests on generating units and interface protection to evaluate their electrical characteristics. EN 50549-10 shall be applied to evaluate the characteristics of generating units and interface protection used in generating plants relating to the requirements of this Standard. Electrical characteristics may alternatively be evaluated according to standards other than EN 50549-10, if the following prerequisites are fulfilled:</p> <p>— The alternative verification procedure covers all required technical aspects and characteristic quantities stipulated in EN 50549-1 and EN 50549-2, respectively. — The alternative verification procedure shall not be less stringent or technically less demanding than the correspondent verification procedure in EN 50549-10. — The alternative verification procedure leads to results of at least equivalent confidence level as EN 50549-10. — The equivalent or higher confidence level of the alternative verification procedure shall be confirmed by the entity stating compliance based upon these tests. — The entity stating compliance based upon these tests shall have sufficient expertise in both EN 50549-10 and the applied standard.</p> <p>NOTE This also applies for a partial application of another standard only for specific functions or operational capabilities</p>		P
<b>4.2</b>	<b>Connection scheme</b>		Info.
	The connection scheme of the generating plant shall be in compliance with the requirements of the DSO. Different requirements may be subject to agreement between the producer and the DSO depending on the power system needs.	It's depended on installer.	Info.
	Inter alia, the generating plant shall ensure the following:		Info.

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> <li>synchronization, operation and disconnection under normal network operating conditions, i.e. in the absence of faults or malfunctions;</li> <li>faults and malfunctions within the generating plant shall not impair the normal functioning of the distribution network;</li> <li>coordinated operation of the interface switch with the generating unit switch, the main switch and switches in the distribution network, for faults or malfunctions within the generating plant or the DSO network during operation in parallel with the distribution network; and</li> <li>disconnection of the generating plant from the distribution network by tripping the interface switch according to 4.9.</li> </ul>		Info.
	<p>In order to satisfy the above functions, coordinated but independent switches and protection equipment may be applied in the generating plant, as shown in the example in Figure 2.</p>  <p>Figure 2 — Example of an generating plant connected to a distribution network (schematic view of switches)</p>	It's depended on installer.	Info.
<b>4.3</b>	<b>Choice of switchgear</b>		P
4.3.1	General		P
	Switches shall be chosen based on the characteristics of the power system in which they are intended to be installed. For this purpose, the short circuit current at the installation point shall be assessed, taking into account, inter alia, the short circuit current contribution of the generating plant.		P
4.3.2	Interface switch		P
	Switches shall be power relays, contactors or mechanical circuit breakers each having a breaking and making capacity corresponding to the rated current of the generating plant and corresponding to the short circuit contribution of the generating plant.		P
	The short-time withstand current of the switching devices shall be coordinated with rated short circuit power at the point of connection.		P

EN 50549-1																								
Clause	Requirement - Test	Result - Remark	Verdict																					
	In case of loss of auxiliary supply power to the switchgear, a secure disconnection of the switch is required immediately.		P																					
	Where means of isolation (according to HD 60364-5-551) is not required to be accessible to the DSO at all times, automatic disconnection with single fault tolerance according to 4.13 shall be provided.		P																					
	The function of the interface switch might be combined with either the main switch or the generating unit switch in a single switching device. In case of a combination, the single switching device shall be compliant to the requirements of both, the interface switch and the combined main switch or generating unit switch. As a consequence, at least two switches in series shall be present between any generating unit and the POC.		P																					
<b>4.4</b>	<b>Normal operating range</b>		P																					
4.4.1	General		P																					
	Generating plants when generating power shall have the capability to operate in the operating ranges specified below regardless of the topology and the settings of the interface protection.		P																					
4.4.2	Operating frequency range		P																					
	<p>The generating plant shall be capable of operating continuously when the frequency at the point of connection stays within the range of 49 Hz to 51 Hz.</p> <p>In the frequency range from 47 Hz to 52 Hz the generating plant should be capable of operating until the interface protection trips. Therefore, the generating plant shall at least be capable of operating in the frequency ranges, for the duration and for the minimum requirement as indicated in Table 1.</p> <p><b>Table 1 — Minimum time periods for operation in underfrequency and overfrequency situations</b></p> <table border="1"> <thead> <tr> <th>Frequency Range</th> <th>Time period for operation Minimum requirement</th> <th>Time period for operation stringent requirement</th> </tr> </thead> <tbody> <tr> <td>47,0 Hz – 47,5 Hz</td> <td>not required</td> <td>20 s</td> </tr> <tr> <td>47,5 Hz – 48,5 Hz</td> <td>30 min <sup>a</sup></td> <td>90 min</td> </tr> <tr> <td>48,5 Hz – 49,0 Hz</td> <td>30 min <sup>a</sup></td> <td>90 min <sup>a</sup></td> </tr> <tr> <td>49,0 Hz – 51,0 Hz</td> <td>Unlimited</td> <td>Unlimited</td> </tr> <tr> <td>51,0 Hz – 51,5 Hz</td> <td>30 min <sup>a</sup></td> <td>90 min</td> </tr> <tr> <td>51,5 Hz – 52,0 Hz</td> <td>not required</td> <td>15 min</td> </tr> </tbody> </table> <p><sup>a</sup> Respecting the legal framework, it is possible that longer time periods are required by the responsible party in some synchronous areas.</p>	Frequency Range	Time period for operation Minimum requirement	Time period for operation stringent requirement	47,0 Hz – 47,5 Hz	not required	20 s	47,5 Hz – 48,5 Hz	30 min <sup>a</sup>	90 min	48,5 Hz – 49,0 Hz	30 min <sup>a</sup>	90 min <sup>a</sup>	49,0 Hz – 51,0 Hz	Unlimited	Unlimited	51,0 Hz – 51,5 Hz	30 min <sup>a</sup>	90 min	51,5 Hz – 52,0 Hz	not required	15 min	(See appended table)	P
Frequency Range	Time period for operation Minimum requirement	Time period for operation stringent requirement																						
47,0 Hz – 47,5 Hz	not required	20 s																						
47,5 Hz – 48,5 Hz	30 min <sup>a</sup>	90 min																						
48,5 Hz – 49,0 Hz	30 min <sup>a</sup>	90 min <sup>a</sup>																						
49,0 Hz – 51,0 Hz	Unlimited	Unlimited																						
51,0 Hz – 51,5 Hz	30 min <sup>a</sup>	90 min																						
51,5 Hz – 52,0 Hz	not required	15 min																						
	This permission does not affect the requirements for interface protection according to clause 4.9. In this case over and under frequency machine protection might trip prior to interface protection. If an integrated interface protection device is used, the reduction of the configuration range of the interface protection in clause 4.9 is acceptable.		P																					
4.4.3	Minimal requirement for active power delivery at underfrequency		P																					

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	<p>A generating plant shall be resilient to the reduction of frequency at the point of connection while reducing the maximum active power as little as possible.</p> <p>The admissible active power reduction due to underfrequency is limited by the full line in Figure 5 and is characterized by a maximum allowed reduction rate of 10% of <math>P_{max}</math> per 1 Hz for frequencies below 49.5 Hz.</p> <p>Figure 5 — Maximum allowable power reduction in case of underfrequency</p>	(See appended table)	P
	<p>It is possible that a more stringent power reduction characteristic is required by the responsible party. Nevertheless this requirement is expected to be limited to an admissible active power reduction represented by the dotted line in Figure 5 which is characterised by a reduction rate of 2 % of the maximum power <math>P_{max}</math> per 1 Hz for frequencies below 49 Hz.</p>		P
	<p>If any technologies intrinsic design or ambient conditions have influence on the power reduction behaviour of the system, the manufacturer shall specify at which ambient conditions the requirements can be fulfilled and eventual limitations. The information can be provided in the format of a graph showing the intrinsic behaviour of the generating unit for example at different ambient conditions. The power reduction and the ambient conditions shall comply with the specification given by the responsible party. If the generating unit does not meet the power reduction at the specified ambient conditions, the producer and the responsible party shall agree on acceptable ambient conditions.</p>		P
4.4.4	Continuous operating voltage range		P
	<p>When generating power, the generating plant shall be capable of operating continuously when the voltage at the point of connection stays within the range of 85 % <math>U_n</math> to 110 % <math>U_n</math>. Beyond these values the under and over voltage ride through immunity limits as specified in clause 4.5.3 and 4.5.4 shall apply.</p>	(see appended table)	P

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	In case of voltages below $U_n$ , it is allowed to reduce the apparent power to maintain the current limits of the generating plant. The reduction shall be as small as technically feasible.		P
	For this requirement all phase to phase voltages and in case a neutral is connected, additionally all phase to neutral voltages shall be evaluated.		P
	The producer shall take into account the typical voltage rise and voltage drop within the generating plant.		Info.
<b>4.5</b>	<b>Immunity to disturbances</b>		P
4.5.1	General		P
	In general, generating plants should contribute to overall power system stability by providing immunity towards dynamic voltage changes unless safety standards require a disconnection.		P
	The following clauses describe the required immunity for generating plants taking into account the connection technology of the generating modules.		P
	The following withstand capabilities shall be provided regardless of the settings of the interface protection.		P
	The described immunity requirements are independent of the interface protection settings. Disconnection settings of the interface protection relay always overrule technical capabilities. So, whether the generating plant will stay connected or not will also depend upon those settings		P
4.5.2	Rate of change of frequency (ROCOF) immunity	(see appended table)	P
	“ROCOF immunity of a power generating plant means that the generating modules in this plant stay connected with the distribution network and are able to operate when the frequency on the distribution network changes with a specified ROCOF. The generating units and all elements in the generating plant that might cause their disconnection or impact their behaviour shall have the same level of immunity.		P
	The generating modules in a generating plant shall have ROCOF immunity for a ROCOF equal or exceeding the value specified by the responsible party. If no ROCOF immunity value is specified, the following ROCOF immunity shall apply, making distinction between generating technologies:		P
	<ul style="list-style-type: none"> <li>Non-synchronous generating technology: at least 2 Hz/s</li> </ul>		P
	<ul style="list-style-type: none"> <li>Synchronous generating technology: at least 1 Hz/s</li> </ul>		N/A
	The ROCOF immunity is defined with a sliding measurement window of 500 ms.		P
4.5.3	Under-voltage ride through (UVRT)		P
4.5.3.1	General		P

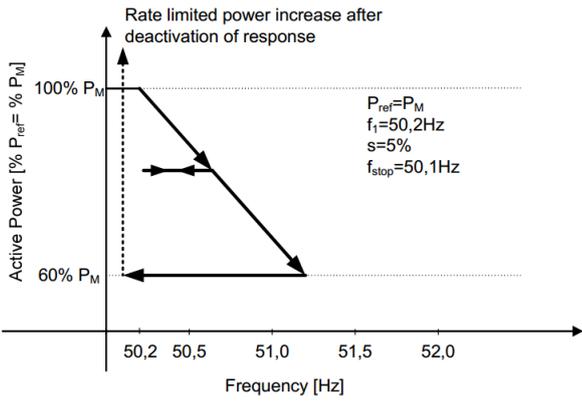
EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	"Generating modules shall comply with the requirements of 4.5.3.2 and 4.5.3.3.		P
	Exempted from this requirement are small generating units below 50 kW of the following generation technologies: CHP, fuel cell, rotating machinery, hydro.		P
	The requirements apply to all kinds of faults (1ph, 2ph and 3ph). NOTE 2 A more distinctive differentiation for 1ph, 2ph and 3ph faults is under consideration. NOTE 3 The FRT curves in Figure 6, Figure 7 and Figure 8 describe the minimum requirements for continued connection of the generating plant to the grid. They are not designed for parameterising the interface protection		P
	The requirements apply to all kinds of faults (1ph, 2ph and 3ph)		P
4.5.3.2	Generating plant with non-synchronous generating technology		P
	<p>Generating modules shall be capable of remaining connected to the distribution network as long as the voltage at the point of connection remains above the voltage-time curve of Figure 6. The voltage is relative to <math>U_n</math>. The smallest phase to neutral voltage, or if no neutral is present, the smallest phase to phase voltage shall be evaluated.</p> <p>Figure 6 — Under-voltage ride through capability for non-synchronous generating technology</p>	(see appended table)	P
	The responsible party may define a different UVRT characteristic. Nevertheless, this requirement is expected to be limited to the most stringent curve as indicated in Figure 6.		P
	This means that the whole generating module has to comply with the UVRT requirement. This includes all elements in a generating plant: the generating units and all elements that might cause their disconnection.		P
	For the generating unit, this requirement is considered to be fulfilled if it stays connected to the distribution grid as long as the voltage at its terminals remains above the defined voltage-time diagram.		P

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	After the voltage returns to continuous operating voltage range, 90 % of pre-fault power or available power whichever is the smallest shall be resumed as fast as possible, but at the latest within 1 s unless the DSO and the responsible party requires another value.		P
4.5.3.3	Generating plant with synchronous generating technology	Not synchronous generator.	N/A
	Generating modules shall be capable of staying connected to the distribution network as long as the voltage at the point of connection remains above the voltage-time curve of Figure 7. The voltage is relative to $U_n$ . The smallest phase to neutral voltage or if no neutral is present the smallest phase to phase voltage shall be evaluated.		N/A
	<p>Figure 7 — Under-voltage ride through capability for synchronous generating technology</p>		
4.5.4	Over-voltage ride through (OVRT)		P
	“Generating modules shall be capable of staying connected to the distribution network as long as the voltage at the point of connection remains below the voltage-time curve of Figure 8.	(see appended table)	P
	<p>Figure 8 — Over-voltage ride through capability</p>		
	The highest phase to neutral voltage or if no neutral is present the highest phase to phase voltage shall be evaluated.		P
	This means that not only the generating units shall comply with this OVRT requirement but also all elements in a generating plant that might cause its disconnection.		P
4.5.5	Phase jump immunity		P

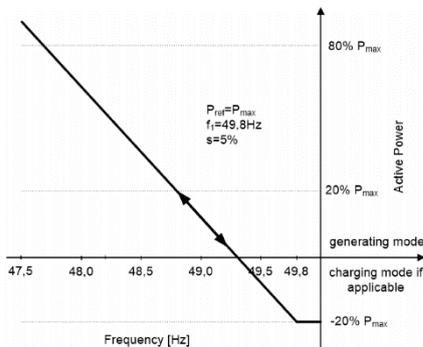
EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
	Phase jump immunity of a power generating plant means that the generating modules in this plant stay connected with the distribution network and are able to operate during and after the occurrence of a phase jump. The generating units and all elements in the generating plant that might cause their disconnection or impact their behaviour shall have the same level of immunity.		P
	The generating modules in a generating plant shall have phase jump immunity equal to or exceeding 20° in case of a symmetrical phase jump.		P
	After the phase jump, 90 % of pre-fault power or available power whichever is the smallest shall be resumed as fast as possible, but at the latest within 3 s in case of synchronous generating technologies and within 1 s in case of non-synchronous generating technologies.		P
<b>4.6</b>	<b>Active response to frequency deviation</b>		P
4.6.1	Power response to over-frequency		P
	Generating plants shall be capable of activating active power response to over-frequency at a programmable frequency threshold $f_1$ at least between and including 50,2 Hz and 52 Hz with a programmable droop in a range of at least $s=2\%$ to $s=12\%$ . The droop reference is $P_{ref}$ . Unless defined differently by the responsible party:		P
	<ul style="list-style-type: none"> <li><math>P_{ref} = P_{max}</math>, in the case of synchronous generating technology and electrical energy storage systems</li> </ul>		N/A
	<ul style="list-style-type: none"> <li><math>P_{ref} = P_M</math>, the actual AC output power at the instant when the frequency reaches the threshold <math>f_1</math>, in the case of all other non-synchronous generating technology</li> </ul>		P
	The power value calculated according to the droop is a maximum power limit. If e.g. the available primary power decreases during a high frequency period below the power defined by the droop function, lower power values are permitted.		P
	<p>The maximum power limit is:</p> $P_{max-limit} = P_M + \Delta P$ <p>with <math>\Delta P = \frac{1}{s} \cdot \frac{(f_1 - f)}{f_n} \cdot P_{ref}</math></p> <p>with <math>f</math> the actual frequency</p>		P
	The generating plant shall be capable of activating active power response to over-frequency as fast as technically feasible with an intrinsic dead time that shall be as short as possible with a maximum of 2 s and with a step response time of maximum 30 s, unless another value is defined by the relevant party. An intentional delay shall be programmable to adjust the dead time to a value between the intrinsic dead time and 2 s.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>After activation, the active power frequency response shall use the actual frequency at any time, reacting to any frequency increase or decrease according to the programmed droop with an accuracy of <math>\pm 10\%</math> of the nominal power (see Figure 9). The resolution of the frequency measurement shall be <math>\pm 10</math> mHz or less. The accuracy is evaluated with a 1 min average value. At POC, loads if present in the producer's network might interfere with the response of the generating plant. The effect of loads is not considered for the evaluation of the accuracy, only the behaviour of the generating plant is relevant.</p> <p style="text-align: center;">Figure 9 — Example of Active power frequency response to overfrequency</p>	(see appended table)	P
	<p>Generating plants reaching their minimum regulating level shall, in the event of further frequency increase, maintain this power level constant unless the DSO and the responsible party requires to disconnect the complete plant or if the plant consists of multiple units by disconnecting individual units.</p>		P
	<p>The active power frequency response is only deactivated if the frequency falls below the frequency threshold <math>f_1</math>.</p>		P

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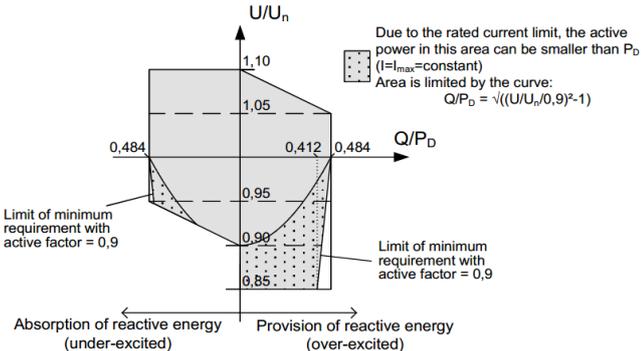
Clause	Requirement - Test	Result - Remark	Verdict																		
	<p>If required by the DSO and the responsible party an additional deactivation threshold frequency <math>f_{stop}</math> shall be programmable in the range of at least 50 Hz to <math>f_1</math>. If <math>f_{stop}</math> is configured to a frequency below <math>f_1</math> there shall be no response according to the droop in case of a frequency decrease (see Figure 10). The output power is kept constant until the frequency falls below <math>f_{stop}</math> for a configurable time <math>t_{stop}</math>.</p>  <p>Figure 10 — Example of active power frequency response to overfrequency with configured deactivation threshold</p>	(see appended table)	P																		
	<p>If at the time of deactivation of the active power frequency response the momentary active power <math>P_M</math> is below the available active power <math>P_A</math>, the active power increase of the generating plant shall not exceed the gradient defined in 4.10.2.</p>		P																		
	<p>Settings for the threshold frequency <math>f_1</math>, the droop and the intentional delay are provided by the DSO and the responsible party. If no settings are provided, the default settings in Table 2 should be applied.</p> <p><b>Table 2 — Standard settings for frequency response to overfrequency</b></p> <table border="1" data-bbox="304 1377 967 1585"> <thead> <tr> <th>Parameter</th> <th>Range</th> <th>Default setting</th> </tr> </thead> <tbody> <tr> <td>Threshold frequency <math>f_1</math></td> <td>50,2 Hz to 52 Hz</td> <td>50,2 Hz</td> </tr> <tr> <td>Deactivation threshold <math>f_{stop}</math></td> <td>50,0 Hz to <math>f_1</math></td> <td>Deactivated</td> </tr> <tr> <td>Deactivation time <math>t_{stop}</math></td> <td>0 to 600 s</td> <td>30s</td> </tr> <tr> <td>Droop</td> <td>2 % to 12 %</td> <td>5 %</td> </tr> <tr> <td>Intentional delay</td> <td>0 s to 2 s</td> <td>0 s</td> </tr> </tbody> </table>	Parameter	Range	Default setting	Threshold frequency $f_1$	50,2 Hz to 52 Hz	50,2 Hz	Deactivation threshold $f_{stop}$	50,0 Hz to $f_1$	Deactivated	Deactivation time $t_{stop}$	0 to 600 s	30s	Droop	2 % to 12 %	5 %	Intentional delay	0 s to 2 s	0 s		P
Parameter	Range	Default setting																			
Threshold frequency $f_1$	50,2 Hz to 52 Hz	50,2 Hz																			
Deactivation threshold $f_{stop}$	50,0 Hz to $f_1$	Deactivated																			
Deactivation time $t_{stop}$	0 to 600 s	30s																			
Droop	2 % to 12 %	5 %																			
Intentional delay	0 s to 2 s	0 s																			
	<p>When applying active power response to overfrequency, the frequency threshold <math>f_1</math> should be set to a value from 50,2 Hz up to 50,5 Hz. Setting the frequency threshold <math>f_1</math> to 52 Hz is considered as deactivating this function.</p>		P																		
	<p>The enabling and disabling of the function and its settings shall be field adjustable and means shall be provided to protect these from unpermitted interference (e.g. password or seal) if required by the DSO and the responsible party.</p>		P																		
	<p>Alternatively for the droop function described above, the following procedure is allowed for generating modules if permitted by the DSO and the responsible party:</p>		P																		

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Clause	Requirement - Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> <li>the generating units shall disconnect at randomized frequencies, ideally uniformly distributed between the frequency threshold <math>f_1</math> and 52 Hz;</li> </ul>		P
	<ul style="list-style-type: none"> <li>in case the frequency decreases again, the generating unit shall start its reconnection procedure once the frequency falls below the specific frequency that initiated the disconnection; for this procedure, the connection conditions described in 4.10 do not apply;</li> </ul>		P
	<ul style="list-style-type: none"> <li>the randomization shall either be at unit level by changing the threshold over time, or on plant level by choosing different values for each unit within a plant, or on distribution system level if the DSO specifies a specific threshold for each plant or unit connected to its distribution system.</li> </ul>		P
	EES units upon reaching zero power output shall continue to follow the configured droop by switching into charging mode. EES units that are in charging mode shall increase the charging power according to the configured droop. In both cases, the minimum regulating level is considered as the maximum charging power taking the state of charge of the storage into account. In case the maximum charging capacity is reached or to prevent any other risk of injury or damage of equipment, a reduction of charging power is permitted		N/A
4.6.2	Power response to underfrequency		P
	EES units shall be capable of activating active power response to underfrequency. Other generating units/plants should be capable of activating active power response to underfrequency. If active power to underfrequency is provided by a generating plant/unit, the function shall comply with the requirements below.		N/A
	Active power response to under-frequency shall be provided when all of the following conditions are met:		P
	<ul style="list-style-type: none"> <li>when generating, the generating unit is operating at active power below its maximum active power <math>P_{max}</math>;</li> </ul>		P
	<ul style="list-style-type: none"> <li>when generating, the generating unit is operating at active power below the available active power <math>P_A</math>;</li> </ul>		P
	<ul style="list-style-type: none"> <li>the voltages at the point of connection of the generating plant are within the continuous operating voltage range; and</li> </ul>		P
	<ul style="list-style-type: none"> <li>when generating, the generating unit is operating with currents lower than its current limit.</li> </ul>		P
	In the case of EES units, active power frequency response to under-frequency shall be provided in charging and generating mode.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>The active power response to underfrequency shall be delivered at a programmable frequency threshold <math>f_1</math> at least between and including 49,8 Hz and 46,0 Hz with a programmable droop in a range of at least 2 % to 12 %.</p> <p>The droop reference <math>P_{ref}</math> is <math>P_{max}</math>. If the available primary power or a local set value increases during an underfrequency period above the power defined by the droop function, higher power values are permitted. The power value calculated according to the droop is therefore a minimum limit.</p> <p>The minimum power limit is,</p> $P_{min-limit} = P_M + \Delta P$ <p>with <math>\Delta P = \frac{1}{s} \times \frac{(f_1 - f)}{fn} \times Pref</math></p> <p>with <math>f</math> the actual frequency.</p>		P
	<p>The generating unit shall be capable of activating active power response to underfrequency as fast as technically feasible with an intrinsic dead time that shall be as short as possible with a maximum of 2 s and with a step response time of maximum 30 s unless another value is defined by the relevant party.</p>		P
	<p>An intentional initial delay shall be programmable to adjust the dead time to a value between the intrinsic dead time and 2 s.</p>  <p>Figure 11 — Example of active power frequency response to underfrequency in case of storage device with 20 % power charging at passing of threshold frequency <math>f_1</math>.</p>		P
	<p>After activation, the active power frequency response shall use the actual frequency at any time, reacting to any frequency increase or decrease according to the programmed droop with an accuracy of <math>\pm 10</math> % of the nominal power. The accuracy is evaluated with a 1 min average value. The resolution of the frequency measurement shall be <math>\pm 10</math> mHz or less. At POC loads, if present in the producer's network, might interfere with the response of the generating plant. The effect of loads is not considered for the evaluation of the accuracy, only the behaviour of the generating plant is relevant.</p>		P
	<p>Generating modules reaching any of the conditions above during the provision of active power frequency response shall, in the event of further frequency decrease, maintain this power level constant.</p>		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The active power frequency response is only deactivated if the frequency increases above the frequency threshold $f_1$ .		P
	Settings for the threshold frequency $f_1$ , the droop and the intentional delay are defined by the DSO and the responsible party, if no settings are provided, the function shall be disabled.		P
	The activation and deactivation of the function and its settings shall be field adjustable and means shall be provided to protect these from unpermitted interference (e.g. password or seal) if required by the DSO and the responsible party.		P
<b>4.7</b>	<b>Power response to voltage changes</b>		P
4.7.1	General		P
	When the contribution to voltage support is required by the DSO and the responsible party, the generating plant shall be designed to have the capability of managing reactive and/or active power generation according to the requirements of this clause.		P
4.7.2	Voltage support by reactive power		P
4.7.2.1	General		P
	Generating plants shall not lead to voltage changes out of acceptable limits. These limits should be defined by national regulation. Generating units and plants shall be able to contribute to meet this requirement during normal network operation.		P
	Throughout the continuous operating frequency (see 4.4.2) and voltage (see 4.4.4) range, the generating plant shall be capable to deliver the requirements stipulated below. Outside these ranges, the generating plant shall follow the requirements as good as technically feasible although there is no specified accuracy required.		P
4.7.2.2	Capabilities		P
	<p>Figure 12 — Reactive power capability at nominal voltage</p>	(see appended table)	P
	Figure 12 gives a graphical representation of the minimum and optional capabilities at nominal voltage.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Unless specified differently below, for specific generating technologies, generating plants shall be able to operate with active factors as defined by the DSO and the responsible party from active factor = 0,90 <sub>underexcited</sub> to active factor = 0,90 <sub>overexcited</sub>		P
	The reactive power capability shall be evaluated at the terminals of the / each generating unit.		P
	CHP generating units with a capacity < 150 kVA shall be able to operate with active factors as defined by DSO from $\cos \varphi = 0,95$ <sub>underexcited</sub> to $\cos \varphi = 0,95$ <sub>underexcited</sub> to $\cos \varphi = 0,95$ <sub>overexcited</sub>		N/A
	Generating units with an induction generator coupled directly to the grid and used in generating plants above micro generating level, shall be able to operate with active factors as defined by the DSO from $\cos \varphi = 0,95$ <sub>underexcited</sub> to $\cos \varphi = 1$ at the terminals of the unit. Deviating from 4.7.2.3 point mode is required. Deviating from the accuracy requirements below, the accuracy is only required at active power $P_D$ .		N/A
	Generating units with an induction generator coupled directly to the grid and used in micro generating plants shall operate with an active factor above 0,95 at the terminals of the generating unit. A controlled voltage support by reactive power is not required from this technology.		N/A
	Generating units with linear generators, coupled directly and synchronously to the grid shall operate with an active factor above 0,95 at the terminals of the generating unit, and therefore a controlled voltage support by reactive power is not required from this technology.		N/A
	In case of different generating technologies with different requirements in one generating plant, each unit shall provide voltage support by reactive power as required for its specific technology. A compensation of one technology to reach the general plant requirement is not expected.		P
	The DSO and the responsible party may relax the above requirements. This relaxation might be general or specific for a certain generating plant or generating technology.		P
	On request, the manufacturer shall provide to all involved parties information documenting the actual choices regarding active power capabilities relative to reactive power requirements and related to the power rating in the operating voltage range (see further in this clause). A P-Q Diagram shall be included in the product documentation of a generating unit.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	When operating above the apparent power threshold $S_{\min}$ equal to 10 % of the maximum apparent power $S_{\max}$ or the minimum regulating level of the generating plant, whichever is the higher value, the reactive power capability shall be provided with an accuracy of $\pm 2\%$ $S_{\max}$ . Up to this apparent power threshold $S_{\min}$ , deviations above 2 % are permissible; nevertheless the accuracy shall always be as good as technically feasible and the exchange of uncontrolled reactive power in this low-power operation mode shall not exceed 10 % of the maximum apparent power $S_{\max}$ . At POC loads, if present in the producer's network might interfere with the response of the generating plant. The effect of loads is not considered for the evaluation of the accuracy, only the behaviour of the generating plant is relevant.		P
	For generating units with a reactive power capability according Figure 12 the reactive power capability at active power $P_D$ shall be at least according Figure 13. For generating units with a reduced reactive power capability Figure 13 is only applicable up to the maximum reactive power capability. 		P
	NOTE 5 Depending on the P-Q characteristic of the generating plant/unit, the reactive power at active powers below $P_D$ might be lower respecting the requirements above. If no or less than 0,484 $Q/P_D$ reactive power is required, the active power might increase above $P_D$ as indicated in Figure 12.		P
	For voltages below $U_n$ it is allowed to reduce apparent power according to 4.4.4.		P
4.7.2.3	Control modes		P
4.7.2.3.1	General		P
	The control shall refer to the terminals of the generating units The generating plant/unit shall be capable of operating in the control modes specified below within the limits specified in 4.7.2.2. The control modes are exclusive; only one mode may be active at a time.		P
	<ul style="list-style-type: none"> <li>Q setpoint mode</li> </ul>	(see appended table)	P
	<ul style="list-style-type: none"> <li>Q (U)</li> </ul>	(see appended table)	P

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Clause	Requirement - Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> <li>• Cos <math>\varphi</math> setpoint mode</li> </ul>	(see appended table)	P
	<ul style="list-style-type: none"> <li>• Cos (P)</li> </ul>	(see appended table)	P
	For mass market products, it is recommended to implement all control modes. In case of site specific generating plant design, only the control modes required by the DSO need to be implemented.		P
	The configuration, activation and deactivation of the control modes shall be field adjustable. For field adjustable configurations and activation of the active control mode, means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO. Which control modes are available in a product and how they are configured shall be stated in the product documentation.		P
4.7.2.3.2	Setpoint control modes	(see appended table)	P
	Q setpoint mode and cos $\varphi$ setpoint mode control the reactive power output and the cos $\varphi$ of the output respectively, according to a set point set in the control of the generating plant/unit.  In the case of change of the set point local or by remote control the settling time for the new set point shall be less than one minute.		P
4.7.2.3.3	Voltage related control mode	(see appended table)	P
	The voltage related control mode Q (U) controls the reactive power output as a function of the voltage.		P
	There is no preferred state of the art for evaluating the voltage. Therefore it is the responsibility of the generating plant designer to choose a method. One of the following methods should be used:		P
	<ul style="list-style-type: none"> <li>• the positive sequence component of the fundamental;</li> </ul>		P
	<ul style="list-style-type: none"> <li>• the average of the voltages measured independently for each phase to neutral or phase to phase;</li> </ul>		P
	<ul style="list-style-type: none"> <li>• phase independently the voltage of every phase to determine the reactive power for every phase.</li> </ul>		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>For voltage related control modes, a characteristic with a minimum and maximum value and three connected lines according to Figure 16 shall be configurable.</p> <p><b>Figure 16 — Example characteristics for Q respectively cos φ control mode</b></p>		P
	<p>In addition to the characteristic, further parameters shall be configurable:</p>		P
	<ul style="list-style-type: none"> <li>The dynamics of the control shall correspond with a first order filter having a time constant that is configurable in the range of 3 s to 60 s.</li> </ul>		P
	<p>NOTE 1 The time to perform 95 % of the changed set point due to a change in voltage will be 3 times the time constant.</p>		Info.
	<p>To limit the reactive power at low active power two methods shall be configurable:</p>		P
	<ul style="list-style-type: none"> <li>a minimal cos φ shall be configurable in the range of 0-0.95;</li> </ul>		P
	<ul style="list-style-type: none"> <li>two active power levels shall be configurable both at least in the range of 0 % to 100 % of P<sub>D</sub>. The lock-in value turns the Q(U) mode on, the lock-out value turns Q(U) off. If lock-in is larger than lock-out a hysteresis is given. See also Figure 14.</li> </ul> <p><b>Figure 14 – Example of lock-in and lock-out values for Q(U) mode</b></p>		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>The static accuracy shall be in accordance with 4.7.2.2. The dynamic accuracy shall be in accordance with Figure 15 with a maximum tolerance of <math>\pm 5\%</math> of <math>P_D</math> plus a time delay of up to 3 seconds deviating from an ideal first order filter response.</p> <p>Figure 15 — Example of dynamic control response and tolerance band for a step from <math>Q=0</math> to <math>Q=33\%P_D</math> with <math>\tau=3,33s</math></p>		P
4.7.2.3.4	Power related control mode	(see appended table)	P
	The power related control mode $\cos \varphi$ (P) controls the output as a function of the active power output.		P
	For power related control modes, a characteristic with a minimum and maximum value and three connected lines shall be configurable in accordance with Figure 16.		P
	Resulting from a change in active power output a new $\cos \varphi$ set point is defined according to the set characteristic. The response to a new $\cos \varphi$ set value shall be as fast as technically feasible to allow the change in reactive power, The new reactive power set value shall be reached at the latest within 10 s after the end value of the active power is reached, the static accuracy of each $\cos$ set point shall be according to 4.7.2.2		P
4.7.3	Voltage related active power reduction		P
	“In order to avoid disconnection due to overvoltage protection (see 4.9.2.3 and 4.9.2.4), generating plants/units are allowed to reduce active power output as a function of this rising voltage. The final implemented logic can be chosen by the manufacturer. Nevertheless, this logic shall not cause steps or oscillations in the output power. The power reduction caused by such a function shall not be faster than the equivalent of a first order filter with a time constant $\tau = 3$ s. The enabling and disabling of the function shall be field adjustable and means have to be provided to protect the setting from unpermitted interference (e.g. password or seal) if required by the DSO	(see appended table)	P
4.7.4	Short circuit current requirements on generating plants		N/A
4.7.4.1	General		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	The following clauses describe the required short circuit current contribution for generating plants taking into account the connection technology of the generating modules.	Type A generator	N/A
	Generating modules classified as type B modules according to COMMISSION REGULATION 2016/631 shall comply with the requirements of 4.7.4.2 and 4.7.4.3.		N/A
	Generating modules classified as type A according to COMMISSION REGULATION 2016/631 should comply with these requirements. The actual behaviour of type A modules shall be specified in the connection agreement.		N/A
4.7.4.2	Generating plant with non-synchronous generating technology		P
4.7.4.2.1	Voltage support during faults and voltage steps		P
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN 50549-2 applies		P
4.7.4.2.2	Zero current mode for converter connected generating technology		P
	If UVRT capability (see 4.5.3) is provided additional to the requirements of 4.5, generating units connected to the grid by a converter shall have the capability to reduce their current as fast as technically feasible down to or below 10 % of the rated current when the voltage is outside of a static voltage range. Generating units based on a doubly fed induction machine can only reduce the positive sequence current below 10 % of the rated current. Negative sequence current shall be tolerated during unbalanced faults. In case this current reduction is not sufficient, the DSO should choose suitable interface protection settings.		P
	The static voltage range shall be adjustable from 20 % to 100 % of $U_n$ for the under-voltage boundary and from 100 % to 130 % of $U_n$ for the overvoltage boundary. The default setting shall be 50% of $U_n$ for the under-voltage boundary and 120% of $U_n$ for the overvoltage boundary. Each phase to neutral voltage or if no neutral is present each phase to phase voltage shall be evaluated. At voltage re-entry into the voltage range, 90% of pre-fault power or available power, whichever is the smallest, shall be resumed as fast as possible, but at the latest according to 4.5.3 and 4.5.4.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>All described settings are defined by the DSO and the responsible party. If no settings are provided, the function shall be disabled.</p> <p>The enabling and disabling and the settings shall be field adjustable and means have to be provided to protect these from unpermitted interference (e.g. password or seal) if required by the DSO.</p>		P
4.7.4.2.3	Induction generator based units	The inverter was not induction generator.	N/A
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN50549-2 applies.		N/A
4.7.4.3	Generating plant with synchronous generating technology - Synchronous generator based units	The inverter is not belonged synchronous generating technology.	N/A
	In general no voltage support during faults and voltage steps is required from generating plants connected in LV distribution networks as the additional reactive current is expected to interfere with grid protection equipment. If the responsible party requires voltage support during faults and voltage steps for generating plants of type B connected to LV distribution grids, the clause 4.7.4 of EN50549-2 applies.		N/A
<b>4.8</b>	<b>EMC and power quality</b>		P
	Similar to any other apparatus or fixed installation, generating units shall comply with the requirements on electromagnetic compatibility established in Directive 2014/30/EU or 2014/53/EU, whichever applies.	See EMC report No. TW202310-026. which complies with EN 61000	P
	EMC limits and tests, described in EN 61000 series, have been traditionally developed for loads, without taking into account the particularities of generating units, such as their capability to create overvoltages or high frequency disturbances due to the presence of power converters, which were either impossible or less frequent in case of loads.		Info.

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>NOTE 1 Currently, IEC SC 77A are reviewing all their existing standards to include, where necessary, specific requirements for generating units/plants. For dispersed generating units in LV networks, the Technical Report IEC/TR 61000-3-15 is addressing gaps in the existing EMC standards making recommendations on the following aspects:</p> <ul style="list-style-type: none"> <li>• Harmonic emissions;</li> <li>• Flicker and voltage fluctuations;</li> <li>• DC injection;</li> <li>• Short and long duration overvoltages emission;</li> <li>• Switching frequency emission;</li> <li>• Immunity to voltage dips and short interruptions;</li> <li>• Immunity to frequency variation;</li> <li>• Immunity to harmonics and inter-harmonics;</li> <li>• Unbalance.</li> </ul>		Info.
	As long as specific tests for generating units are not available for immunity and/or emission, generic EMC standards and/or any relevant EU harmonized EMC standard should be applied.	See EMC report No. TW202310-026. which complies with EN 61000	P
	NOTE 2 Besides the compliance with EN 61000 Series, in most countries power quality characteristic according to standards such as for example EN 61400-21 or VDE V 0124-100 are required as part of the connection agreement.		P
	Additional phenomena need to be addressed specifically to generating plants and their integration in the power system.		P
	<ul style="list-style-type: none"> <li>• ROCOF: See 4.5.2</li> </ul>	(see appended table)	P
	<ul style="list-style-type: none"> <li>• UVRT: See 4.5.3</li> </ul>		P
	<ul style="list-style-type: none"> <li>• OVRT: See 4.5.4</li> </ul>		P
	<ul style="list-style-type: none"> <li>• DC injection: Generating plants shall not inject direct currents.</li> </ul>	(see appended table)	P
	NOTE 3 The DC injection clause is considered to be passed when for all generating units within the generating plant the measured DC injection of a type-tested unit is below the testing threshold.		P
	Generating plants can also disturb mains signalling (ripple control or power line carrier systems). EMC requirements on inter-harmonics and on conducted disturbances in the frequency range between 2 kHz and 150 kHz are under development. In case of electromagnetic interferences to mains signalling systems due to the connection of a generating plant, mitigation measures should be taken and national requirements may apply.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Generating units are also expected to be compatible with voltage characteristics at the point of connection, as described in EN 50160 or in national regulations; however no compliance test is required due to the scope of EN 50160.		P
<b>4.9</b>	<b>Interface protection</b>		P
4.9.1	General		P
	According to HD 60364-5-551:2010, 551.7.4, means of automatic switching shall be provided to disconnect the generating plant from the distribution network in the event of loss of that supply or deviation of the voltage or frequency at the supply terminals from values declared for normal supply.		P
	This automatic means of disconnection has following main objectives:		P
	<ul style="list-style-type: none"> <li>prevent the power production of the generating plant to cause an overvoltage situation in the distribution network it is connected to. Such over-voltages could result in damages to the equipment connected to the distribution network as well as the distribution network itself;</li> </ul>		P
	<ul style="list-style-type: none"> <li>detect unintentional island situations and disconnect the generating plant in this case. This is contributing to prevent damage to other equipment, both in the producers' installations and the distribution network due to out of phase re-closing and to allow for maintenance work after an intentional disconnection of a section of the distribution network;</li> </ul>		P
	<ul style="list-style-type: none"> <li>assist in bringing the distribution network to a controlled state in case of voltage or frequency deviations beyond corresponding regulation values.</li> </ul>		P
	It is not the purpose of the interface protection system to:		P
	<ul style="list-style-type: none"> <li>disconnect the generating plant from the distribution network in case of faults internal to the power generating plant. Protection against internal faults (short-circuits) shall be coordinated with network protection, according to DSO protection criteria. Protection against e.g. overload, electric shock and against fire hazards shall be implemented additionally according to HD 60364-1 and local requirements;</li> </ul>		P
	<ul style="list-style-type: none"> <li>prevent damages to the generating unit due to incidents (e.g. short circuits) on the distribution network</li> </ul>		P
	Interface protections may contribute to preventing damage to the generating units due to out-of-phase reclosing of automatic reclosing which may happen after some hundreds of ms. However, in some countries some technologies of generating units are explicitly required to have an appropriate immunity level against the consequences of out-of-phase reclosing.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The type of protection and the sensitivity and operating times depend upon the protection and the characteristics of the distribution network.		P
	A wide variety of approaches to achieve the above mentioned objectives is used throughout Europe. Besides the passive observation of voltage and frequency other active and passive methods are available and used to detect island situations. The requirements given in this clause are intended to provide the necessary functions for all known approaches as well as to give guidance in their use. Which functions are available in a product shall be stated in the product documentation.		P
	The interface protection system shall comply with the requirements of this European Standard, the available functions and configured settings shall comply with the requirements of the DSO and the responsible party. In any case, the settings defined shall be understood as the values for the interface protection system, i.e. where there is a wider technical capability of the generation module, it shall not be withheld by the settings of the protections (other than the interface protection).		P
	For micro generating plants, the interface protection system and the point of measurement might be integrated into the generating units. For generating plants with nominal current above 16 A the DSO may define a threshold above which the interface protection system shall be realized as a dedicated device and not integrated into the generating units.		P
	<ul style="list-style-type: none"> <li>to place the protection system as close to the point of connection as possible, to avoid tripping due to overvoltages resulting from the voltage rise within the producer's network;</li> </ul>		P
	<ul style="list-style-type: none"> <li>to allow for periodic field tests. In some countries periodic field tests are not required if the protection system meets the requirements of single fault safety.</li> </ul>		P
	The interface protection relay acts on the interface switch. The DSO may require that the interface protection relay acts additionally on another switch with a proper delay in case the interface switch fails to operate.		P
	In case of failure of the power supply of the interface protection, the interface protection shall trigger the interface switch without delay. An uninterruptible power supply may be required by the DSO, for instance in case of UVRT capability, delay in protection etc.		P
	In case of field adjustable settings of threshold and operation time, means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.		P
4.9.2	Void		N/A
4.9.3	Requirements on voltage and frequency protection		P

EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict
4.9.3.1	General		P
	Part or all of the following described functions may be required by the DSO and the responsible party.		P
	The protection functions shall evaluate at least all phases where generating units, covered by this protection system, are connected to.		P
	In case of three phase generating units/plants and in all cases when the protection system is implemented as an external protection system in a three phase power supply system, all phase to phase voltages and, if a neutral conductor is present, all phase to neutral voltages shall be evaluated.		P
	The frequency shall be evaluated on at least one of the voltages.		P
	If multiple signals (e.g. 3 phase to phase voltages) are to be evaluated by one protection function, this function shall evaluate all of the signals separately. The output of each evaluation shall be OR connected, so that if one signal passes the threshold of a function, the function shall trip the protection in the specified time.		P
	The minimum required accuracy for protection is:		P
	<ul style="list-style-type: none"> <li>for frequency measurement <math>\pm 0,05</math> Hz;</li> </ul>		P
	<ul style="list-style-type: none"> <li>for voltage measurement <math>\pm 1</math> % of <math>U_n</math>.</li> </ul>		P
	<ul style="list-style-type: none"> <li>The reset time shall be <math>\leq 50</math> ms</li> </ul>		P
	<ul style="list-style-type: none"> <li>The interface protection relay shall not conduct continuous starting and disengaging operations of the interface protection relay. Therefore a reasonable reset ratio shall be implemented which shall not be zero but be below 2% of nominal value for voltage and below 0,2 Hz for frequency.</li> </ul>		P
4.9.3.2	Under-voltage protection [27]	(see appended table)	P
	The protection shall comply with EN 60255-127. The evaluation of the r.m.s. or the fundamental value is allowed.		P
	Undervoltage protection may be implemented with two completely independent protection thresholds, each one able to be activated or not. The standard adjustment ranges are as follows.		P
	Undervoltage threshold stage 1 [27 <]:		P
	<ul style="list-style-type: none"> <li>Threshold <math>(0,2 - 1) U_n</math> adjustable by steps of <math>0,01 U_n</math></li> </ul>		P
	<ul style="list-style-type: none"> <li>Operate time <math>(0,1 - 100)</math> s adjustable in steps of <math>0,1</math> s</li> </ul>		P
	Undervoltage threshold stage 2 [27 < <]:		P
	<ul style="list-style-type: none"> <li>Threshold <math>(0,2 - 1) U_n</math> adjustable by steps of <math>0,01 U_n</math></li> </ul>		P
	<ul style="list-style-type: none"> <li>Operate time <math>(0,1 - 5)</math> s adjustable in steps of <math>0,05</math> s</li> </ul>		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The undervoltage threshold stage 2 is not applicable for micro-generating plants		P
4.9.3.3	Overvoltage protection	(see appended table)	P
	The protection shall comply with EN 60255-127. The evaluation of the r.m.s. or the fundamental value is allowed.		P
	Overvoltage protection may be implemented with two completely independent protection thresholds, each one able to be activated or not. The standard adjustment ranges are as follows.		P
	Overvoltage threshold stage 1 [59 >]:		P
	• Threshold (1,0 – 1,2) $U_n$ adjustable by steps of 0,01 $U_n$		P
	• Operate time (0,1 – 100) s adjustable in steps of 0,1 s		P
	Overvoltage threshold stage 2 [59 > >]:		P
	• Threshold (1,0 – 1,30) $U_n$ adjustable by steps of 0,01 $U_n$		P
	• Operate time (0,1 – 5) s adjustable in steps of 0,05 s		P
4.9.3.4	Overvoltage 10 min mean protection	(see appended table)	P
	The calculation of the 10 min value shall comply with the 10 min aggregation of EN 61000-4-30 Class S, but deviating from EN 61000-4-30 as a moving window is used. Therefore the function shall be based on the calculation of the square root of the arithmetic mean of the squared input values over 10 min. The calculation of a new 10 min value at least every 3 s is sufficient, which is then to be compared with the threshold value.		P
	• Threshold (1,0 – 1,15) $U_n$ adjustable by steps of 0,01 $U_n$		P
	• Start time 3s not adjustable		P
	• Time delay setting = 0 ms		P
4.9.3.5	Under-frequency protection [81 <]	(see appended table)	P
	Under frequency protection may be implemented with two completely independent protection thresholds, each one able to be activated or not. The standard adjustment ranges are as follows.		P
	Under-frequency threshold stage 1 [81 <]:		P
	• Threshold (47,0 – 50,0) Hz adjustment by steps of 0,1 Hz		P
	• Operate time (0,1 – 100) s adjustable in steps of 0,1 s		P
	Under-frequency threshold stage 2 [81 < <]:		P
	• Threshold (47,0 – 50,0) Hz adjustment by steps of 0,1 Hz		P
	• Operate time (0,1 – 5) s adjustable in steps of 0,05 s		P

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Clause	Requirement - Test	Result - Remark	Verdict
	In order to use narrow frequency thresholds for islanding detection (see 4.9.3.3) it may be required to have the ability to activate and deactivate a stage by an external signal.		P
	The frequency protection shall function correctly in the input voltage range between 20 % $U_n$ and 120 % $U_n$ and shall be inhibited for input voltages of less than 20 % $U_n$ . Under 0,2 $U_n$ the frequency protection is inhibited. Disconnection may only happen based on under-voltage protection.		P
4.9.3.6	Over-frequency protection [81 >]	(see appended table)	P
	Overfrequency protection may be implemented with two completely independent protection thresholds, each one able to be activated or not. The standard adjustment ranges are as follows.		P
	Overfrequency threshold stage 1 [81 >]:		P
	<ul style="list-style-type: none"> <li>• Threshold (50,0 - 52,0) Hz adjustment by steps of 0,1 Hz</li> </ul>		P
	<ul style="list-style-type: none"> <li>• Operate time (0,1 – 100) s adjustable in steps of 0,1 s</li> </ul>		P
	Overfrequency threshold stage 2 [81 > >]:		P
	<ul style="list-style-type: none"> <li>• Threshold (50,0 - 52,0) Hz adjustment by steps of 0,1 Hz</li> </ul>		P
	<ul style="list-style-type: none"> <li>• Operate time (0,1 - 5) s adjustable in steps of 0,05 s</li> </ul>		P
	In order to use narrow frequency thresholds for islanding detection (see 4.9.3.3) it may be required to have the ability to activate and deactivate a stage by an external signal.		P
	The frequency protection shall function correctly in the input voltage range between 20 % $U_n$ and 120 % $U_n$ and shall be inhibited for input voltages of less than 20 % $U_n$ .		P
4.9.4	Means to detect island situation		P
4.9.4.1	General		P
	Besides the passive observation of voltage and frequency further means to detect an island may be required by the DSO. Detecting islanding situations shall not be contradictory to the immunity requirements of 4.5.		P
	Commonly used functions include: <ul style="list-style-type: none"> <li>• Active methods tested with a resonant circuit;</li> <li>• ROCOF tripping;</li> <li>• Switch to narrow frequency band;</li> <li>• Vector shift;</li> <li>• Transfer trip.</li> </ul>	Active methods tested with a resonant circuit	P

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Clause	Requirement - Test	Result - Remark	Verdict
	Only some of the methods above rely on standards. Namely for ROCOF tripping and for the detection of a vector shift, also called a vector jump, currently no European Standard is available.		P
4.9.4.2	Active methods tested with a resonant circuit		P
	These are methods which pass the resonant circuit test for PV inverters according to EN 62116.		P
4.9.4.3	Switch to narrow frequency band (see Annex E and Annex F)		P
	In case of local phenomena (e.g. a fault or the opening of circuit breaker along the line) the DSO in coordination with the responsible party may require a switch to a narrow frequency band to increase the interface protection relay sensitivity. In the event of a local fault it is possible to enable activation of the restrictive frequency window (using the two under-frequency / over-frequency thresholds described in 4.9.2.5 and 4.9.2.6) correlating its activation with another additional protection function.		P
	If required by the DSO, a digital input according to 4.9.4 shall be available to allow the DSO the activation of a restrictive frequency window by communication.		P
4.9.5	Digital input to the interface protection		P
	If required by the DSO, the interface protection shall have at least two configurable digital inputs. These inputs can for example be used to allow transfer trip or the switching to the narrow frequency band.		P
<b>4.10</b>	<b>Connection and starting to generate electrical power</b>		P
4.10.1	General		P
	Connection and starting to generate electrical power is only allowed after voltage and frequency are within the allowed voltage and frequency ranges for at least the specified observation time. It shall not be possible to overrule these conditions.		P
	Within these voltage and frequency ranges, the generating plant shall be capable of connecting and starting to generate electrical power.		P
	The setting of the conditions depends on whether the connection is due to a normal operational startup or an automatic reconnection after tripping of the interface protection. In case the settings for automatic reconnection after tripping and starting to generate power are not distinct in a generating plant, the tighter range and the start-up gradient shall be used.		P
	The frequency range, the voltage range, the observation time and the power gradient shall be field adjustable.		P
	For field adjustable settings, means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.		P

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Clause	Requirement - Test	Result - Remark	Verdict																					
4.10.2	Automatic reconnection after tripping		P																					
	<p>The frequency range, the voltage range, the observation time shall be adjustable in the range according to Table 3 column 2. If no settings are specified by the DSO and the responsible party, the default settings for the reconnection after tripping of the interface protection are according to Table 3 column 3.</p> <p style="text-align: center;"><b>Table 3 — Automatic reconnection after tripping</b></p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Range</th> <th>Default setting</th> </tr> </thead> <tbody> <tr> <td>Lower frequency</td> <td>47,0Hz – 50,0Hz</td> <td>49,5Hz</td> </tr> <tr> <td>Upper frequency</td> <td>50,0Hz – 52,0Hz</td> <td>50,2Hz</td> </tr> <tr> <td>Lower voltage</td> <td>50% – 100%U<sub>n</sub></td> <td>85 % U<sub>n</sub></td> </tr> <tr> <td>Upper voltage</td> <td>100% – 120% U<sub>n</sub></td> <td>110 % U<sub>n</sub></td> </tr> <tr> <td>Observation time</td> <td>10s – 600s</td> <td>60s</td> </tr> <tr> <td>Active power increase gradient</td> <td>6% – 3000%/min</td> <td>10%/min</td> </tr> </tbody> </table>	Parameter	Range	Default setting	Lower frequency	47,0Hz – 50,0Hz	49,5Hz	Upper frequency	50,0Hz – 52,0Hz	50,2Hz	Lower voltage	50% – 100%U <sub>n</sub>	85 % U <sub>n</sub>	Upper voltage	100% – 120% U <sub>n</sub>	110 % U <sub>n</sub>	Observation time	10s – 600s	60s	Active power increase gradient	6% – 3000%/min	10%/min	(see appended table)	P
Parameter	Range	Default setting																						
Lower frequency	47,0Hz – 50,0Hz	49,5Hz																						
Upper frequency	50,0Hz – 52,0Hz	50,2Hz																						
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Observation time	10s – 600s	60s																						
Active power increase gradient	6% – 3000%/min	10%/min																						
	<p>After reconnection, the active power generated by the generating plant shall not exceed a specified gradient expressed as a percentage of the active nominal power of the unit per minute. If no gradient is specified by the DSO and the responsible party, the default setting is 10 % P<sub>n</sub> /min. Generating modules for which it is technically not feasible to increase the power respecting the specified gradient over the full power range may connect after 1 min to 10 min (randomized value, uniformly distributed) or later.</p>		P																					
4.10.3	Starting to generate electrical power		P																					
	<p>The frequency range, the voltage range, the observation time shall be adjustable in the range according to Table 4 column 2. If no settings are specified by the DSO and the responsible party, the default settings for connection or starting to generate electrical power due to normal operational startup or activity are according to Table 4 column 3.</p> <p style="text-align: center;"><b>Table 4 — Starting to generate electrical power</b></p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Range</th> <th>Default setting</th> </tr> </thead> <tbody> <tr> <td>Lower frequency</td> <td>47,0Hz – 50,0Hz</td> <td>49,5Hz</td> </tr> <tr> <td>Upper frequency</td> <td>50,0Hz – 52,0Hz</td> <td>50,1Hz</td> </tr> <tr> <td>Lower voltage</td> <td>50% – 100% U<sub>n</sub></td> <td>85 % U<sub>n</sub></td> </tr> <tr> <td>Upper voltage</td> <td>100% – 120% U<sub>n</sub></td> <td>110 % U<sub>n</sub></td> </tr> <tr> <td>Observation time</td> <td>10s – 600s</td> <td>60s</td> </tr> <tr> <td>Active power increase gradient</td> <td>6% – 3000%/min</td> <td>disabled</td> </tr> </tbody> </table>	Parameter	Range	Default setting	Lower frequency	47,0Hz – 50,0Hz	49,5Hz	Upper frequency	50,0Hz – 52,0Hz	50,1Hz	Lower voltage	50% – 100% U <sub>n</sub>	85 % U <sub>n</sub>	Upper voltage	100% – 120% U <sub>n</sub>	110 % U <sub>n</sub>	Observation time	10s – 600s	60s	Active power increase gradient	6% – 3000%/min	disabled	(see appended table)	P
Parameter	Range	Default setting																						
Lower frequency	47,0Hz – 50,0Hz	49,5Hz																						
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Lower voltage	50% – 100% U <sub>n</sub>	85 % U <sub>n</sub>																						
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Observation time	10s – 600s	60s																						
Active power increase gradient	6% – 3000%/min	disabled																						
	<p>If applicable, the power gradient shall not exceed the maximum gradient specified by the DSO and the responsible party. Heat driven CHP generating units do not need to keep a maximum gradient, since the start up is randomized by the nature of the heat demand.</p>		P																					
	<p>For manual operations performed on site (e.g. for the purpose of initial start-up or maintenance) it is permitted to deviate from the observation time and ramp rate.</p>		P																					
4.10.4	Synchronization		P																					

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Clause	Requirement - Test	Result - Remark	Verdict
	Synchronizing a generating plant/unit with the distribution network shall be fully automatic i.e. it shall not be possible to manually close the switch between the two systems to carry out synchronization.		P
<b>4.11</b>	<b>Ceasing and reduction of active power on set point</b>		
4.11.1	Ceasing active power		P
	Generating plants with a maximum capacity of 0,8 kW or more shall be equipped with a logic interface (input port) in order to cease active power output within five seconds following an instruction being received at the input port. If required by the DSO and the responsible party, this includes remote operation.	(see appended table)	P
4.11.2	Reduction of active power on set point		P
	“Generating plants with a maximum capacity of 0,8 kW or more shall be capable of reducing their active power to a limit value provided remotely by the DSO. The limit value shall be adjustable in the complete operating range from the maximum active power to minimum regulating level.		P
	The adjustment of the limit value shall be possible with a maximum increment of 10 % of nominal power.		P
	A generation unit/plant shall be capable of carrying out the power output reduction to the respective limit within an envelope of not faster than 0,66 % Pn/ s and not slower than 0,33 % Pn/ s with an accuracy of 5 % of nominal power. Generating plants are permitted to disconnect from the network at a limit value below their minimum regulating level. If required by the DSO, this includes remote operation	(see appended table)	P
<b>4.12</b>	<b>Remote information exchange</b>		P
	Generating plants whose power is above a threshold to be determined by the DSO and the responsible party shall have the capacity to be monitored by the DSO or TSO control centre or control centres as well as receive operation parameter settings for the functions specified in this European Standard from the DSO or TSO control centre or control centres.		P
	It should not interact directly with the power generation equipment and the switching devices of the generating plant. It should interact with the operation and control system of the generating plant.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	In principle, standardized communication should be used. It is recommended that in case of using protocols for signal transmission used between the DSO or TSO control centre or control centres and the generating plant, relevant technical standards (e.g. EN 60870-5-101, EN 60870-5-104, EN 61850 and in particular EN 61850-7-4, EN 61850-7-420, IEC/TR 61850-90-7, as well as EN 61400-25 for wind turbines and relevant parts of IEC 62351 for relevant security measures) are recognized.		P
	Alternative protocols can be agreed between the DSO and the producer. These protocols include hardwired digital input/output and analogue input/output provided locally by DSO. The information needed for remote monitoring and the setting of configurable parameters are specific to each distribution network and to the way it is operated.		P
	Signal transmission times between the DSO and/or the TSO control centre and the generating plant will depend on the means of transmission used between the DSO and/or TSO control centre and the generating plant.		P
<b>4.13</b>	<b>Requirements regarding single fault tolerance of interface protection system and interface switch</b>		P
	If required in 4.3.2, the interface protection system and the interface switch shall meet the requirements of single fault tolerance.	(see appended table)	P
	A single fault shall not lead to a loss of the safety functions.		P
	Series-connected switches shall each have a independent breaking capacity corresponding to the rated current of the generating unit and corresponding to the short circuit contribution of the generating unit.		P
	The short-time withstand current of the switching devices shall be coordinated with maximum short circuit power at the connection point.		P
	At least one of the switches shall be a switch-disconnector suitable for overvoltage category 2. For single-phase generating units, the switch shall have one contact of this overvoltage category for both the neutral conductor and the line conductor. For poly-phase generating units, it is required to have one contact of this overvoltage category for all active conductors. The second switch may be formed of electronic switching components from an inverter bridge or another circuit provided that the electronic switching components can be switched off by control signals and that it is ensured that a failure is detected and leads to prevention of the operation at the latest at the next reconnection.		P

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Clause	Requirement - Test	Result - Remark	Verdict																																																		
	For PV-inverters without simple separation between the network and the PV generating unit (e.g. PV Inverter without transformer) both switches mentioned in the paragraph above shall be switch disconnectors with the requirements described therein, although one switching device is permitted to be located between PV array and PV inverter.		N/A																																																		
<b>Annex A</b>	<b>Interconnection guidance</b>		P																																																		
<b>Annex B</b>	<b>Void</b>		Info.																																																		
<b>Annex C</b>	<b>Parameter Table</b>		P																																																		
<b>Annex D</b>	<b>List of national requirements applicable for generating plants</b>		Info.																																																		
<b>Annex E</b>	<b>Loss of Mains and overall power system security</b>		P																																																		
<b>Annex F</b>	<b>Examples of protection strategies</b>		Info.																																																		
<b>Annex G</b>	<b>Abbreviations</b>		Info.																																																		
<b>Annex H</b>	<b>Relationship between this European standard and the COMMISSION REGULATION (EU) 2016/631</b>		P																																																		
	<p>Generating plants compliant with the clauses of this European Standard are considered to be compliant with the relevant Article of COMMISSION REGULATION (EU) 2016/631, provided, that all settings as provided by the DSO and the responsible party are complied with.</p> <p><b>Table H.1 – Correspondence between this European standard and the COMMISSION REGULATION (EU) 2016/631</b></p> <table border="1"> <thead> <tr> <th>Article</th> <th>Clause(s) / subclause(s) of this EN</th> </tr> </thead> <tbody> <tr> <td>13.1(a)</td> <td>4.4.2 Operating frequency range</td> </tr> <tr> <td>13.1(b)</td> <td>4.5.2 Rate of change of frequency (ROCOF) immunity</td> </tr> <tr> <td>13.2</td> <td>4.6.1 Power response to overfrequency</td> </tr> <tr> <td>13.3</td> <td>4.4.3 Minimal requirement for active power delivery at underfrequency</td> </tr> <tr> <td>13.4</td> <td>4.4.3 Minimal requirement for active power delivery at underfrequency</td> </tr> <tr> <td>13.5</td> <td>4.4.3 Minimal requirement for active power delivery at underfrequency</td> </tr> <tr> <td>13.6</td> <td>4.11.1 Ceasing active power</td> </tr> <tr> <td>13.7</td> <td>4.10 Connection and starting to generate electrical power</td> </tr> <tr> <td>14.1</td> <td>4.4.2, 4.5.2, 4.6.1, 4.4.3, 4.11.1 and 4.10</td> </tr> <tr> <td>14.2(a)</td> <td>4.11.2 Reduction of active power on set point</td> </tr> <tr> <td>14.2(b)</td> <td>4.12 Remote information exchange</td> </tr> <tr> <td>14.3</td> <td>4.5.3 Under-voltage ride through (UVRT)</td> </tr> <tr> <td>14.4.</td> <td>4.10 Connection and starting to generate electrical power</td> </tr> <tr> <td>14.5(a)</td> <td>4.6, 4.7, 4.9, 4.10, 4.11, 4.12</td> </tr> <tr> <td>14.5(b)</td> <td>4.9 Interface protection,</td> </tr> <tr> <td>14.5(c)</td> <td>4.1 General</td> </tr> <tr> <td>14.5(d)</td> <td>4.12 Remote information exchange</td> </tr> <tr> <td>17.1</td> <td>4. as applicable above</td> </tr> <tr> <td>17.2</td> <td>4.7.2 Voltage support by reactive power</td> </tr> <tr> <td>17.3</td> <td>4.5.3 Under-voltage ride through (UVRT)</td> </tr> <tr> <td>20.1</td> <td>4. as applicable above</td> </tr> <tr> <td>20.2 (a)</td> <td>4.7.2 Voltage support by reactive power</td> </tr> <tr> <td>20.2 (b) (c)</td> <td>4.7.4.2 Short circuit current requirements on generating plants</td> </tr> <tr> <td>20.3</td> <td>4.5.3 Under-voltage ride through (UVRT)</td> </tr> </tbody> </table>	Article	Clause(s) / subclause(s) of this EN	13.1(a)	4.4.2 Operating frequency range	13.1(b)	4.5.2 Rate of change of frequency (ROCOF) immunity	13.2	4.6.1 Power response to overfrequency	13.3	4.4.3 Minimal requirement for active power delivery at underfrequency	13.4	4.4.3 Minimal requirement for active power delivery at underfrequency	13.5	4.4.3 Minimal requirement for active power delivery at underfrequency	13.6	4.11.1 Ceasing active power	13.7	4.10 Connection and starting to generate electrical power	14.1	4.4.2, 4.5.2, 4.6.1, 4.4.3, 4.11.1 and 4.10	14.2(a)	4.11.2 Reduction of active power on set point	14.2(b)	4.12 Remote information exchange	14.3	4.5.3 Under-voltage ride through (UVRT)	14.4.	4.10 Connection and starting to generate electrical power	14.5(a)	4.6, 4.7, 4.9, 4.10, 4.11, 4.12	14.5(b)	4.9 Interface protection,	14.5(c)	4.1 General	14.5(d)	4.12 Remote information exchange	17.1	4. as applicable above	17.2	4.7.2 Voltage support by reactive power	17.3	4.5.3 Under-voltage ride through (UVRT)	20.1	4. as applicable above	20.2 (a)	4.7.2 Voltage support by reactive power	20.2 (b) (c)	4.7.4.2 Short circuit current requirements on generating plants	20.3	4.5.3 Under-voltage ride through (UVRT)		P
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EN 50549-1			
Clause	Requirement - Test	Result - Remark	Verdict

<b>Test overview:</b>			
<b>EN 50549-1:2019</b>			
4.4.2	Operating frequency range		P
4.4.3	Minimal requirement for active power delivery at under-frequency		P
4.4.4	Continuous operating voltage range		P
4.5.2	Rate of change of frequency (ROCOF) immunity		P
4.5.3	Under-voltage ride through (UVRT)		P
4.5.4	Over-voltage ride through (OVRT)		P
4.6.1	Power response to over-frequency		P
4.6.2	Power response to under-frequency		P
4.7.2	Voltage support by reactive power		P
4.7.2.3.2	Setpoint control modes – Q setpoint mode		P
4.7.2.3.2	Setpoint control modes – Cos $\varphi$ setpoint mode		P
4.7.2.3.3	Voltage related control mode – Q(U)		P
4.7.2.3.4	Power related control mode – cos $\varphi$ (P)		P
4.7.3	Voltage related active power reduction		P
4.7.4	Short circuit current requirements on generating plants		P
4.8	EMC and power quality		P
4.9.3	Requirements on voltage and frequency protection		P
4.9.3.2	Under-voltage protection		P
4.9.3.3	Overvoltage protection		P
4.9.3.4	Overvoltage 10 min mean protection		P
4.9.3.5	Underfrequency protection		P
4.9.3.6	Overfrequency protection		P
4.9.4	Means to detect island situation		P
4.9.5	Digital input to the interface protection		P
4.10.2	Automatic reconnection after tripping		P
4.10.3	Starting to generate electrical power		P
4.11.1	Ceasing active power		P
4.11.2	Reduction of active power on set point		P
4.13	Requirements regarding single fault tolerance of interface protection system		P

**Note :**

All test data about EN 50549-1 please see the initial EN-50549-10 test report issued by DEKRA with Report No.: 6209657.50A.

--- End of test report---