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This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



82/2440/CD

COMMITTEE DRAFT (CD)

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IEC TC 82 : SOLAR PHOTOVOLTAIC ENERGY SYSTEMS

SECRETARIAT:

United States of America

SECRETARY:

Mr George Kelly

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 8,TC 22,TC 57,TC 69,TC 77,TC 88,ACTAD

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

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TITLE:

Photovoltaic power generating systems connection with the grid - Testing of power conversion equipment- Part 7: Remote configuration, control and monitoring

NOTE FROM TC/SC OFFICERS:

This project was discussed and supported by WG6 during their meeting in 2025-05.

Note that the title has been changed from "Information exchange" to "Remote configuration, control and monitoring".

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC POWER GENERATING SYSTEMS CONNECTION WITH THE GRID – TESTING OF POWER CONVERSION EQUIPMENT –

Part 7: Remote configuration, control and monitoring

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International Standard IEC PHOTOVOLTAIC POWER GENERATING SYSTEMS CONNECTION WITH THE GRID – TESTING OF POWER CONVERSION EQUIPMENT Part 7: Information exchange has been prepared by IEC technical committee 82.

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table..

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available

173 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
174 described in greater detail at www.iec.ch/publications.

175 The committee has decided that the contents of this document will remain unchanged until the
176 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
177 specific document. At this date, the document will be

- 178 • reconfirmed,
- 179 • withdrawn,
- 180 • replaced by a revised edition, or
- 181 • amended.

182

INTRODUCTION

Since 2016, TC82 has been contributing to the standardization of requirements for DER connection with the grid under TC8/JWG10, which is a joint working group consisting with TC82, TC120 and SC22E. In parallel with the join work with TC8, since 2016, TC82 has been considering the development of testing standards to evaluate performance and characteristics of power conversion equipment which are relevant to connection with the grid.

Having multiple issues into a single document may not only require a lot of time and effort but could also cause difficulties where a single issue could delay the standardization process. Therefore, TC82/WG6 agreed to separate the IEC 63409 into seven parts. In 2021, TC82/WG6 started the official project to develop IEC 63409 series.

Figure 1 shows the whole views of the series and the scope of each part of the IEC 63409.

The part 7 specifies testing conditions and procedures to evaluate functions which can be realised by information exchange with energy management systems.

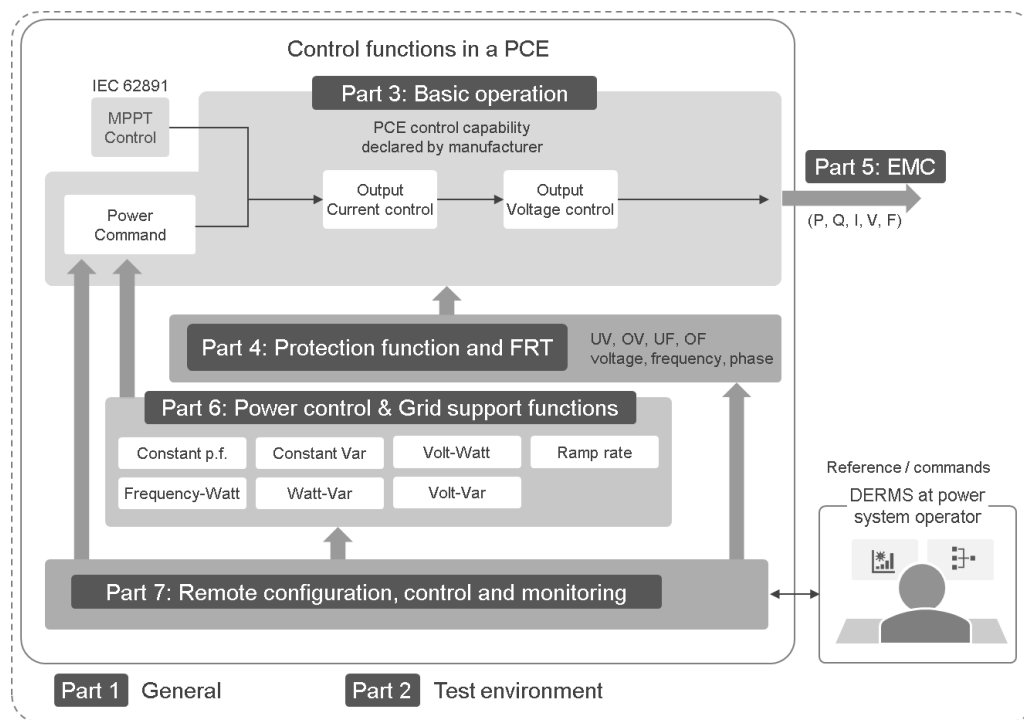


Figure 1 – Whole views of the IEC 63409 series

PHOTOVOLTAIC POWER GENERATING SYSTEMS CONNECTION WITH THE GRID – TESTING OF POWER CONVERSION EQUIPMENT –

Part 7: Remote configuration, control and monitoring

1 Scope

The IEC 63409 series specifies requirements for the testing of power conversion equipment (PCE) for use in photovoltaic power systems (PV systems) with or without DC-coupled electrical energy storage devices. Part 7 of IEC 63409 series specifies testing requirements for the evaluation of performance and characteristics of the following three functions which are equipped with PCE:

- configuration,
- control,
- monitoring.

Those functions can be realized by information exchange with uni- and/or bi-directional communication with the management system. Therefore, this document specifies the general test environment and setup which consist with PCE, communication interfaces and the energy management system. Testing conditions and operating conditions of PCE are given for the evaluation of three functions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850-7-420:2021, *Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources and distribution automation logical nodes*

IEC 61850-7-1:2011/AMD1:2020, *Amendment 1 - Communication networks and systems for power utility automation - Part 7-1: Basic communication structure - Principles and models*

IEC 61850-7-3:2010/AMD1:2020, *Amendment 1 - Communication networks and systems for power utility automation - Part 7-3: Basic communication structure - Common data classes*

IEC 61850-7-4:2010/AMD1:2020, *Amendment 1 - Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes*

IEC 61850-8-1:2011/AMD1:2020, *Amendment 1 – Communication networks and systems for power utility automation – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC 61850-8-2:2018, *Communication networks and systems for power utility automation - Part 8-2: Specific communication service mapping (SCSM) - Mapping to Extensible Messaging Presence Protocol (XMPP)*

243 IEC 60375:2018, *Conventions concerning electric circuits*

244 IEC 61557-12:2018/AMD1:2021, *Amendment 1 - Electrical safety in low voltage distribution*
 245 *systems up to 1 000 V AC and 1 500 V DC - Equipment for testing, measuring or monitoring of*
 246 *protective measures - Part 12: Power metering and monitoring devices (PMD)*

247 IEC 62053-23:2020, *Electricity metering equipment - Particular requirements - Part 23: Static*
 248 *meters for reactive energy (classes 2 and 3)*

249 IEC 63409-6, *Photovoltaic power generating systems connection with the grid – Testing of*
 250 *power conversion equipment – Part6: Power control functions and grid support*

251 **3 Terms and definitions**

252 For the purposes of this document, the terms and definitions given in IEC 62934, IEC TS 62786
 253 series, and the following apply.

254 ISO and IEC maintain terminology databases for use in standardization at the following
 255 addresses:

- 256 • IEC Electropedia: available at <https://www.electropedia.org/>
- 257 • ISO Online browsing platform: available at <https://www.iso.org/obp>

258 **3.1** 259 **photovoltaic power generating system**

260 PV system
 261 electric power generating system which uses the photovoltaic effect to convert solar power into
 262 electricity

263 **3.2** 264 **power conversion equipment**

265 PCE
 266 electrical device converting one form of electrical power to another form of electrical power with
 267 respect to voltage, current, frequency, phase and the number of phases

268 [SOURCE: IEC 62109-1:2010, 3.66, modified – The definition has been rephrased, and the note
 269 has been deleted.]

270 **3.3** 271 **intelligent electronic device**

272 IED
 273 any device incorporating one or more processors, with the capability to receive data from an
 274 external sender or to send data to an external receiver

275 **3.4** 276 **distributed energy resources management system** 277 DERMS

278 The system which, on the behalf of other interested systems, manages the communications and
 279 control of individual Distributed Energy Resource (DER (and may do this with a variety of field
 280 message protocols), and aggregates this information and communicates with other utility
 281 systems, such as a DMS.

282 [SOURCE: IEC 61968-5:2020, 3.1.1]

283

4 Testing environment

4.1 Test setup

Figure 2 shows an example of the general test setup for the evaluation of the configuration, control and monitoring functions equipped with PCE. The evaluation of performance of those three functions shall be performed in manufacture's factories and/or in testing premises equipped with power supplies and measuring instrument/devices as shown in Figure 2. Examples of the power supplies and the measuring instrument/devices are specified in Annex D. Specifications of the power supplies and the measuring instrument/devices shall be reported in the test report.

The performance and characteristics of PCE shall be evaluated with electrical quantity such as voltage, current and power, which are measured at the AC power ports of PCE. Annex C specifies the definitions of sign conventions for measurements of voltage, current and power.

Information exchange with PCE shall be based on the client/server role specified in IEC 61850-7-1. The PCE with the IED (Intelligent Electronic Device) is the sever, and DERMS (Distributed Energy Resources Management System) is the client. The IED can be a part of the PCE or be an external device. In both cases, the inner (local) communication network between the IED and the PCE is out of scope. The sever which consists of PCE and IED are the devices under test (DUT).

Clients issue service requests, such as configuration, control and monitoring. Then, clients receive confirmations of the service that has been processed in the server. A client may also receive report indications from a server. Therefore, configuration, control and monitoring functions of PCE shall be remotely implemented at the DERMS.

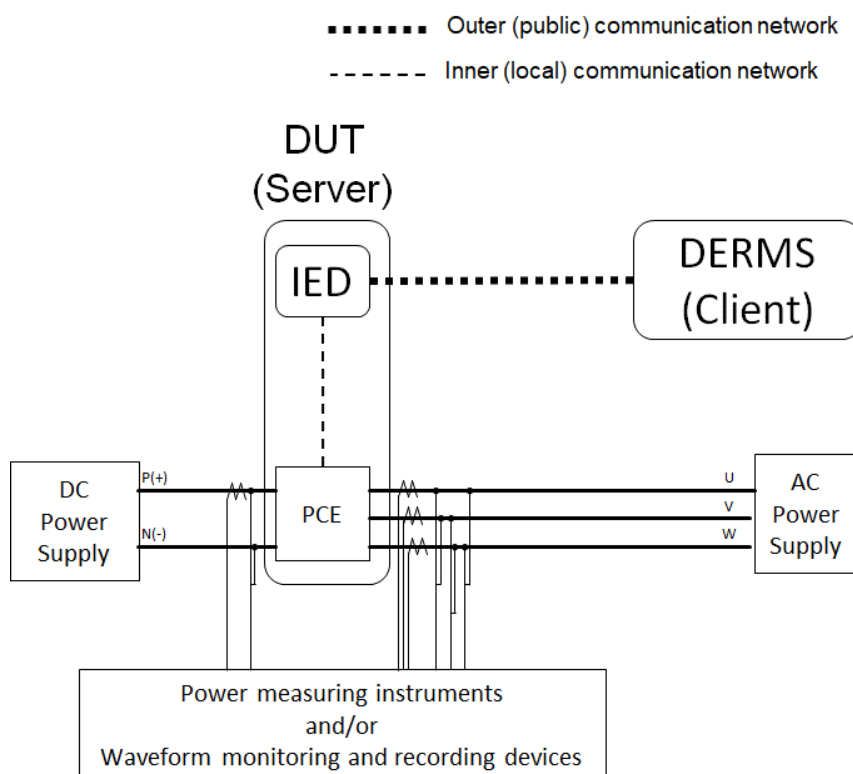


Figure 2 – Example of the general test setup

The testing of the DUT shall not be influenced by the performance of DC power supply used for the test. Therefore, where the EUT has the capability to disable MPPT control, it is allowed to do so and a DC power supply that is able to provide constant voltage at any required power

levels shall be used. A PV simulator may be used provided that the test results are not influenced by any DC instability by the PV simulator. In each case, remarks shall be written in the test report to note the type of the DC power supply or PV simulator used in the test. See Annex E for supplemental information regarding the influences from the PV simulator.

4.2 Communication specification

The information model is used for the information exchange to implement remote configuration, control and monitoring of the PCE. The information model is defined in IEC 61850 series, and Annex A describes overviews of information model.

IEC 61850-8-2 shall be used as the communication mapping for the outer (public) communication network.

5 Testing requirements

5.1 General

The evaluation of the performance of the information exchange shall be implemented in the following order.

- First, the evaluation of the monitoring function shall be done as specified in 5.2.
- Second, the evaluation of the control function shall be done as specified in 5.3.
- Finally, the evaluation of the configuration function shall be done as specified 5.4.

Results of the evaluation of three functions shall be recorded in test reports.

5.2 Evaluation of the nameplate data, the basic information and the monitoring function

5.2.1 Testing items

All data listed from Table 1 to Table 4 shall be read on DERMS while PCE is under halt or rated power condition. Data which are monitored at DERMS shall be evaluated with data which are set in PCE and measured by measuring instruments.

Table 1 and Table 2 show the lists of the minimum required monitored data for the confirmation of the nameplate data and the basic information of PCE.

Table 3 and Table 4 show the lists of the minimum required monitored data for the confirmation of the status and measured values of PCE.

When there are other data to be monitored, all additional monitored data shall be reported in a test report.

Table 1 – Nameplate data

Item	IEC 61850			
	Standard	LN	message parameter	Description
Name of the vendor	IEC 61850-7-4	LPHD	PhyNam.vendor	Name of the vendor.
Serial Number			PhyNam.serNum	Serial number.
Hardware revision.			PhyNam.hwRev	HW-revision.
Software revision			PhyNam.swRev	SW-revision.
Rated apparent power	IEC 61850-7-420	DINV	VARTg	The continuous apparent power

				capability of the power inverter.
Rated active power			WRtg	Rated active power of the inverter
Rated reactive power			WRtg	Rated active power of the inverter
Rated voltage			VRtg	Rated voltage
Maximum Input voltage limit			InVMax	Maximum Input voltage limit.
Over-Excited Power Factor Rating			OvPFRtg	Specified Over-Excited Power Factor Rating
Under-Excited Power Factor Rating			UnPFRtg	Specified Under-Excited Power Factor Rating

Table 2 – Basic information (Those data not in the nameplate)

Item	IEC 61850			
	Standard	LN	message parameter	Description
Rated frequency Nominal	IEC 61850-7-420	DGEN	HzNomRtg	Rated Nominal frequency of usage of the DER
Rated minimal frequency			HzMinRtg	Rated minimal frequency of usage of the DER
Rated frequency maximum			HzMaxRtg	Rated maximum frequency of usage of the DER
Sign convention for power factor 'PF'			PFSign	Power factor convention: IEC or EEI

Table 3 – Status of PCE

Item	IEC 61850			
	Standard	LN	message parameter	Description
Switch controller	IEC 61850-7-4	CSWI	Pos.stVal	Circuit breaker / switch position
Over frequency	IEC 61850-7-420	DHFT	TrZnSt	True = the frequency of the Referenced ECP exceeds the Trip zone
Under Frequency		DLFT	TrZnSt	True = the frequency of the Referenced ECP exceeds the Trip zone
AC Over Voltage		DHVT	TrZnSt	True = the voltage of the Referenced ECP exceeds the Trip zone
AC Under Voltage		DLVT	TrZnSt	True = the voltage of the Referenced ECP exceeds the Trip zone

Table 4 – Measured values of PCE

Item	IEC 61850			
	Standard	LN	message parameter	Description
AC voltage	IEC 61850-7-4	MMXU	PPV.phsAB / PNV.phsA	"PPV: Phase to Phase Voltage PNV: Phase to Neutral Voltage"
			PPV.phsBC / PNV.phsB	"PPV: Phase to Phase Voltage"

				PNV: Phase to Neutral Voltage"
			PPV.phsCA / PNV.phsC	"PPV: Phase to Phase Voltage PNV: Phase to Neutral Voltage"
AC current			A.phsA	phase current
			A.phsB	phase current
			A.phsC	phase current
Apparent power			TotVA	The total apparent power in a three-phase circuit [VA].
Active power			TotW	The total Active power in a three-phase circuit [W].
Reactive power			TotVAr	The total Reactive power in a three-phase circuit [VAr].
Power factor			TotPF	The total power factpr in a three-phase circuit
Frequency			Hz	Frequency [Hz].
AC voltage		MMXN	Vol	Non-phase-related AC rms voltage.
AC current			Amp	Non-phase-related AC rms current.
Apparent power			VolAmp	Non-phase-related AC apparent power.
Active power			Watt	Non-phase-related AC real power.
Reactive power			VolAmpr	Non-phase-related AC reactive power.
Power factor			PwrFact	Average power factor in a three-phase circuit.
Frequency			Hz	Frequency [Hz].
DC voltage		MMDC	Vol	DC voltage.
DC current			Amp	DC current.
DC power			Watt	DC power.

5.2.2 Testing conditions

Connect PCE to DC and AC power supplies according to manufacturer's instructions and specifications.

Set operating conditions of the AC power supply so that PCE can operate with nominal voltage and frequency.

Voltage of DC power supply shall be set within the operating range of PCE.

5.2.3 Testing procedures

a) Set DERMS to send command to PCE so that PCE is set under the halt condition.

b) Read the nameplate data monitored on DERMS.

c) Confirm that the monitored nameplate data are correct, by referring to manufacturer's specifications.

d) Confirm that the status and measured values of PCE on DERMS are correct, by observing the operation of PCE and data which are measured by measuring instruments.

e) (Regarding test report)

5.2.4 Performance criteria

The following points shall be evaluated.

- Confirm that the monitored nameplate data is not empty and is the same with manufacturer's specifications.
- The status displayed on DERMS is the same with those observing the operation of PCE.
- Compare monitored values of DUT and measured values with measuring devices and confirm that the difference of those values is kept within the tolerance which is declared by the manufacturer.

5.3 Evaluation of the remote control and monitoring functions

5.3.1 Testing items

The operation and status of PCE shall be evaluated according to the setting of testing items listed on Table 5.

All data listed in Table 3 and Table 4 shall be confirmed on DERMS during the test. Data which are monitored at DERMS shall be evaluated with data which are set in PCE and measured by measuring instruments.

Communication of PCE shall also be confirmed by monitoring exchanged data.

Table 5 – Testing items of remote control

Items controlled remotely	Relevant clause specifying requirements of the function in IEC TS 62786-1	IEC 61850		
		Standard	LN	Description
Autonomous connection and disconnection	4.10 Connection and starting to generate electrical power	IEC 61850-7-420	DCTE	To cover the Cease to energize authorization, state, and external request, as well as the Return to service authorizations, state, and external request
Constant power factor control	4.7.3 Dynamic reactive power capabilities	IEC 61850-7-420	DFPF	To set the power factor and the quadrant of the DER, with the possibility of different settings for generating and consuming
Maximum active power control	4.11 Ceasing and reduction of active power on set point		DWMX	To cause the DER to limit its maximum active power at the Referenced ECP to the target value
Active power control	4.11 Ceasing and reduction of active power on set point		DWGC	To set a target active power value (generating or consuming) at the Referenced ECP that the DER should achieve
Reactive power control	4.7.3 Dynamic reactive power capabilities		DVAR	To the amount of reactive power as a percentage of WMax, VARMax, or AvIVAr, or

				an absolute value of reactive power
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5.3.2 Testing conditions

Connect PCE to DC and AC power supplies according to manufacturer's instructions and specifications.

Set operating conditions of the AC power supply so that PCE can operate with nominal voltage and frequency.

Voltage of DC power supply shall be set within the operating range of PCE.

Table 6 shows testing items, which are controlled remotely, and parameters, which are changed during the test.

Table 6 – Overview of testing procedures for each testing item

Items controlled remotely	Sequence of setting of parameters to be changed
Autonomous connection and disconnection	1) Confirmation of autonomous connection and disconnection with the grid when the grid is stable. 2) Confirmation of autonomous connection and disconnection with the grid when the grid voltage is changed. 3) Confirmation of autonomous connection and disconnection with the grid when the grid frequency is changed. 4) Confirmation of autonomous connection and disconnection with the grid after OV/UV/OF/UF protections are operated.
Constant power factor control	Start with 1,0, then set to 0,9 over-exciting condition. Set to 1,0, then set to 0,9 under exciting condition. Optional: Start with 1,0, then set to the minimum over-exciting condition. Set to 1,0, then set to the minimum under-exciting condition. Note: minimum values shall be declared by vendors.
Maximum active power control	Start with 80%, then setting to 100%.
Active power control	Start with 80%, then setting to 100%.
	Set the maximum and minimum limit.
Reactive power control	Start with 10%, then setting to 0%.

5.3.3 Testing procedures

5.3.3.1 Autonomous connection and disconnection

5.3.3.1.1 Parameters

The remote control function for autonomous connection and disconnection shall be evaluated by setting and changing parameters listed on Table 7.

Table 7 – Minimum required parameters for autonomous connection and disconnection

Item	IEC 61850			
	Standard	LN	message parameter	Description
Switch controller	IEC 61850-7-4	CSWI	Pos.ctlVal	Circuit breaker / switch position

Configuration of HVRT		PTOV	StrVal	Voltage start value setting; if this level is exceeded, 'Str.general' becomes true.
Configuration of LVRT		PTUV	StrVal	Voltage start value setting; if this level is exceeded, 'Str.general' becomes true.
Configuration of HFRT		PTOF	StrVal	Frequency or frequency rate change setting; if this level is exceeded, 'Str.general' becomes true.
Configuration of LFRT		PTUF	StrVal	Frequency or frequency rate change setting; if this level is exceeded, 'Str.general' becomes true.
Enabling function	IEC 61850-7-420	DCTE	RtnSvcAuto	If true, the DER is authorized to automatically return to service; if false, the DER must wait until an external RtnSvcAuth is received to allow it to return to service.
Value of ramp rate t			RtnRmpTmms	Return to service duration (ms) that is a time for ramping up that must not be exceeded. Active power shall increase linearly, or in a stepwise linear ramp, with an average rate-of-change not exceeding the DER nameplate active power rating divided by this return to service duration.
Delay time			RtnDITmms	Time delay (ms) before returning to service in order to ensure that both the frequency and voltage are within their high and low limits
Normal voltage range			VHiLim	The voltage high limit of the normal voltage range. The measured voltage must be below this high limit before the DER may be allowed to return to service.
			VLoLim	The voltage low limit of the normal voltage range. The measured voltage must be above this low limit before the DER may be allowed to return to service.
Normal frequency range			HzHiLim	The frequency high limit of the normal frequency range. The measured frequency must be below this high limit before the DER may be allowed to return to service.
			HzLoLim	The frequency low limit of the normal frequency range. The measured frequency must be above this low limit before the DER may be allowed to return to service.
Active power setpoint		DWGC	WSptPct	Active power setpoint setting as a percentage of Wmax.

391 During the test, confirm that the status and measured values of PCE on DERMS are correct by
392 observing the operation of PCE and data which are measured by measuring instruments. For
393 evaluating response time of the remote control function, measure the time from when DERMS
394 sends a command until the PCE begins operating.

5.3.3.1.2 When the grid is stable**5.3.3.1.2.1 Procedures**

- a) Set parameter of PCE "CSWI.Pos.ctlVal" with False by sending command from DERMS.
 - b) Set parameter of PCE "DCTE.RtnSvcAuto" with True by sending command from DERMS.
 - c) Set parameter of PCE "DCTE.RtnRmpTmms" with declared value by sending command from DERMS.
 - d) Set parameter of PCE "DCTE.RtnDITmms" with declared value by sending command from DERMS.
 - e) Set parameter of PCE "DWGC.WSptPct" with rated value by sending command from DERMS.
 - f) Set parameter of PCE "DCTE.VHiLim", "DCTE.VLoLim", "DCTE.HzHiLim", and "DCTE.HzLoLim" with operable range as manufacturer's declaration by sending command from DERMS.
 - g) Set parameter of PCE "CSWI.Pos.ctlVal" with True by sending command from DERMS.
 - h) Set AC power supply to rated voltage and rated frequency.
 - i) Increase voltage of DC power supply gradually.
 - j) Confirm that PCE connect with the grid.
 - k) Measure active power at the AC power ports.
 - l) Decrease voltage of DC power supply gradually.
 - m) Confirm that PCE disconnect with the grid.
- If manufacture has multiple declared value, change the parameters, and repeat step c) to m).

5.3.3.1.2.2 Performance criteria

The following points shall be evaluated by using both measuring device and DERMS.

- At the step j), it shall be confirmed that PCE connects to the grid by monitoring contactor and parameter "CSWI.Pos.stVal". And delay time shall be manufacturer's declaration.
- At the step k), output active power of PCE ("MMXU.TotW" or "MMXN.Watt") shall be rated value, and ramp rate shall be declared value.
- At the step m), it shall be confirmed that PCE disconnects to the grid by monitoring contactor and parameter "CSWI.Pos.stVal".

5.3.3.1.3 When the grid voltage is changed**5.3.3.1.3.1 Procedures**

- a) Set parameter of PCE "CSWI.Pos.ctlVal" with False by sending command from DERMS.
- b) Set parameter of PCE "DCTE.RtnSvcAuto" with True by sending command from DERMS.
- c) Set parameter of PCE "DCTE.RtnRmpTmms" with declared value by sending command from DERMS.
- d) Set parameter of PCE "DCTE.RtnDITmms" with declared value by sending command from DERMS.
- e) Set parameter of PCE "DWGC.WSptPct" with rated value by sending command from DERMS.
- f) Set parameter of PCE "DCTE.VHiLim", "DCTE.VLoLim", "DCTE.HzHiLim", and "DCTE.HzLoLim" with operable range as manufacturer's declaration by sending command from DERMS.
- g) Set parameter of PCE "PTOV.StrVal" and "PTUV.StrVal" as manufacturer's declaration by sending command from DERMS.
- h) Set parameter of PCE "CSWI.Pos.ctlVal" with True by sending command from DERMS.
- i) Set voltage of AC power supply to outside of the operable range of PCE ("DCTE.VHiLim" / "DCTE.VLoLim") within the range of OV/UV ("PTOV.StrVal", "PTUV.StrVal").