Modification	At what stage is this document in the process?
DCRP/MP/21/01 Report to Authority Minor technical modifications to EREC's G98 and G99 within the existing Distribution Code documentation.	01 Modification 02 DCRP report 03 Public Consultation 04 Final Modification Report

The purpose of this document is to assist the Authority in its decision to implement the proposed minor technical modifications to EREC G98, G99 and the Distribution Code. The proposed modification aims to implement changes in line with stakeholder's requests, and with industry requirements.

Date of publication: 22nd July 2021

Recommendation

The Distribution Code Review Panel (DCRP) recommend that the proposed modifications are made to EREC G98, EREC G99 and the Distribution Code.

	The DNOs and DCRP recommend that this modification should be: Submitted to the Authority for approval
	High Impact: Manufacturers/Regulator/Directly connected Demand (including response providers),
	Medium Impact: DNO's, Developers & operators of medium and small generating units
	Low Impact: None

Contents

Timetable

Workgroup Report presented to Panel	04 February 2021
Draft Modification Report issued for consultation	19 February 2021
Consultation Closed	19 March 2021
Final Modification Report available for Panel	22 July 2021

Any questions?

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Proposer: **Distribution Network Licensees**

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Purpose of the Modification

ERECs G98 and G99 cover the requirements of connections to the GB distribution network at differing levels. As a result these documents must be reviewed at regular intervals to ensure accurate compliance with both network and device requirements.

Since the last minor technical modification to G98, G99 and the DCode, there has been a call from stakeholders to increase clarity surrounding the connection and compliance process. This modification is intended to provide that clarity to users.

Details of the Proposal

The transition from ERECs G83 / G59 to ERECs G98 / G99 resulted in significant changes to generation connection requirements and compliance demonstration, in the case of G98 the original version was based on EREC G83 and EN50438. With the replacement of EN50483 with EN50549 parts 1 and part 2 and in the absence of part 10 (testing), it has been necessary to remove the refences to EN50438 and reintroduce some text along the lines of G83. It is taking time for manufacturers and generators to familiarise themselves with the new technical and compliance requirements, and for DNOs to embed new processes in their organisations. Issues with the understanding and implementation of ERECs G98 and G99 can be brought to a number of forums. The bulk of these amendments have arisen between the implementation of the last Minor technical Modification (March 2020) and this modification, proposed in December 2020 from feedback, and items raised through the Distributed Energy Resources Technical Forum.

Responses to the Consultation

Nine responses were received,

1. BDH (Bundesverband der Deutschen Heizungsindustrie e.V. Cologne, Germany)
2. Caterpillar (Electric power division)
3. Senertec (GmbH, Germany)
4. NPg (Northern Powergrid)
5. COGEN Europe/PACE
6. AMPS
7. Centrica
8. SMA (Solar technology AG)
9. Baxi Heating UK

All nine were generally supportive of the changes, with the main points from their responses summarised below.

BDH‘s response, (as well as a number of other respondents) was broadly supportive of the changes, although it did raise points around cyber security in relation to risks arising through the input port on the device.

Senertec responded in a similar fashion to BDH’s response, along with some minor editorial changes.

COGEN Europe/PACE’s response was similar to that received from BDH and Senertec.

Baxi’s response was broadly supportive, and similar to others received, we considered the minor editorials proposed.

Caterpillar responded in support of the changes, with points raised around family type tested devices and some questions around power factor testing. Their points have been carefully considered, but the DNOs believe there are one or two misconceptions and which the DNOs tried to clarify in the response to Caterpillar.

Northern Powergrid's response was supportive and helpfully listed several editorial improvements.

AMPS' views were broadly supportive, with feedback on type testing and power factor tests on PGMs. This feedback was considered when drafting the documents.

Centrica's response was supportive but with concerns on the cyber security provisions.

SMA responded in support of the changes, with comments on compliance of historic Type A PGMs and a call for clarity around cyber security.

Impacts on Total System and the DNOs' Systems

In the main the proposals are clarifications of existing requirements and will have no effect on the Total System or DNOs' systems. The specification of appropriate cyber security requirements is intended to reduce the risk of cyber attacks adversely affecting the operation of DNOs' and the Total System.

Impacts on the Users of DNOs' Systems

The main changes to G98 and G99 are to provide improved clarity of application. This should help Users implement G98 and G99 more efficiently.

Assessment against Distribution Code Objectives

(i) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the distribution of electricity.

The proposal has a positive impact on this objective by aligning the characteristics and performance requirements of connected generation.

(ii) To facilitate competition in the generation and supply of electricity.

The proposal has a positive impact on this objective by aligning the characteristics and performance requirements of connected generation.

(iii) Efficiently discharge the obligations imposed upon DNOs by the Distribution Licence and comply with the Regulation (where Regulation has the meaning defined in the Distribution Licence) and any relevant legally binding decision of the European Commission and/or Agency for the Co-operation of Energy Regulators.

The proposal has a neutral impact on this objective.

(iv) Promote efficiency in the implementation and administration of the Distribution Code.

The proposal has a positive impact on this objective by reducing the scope for uncertainty and ambiguity in the minds of users.

Impact on other Industry documents

There are no impacts on other industry documents.

Environmental Impact Assessment

There are no environmental impacts associated with this proposed modification.

Distribution Code Review Panel Recommendation

The responses to the consultation were discussed at the DCRP meeting on 3rd June 2021 and the Panel agreed that the changes should be submitted to Ofgem.

Recommendation

The Licensed Distribution Network Operators and the DCRP recommend that this modification report should;

- be submitted to the Authority for approval; and
- subject to the agreement of the Authority the modification should be implemented from the date the revised Distribution Code and associated documents are published. This date is recommended as 01 August 2021 or such other date as the Authority directs.

Appendices

Appendix 1 – Details of the proposed changes to documents

Appendix 2 – Responses to the consultation

Appendix 3 – Distribution Code Modifications

Appendix 4 – EREC G98 Amendment 6

Appendix 5 – EREC G99 Amendment 8

1 Appendix 1 – Details of proposed changes to documents

The modifications proposed have been outlined in this section and cover the three affected documents within the Distribution Code.

1.1 Distribution Code v45 Modifications

1.1.1 Expressions section

For formatting purposes within this section of RTA, the expressions section must be included,

Act	The Electricity Act 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004).
Active Power	The product of voltage and the in-phase component of alternating current measured in units of watts, normally measured in kilowatts (kW) or megawatts (MW).
Annex 1 Standard	A electricity industry national standard that implements **Distribution Code r**equirements and which is listed in Annex 1 of the **Distribution Code,** and forms part of the **Distribution Code**.
Annex 2 Standard	A electricity industry national standard that has a material effect on **Users** but does not implement any **Distribution Code** requirements and does not form part of the **Distribution Code** technical requirements.
Annual Average Cold Spell (ACS) Conditions	A particular combination of weather elements that give rise to a level of **Peak Demand** within a financial year which has a 50% chance of being exceeded as a result of weather variation alone.
Apparatus	All **Equipment** in which electrical conductors are used, supported or of which they may form a part.
Authorised Electricity Operator or AEO	Any person (other than the **DNO** in its capacity as an operator of a Distribution System) who is authorised to generate, participate in the transmission of, distribute or supply electricity.
Authority	The Gas and Electricity Markets Authority established under Section 1 of the Utilities Act 2000.
Average Conditions	That combination of weather elements within a period of time which is the average of the observed values of these weather elements during equivalent periods over many years (Sometimes referred to as normal weather).
Balancing and Settlement Code (BSC)	The code of that title as from time to time amended.
Balancing Mechanism	Has the meaning set out in **NGESO's Transmission Licence**.
BM Unit	Has the meaning set out in the **BSC**, except that for the purposes of the **Distribution Code** the reference to "Party" in the **BSC** shall be a reference to a **User**.

BM Participant	A person who is responsible for and controls one or more **BM Units** or where a **CUSC Bilateral Agreement** specifies that a **User** is required to be treated as a **BM Participant** for the purpose of the **Grid Code.** For the avoidance of doubt, it does not imply that they must be active in the **Balancing Mechanism**.
Black Start	The procedure necessary for a recovery from a **Total Shutdown** or **Partial Shutdown.**
Black Start Station	A **Power Station** which is registered pursuant to a **CUSC Bilateral Agreement** with **NGESO**, as having a Black Start Capability.
CENELEC	European Committee for Electrotechnical Standardisation.
Citizens Advice (CA)	National Association of Citizens Advice Bureaux
Citizens Advice Scotland (CAS)	Scottish Association of Citizens Advice Bureaux
Civil Emergency Direction	Directions given by the **Secretary of State** to **AEOs** for the purpose of mitigating the effects of any natural disaster or other emergency which, in the opinion of the **Secretary of State**, is or may be likely to disrupt electricity supplies.
Committed Project Planning Data	Data relating to a **User Development** once the offer for a **Connection Agreement** is accepted.
Connection Agreement	An agreement between the **DNO** and the **User** or any **Customer** setting out the terms relating to a connection with the **DNO's Distribution System** (excluding any **CUSC Bilateral Agreement**).
Connection Point	An **Entry Point** or an **Exit Point** of the **Distribution System** as the case may be**.**
Control Centre	A location used for the purpose of control and operation of all, or of part of a **Distribution System**, **National Electricity Transmission System** or the **System** of a **User.**
Control Person	A person who has been nominated by an appropriate officer of the **DNO, Transmission Licensee** or a **User** to be responsible for controlling and co-ordinating safety activities necessary to achieve **Safety From The System.**
Control Phase	The period 0-24 hours inclusive ahead of real time operation. The **Control Phase** follows on from the **Programming Phase** and covers the period down to real time.
CUSC	Has the meaning set out in **NGESO's Transmission Licence**
CUSC Bilateral Agreement	An agreement pursuant to the **CUSC Framework Agreement** made between **NGESO** and a **User** of the **National Electricity Transmission System**
CUSC Disputes Resolution Procedure	The procedure described in **CUSC** relating to disputes resolution.
CUSC Framework Agreement	Has the meaning set out in **NGESO's Transmission Licence.**
Customer	Any person supplied or entitled to be supplied with electricity at any premises within **Great Britain** but shall not include any **Authorised Electricity Operator** in its capacity as such.

Customer With Own Generation or CWOG	A **Customer** with one or more **Power Generating Modules** connected to the **Customer's System**, providing all or part of the **Customer's** electricity requirements**,** and which may use the **DNO's Distribution System** for the transport of any surplus of electricity being exported.
DC Converter	Any **Apparatus** used to convert alternating current electricity to direct current electricity, or vice versa. A **DC Converter** is a standalone operative configuration at a single site comprising one or more converter bridges, together with one or more converter transformers, converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion. In a bipolar arrangement, a **DC Converter** represents the bipolar configuration.
DNO's Distribution System	The **System** consisting (wholly or mainly) of electric lines owned or operated by the **DNO** and used for the distribution of electricity between the **Grid Supply Points** or **Power Generating Modules** or other **Entry Points** to the points of delivery to **Customer**s or **Authorised Electricity Operators**, or any **Transmission Licensee** within **Great Britain** and **Offshore** in its capacity as operator of the licensee's **Transmission System** or the **National Electricity Transmission System** and includes any **Remote Transmission Assets** (owned by a **Transmission Licensee** within **Great Britain**), operated by the **DNO** and any electrical plant and meters and metering equipment owned or operated by the **DNO** in connection with the distribution of electricity, but shall not include any part of the **National Electricity Transmission System**
Decimal Week	The week numbering system where week 1 commences in the first week of January on a date as advised by the **DNO**.
Demand	The demand of MW or MVAr of electricity (ie both **Active Power** and **Reactive Power** respectively) unless otherwise stated.
Demand Control	Any or all of the following methods of achieving a **Demand** reduction: (a) **Customer** voltage reduction initiated by the **DNO** (other than following an instruction from **NGESO**); (b) **Customer Demand** reduction by disconnection initiated by the **DNO** (other than following an instruction from **NGESO**); (c) **Demand** reduction instructed by **NGESO**; (d) automatic low frequency **Demand** disconnection; (e) emergency manual **Demand** disconnection
Demand Control Notification Level	The level above which the **DNO** has to notify **NGESO** of its proposed or achieved use of **Demand Control** which is 12 MW in England and Wales and 5 MW in Scotland.
Demand Facility	An installation under the control of a **Customer** where electrical energy is consumed and is connected at one or more **Connection Point**s to the **DNO's Distribution System**.
Demand Services Provider	A party who contracts with the **DNO** to provide a demand side service. The party might be a **Customer** contracting bilaterally with the **DNO** for the provision of services, or may be a third party providing an aggregated service from many individual **Customer**s. In the latter case there will be a specific contract for the provision of the services to the **DNO** and will include compliance by that third party with the requirements of DPC9 in relation to each **Demand Unit** included in the aggregated service.

Demand Unit	An appliance or a device whose **Active Power Demand** or **Reactive Power** production or consumption is being actively controlled by the **Customer** in whose **Demand Facilit** it is installed and which has been commissioned on or after 18 August 2019 in pursuance of a contract to this end with the **DNO**. Such an appliance or device commissioned before this date, but which has been materially altered will also be included in this definition. Where there is more than one **Demand Unit** in a **Demand Facilit**, these **Demand Units** shall together be considered as one **Demand Unit** if they cannot be operated independently from each other. **Demand Units** of **Customers** where the **Customer** has concluded a final and binding contract for the purchase of a **Demand Unit** before 07 September 2018 are not included the scope of DPC9. The **Customer** must have notified the **DNO** of the conclusion of this final and binding contract by 07 March 2019. Any **Demand Unit** including storage, with the exception of a pumped storage **Power Generating Module**, as a component part is also excluded from the requirements of DPC9.
Detailed Planning Data (DPD)	Detailed additional data which the **DNO** requires under the **Distribution Planning and Connection Code** in support of **Standard Planning Data.**
Distribution Business	The authorised business of the **DNO** or any affiliate or related undertaking of the **DNO** (whether the business is undertaken by the **DNO** or another licence holder), comprising: (a) the distribution of electricity through the **DNO's Distribution System**, including any business in providing connections to such **System**; and (b) the provision of Distributor Metering and Data Services as defined in the **Distribution Licence**.
Distribution Code	A code required to be prepared by a **DNO** pursuant to condition 9 (**Distribution Code**) of a **Distribution Licence** and approved by the **Authority** as revised from time to time with the approval of, or by the direction of, the **Authority**.
Distribution Code Review Panel or Panel	The standing body established under the **Distribution General Conditions.**
Distribution Data Registration Code	That portion of the **Distribution Code** which is identified as the **Distribution Data Registration Code.**
Distribution General Conditions or DGC	That portion of the **Distribution Code** which is identified as the **Distribution General Conditions.**
Distribution Glossary and Definitions	That portion of the **Distribution Code** which is identified as the **Distribution Glossary and Definitions.**
Distribution Introduction (DIN)	That portion of the **Distribution Code** which is identified as the **Distribution Introduction**.
Distribution Licence	A distribution licence granted under Section 6(1)(c) of the **Act**.
Distribution Network Operator (DNO)	The person or legal entity named in Part 1 of the **Distribution Licence** and any permitted legal assigns or successors in title of the named party.
Distribution Operating Code (DOC)	That portion of the **Distribution Code** which is identified as the **Distribution Operating Code.**

Distribution Planning and Connection Code (DPC)	That portion of the **Distribution Code** which is identified as the **Distribution Planning and Connection Code.**
Distribution System	The electrical network operated by an **Other Authorised Distributor.**
Distribution Use of System Agreement	The standard form of agreement of that name, as amended from time to time.
Earthing Device	A means of providing a connection between an **Isolated** conductor and earth.
Electricity Safety, Quality and Continuity Regulations (ESQCR)	The statutory instrument entitled The Electricity Safety, Quality and Continuity Regulations 2002 as amended from time to time and including any further statutory instruments issued under the **Act** in relation to the distribution of electricity.
Embedded	Having a direct electrical connection to a **Distribution System.**
Embedded Generator	A **Generator** including a **Customer With Own Generation** whose **Power Generating Modules** are directly connected to the **DNO's Distribution System** or to an **Other Authorised Distributor** connected to the **DNO's Distribution System.** The definition of **Embedded Generator** also includes the **OTSO** in relation to any **Embedded Transmission System**
Embedded Transmission Licensee	**Offshore Transmission Licensee** for an **Embedded Transmission System**
Embedded Transmission System	An **Offshore Transmission System** directly connected to the **DNO's Distribution System** or to an **Other Authorised Distributor** connected to the **DNO's Distribution System.**
Entry Point	The point at which an **Embedded Generator** or other **Users** connect to the **DNO's Distribution System** where power flows into the **DNO's Distribution System** under normal circumstances**.**
Equipment	**Plant** and/or **Apparatus.**
Electricity Supply Industry (ESI)	Electricity Supply Industry.
Event	An unscheduled or unplanned (although it may be anticipated) occurrence on or relating to a **System** including, without limiting that general description, faults, incidents and breakdowns and adverse weather conditions being experienced. It includes an occurrence where the compliance of **Customer's Equipment** with this **Distribution Code** or where relevant the **Grid Code** is or might be compromised.
Existing Offshore Generators	A **Generator** with a **Power Station**y located in offshore waters that has an agreement for connection to the **DNO's Distribution System** via lines of 132kV or above that are wholly or partly in offshore waters.
Exit Point	The point of supply from the **DNO's Distribution System** to a **User** where power flows out from the **DNO's Distribution System** under normal circumstances**.**
External Interconnection	A connection to a party outside the **Total System.**
Fault Level	Prospective current that would flow into a short circuit at a stated point in the **System** and which may be expressed in kA or, if referred to a particular voltage, in MVA.

Feasibility Project Planning Data	Data relating to a proposed **User Development** until such time that the **User** applies for a **Connection Agreement**.
Frequency	The number of alternating current cycles per second (expressed in Hertz) at which a **System** is running.
Fuel Security Code	The document of that title designated as such by the **Secretary of State**, as from time to time amended.
Generator	A person who generates electricity under licence or exemption under the **Act.** A person who has connected a **Power Generating Module(s)** in accordance with Item 8 Engineering Recommendation G83/2 ("Recommendations For The Connection of Type Tested Small-Scale Embedded Generators (Up To 16 A Per Phase) in Parallel With Public Low-Voltage Distribution Networks") or with Item 9 Engineering Recommendation G98 (Requirements for the connection of type-tested micro generators (up to and including 16 A per phase) in parallel with public low voltage distribution networks on or after 27 April 2019) and where this is (are) their only **Power Generating Module(s)**, is not classed as a **Generator** for the purpose of this **Distribution Code.**
Great Britain or GB	"The landmass of England & Wales and Scotland, including internal waters".
Grid Code	The code which **NGESO** is required to prepare under its **Transmission Licence** and have approved by the **Authority** as from time to time revised with the approval of, or by the direction of, the **Authority**.
Grid Supply Point	Any point at which electricity is delivered from the **National Electricity Transmission System** to the **DNO's Distribution System.**
High Voltage (HV)	A voltage exceeding 1000 Volts**.**
High Voltage Customer	A **Customer** connected to a part of the **Distribution System** which is operating at **HV**.
Implementing Control Person	Pursuant to DOC8, the person implementing **Safety Precautions** at an Operational Boundary.
Individual DNO Standard	A standard adopted by an individual **DNO** and which is published as such by an individual **DNO** and that has a material effect on **Users.**
IEC	International Electrotechnical Commission.
Independent Distribution Network Operator	A **DNO** that does not have a Distribution Services Obligation Area in its **Distribution Licence** and is not an ex Public Electricity Supplier
Industry Codes Technical Group (ITCG)	A standing body comprised of representatives of all the **DNO**s to carry out the functions referred to in its own Constitution and Rules
Isolated	Disconnected from associated **Plant** and **Apparatus** by an **Isolating Device(s)** in the isolating position or by adequate physical separation or sufficient gap.
Isolating Device	A device for rendering **Plant** and **Apparatus Isolated.**

Joint System Incident	Is an **Event** occurring on the **System** or installation, which, in the opinion of the **DNO**, has or may have a serious and/or widespread effect on the **System** or installation of another.
Large Power Station	As defined in the **Grid Code**.
Load Managed Area	Has the meaning given to that term in the **Distribution Use of System Agreement**.
Low Voltage or LV	In relation to alternating current, a voltage exceeding 50 volts but not exceeding 1 000 volts**.**
Manufacturers' Information	Information in suitable form provided by a manufacturer in order to demonstrate compliance with one or more of the requirements of the **Distribution Code**. Where equipment certificate(s) as defined in EU 2016/631, or 2016/1388 cover all or part of the relevant compliance points, the equipment certificate(s) demonstrate compliance without need for further evidence for those aspects within the scope of the equipment certificate
Maximum Generation	The additional output obtainable from a **Power Generating Module** in excess of **Registered Capacity.**
Medium Power Station	A **Power Station** which is connected to a **System** notionally connected to a **Grid Supply Point** in **NGET**'s Transmission Area with a **Registered Capacity** of 50 MW or more but less than 100 MW. For the avoidance of doubt an installation comprising one or more **DC Converters** with an aggregate capacity of between 50 and 100MW will be classed as a Medium Power Station for the purposes of this Distribution Code.
Meter Operation Code of Practice Agreement	The agreement of that name, as amended from time to time.
Meter Operator	A person, registered with the Registration **Authority**, appointed by either a **Supplier** or **Customer** to provide electricity meter operation services. (This **Distribution Code** does not place any direct obligation on **Meter Operators** other than through the appointment by either a **Supplier** or a **Customer**.)
~~**Minimum Generation**~~	~~The minimum output which a **Power Generating Module** can reasonably generate as registered under the **Distribution Data Registration Code**.~~
Minimum Regulating Level	The minimum **Active Power** output down to which a **Power Generating Module** can control **Active Power**.
Minimum Stable Operating Level	The minimum **Active Power** output at which the **Power Generating Module** can be operated stably for an unlimited time.
National Electricity Transmission System	The **Onshore Transmission System** and **Offshore Transmission System .**
National Electricity Transmission System Demand	As defined in the **Grid Code**.
NGESO	National Grid Electricity System Operator Limited.
NGET	National Grid Electricity Transmission plc.
Normal Operating Frequency	The number of Alternating Current cycles per second, expressed in Hertz at which the **System** normally operates, ie 50 Hertz.

Offshore	Means in Offshore Waters, as defined in Section 90(9) of the Energy Act 2004.
Offshore Transmission Implementation Plan	As defined in the **Transmission Licence**
Offshore Transmission System Operator (OTSO)	The **NGESO** acting as operator of an **Offshore Transmission System .**
Offshore Transmission Licensee	The holder of a licence granted under Section 6 (1)(b) of the **Act** excluding **NGET**,**NGESO**, **SPT** and **SHETL**.
Offshore Transmission System	Has the meaning set out in the **Grid Code**.
Onshore Transmission Licensees	**NGET**, **SHETL** and **SPT**
Onshore Transmission System	Has the meaning set out in the **Grid Code.**
Operation	A scheduled or planned action relating to the operation of the **System.**
Operation Diagrams	Diagrams which are a schematic representation of the **HV Apparatus** and the connections to all external circuits at a **Connection Point,** incorporating its numbering, nomenclature and labelling.
Operational Boundary	The boundary between the **Apparatus** operated by the **DNO** or a **User** and the **Apparatus** operated by **Other Authorised Distributor(s)** or other **User(s)**, as specified in the relevant **Site Responsibility Schedule**.
Operational Data (OD)	Information to be supplied pursuant to the **Distribution Operating Codes** and as set out in the Schedules to the **DDRC**.
Operational Day	The period from 0500 hours on one day to 0500 on the following day.
Operational Effect	Any effect on the **Operation** of the relevant other **System** which causes the **National Electricity Transmission System** or **DNO's Distribution System**or the **System** of the other **User** or **Users,** as the case may be, to operate (or be at a materially increased risk of operating) differently from the way in which they would or may have operated in the absence of such an effect.
Operational Planning	The procedure set out in **Distribution Operating Code** DOC2 comprising, through various timescales, the co-ordination of planned outages of **Users' Plant** and **Apparatus**.
Operational Planning Phase	The period from 8 weeks to 3 years inclusive ahead of real time operation.
Other Authorised Distributor	A **User** authorised by Licence or exemption to distribute electricity and having a **User Distribution System** connected to the **DNO's Distribution System.**
Output Usable or OU	That portion of **Registered Capacity** which is not unavailable due to a **Planned Outage** or breakdown.
Ownership Boundary	The electrical boundary between the **Equipment** owned by one **DNO** or **User** and the **Equipment** owned by another **User**.

Partial Shutdown	The same as a **Total Shutdown** except that all generation has ceased in a separated part of the **Total System** and there is no electricity supply from **External Interconnections** or other parts of **Total System** to that part of the **Total System** and, therefore, that part of the **Total System** is shutdown with the result that it is not possible for that part of the **Total System** to begin to function again without **NGESO's** directions relating to a **Black Start**.
Peak Demand	The highest level of **Demand** recorded/forecast for a 12-month period, as specified in the relevant sections of the **Distribution Code**.
Phase (Voltage) Unbalance	The ratio (in percent) between the rms values of the negative sequence component and the positive sequence component of the voltage.
Planned Outage	An outage of a **Power Generating Module**, its contsitutent units (eg generating transformer) or parts, or a relevant part of a **User**'s **System** or of part of the **National Electricity Transmission System** or of part of a **Distribution System.**
Plant	Fixed and movable items used in the generation and/or supply and/or transmission of electricity other than **Apparatus**.
Power Factor	The ratio of **Active Power** to apparent power (apparent power being the product of voltage and alternating current measured in volt-amperes and standard multiples thereof, ie VA, kVA, MVA).
Power Generating Module	Any **Apparatus** which produces electricity
Power Island	**Power Generating Module**s at an isolated **Power Station**, together with complementary local **Demand.** In Scotland a **Power Island** may include more than one **Power Station**.
Power Station	A **Power Generating Facilit**y
Power Generating Facility	An installation comprising one or more **Power Generating Module**s (even where sited separately) and/or controlled by the same **Generator** and which may reasonably be considered as being managed as one **Power Generating Facility**
Preliminary Project Planning Data	Data relating to a proposed **User Development** at the time the **User** applies for a **Connection Agreement** but before an offer is made.
Programming Phase	The period between the **Operational Planning Phase** and the **Control Phase**. It starts at the 8 weeks ahead stage and finishes at 17:00 on the day ahead of real time
Protection	The provisions for detecting abnormal conditions in a **System** and initiating fault clearance or actuating signals or indications.
Qualifying Standard	Electrical standards in use by **DNO**s and included in the **Distribution Code Review Panel's** governance procedures, and falling into one of the categories below: **i. Annex 1 Standard** **ii. Annex 2 Standard** **iii. Individual DNO Standard**
Reactive Power	The product of voltage and current and the sine of the phase angle between them which is normally measured in kilovar (kVAr) or megavar (MVAr).

Registered Capacity	The normal full load capacity of a **Power Generating Module** as declared by the **Generator** less the MW consumed when producing the same; ie for all **Generators**, including **Customer With Own Generation,** this will relate to the maximum level of **Active Power** deliverable to the **DNO's Distribution System**. For **Power Generating Modules** connected to the **DNO's Distribution System**via an inverter, the inverter rating is deemed to be the **Power Generating Module's** rating.
Registered Data	Data referred to in the schedules to the **Distribution Data Registration Code.**
Remote Transmission Assets.	Any **Plant** and **Apparatus** or meters owned by **NGET** which: a) are **Embedded** in the **DNO's Distribution System** and which are not directly connected by **Plant** and/or **Apparatus** owned by **NGET** to a sub-station owned by **NGET**; and b) are by agreement between **NGET** and the **DNO** operated under thedirection and control of the **DNO.**
Requesting Control Person	Pursuant to DOC8, the person requesting **Safety Precautions** at an **Operational Boundary**.
Safety From The System	That condition which safeguards persons working on or testing **Apparatus** from the dangers which are inherent in working on items of **Apparatus** which are used separately or in combination in any process associated with the generation, transmission or distribution of electricity.
Safety Management System	The procedure adopted by the **DNO** or a **User** to ensure the safe **Operation** of the **System** and the safety of personnel required to work on that **System**.
Safety Precautions	The procedures specified within a **Safety Management System.**
Safety Rules	The rules or procedure of the **DNO** or a **User** to ensure **Safety From The System**.
Scheduling	The procedure for determining intended usage of **Power Generating Module**s**.**
Secretary of State	Has the same meaning as in the **Act**.
SHETL	Scottish Hydro-Electric Transmission Limited
Significant Incident	An **Event** on the **Transmission System** or **DNO's Distribution System** or in a **User's System** which has or may have a significant effect on the **System** of others.
Site Responsibility Schedule	A schedule defining the ownership, operation and maintenance responsibility of **Plant** and **Apparatus** at a **Connection Point** of the **DNO**.
Small Power Station	As defined in the **Grid Code**.
SPT	Scottish Power Transmission Limited
Standard Planning Data (SPD)	General information required by the **DNO** under the **Distribution Planning Code**.

Standby	The supply of electricity by a **Supplier** to a **Customer** on a periodic or intermittent basis to make good any shortfall between the **Customer's** total supply requirements and that met by his own generation.
Superimposed Signals	Those electrical signals present on a **Distribution System** for the purposes of information transfer.
Supplier	(a) A person supplying electricity under an Electricity Supply Licence; or (b) A person supplying electricity under exemption under the **Act**; in each case acting in its capacity as a supplier of electricity to **Customers** in **Great Britain** .
Supply Agreement	An agreement for the supply of electricity made between a **Supplier** and a consumer of electricity.
System	An electrical network running at various voltages.
System Control	The administrative and other arrangements established to maintain as far as possible the proper safety and security of the **System**.
System Incident Centre	A centre set up by the **DNO** pursuant to the declaration of a **Joint System Incident**, under DOC 9, to assume control of the incident.
System Stability	The ability of the **System** for a given initial operating condition to regain a state of operating equilibrium after being subjected to a given disturbance, with most **System** variables being within acceptable limits so that practically the whole **System** remains intact.
System Test	That test or tests which involve simulating conditions or the controlled application of irregular, unusual or extreme conditions on the **Total System** or any part of it, but not including routine testing, commissioning or recommissioning tests.
Test Coordinator	A suitably qualified person appointed to coordinate **System Test** pursuant to DOC12.
Test Panel	A panel, the composition of which is detailed in DOC12, and which will be responsible for formulating **System Test** proposals and submitting a test programme.
Top - Up	The supply of electricity by any **Supplier** to the **Customer** on a continuing or regular basis to make good any shortfall between the **Customer's** total supply requirements and that met from other sources.
Total Shutdown	The situation existing when all generation has ceased and there is no electricity supply from **External Interconnections** and therefore the **Total System** has shutdown with the result that it is not possible for the **Total System** to begin to function again without **NGESO's** directions relating to a **Black Start** .
Total System	The **National Electricity Transmission System** and all **Systems** of **Users** of this **National Electricity Transmission System** in **Great Britain and Offshore.**
Transmission Licence	The licence granted under Section 6(1)(b) of the **Act**.
Transmission Licensee	Any **Onshore Transmission Licensee**, **Offshore Transmission Licensee** or **NGESO**.
Transmission System	Has the same meaning as the term "licensee's transmission system" in the **Transmission Licence** of a **Transmission Licensee**.

Unmetered Supply	A supply of electricity to premises which is not, for the purposes of calculating charges for electricity supplied to the **Customer** at such premises, measured by metering equipment.
User	A term used in various sections of the **Distribution Code** to refer to the persons using the **DNO's Distribution System**, more particularly identified in each section of the **Distribution Code**, including for the avoidance of doubt the **OTSO** for **Embedded Transmission System.**
User Development	Either a **User's Plant** and/or **Apparatus** and/or **System** to be connected to the **DNO's Distribution System**, or a modification relating to a **User's Plant** and/or **Apparatus** and/or **System** already connected to the **DNO's Distribution System**, or a proposed new connection or modification to the connection within the **User's System**.
Voltage Reduction	The method to temporarily control **Demand** by reduction of **System** voltage.
Weekly Average Cold Spell (ACS) Condition	That particular combination of weather elements that gives rise to a level of **Peak Demand** within a week, taken to commence on a Monday and end on a Sunday, which has a particular chance of being exceeded as a result of weather variation alone. This particular chance is determined such that the combined probabilities of **Demand** in all weeks of the year exceeding the annual **Peak Demand** under **Annual ACS Conditions** is 50%, and in the week of maximum risk the weekly **Peak Demand** under **Weekly ACS Conditions** is equal to the annual **Peak Demand** under **Annual ACS Conditions.**

1.1.2 Expressions section – Demand unit

The modifications to the current version of DCode (v46) require a set number of changes to existing text in line with those needed as part of the minor technical modification to EREC G98 and G99. The first change in the document shall be to remove the definition of Minimum Generation, and include definitions for Minimum Regulating Level, and Minimum Stable Operating Level. Shown below.

~~**Minimum Generation**~~	~~The minimum output which a **Power Generating Module** can reasonably generate as registered under the **Distribution Data Registration Code**.~~
Minimum Regulating Level	The minimum **Active Power** output down to which a **Power Generating Module** can control **Active Power**.
Minimum Stable Operating Level	The minimum **Active Power** output at which the **Power Generating Module** can be operated stably for an unlimited time.

1.1.3 Annex 1 Qualifying Standards

The titles for EREC G98 and G99 will be updated in the annex 1 qualifying standards section of the document to demonstrate the new amendment versions, as below.

9 **Engineering Recommendation G98 Issue 1 Amendment 6~~5~~**

Requirements for the connection of type-tested micro generators (up to and including 16 A per phase) in parallel with public low voltage distribution networks on or after 27 April 2019.

10 **Engineering Recommendation G99 Issue 1 Amendment 8~~7~~**

Requirements for the connection of generating equipment in parallel with public distribution networks on or after 27 April 2019.

1.1.4 Schedule 5a – Data registration code

The Power Station Data table will have minor changes to the text relating to the expressions changes earlier in the document. Below is an exert of the table with only the sections where the editorials have been made.

DATA DESCRIPTION **5a Power Station Data**	**UNITS**	**DATA CATEGORY**
Power Generating Facility LOCATION AND OPERATION		
Power Station name	Text	**SPD**
Details of any existing **Connection Agreements** for this **Power Station**	Text	**SPD**
Target date for the provision of the connection / commissioning of the **Power Station**	Text	**SPD**
Postal address or site boundary plan (1/500)	Text / Plan	**SPD**
Connection Point (OS six (or seven) digit grid reference or description)	Text	**SPD**
Connection Point voltage	V	**SPD**
Single line diagram of any on-site existing or proposed electrical plant or, where available, **Operation Diagrams**	Diagram	**SPD**
What security is required for the connection? (see note 1)	Text	**SPD**
Number of **Power Generating Module**s in **Power Station**	Number	**SPD**
Are all **Power Generating Module**s of the same design/rating? (If not ~~complete~~ the relevant information specified in Schedules 5b and 5c shall be provided for each each **Power Generating Module**~~type~~)	Y/N	**SPD**
Will the **Power Station** operate in islanded mode?	Y/N	**SPD**
Will **Power Generating Module** supply electricity to on-site premises?	Y/N	**SPD**
Total **Power Station** output at **Minimum Stable Operating Level**~~Minimum Generation~~ (net of auxiliary loads)		
Minimum Stable Operating Level~~Minimum Generation~~ (minimum **Active Power** export)	MW	**DPD**
Minimum Regulating Level	MW	**DPD**
Maximum **Reactive Power** export (lagging)	MVAr	**DPD**

DATA DESCRIPTION **5a Power Station Data**	UNITS	DATA CATEGORY
Maximum **Reactive Power** import (leading)	MVAr	**DPD**
Power Station performance chart (net, at **Connection Point**, as per DPC7 Figure 1)	Figure	**DPD**

In the notes section that follow schedule 5a the following change in note 4 will be made.

4. This section relates to operating conditions when the **Power Station** is exporting **Active Power**. The **Active Power** export and associated maximum **Reactive Power** range should be stated for operation at **Registered Capacity** and for operation at **Minimum Stable Operating Level**~~**Minimum Generation**~~.

1.1.5 Schedule 5b – Data registration code

A small editorial change has been made to the title, as well changes to sections of table 5b as shown below.

Power Generating Module DATA FOR ALL EMBEDDED Power Generating Modules~~S~~

DATA DESCRIPTION **5b Power Generating Module Data**	UNITS	Data Category for Generators connected at LV	Data Category for Generators Connected at HV
Power Generating Module GENERAL DATA			
Number of **Power Generating Modules** to which this data applies	Value	**SPD**	**SPD**
Type of **Power Generating Module**: Synchronous Generator, ~~-~~Fixed Speed Induction Generator, Double Fed Induction Generator, Series Convertor Connected Generator, Other (provide details)	Text	**SPD**	**SPD**
Energy Source (see note 1)	Text	**SPD**	**SPD**
Energy Conversion Technology~~/Production~~ type (see note 1)	Text	**SPD**	**SPD**
Operating regime – intermittent or non-intermittent (see note 2)	Text	**SPD**	**SPD**
Is the **Power Generating Module** part of a combined heat and power installation?	Y/N	**SPD**	**SPD**
Power Generating Module OUTPUT DATA			
Rated terminal voltage (generator)	V	**SPD**	**SPD**
Rated terminal current (generator)	A	**SPD**	**SPD**
Power Generating Module Registered Capacity	MW	**SPD**	**SPD**

DATA DESCRIPTION **5b Power Generating Module Data**	**UNITS**	**Data Category for Generators connected at LV**	**Data Category for Generators Connected at HV**
Power Generating Module apparent power rating (to be used as base for generator parameters)	MVA	**SPD**	**SPD**
Power Generating Module rated **Active Power**	MW	**SPD**	**SPD**
Maximum measured **Active Power** P_{60} (see note 3)	MW	**DPD**	**DPD**
Maximum measured **Active Power** $P_{0.2}$ (see note 3)	MW	**DPD**	**DPD**
Minimum Stable Operating Level~~**Minimum Generation**~~ (set connected; net of auxiliary loads)	MW	**DPD**	**DPD**
Minimum Regulating Level	MW	**DPD**	**DPD**

The note section to schedule 5b has been amended to incorporate changes to the ECR used by DNOs. The energy source and resource technologies used have been added as tables along with some changes to note 1, below.

- For all new connections the energy source shall be selected from Table 1 and the energy conversion technology should be selected from Table 2. For ~~example~~Manual of Procedures for the ENTSO-E Central Information Transparency Platform:
- ~~Biomass;~~
- ~~Fossil brown coal/lignite;~~
- ~~Fossil coal-derived gas;~~
- ~~Fossil gas;~~
- ~~Fossil hard coal;~~
- ~~Fossil oil;~~
- ~~Fossil oil shale;~~
- ~~Fossil peat;~~
- ~~Geothermal;~~
- ~~Hydro pumped storage;~~
- ~~Hydro run-of-river and poundage;~~
- ~~Hydro water reservoir;~~
- ~~Marine;~~
- ~~Nuclear;~~
- ~~Other renewable;~~
- ~~Solar;~~
- ~~Waste;~~
- ~~Wind offshore;~~
- ~~Wind onshore; or~~
- ~~Other.~~

Note 1 reads,

~~For connections made before 1 Jan~~type(s) used, ~~the~~the list ~~b~~the list set out at ~~paragraph~~der23 in ~~Version 2 of the Regulatory Instructions and Guidance relating to the distributed generation incentive, innovation funding incentive and registered~~a solar PV power ~~zones, reference 83/07, published by Ofgem, in April 2007, may be submitted as~~generating module would have an ~~alternative to the production type.~~energy source R and an energy conversion technology of 11):

Table 1

	Energy Source
A	Advanced Fuel (produced via gasification or pyrolysis of biofuel or waste)
B	Biofuel - Biogas from anaerobic digestion (excluding landfill & sewage)
C	Biofuel - Landfill gas
D	Biofuel - Sewage gas
E	Biofuel - Other
F	Biomass
G	Fossil - Brown coal/lignite
H	Fossil - Coal gas
I	Fossil - Gas
J	Fossil - Hard coal
K	Fossil - Oil
L	Fossil - Oil shale
M	Fossil - Peat
N	Fossil - Other
O	Geothermal
P	Hydrogen
Q	Nuclear
R	Solar
S	Stored Energy (all stored energy irrespective of the original energy source)
T	Waste
U	Water (flowing water or head of water)
V	Wind
W	Other

Table 2

	Energy Conversion Technology
1	Engine (combustion / reciprocating)
2	Fuel Cell
3	Gas turbine (OCGT)
4	Geothermal power plant
5	Hydro - Reservoir (not pumped)
6	Hydro - Run of river

	Energy Conversion Technology
7	Hydro - Other
8	Interconnector
9	Offshore wind turbines
10	Onshore wind turbines
11	Photovoltaic
12	Steam turbine (thermal power plant)
13	Steam-gas turbine (CCGT)
14	Tidal lagoons
15	Tidal stream devices
16	Wave devices
17	Storage - Chemical - Ammonia
18	Storage - Chemical - Hydrogen
19	Storage - Chemical - Synthetic Fuels
20	Storage - Chemical - Drop-in Fuels
21	Storage - Chemical - Methanol
22	Storage - Chemical - Synthetic Natural Gas
23	Storage - Electrical - Supercapacitors
24	Storage - Electrical - Superconducting Magnetic ES (SMES)
25	Storage - Mechanical - Adiabatic Compressed Air
26	Storage - Mechanical - Diabatic Compressed Air
27	Storage - Mechanical - Liquid Air Energy Storage
28	Storage - Mechanical - Pumped Hydro
29	Storage - Mechanical - Flywheels
30	Storage - Thermal - Latent Heat Storage
31	Storage - Thermal - Thermochemical Storage
32	Storage - Thermal - Sensible Heat Storage
33	Storage - Electrochemical Classic Batteries -Lead Acid
34	Storage - Electrochemical Classic Batteries -Lithium Polymer (Li-Polymer)
35	Storage - Electrochemical Classic Batteries -Metal Air
36	Storage - Electrochemical Classic Batteries -Nickle Cadmium (Ni-Cd)
37	Storage - Electrochemical Classic Batteries -Sodium Nickle Chloride (Na-NiCl2)
38	Storage - Electrochemical Classic Batteries -Lithium Ion (Li–ion)
39	Storage - Electrochemical Classic Batteries -Sodium Ion (Na–ion)
40	Storage - Electrochemical Classic Batteries -Lithium Sulphur (Li-S)
41	Storage - Electrochemical Classic Batteries -Sodium Sulphur(Na-S
42	Storage - Electrochemical Classic Batteries -Nickle –Metal Hydride (Ni-MH)
43	Storage - Electrochemical Flow Batteries - Vanadium Red-Oxide
44	Storage - Electrochemical Flow Batteries - Zinc – Iron (Zn –Fe)
45	Storage - Electrochemical Flow Batteries - Zinc – Bromine (Zn –Br)
46	Storage - Other
47	Other

1.1.6 Schedule 5e – Data registration code

The table for schedule 5e will been amended in line with the changes to the definitions section, affected sections of the table are shown below,

DATA DESCRIPTION **5e Embedded Transmission System Data**	**UNITS**	**DATA CATEGORY**
Total **Embedded Transmission System** output **Minimum Stable Operating Level** ~~at **Minimum Generation**~~ (net of auxiliary loads)		
Minimum Stable Operating Level ~~**Minimum Generation**~~ (minimum **Active Power** export)	MW	**DPD**
Minimum Regulating Level	MW	**DPD**
Maximum **Reactive Power** export (lagging)	MVAr	**DPD**
Maximum **Reactive Power** import (leading)	MVAr	**DPD**

Note 3 to the accompanying text to this table has been amended as shown,

3. This section relates to operating conditions when the **Embedded Transmission System** is exporting **Active Power**. The **Active Power** export and associated maximum **Reactive Power** range should be stated for operation at **Registered Capacity** and for operation at **Minimum Stable Operating Level**.

1.1.7 Issue summary

The issue summary table will be amended to document these changes and document version 47 of the distribution code.

1.2 G98 Issue 1 Amendment 6 Modifications

1.2.1 Foreword

The foreword will have text modifications to two paragraphs, these have been shown below,

This Engineering Recommendation (EREC) G98 is published by the Energy Networks Association (ENA) and comes into effect on 27 April 2019 for **Micro-generators** commissioned on or after that date. The definition of **Micro-generators** within this document includes **Electricity Storage** devices and hence this document also applies to **Electricity Storage** devices.~~**Micro-generators** that conform to this EREC G98 can be connected in advance of 27 April 2019 as they also conform to the pre-existing EREC G83 requirements.~~

In order to conform to this EREC G98, the relevant part of the **Customer Installation** shall conform to the requirements of EN ~~50438~~50549-1 as applicable to **Micro-generating Plant** ~~-~~together with additional or specific requirements ~~also~~ detailed in this document. The purpose of this EREC G98 is to explain the technical requirements for connection of **Micro-generators** for operation in parallel with a public **Low Voltage Distribution Network**, by addressing all technical aspects of the connection process, from standards of functionality to on-site commissioning.

1.2.2 Section 1 – Legal aspects

Section 1.4 of G98 will be amended to for compliance reasons,

1.4. In addition to the requirements specified in this document which allows connection to the **GB** public **Low Voltage Distribution Network**, the **Micro-generator** and all of its components shall conform to all relevant legal compliance and safety requirements ~~including European Directives and CE marking~~.

1.2.3 Section 2 – Scope

The scope will be amended to update the reference to European standards (50549-1) and remove section 2.8. as a result, all sections after this will have their numbering altered to suit.

2.1 This EREC G98 provides guidance on the **GB** technical requirements for the connection of **Micro-generators** in parallel with public **Low Voltage Distribution Networks**. The requirements set out in this EREC G98 are in addition to those of European standard EN ~~50438~~50549-1 which should be complied with ~~in full~~as applicable to **Micro-generating Plant**.

2.7 Where **Micro-generators** form part of a combined heat and power facility the impact on the **DNO's Distribution Network** shall be assessed on the basis of their electrical **Registered Capacity**.

~~2.8 Where the **Micro-generator** includes an **Inverter**, its **Registered Capacity** is deemed to be the **Inverter's** continuous steady state rating.~~

2.9 For the avoidance of doubt where a **Customer's Installation** comprises a single **Connection Point** and more than one **Inverter**, which have an aggregate **Registered Capacity** of less than or equal to 16 A per phase, single or multi- phase, 230/400 V **AC**; the installation shall be considered as a single **Micro-generating Plant**.

2.10 This EREC G98 only specifies the requirements applicable to those **Micro-generators** that are designed to normally operate in parallel with a public **Low Voltage Distribution Network**. Those installations that are designed to operate in parallel with the **DNO's Distribution Network** for short periods (ie less than 5 minutes per month) or as an islanded installation should refer to EREC G99

as they are considered to be out of scope of this EREC G98, on the basis that it is not possible to devise generic rules that will ensure safe operation under all operating conditions.

2.11 Appendix 3 contains pro forma that relate to the connection, commissioning, testing, and decommissioning of **Micro-generators**.

2.12 ~~EN 50438 Annex D together with~~ Annexes A1 and A2 of this EREC G98 describe a methodology for testing various types of electrical interface between the **Micro-generator** and the public **Low Voltage Distribution Network**. The purpose of ~~the~~these type tests ~~set out in EN 50438 Annex D~~ is to demonstrate compliance with the requirements of ~~EN 50438 and hence the requirements of~~ this EREC G98. The **Micro-generator** can be considered an approved **Micro-generator** for connection to the **GB** public **Low Voltage Distribution Network** by:

- completing the **Type Test Verification Report** in Appendix 3 Form C of this EREC G98; and
- ~~satisfying the tests in EN 50438 Annex D; and~~
- ~~satisfying the supplementary~~ tests in Annex A1 (for **Inverter** connected **Micro-generators**) or Annex A2 (for synchronous **Micro-generators**) ~~as appropriate~~ of this EREC G98 as appropriate.

2.13 A **Manufacturer** of a **Fully Type Tested Micro-generator** should allocate a **Manufacturer**'s reference number, which should be registered on the Energy Networks Association (ENA) Type Test ~~**Verification Report**~~ Register as the ~~Product ID.~~system reference. It is not necessary for **Manufacturers** of **Fully Type Tested Micro-generators** to complete a **Type Test Verification Report**, Appendix 3 Form C, for each I**nstallation**.

Footnote 3 has been removed.

1.2.4 Section 3 - References

Minor editorial changes will be made in the reference section to align EREC G98 with organisation name changes and modern standards applicable. There changes are shown below.

~~COMMISSION REGULATION~~Commission Regulation (EU) No 2016/631
Establishing a network code on Requirements for Grid Connection of Generators.

Directive 2009/72/EC ~~OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL~~of the European Parliament and of the Council
Concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

BS 7671 Requirements for Electrical Installations
~~IEE~~IET Wiring Regulations.

EN ~~50438~~50549-1
Requirements for ~~the connection of micro-generators~~generating plants to be connected in parallel with ~~public low-voltage~~ distribution networks~~.~~, Part 1: Connection to a LV distribution network - Generating plants up to and including Type B.

Engineering Recommendation G5
~~Planning levels for harmonic~~ Harmonic voltage distortion and the connection of ~~non-linear equipment~~harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom.

Engineering Recommendation P28
~~Planning limits for voltage~~Voltage fluctuations ~~caused by industrial, commercial~~ and ~~domestic~~the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom.

ENA and Department for Business, Energy and Industrial Strategy (BEIS) Distributed Energy Resources (DER) – Cyber Security Connection Guidance
Guidance to support users in the design, development, deployment, connection and maintenance of new and existing DERs to the distribution networks to improve their cyber security.

Publicly Available Specification (PAS) 1879
Energy smart appliances – Demand side response operation – Code of practice.

1.2.5 Section 4 – Definitions

The definitions section has been amended as below.

Droop

The ratio of the per unit steady state change in speed~~-~~, (or frequency), to the per unit steady state change in ~~**power**~~**Active Power** output. Whilst not mandatory, it is often common practice to express **Droop** in percentage terms.

Registered Capacity

The normal full load capacity of a **Micro-generator**, as declared by the **Manufacturer** which should exclude the **Active Power** consumed by the **Micro-generator** when producing the **Registered Capacity**; ie this will relate to the maximum level of **Active Power** deliverable from the **Micro-generating Plant**. For **Micro-generators** connected to the **DNO's Distribution Network** via an **Inverter**, the ~~**Inverter** rating is deemed to be the **Micro-generator's**~~ **Registered Capacity** of the **Micro-generator** is the lesser of the **Inverter**(s) rating or the rating of the energy source.

a new footnote (4) to accompany the registered capacity definition text.

The **Manufacturer** may restrict the rating of the **Micro-generator** by applying software settings provided these settings are not accessible to the **Customer**.

1.2.6 Section 6 – Certification requirements

This section has added text relating to family type testing devices.

6.1.2 **Manufacturer**s of a **Fully Type Tested Micro-generator** should allocate a **Manufacturer**'s reference number and register this together with the required details of the **Micro-generator** with the Energy Networks Association **Type Test** ~~**Verification Report** Register~~register.

6.2.2 The **Micro-generator(s)** shall conform to all relevant ~~European Directives~~compliance and ~~should~~safety legislation.

6.3 **Family approach to Type Testing**

6.3.1 A family approach to type testing is acceptable, whereby **Micro-generators** that are the same model and produced by the same **Manufacturer** but vary in electrical output can be ~~labelled with~~considered to be **Fully Type Tested** once one **Micro-generator** in the family has been shown

to be compliant. The approach is permissible in the following range of **Micro-generator** electrical output:

- For synchronous **Micro-generator**s:
  - Lower limit: 1/√10 (0.3162) times the tested **Micro-generator Registered Capacity**
  - Upper limit: √10 (3.162) times the tested **Micro-generator Registered Capacity**
- For all other **Micro-generator**s:
  - Lower limit: 1/√10 (0.3162) times the tested **Micro-generator Registered Capacity**
  - Upper limit: 2 times the tested **Micro-generator Registered Capacity**

6.3.2 All absolute values (e.g. operating range tests) from the tested **Micro-generator** shall be transferred directly in the compliance forms of an assumed compliant **Micro-generator** of the same family. All relative results related to design **Active Power** or current (e.g. power quality fluctuation and flicker) from the tested **Micro-generator** shall be transferred to the compliance form of a ~~CE marking~~ **Micro-generator** in the same family according to the ratio of the respective **Registered Capacity** of the tested **Micro-generator** and the assumed compliant **Micro-generator**. For the avoidance of doubt, the **Manufacturer** shall register each **Micro-generator** in the family on the Energy Networks Association Type Test register.

6.3.3 It is the responsibility of the **Manufacturer** to provide technical justification that the results are transferable. For example, the **Micro-generator**s have the same control systems.

A new footnote (5) accompanies section 6.3.1 as below,

This approach is taken in Germany by VDE, a standards, testing and certification institution.

1.2.7 Section 7 – Operation and safety

This section has been amended to include the following changes,

7.2 **Installation Wiring and Isolation**

7.2.1 The installation that connects the **Micro-generating Plant** to the **Connection Point** shall comply with the requirements of BS 7671. All wiring between the **Connection Point** and the **Micro-generator**(s) shall be protected by a suitably rated protective device and shall be of suitable size and type for the rating of the **Micro-generator**. The **Micro-generator**(s) shall be connected via an accessible isolation switch that is capable of isolating all phases and neutral. The isolation switch shall be capable of being secured in the 'off' (isolated) position.

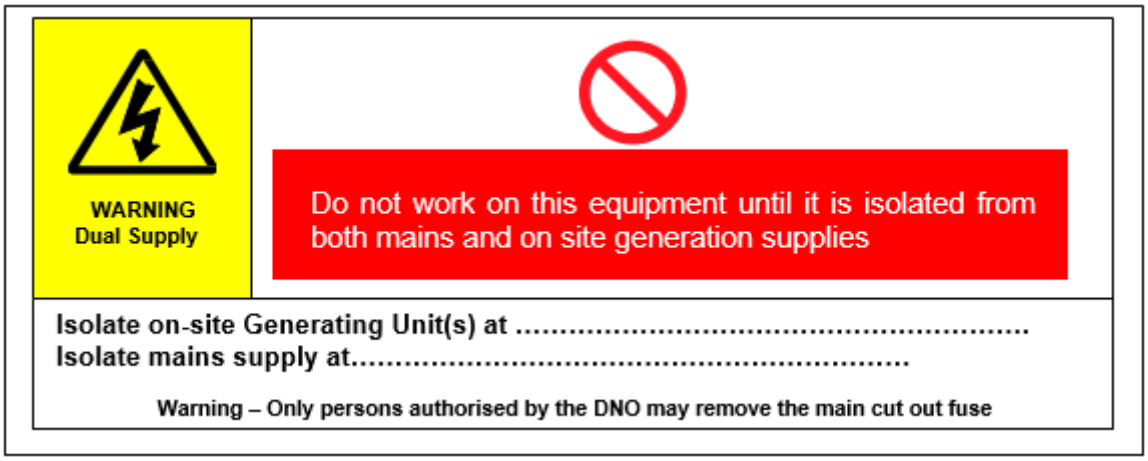


Figure 1 – Example of a Warning Label

7.3 Labelling

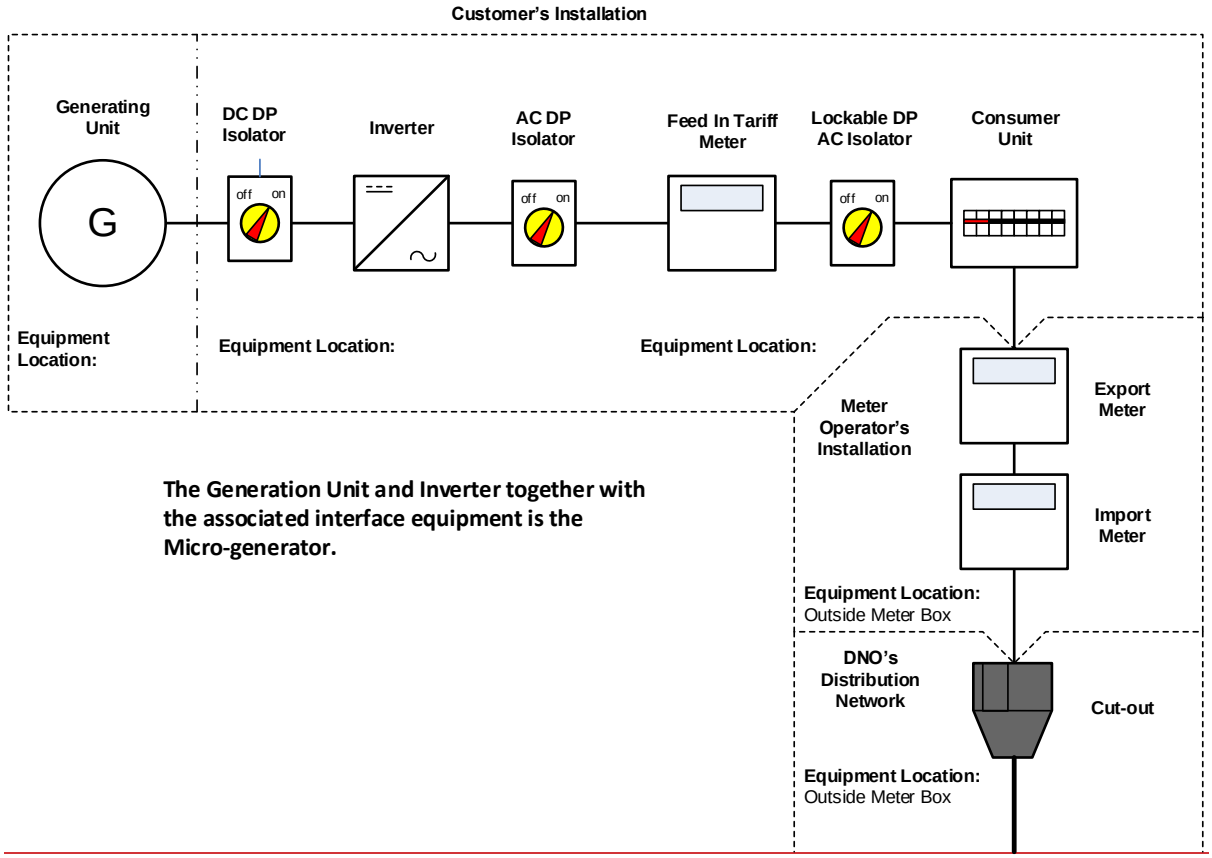
7.3.1 ~~Labelling shall be placed in accordance with EN 50438.~~The **Installer** shall provide labelling at the **Connection Point** with the **DNO's Distribution Network** (cut-out), meter position, consumer unit and at all points of isolation between the **Connection Point** and the **Micro-generating Plant** within the **Customer**'s premises to indicate the presence of a **Micro-generating Plant** The labelling should be sufficiently robust and if necessary fixed in place to ensure that it remains legible and secure for the lifetime of the installation. Warning labels of the form shown in Figure 1 shall be used. It should be noted that the warning label does not imply a right on the **Customer**, **Installer** or maintainer to operate (remove / replace) the **DNO's** cut-out fuse and a note to this effect should be included on the warning label.

7.3.2 In addition to the warning label, this EREC G98 requires the following, up to date, information to be displayed at the **Connection Point** with the **DNO's Distribution Network**.

a) A circuit diagram relevant to the installation showing the circuit wiring, including all protective devices, between the **Micro-~~generator~~generating Plant** and the **DNO**'s fused cut-out. This diagram should also show by whom all apparatus is owned and maintained; and

b) A summary of the **Interface Protection** settings incorporated within the **Micro-generator**.

7.3.3 ~~Figure 1~~Figure 2 shows an outline example of the type of circuit diagram that will need to be displayed. ~~Figure 1~~Figure 2 is non-prescriptive and is for illustrative purposes only.



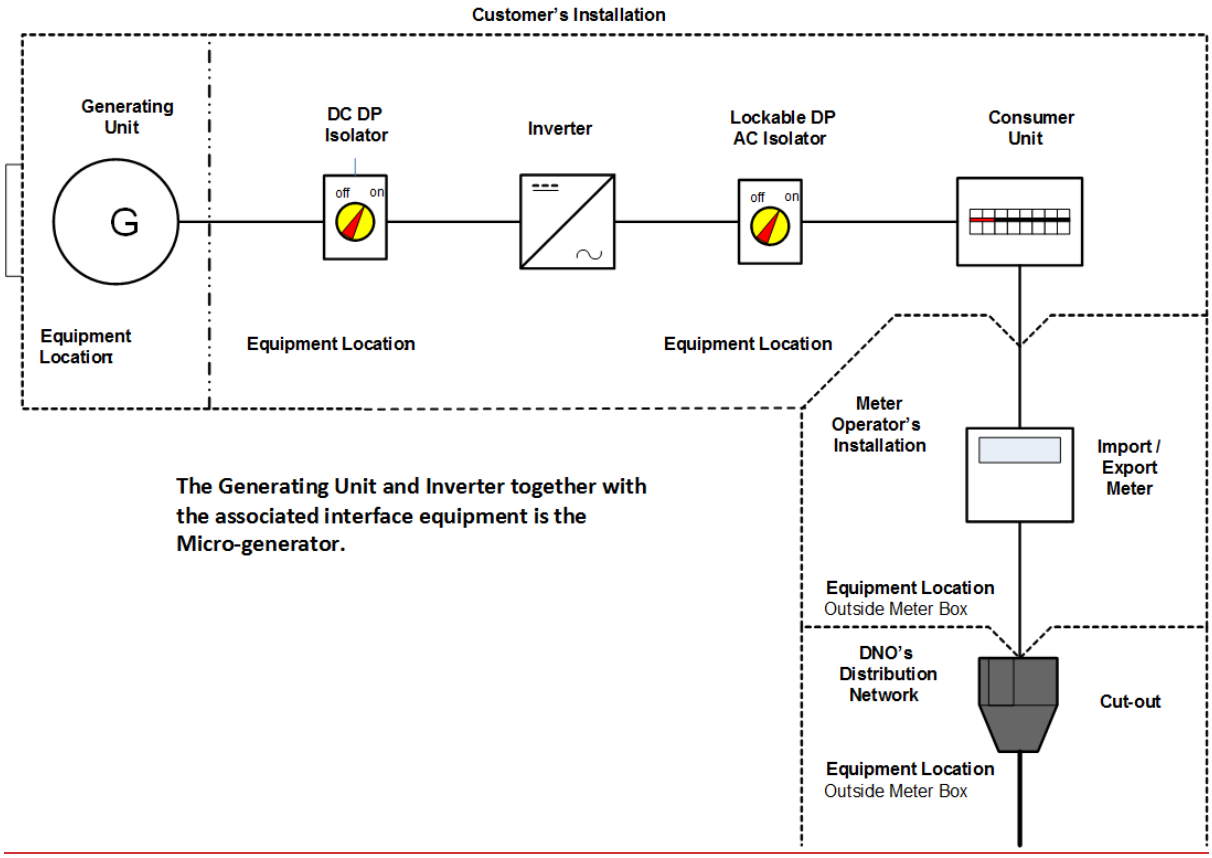


Figure ~~1~~2 – Example of the type of circuit diagram

A new section for Earthing has been added as follows,

7.7 **Earthing**

7.71 There shall be no direct connection between the **Micro-generator** current carrying conductors and earth with the following exception:

- For a **Micro-generator** that is connected via an **Inverter** (eg a PV array or fuel cell) it is permissible to connect one pole of the **DC** side of the Inverter to the **DNO**'s earth terminal if the insulation between the AC and the **DC** sides of the **Inverter** meets the requirements for at least simple separation. The requirements for simple separation are those given in Section 5.3.3 of BS EN 60664-1 for basic insulation. In such cases the **Installer** shall take all reasonable precautions to ensure that the **Micro-generating Plant** will not impair the integrity of the **DNO's Distribution Network** and will not suffer unacceptable damage for all credible operating conditions, including faults on the **DNO's Distribution Network**.

7.7.2 Earthing of all exposed conductive parts shall comply with the requirements of BS 7671.

1.2.8 Section 8 – Commissioning, notification and decommissioning

Section 8.44 has been added to ensure micro generators comply with the relevant EREC documents.

8.44 Where an existing **Micro-generator** installed under EREC G83 is substantially modified (eg a significant piece of equipment, such as an inverter, is replaced) then it will be necessary for that **Micro-generator** to be modified to be compliant with this EREC G98. Modifications to an existing **Micro-generator** which complies with the requirements of EREC G83 that are not considered to

be substantial do not change the compliance requirements of that **Micro-generator**, ie it can remain compliant with EREC G83.

A new footnote (6) accompanies section 8.44 and reads,

EREC G99 Annex A.6 provides guidance on modifications that are considered substantial. While this is aimed at larger generation installations than this EREC G98, some of the guidance may be helpful in establishing whether a modification is considered to be substantial.

As a result a section 8.51 has been re-numbered.

1.2.9 Section 9 – General technical requirements

This section has had the following amendments made,

9.3.1 With regard to the **Limited Frequency Sensitive Mode — Overfrequency (LFSM-O)**, the **Micro-generator** shall be capable of ~~activating the provision of~~reducing its **Active Power** ~~**Frequency Response** according to EN 50438. The **GB** specific standard~~ output when the frequency ~~threshold shall be~~rises above 50.4 Hz~~, the~~. The **Droop** ~~setting~~ shall be 10%. No intentional delay should be programmed to ensure that the initial delay is as short as possible with a maximum of 2 s.

9.3.2 The **Micro-generator** ~~will~~shall continue to reduce ~~power~~its **Active Power** output with rising frequency with a **Droop** of 10% until 52.0 Hz, at which point the **Micro-generator** should disconnect.

9.3.3 If the reduction in **Active Power** output is such that the **Micro-generator** reaches its minimum stable operating level, it shall continue to operate stably at this level.

9.3.4 Steady state operation below a **Micro-generator**'s minimum stable operating level is not expected but if system frequency would cause operation below its minimum stable operating level then the **Micro-generator** shall be able to deliver an output of not less than the minimum stable operating level.

The **Micro-generator** shall be capable of maintaining constant **Active Power** output at its **Registered Capacity** regardless of changes in frequency in the range 49.5 – 50.4 Hz. Below 49.5 Hz, the ~~power~~**Active Power** output should not drop by more than pro-rata with frequency, ie the maximum permitted requirement is 100% power at 49.5 Hz falling linearly to 95% power at 47.0 Hz as illustrated in Figure 2.

9.4.2 The **Micro-generator** shall be capable of maintaining constant **Active Power** output at its **Registered Capacity** regardless of changes in frequency in the range 49.5 – 50.4 Hz. Below 49.5 Hz, the ~~power~~**Active Power** output should not drop by more than pro-rata with frequency, ie the maximum permitted requirement is 100% power at 49.5 Hz falling linearly to 95% power at 47.0 Hz as illustrated in Figure ~~2~~3.

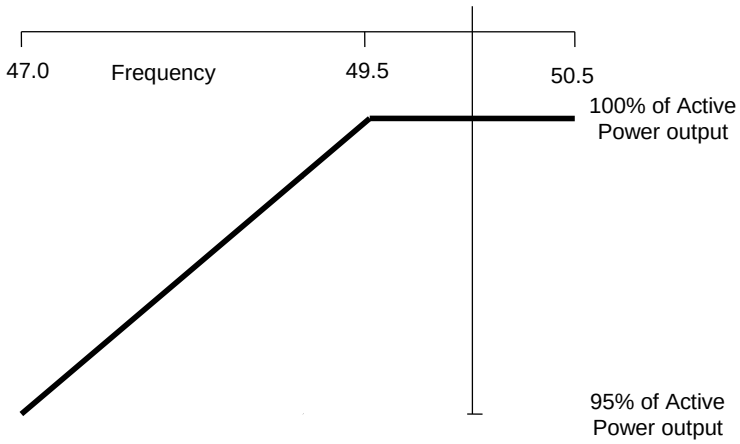


Figure ~~2~~3 – Change in output power with falling frequency

9.5 **Power Factor**

9.5.1 The power factor capability of the **Micro-generator** shall conform to EN ~~50438.~~50549-1 as applicable to **Micro-generating Plant**. When operating at **Registered Capacity** the **Micro-generator** shall operate at a power factor within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the **DNO** eg for power factor improvement.

9.6 **Automatic Connection**

9.6.1 **Micro-generators** shall conform to EN ~~50438~~50549-1 in respect of connection and starting to generate electric power. ~~This includes automatic~~Connection, reconnection ~~where~~ and starting to generate electrical power is only allowed after the voltage and frequency at the **Connection Point** is within the limits of the **Interface Protection** settings for a minimum of 20 s.~~This includes automatic reconnection where the minimum observation time shall be as stated in Annex A12 of EN 50438.~~

9.7 **Cyber Security**

9.7.1 Every **Micro-generator** and any associated equipment must be designed and operated appropriately to comply with cyber security requirements. As a minimum the recommendations in "ENA and Department for Business, Energy and Industrial Strategy (BEIS) Distributed Energy Resources (DER) – Cyber Security Connection Guidance" (where applicable) and the relevant principles for cybersecurity from PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice" should be implemented.

~~9.6.1~~ The **Manufacturer** or **Installer** shall provide information describing the high level cyber security approach, as well as the specific cyber security requirements complied with. The statement will make appropriate reference to the **Micro-generator**'s compliance with ETSI EN 303 645, relevant aspects of PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice" and also to "Distributed Energy Resources – Cyber Security Connection Guidance" published by BEIS and the ENA.

1.2.10 Section 10 – Interface protection

The footnote (7) in section 10 has been amended to read,

> For voltages greater than ~~230V~~230 V +19% which are present for periods of <0.~~5s~~5 s the **Micro-generator** is permitted to reduce/cease exporting in order to protect the equipment.

A new section of text has been added (10.1.10), as a result the following two numbered sections of text have been renumbered to allow for the new paragraph.

10.1.10 The **Interface Protection** shall function correctly, ie operate within the required tolerance range as given in paragraph 10.1.4, across the expected range of ambient operating temperatures and other environmental factors.

10.1.11 Where a common protection system is used to provide the protection function for multiple **Micro-generators** the complete installation cannot be considered to comprise **Fully Type Tested Micro-generators** if the protection and connections are made up on site and so cannot be factory tested or **Fully Type Tested**. In accordance with Annex A1 or Annex A2 if the units or **Micro-generators** are specifically designed with plugs and sockets to be interconnected on site, then provided the assembly passes the function tests required in Appendix 3 Form C, the **Micro-generator**(s) can retain **Fully Type Tested** status.

10.1.12 Once the **Micro-generator** has been installed and commissioned the protection settings shall only be altered following written agreement between the **DNO** and the **Customer** or their agent.

10.2 **Loss of Mains Protection**

10.2.1 Loss of mains protection shall be incorporated and tested as defined in the relevant compliance type testing annex of ~~EN 50438~~this EREC G98. Active methods which use impedance measuring techniques by drawing current pulses from or injecting AC currents into the **DNO's Distribution Network** are not considered to be suitable. For **Micro-generators** which generate on more than one phase, the loss of mains protection should be able to detect the loss of a single phase of the supply network. This should be tested during type testing and recorded in the **Type Test Verification Report** as per Appendix 3 Form C.

1.2.11 Section 11 – Quality of supply

Section 11.1 has been added, and a heading of 'DC Injection' added, as a result the subsequent sections have been re-numbered.

11.1 **Harmonics and voltage fluctuation**

11.1.1 ~~The power quality requirements set out in EN 50438 should be met along with the requirements described in this section of EREC G98.~~The connection and operation of a **Micro-generator** in parallel with a **DNO's Distribution Network** shall not impair the quality of supply provided by the **DNO** to any **Customer**s. In this respect the **Micro-generator** shall comply with:

- EN 61000-3-2 Class A for harmonics and
- EN 61000-3-3 for voltage fluctuation and flicker with a d_{max} value of 4%.

Micro-generators are likely to be installed in large numbers on **LV Distribution Networks**. They are likely to operate for long periods with no diversity between them, and adjacent **Micro-generators** are likely to be of the same technology. Therefore, in order to accommodate a high number of **Micro-generators** on a **Distribution Network,** procedures are specified in Annex A1 and Annex A2, which need to be applied when testing for ~~harmonic current emissions and flicker~~harmonics, voltage fluctuations, flicker and **DC** injection.

11.2 **DC injection**

11.2.1 The ~~requirements of EN 50438 shall be met~~upper limit for **DC** injection is 0.25% of AC current rating per phase.

A new section (11.3) has been added to cover Electromagnetic Compatibility.

11.3 **Electromagnetic Compatibility (EMC)**

11.3.1 All equipment shall conform to the generic EMC standards: BS EN61000-6-3: Electromagnetic Compatibility, Generic Emission Standard; and BS EN61000-6-1: Electromagnetic Compatibility, Generic Immunity Standard.

11.4 **Short Circuit Current Contribution**

11.4.1 **Directly Coupled Micro-generators**

The **Manufacturer** shall establish the maximum short- circuit ~~parameters of synchronous~~current contribution from the **Micro-~~generators~~generator** and the conditions under which this exists. This shall be determined ~~by means of a short-circuit test~~ in accordance with ~~EN 50438.~~Annex A.2.3.4.

11.4.2 **Inverter Connected Micro-generators**

~~In addition to EN 50438 **Manufacturers** of **Inverters** shall take account of the following:~~

DNOs need to understand the contribution that **Inverters** make to system fault levels in order to determine that they can continue to safely operate their **Distribution Networks** without exceeding design fault levels for switchgear and other circuit components~~; and~~.

As the output from an **Inverter** reduces to zero when a short circuit is applied to its terminals, a short circuit test does not represent the worst case scenario; in most cases the voltage will not collapse to zero for a **Distribution Network** fault.

To address this issue a test, which ensures that at least 10% of nominal voltage remains and which allows the **Micro-generator** to feed into a load with an X to R ratio of 2.5, is specified as detailed in Annex A1.3.5.

1.2.12 G98 Appendix 1 – Emerging technologies and other exceptions

One change in this appendix was required, due to tables added earlier in the document table 3 in this section has been re-numbered to table 4 (emerging technology exceptions)

Table ~~3~~4 – Emerging Technology Exceptions

Manufacturer	Micro-generator
Baxi	'Baxi Ecogen' generators (the specific products are the Baxi Ecogen 24/1.0, Baxi Ecogen 24/1.0 LPG and Baxi Ecogen System).
KD Navien	KD Navien stirling engine m-CHP (Hybrigen SE) (the specific products are the 'NCM-1130HH – 1 KWel' and the 'NCM-2030HH – 2 kWel').
OkoFEN	Pellematic Smart_e
SenerTec	Dachs Stirling SE Erdgas and Dachs Stilring SE Flussiggas

1.2.13 G98 Appendix 3 – Micro generator documentation

The link noted in footnote 8 has been amended to read,

~~http://www.energynetworks.org/electricity/engineering/distributed-generation/dg-connection-guides.html~~ https://www.energynetworks.org/industry-hub/resource-library/?search=generation%20&id=267

1.2.14 G98 Form A – Application for connection of multiple micro-generating installations

The proposed micro-generator details section of form A has been amended to include a section for energy storage devices and a small editorial to note the system reference in relation to type tested devices.

	Proposed Micro-generator Details:				
Address	Post Code	MPAN	**Micro-generator Registered Capacity** in kW at 230 V AC	Energy storage capacity for **Electricity Storage** devices (kWh)	**Manufacturer's** Ref No (this number should be registered on the ENA Type Test ~~**Verification Report**~~ Register as ~~Product ID)~~the system reference)

1.2.15 G98 Form B – Installation document for connection under G98

In line with the changes to Form A, Form B has been amended as follows,

Details of Micro-generators. Use a separate line for new and existing installations and for different technology type. Use PH 1 column for single phase supply.								
Manufacturer	Date of Installation	~~Technology Type / Primary~~ Energy ~~Source please~~ source and energy conversion technology (enter ~~code~~codes from ~~table~~tables 1 and 2 below)	**Manufacturer**'s Ref No (this number should be registered on the ENA Type Test ~~**Verification Report**~~ Register as ~~Product ID)~~the system reference)	**Micro-generator Registered Capacity** in kW				~~Power Factor~~Energy storage capacity for **Electricity Storage** devices (kWh)
				3-Phase Units	Single Phase Units			
					PH1	PH2	PH3	

In conjunction with ECR requirements 2 tables have been included listing compatible energy sources and resource types,

Table 1

	Energy Source
A	Advanced Fuel (produced via gasification or pyrolysis of biofuel or waste)
B	Biofuel - Biogas from anaerobic digestion (excluding landfill & sewage)
C	Biofuel - Landfill gas
D	Biofuel - Sewage gas
E	Biofuel - Other
F	Biomass

	Energy Source
G	Fossil - Brown coal/lignite
H	Fossil - Coal gas
I	Fossil - Gas
J	Fossil - Hard coal
K	Fossil - Oil
L	Fossil - Oil shale
M	Fossil - Peat
N	Fossil - Other
O	Geothermal
P	Hydrogen
Q	Nuclear
R	Solar
S	Stored Energy (all stored energy irrespective of the original energy source)
T	Waste
U	Water (flowing water or head of water)
V	Wind
W	Other

Table 2

	Energy Conversion Technology
1	Engine (combustion / reciprocating)
2	Fuel Cell
3	Gas turbine (OCGT)
4	Geothermal power plant
5	Hydro - Reservoir (not pumped)
6	Hydro - Run of river
7	Hydro - Other
8	Interconnector
9	Offshore wind turbines
10	Onshore wind turbines
11	Photovoltaic
12	Steam turbine (thermal power plant)
13	Steam-gas turbine (CCGT)
14	Tidal lagoons
15	Tidal stream devices
16	Wave devices
17	Storage - Chemical - Ammonia
18	Storage - Chemical - Hydrogen
19	Storage - Chemical - Synthetic Fuels
20	Storage - Chemical - Drop-in Fuels
21	Storage - Chemical - Methanol
22	Storage - Chemical - Synthetic Natural Gas
23	Storage - Electrical - Supercapacitors
24	Storage - Electrical - Superconducting Magnetic ES (SMES)
25	Storage - Mechanical - Adiabatic Compressed Air
26	Storage - Mechanical - Diabatic Compressed Air
27	Storage - Mechanical - Liquid Air Energy Storage
28	Storage - Mechanical - Pumped Hydro
29	Storage - Mechanical - Flywheels
30	Storage - Thermal - Latent Heat Storage
31	Storage - Thermal - Thermochemical Storage
32	Storage - Thermal - Sensible Heat Storage
33	Storage - Electrochemical Classic Batteries -Lead Acid
34	Storage - Electrochemical Classic Batteries -Lithium Polymer (Li-Polymer)
35	Storage - Electrochemical Classic Batteries -Metal Air
36	Storage - Electrochemical Classic Batteries -Nickle Cadmium (Ni-Cd)
37	Storage - Electrochemical Classic Batteries -Sodium Nickle Chloride (Na-NiCl2)
38	Storage - Electrochemical Classic Batteries -Lithium Ion (Li–ion)
39	Storage - Electrochemical Classic Batteries -Sodium Ion (Na–ion)
40	Storage - Electrochemical Classic Batteries -Lithium Sulphur (Li-S)

	Energy Conversion Technology
41	Storage - Electrochemical Classic Batteries -Sodium Sulphur (Na-S
42	Storage - Electrochemical Classic Batteries -Nickle –Metal Hydride (Ni-MH)
43	Storage - Electrochemical Flow Batteries - Vanadium Red-Oxide
44	Storage - Electrochemical Flow Batteries - Zinc – Iron (Zn –Fe)
45	Storage - Electrochemical Flow Batteries - Zinc – Bromine (Zn –Br)
46	Storage - Other
47	Other

1.2.16 G98 Form C – Type test verification report

Form C has undergone several changes, with modified text and tests to be demonstrated as part of the type test verification reporting process. The modified sections of the form are shown below,

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA) ~~.~~Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test ~~**Verification Report**~~ Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the ~~Product ID~~system reference), and this form does not need to be submitted.

~~Where the **Micro-generator** is **Fully Type Tested** and not registered with the ENA **Type Test Verification Report** Register this form needs to be completed and provided to the **DNO**, to confirm that the **Micro-generator** has been tested to satisfy the requirements of this EREC G98.~~

Energy storage capacity for **Electricity Storage** devices		kWh

Operating Range: This test should be carried out as specified in ~~EN 50438 D.3~~A.1.2.9.

Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement "Pass", "No disconnection occurs", etc. Graphical evidence is preferred.

~~**Active Power** shall be recorded every second. The tests will verify that the **Micro-generator** can operate within the required ranges for the specified period of time.~~

~~The **Interface Protection** shall be disabled during the tests.~~

~~In case of a PV **Micro-generator** the PV primary source may be replaced by a **DC** source.~~

~~In case of a full converter **Micro-generator** (eg wind) the primary source and the prime mover **Inverter**/rectifier may be replaced by a **DC** source.~~

~~In case of a DFIG **Micro-generator** the mechanical drive system may be replaced by a test bench motor~~.

Test 1 Voltage = 85% of nominal (195.5 V) Frequency = 47.0 Hz Power factor = 1 Period of test 20 seconds	Test results or chart to confirm operation
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Test results or chart to confirm operation
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Test results or chart to confirm operation
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Test results or chart to confirm operation
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Test results or chart to confirm operation
Test 6 RoCoF withstand Confirm that the **Micro-Generating Plant** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms.	Test results or chart to confirm operation

Power Quality – Harmonics: These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of **Registered Capacity**. The test requirements are specified in Annex A1 A.1.3.1 (**Inverter** connected) or Annex A2 A.2.3.1 (Synchronous).

Micro-generator tested to BS EN 61000-3-2

Micro-generator rating per phase (rpp)		kW	
For 3-phase **Micro-generator**s, tick this box if harmonic measurements are identical for all three phases. If the harmonics are not identical for each phase, please replicate this section with the results for each phase.			

Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2					1.080	
3					2.300	
4					0.430	
5					1.140	
6					0.300	
7					0.770	
8					0.230	
9					0.400	
10					0.184	
11					0.330	
12					0.153	
13					0.210	
14					0.131	
15					0.150	
16					0.115	
17					0.132	

18					0.102	
19					0.118	
20					0.092	
21					0.107	0.160
22					0.084	
23					0.098	0.147
24					0.077	
25					0.090	0.135
26					0.071	
27					0.083	0.124
28					0.066	
29					0.078	0.117
30					0.061	
31					0.073	0.109
32					0.058	
33					0.068	0.102
34					0.054	
35					0.064	0.096
36					0.051	
37					0.061	0.091
38					0.048	
39					0.058	0.087
40					0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

Additional comments:

Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (**Inverter** connected) or Annex A2 A.2.3.3 (Synchronous).

The standard test impedance is 0.4 Ω for a single phase **Micro-generating Plant** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Micro-generating Plant** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the standard impedance.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date		Test end date	
Test location			

	Starting			Stopping			Running	
	d max	~~d c~~ **DC**	d(t)	d max	~~d c~~**DC**	d(t)	P_{st}	P_{lt} 2 hours
Measured Values at test impedance								
Normalised to standard impedance								
Normalised to required maximum impedance								
Limits set under BS EN 61000-3-11	4%	3.3 %	3.3 %	4%	3.3 %	3.3%	1.0	0.65

Test Impedance	R		Ω	X		Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R		Ω	X		Ω

*Applies to three phase and split single phase **Micro-generators**. Delete as appropriate.

^ Applies to single phase **Micro-generators** and **Micro-generators** using two phases on a three phase system. Delete as appropriate.

~~For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation output is 0.98 or above.~~

~~Normalised value = Measured value*reference source resistance/measured source resistance at test point.~~

~~Single phase units reference source resistance is 0.4 Ω~~

~~Two phase units in a three phase system reference source resistance is 0.4 Ω.~~

~~Two phase units in a split phase system reference source resistance is 0.24 Ω.~~

~~Three phase units reference source resistance is 0.24 Ω.~~

~~Where the power factor of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the Standard Impedance.~~

~~The stopping test should be a trip from full load operation.~~

~~The duration of these tests need to conform to the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below.~~

~~Test start date~~		~~Test end date~~	
~~Test location~~			

Power quality – DC injection: This test should be carried out in accordance with ~~EN 50438 Annex D~~A 1.3.~~104~~ as applicable.

The % **DC** injection ("as % of rated AC current" below) is calculated as follows:

% **DC** injection = Recorded **DC** value in Amps / base current

where the base current is the **Registered Capacity** (W) / 230 V. The % **DC** injection should not be greater than 0.25%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps				
as % of rated AC current				
Limit	0.25%	0.25%	0.25%	0.25%

Power Quality – Power factor: This test shall be carried out in accordance with ~~EN 50538 Annex DA~~.1.3.~~4.1 but with nominal~~2 and A.2.3.2 at three voltage ~~-6% and +10%.~~levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test.			
	216.2 V	230 V	253 V
~~20% of **Registered Capacity**~~Measured value			
~~50% of **Registered Capacity**~~			
~~75% of **Registered Capacity**~~			
~~100% of **Registered Capacity**~~			
Power Factor Limit	>0.95	>0.95	>0.95

A new footnote (9) has been added to accompany the box within the table labelled 'At 45-55% of **Registered Capacity'** it reads,

> See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

Some minor editorial changes have been made to the table section coving voltage and frequency tests in relation to protection. It is worth noting the figures stated in this table will remain unchanged from the previous amendment of G98. The changes to the text are shown below,

Protection – Frequency tests: These tests should be carried out in accordance with ~~EN 50438 Annex D.2.4 and the notes in EREC G98~~ Annex A1 A.1.2.3 (**Inverter** connected) or Annex A2 A.2.2.3 (Synchronous~~)~~). For trip tests, frequency and time delay should be stated. For "no trip tests", "no trip" can be stated.
Protection – Voltage tests: These tests should be carried out in accordance with ~~EN 50438 Annex D.2.3 and the notes in EREC G98~~ Annex A1 A.1.2.2 (**Inverter** connected) or Annex A2 A.2.2.2 (Synchronous~~)~~). For trip tests, voltage and time delay should be stated. For "no trip tests", "no trip" can be stated.

A minor change to the wording of the loss of mains table has been made, as shown below,

Protection – Loss of Mains test: For PV **Inverters** shall be tested in accordance with BS EN 62116. Other ~~**Inverters**~~**Micro-generators** should be tested in accordance with ~~EN 50438 Annex DA~~.2.~~5~~2.4 at 10%, 55% and 100% of rated power.
To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.

A new footnote (10) has been added to accompany the section of the table shown directly above this text,

> See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

A text box for additional comment has also been added,

For **Inverters** tested to BS EN 62116 the following sub set of tests should be recorded in the following table.

Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5 s						

Protection – Frequency change, Vector Shift Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous). Confirmation is required that the **Micro-generating Plant** does not trip under positive / negative vector shift.

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.0 Hz	+50 degrees	
Negative Vector Shift	50.0 Hz	- 50 degrees	

Protection – Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous). Confirmation is required that the **Micro-generating Plant** does not trip for the duration of the ramp up and ramp down test.

Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	

Limited Frequency Sensitive Mode – Overfrequency test: This test should be carried out in accordance with ~~EN 50438 Annex D.3.3 Power response to over- frequency.~~A.1.2.8. The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. The measurement tolerances are contained in A.1.2.8.

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz				-
Step b) 50.45 Hz ±0.05 Hz				-
Step c) 50.70 Hz ±0.10 Hz				-
Step d) 51.15 Hz ±0.05 Hz				-

Step e) 50.70 Hz ±0.10 Hz				-
Step f) 50.45 Hz ±0.05 Hz				-
Step g) 50.00 Hz ±0.01 Hz				
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz				-
Step b) 50.45 Hz ±0.05 Hz				-
Step c) 50.70 Hz ±0.10 Hz				-
Step d) 51.15 Hz ±0.05 Hz				-
Step e) 50.70 Hz ±0.10 Hz				-
Step f) 50.45 Hz ±0.05 Hz				-
Step g) 50.00 Hz ±0.01 Hz				
~~Steps as defined in EN 50438~~				

Power output with falling frequency test: This test should be carried out in accordance with ~~EN 50438 Annex D.3~~A.1.2~~ active power feed-in at under-frequency~~.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz			
Test b) Point between 49.5 Hz and 49.6 Hz			
Test c) Point between 47.5 Hz and 47.6 Hz			
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

Re-connection timer.

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Micro-generating Plant** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.

Time delay setting	Measured delay		Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.			
			At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.						

Fault level contribution: These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (**Inverter** connected) and Annex A2 A.2.3.4 (Synchronous). Please complete each entry, even if the fault contribution is zero.					
For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p		20 ms		
Initial Value of aperiodic current	A		100 ms		
Initial symmetrical short-circuit current*	I_k		250 ms		
Decaying (aperiodic) component of short circuit current*	i_{DC}		500 ms		
Reactance/Resistance Ratio of source*	X/R		Time to trip		In seconds
For rotating machines and linear piston machines the test should produce a 0 s – 2 s plot of the short circuit current as seen at the **Micro-generator** terminals. * Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot					
Logic Interface~~.~~ ~~Yes~~ **(input port)**					
Confirm that an input port is provided and can be used to reduce the **Active Power** output to zero					Yes / NA
Provide high level description of logic interface, e.g. details in 9.4.3 such as AC or DC signal (the additional comments box below can be used)					Yes / NA
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).					Yes~~/or~~ / NA
It has been verified that in the event of the solid state switching device failing to disconnect the **Micro-generator**, the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s.					
Cyber security					
Confirm that the **Micro-generator** has been designed to comply with cyber security requirements, as detailed in 9.7.					Yes / NA

A new footnote (11) has been added to accompany the table cell labelled ‘Trip time. Limit is 0.5 s’,

If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

1.2.17 G98 Annex A1 – Requirements for type testing of inverter connected micro-generators

The following section of text has been removed from section A 1.1 (General).

~~The compliance testing annex of EN 50438 should be complied with except where alternative requirements are detailed in this Annex.~~

The sections of text section A 1.2.2 (Over / Under Voltage) shown below have been amended,

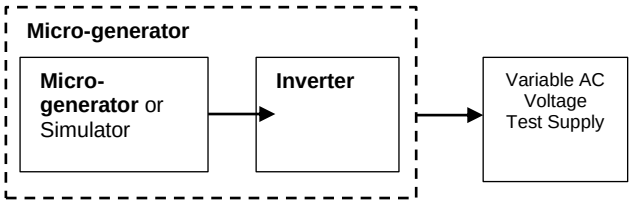
~~In addition to the EN 50438 over / under voltage tests the tests in this paragraph shall be undertaken.~~

The ~~**Interface Protection**~~**Micro-generator** shall be tested by operating the ~~**Controller**~~**Micro-generator** in parallel with a variable AC test supply, as an example see Figure A1.1. Correct protection and ride-through operation shall be confirmed. The set points for over and under voltage at which the ~~**Interface Protection**~~ **Micro-generator** disconnects from the supply will be established by varying the AC supply voltage. The disconnect sequence should be initiated when the network conditions mean the protection should trip in accordance with the settings in Table 2, otherwise normal operation should continue.

To establish the certified trip time, the test voltage should be applied starting from ± 1.8% below the certified trip voltage in a step of at least ± 0.5% of setting for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0.5 s. Where the **Interface Protection** functionality is implemented in the ~~**Controller**~~**Micro-generator** it will be necessary to carry out five tests for each trip setting. The longest trip time is to be recorded as the certified trip time.

A minor editorial change has been made to the title of figure A 1.1

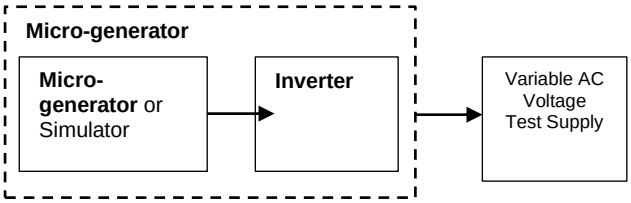
Figure A1.1~~.~~ Micro-generator ~~Test**~~test set up – ~~**Over / Under**~~over / under Voltage**



Section A 1.2.3 (Over / under frequency) has had the following text removed and minor editorial change to figure A 1.2,

~~In addition to the EN 50438 over / under voltage tests the tests in this paragraph shall be undertaken.~~

Figure A1.2~~.~~ ~~Test**~~test set up – ~~**Over / Under**~~over / under Frequency**



Section A 1.2.7 (Active power feed-in at under-frequency) has had a minor amendment to existing title, and new text added as shown below,

A 1.2.7 Active ~~power~~Power feed-in at under-frequency

~~EN 50438~~Tests shall be ~~complied **with in respect**~~undertaken to verify the **Active Power** feed-in at under-frequency.

The tests for providing evidence of the frequency dependent active power feed-in ~~at under-frequency~~of the **Micro-generator** shall be carried out on a network simulator.

Measurements shall be carried out at the following operating points:

a) 50 Hz ± 0.01 Hz;
b) a point between 49.5 Hz and 49.6 Hz;
c) a point between 47.5 Hz and 47.6 Hz.

The operating point b) and c) shall be maintained for at least 5 minutes.

The test is regarded as passed if:

- the **Micro-generator** does not disconnect from the network at the operating points a) to c) when the network frequency is changed and
- the **Micro-generator** does not reduce output energy at Point b) and
- the power reduction at point c) is less than or equal to the allowed power reduction according to paragraph 9.4.2

The following data shall be documented:

- variation of the network frequency with time;
- the measured **Active Power** with time.

Section A 1.2.8 (Power response to over-frequency) has been amended as shown below,

~~EN 50438~~Tests shall be ~~complied with~~ undertaken using the test set up in ~~respect of power response~~Figure A1.2 to verify the **Active Power** reduction to over-frequency using a specific standard frequency threshold of 50.4 Hz and a **Droop** ~~setting~~of 10%. The test should be carried out above 80% **Registered Capacity** and repeated at 40-60% **Registered Capacity**.

The **Micro-generator** shall be at the following frequencies (refer to Figure A1.3):

- a) 50.00 Hz ± 0.01 Hz;
- b) 50.40+0.05 Hz ± 0.05 Hz;
- c) 50.70 Hz ± 0.10 Hz;
- d) 51.15 Hz ± 0.05 Hz;
- e) 50.70 Hz ± 0.10 Hz;
- f) 50.40+0.05 Hz ± 0.05 Hz;
- g) 50.00 Hz ± 0.01 Hz.

The frequency at each step should be maintained for at least one minute and the **Active Power** reduction in the form of a gradient determined and assessed for compliance with paragraph 9.4.

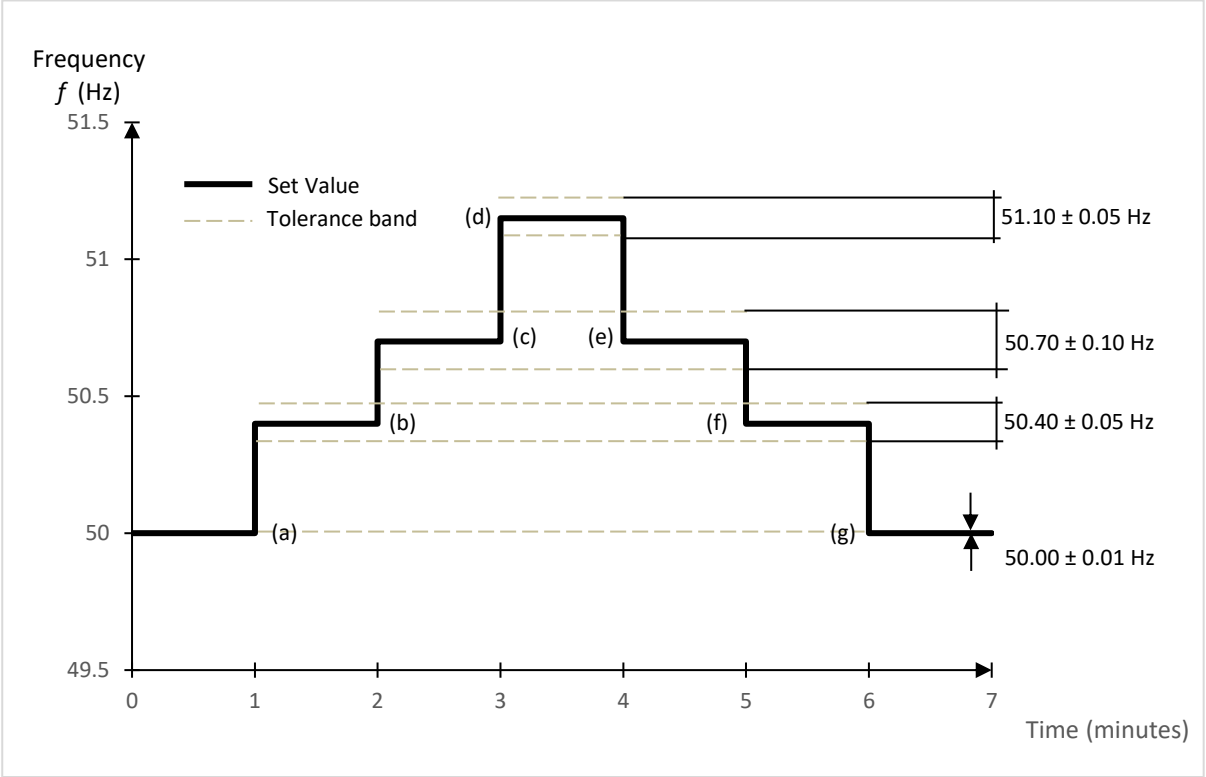


Figure A1.3 Testing the **Active Power** feed-in of the **Micro-generator** at over frequency.

The **Droop** should be determined from the measurements between 50.4 Hz and 51.15 Hz. The allowed tolerance for the frequency measurement shall be ± 0.05 Hz. The allowed tolerance for **Active Power** output measurement shall be ±10% of the required change in **Active Power**. The resulting overall tolerance range for a nominal 10% **Droop** is +2.8% and – 1.5%, ie a **Droop** less than 12.8% and greater than 8.5%.

A.1.2.9 Operating Range

Six tests shall be conducted with the Micro-generator operating at **Registered Capacity** connected to a grid simulator set as follows:

- Test 1, Voltage = 85% of nominal, frequency = 47 Hz, Power factor = 1, Period of test 20 s.
- Test 2, Voltage = 85% of nominal, frequency = 47.5 Hz, Power factor = 1, Period of test 90 minutes.
- Test 3, Voltage = 110% of nominal, frequency = 51.5 Hz, Power factor = 1, Period of test 90 minutes.
- Test 4, Voltage = 110% of nominal, frequency = 52.0 Hz, Power factor = 1, Period of test 15 minutes.
- Test 5, Voltage = 100% of nominal, frequency = 50.0 Hz, Power factor = 1, Period of test 90 minutes.
- Test 6, Confirm that the **Micro-Generating Plant** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms.

The **Interface Protection** shall be disabled during the tests.
Automatic adjustment to reduce power in the case of over frequency shall be disabled for Tests 3 and 4.

Active Power shall be recorded every second. The tests will verify that the **Micro-generator** can operate within the required ranges for the specified period of time.

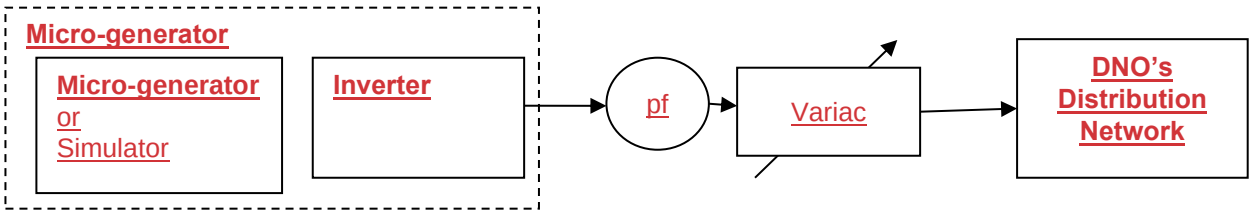
In case of a PV **Micro-generator** the PV primary source may be replaced by a **DC** source.

In case of a full converter **Micro-generator** (eg wind) the primary source and the prime mover **Inverter**/rectifier may be replaced by a **DC** source.

In case of a DFIG **Micro-generator** the mechanical drive system may be replaced by a test bench motor~~10%.~~

Text in Section A 1.3.2 (Power factor) has amended as shown below,

The test set up shall be such that the **Inverter** supplies full load to the **DNO**'s **Distribution Network** via the power factor (pf) meter and the variac as shown below in figure A1.4. The **Inverter** pf should be ~~undertaken as laid out in EN 50438 with the following~~within the limits given in paragraph 9.6 for three test voltages 230 V –6%, ~~230V~~230 V and 230 V +10%. The voltage shall be maintained within ±1.5% of the stated level during the test.



NOTE 1. For reasons of clarity the points of isolation are not shown
NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown

Figure A1.4 test set up – Power Factor

Section A 1.3.4 (DC Injection for inverters) has been amended as follows,

~~**DC** injection compliance testing in EN 50438 shall be applicable to all **Inverter** connected **Micro-generators** regardless of connection configuration.~~
Where a **Micro-generator** is designed to be installed singly in an installation, for example a domestic CHP unit, then this **DC** injection limit can be a maximum value of 20 mA for sub 2 kW **Micro-generator** and can be tested alone. Where **Micro-generator**s are designed such that multiple units may be installed in an installation for example roof mounted wind turbines and PV with micro **Inverter**s on each panel, then they should be tested as a group of at least 2 kW and with a maximum group size of 4 kW.

The level of **DC** injection from the **Inverter**-connected **Micro-generator** into the **DNO's Distribution Network** shall not exceed the levels specified in Section 11 when measured during operation at three levels, 10%, 55% and 100% of **Registered Capacity** with a tolerance of plus or minus 5%.

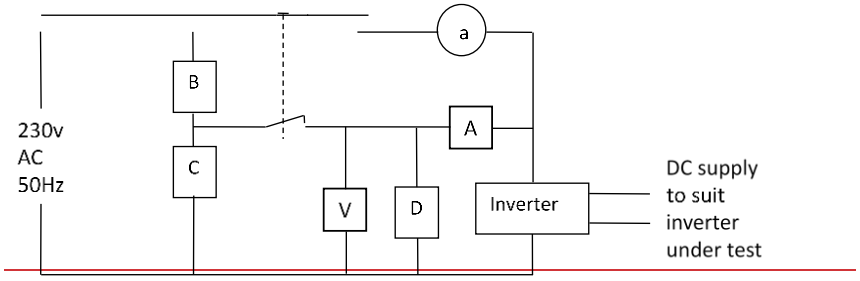
The **DC** component can be measured by one of the following two methods:
- the average of the current samples (preferred);
- root mean square of frequencies components below 1 Hz.

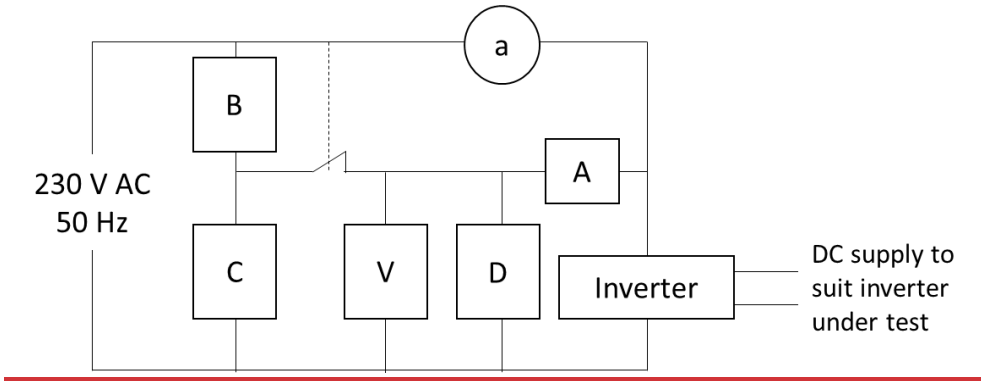
The **DC** component level shall be measured with an observation period large enough to ensure repeatability, and of at least 60 s.

As an example, at 230 V a 2 kW single phase **Inverter** has a current output of 8.7 A so **DC** limit is 21.75 mA; a 10 kW three phase **Inverter** has a current output of 14.5 A per phase which is equivalent to a total of 43.5 A at 230 V so **DC** limit is 108.75 mA.

Section A 1.3.5 (Short circuit current contribution for inverters) has an amended figure diagram (figure A1.5) and title, the wording in the following paragraph has also been amended in line with the change.

Figure ~~A3.~~A1.5 Test circuit





Test procedure
In Figure ~~A3~~A1.5 'A' and 'V' are ammeters and voltmeters used to record the test data required. Component 'D' is a resistive load plus resonant circuit as required for the loss of mains test as specified in BS EN 62116 set up to absorb 100% **Registered Capacity** of the **Micro-generator**. Component 'a' is an ammeter used to confirm that all the output from the **Inverter** is being absorbed by component D. Components 'B' and 'C' are set up to provide a voltage of between 10% and 40% of nominal when component 'C' carries the **Registered Capacity** of the **Micro-generator** in Amps.

Section A 1.3.7 (Electromagnetic compatibility (EMC)) has been removed, as shown below,

~~All equipment shall conform to the generic EMC standards: BS EN61000-6-3: Electromagnetic Compatibility, Generic Emission Standard; and BS EN61000-6-1: Electromagnetic Compatibility, Generic Immunity Standard.~~

1.2.18 G98 Annex A2 – Requirements for type testing of synchronous and non-inverter micro generators

The first change in this section is to the title od the annex, where the 'and non-inverter' has been added,

A2 Annex A2 Requirements for Type Testing of Synchronous and non-Inverter Micro-generators

Section A.2.1 (General) has had the following text removed, and small editorial change,

~~The compliance testing annex of EN 50438 should be complied with except where alternative requirements are detailed in this Annex.~~

This Annex describes a methodology for obtaining type certification or type verification for the interface equipment between a directly coupled **Micro-generator** and the **DNO's Distribution Network**. Interface functions can be provided either as an integrated part of the ~~Controller~~Micro-generator or by incorporating a protection relay but for a **Fully Type Tested Micro-generator** the completed **Micro-generator's Interface Protection** shall not rely on interconnection using cables which could be terminated incorrectly on site ie the interconnections shall be made by non-reversible plug and socket which the **Manufacturer** has made and tested prior to delivery to site.

Currently there are no harmonised functional standards that apply to the **Micro-generator Interface Protection**, therefore in order to achieve **Fully Type Tested** status the ~~Controller~~Micro-generator and any separate **Interface Protection** unit will require their functionality to be **Fully Type Tested** as described in this Annex, and recorded in format similar to that shown in the **Type Test Verification Report**, Appendix 3 Form C.

This Annex applies to **Micro-generator**s:

- with or without **energy storage systems** connected on the alternator side of the ~~Controller~~Micro-generator; and
- with or without load management devices.

Section A.2.2.1 (Disconnection times) has had a minor editorial change as shown below,

In some systems it may be safer and more convenient to test the trip delay time and the disconnection time separately. This will allow the trip delay time to be measured in a test environment (in a similar way as for a protection relay). The disconnection time can be measured in the **Micro-generator** normal operation, allowing accurate measurement with correct inertia and prime mover characteristics. This is permitted providing the total disconnection time does not exceed the value specified in Table 2. When measuring the disconnection time where the **Interface Protection** is included in the ~~Controller~~Micro-generator, 5 s disconnections should be initiated, and the average time recorded.

The following sections within A.2.2.2 (Over / Under Voltage) have had text removed and minor editorial changes made,

~~In addition to the EN 50438 over / under voltage tests the tests in this paragraph shall be undertaken.~~

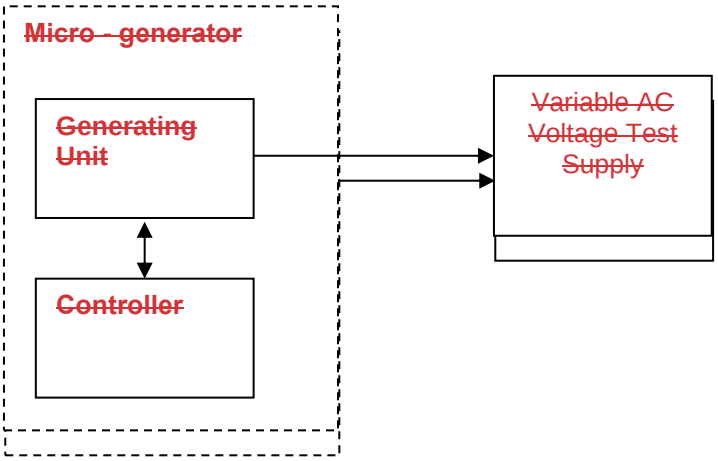
The **Interface Protection** shall be tested by operating the ~~Controller~~Micro-generator in parallel with a variable AC test supply, as an example see Figure A2.1. Correct protection and ride-through operation shall be confirmed**.** The set points for over and under voltage at which the **Interface Protection** disconnects from the supply will be established by varying the AC supply voltage. The disconnect sequence should be initiated when the network conditions of Table 2 are met, otherwise normal operation should continue.

To establish the certified trip time, the test voltage should be applied starting from ± 1.8% below the certified trip voltage in a step of at least ± 0.5% of setting for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0.5 s. Where the **Interface Protection** functionality is implemented in the ~~Controller~~Micro-generator, it will be necessary to carry out five tests for each trip setting. The longest trip time is to be recorded as the certified trip time.

To confirm that the protection does not trip before the required time, the test voltage should be applied at each setting ± ~~4V~~4 V and for the relevant times shown in the **Type Test Verification Report**, Appendix 3 Form C.

Figure A2.1. title has been amended as shown below,

Figure A2.1. Micro-generator ~~Test~~test set up – ~~Over / Under~~over / under Voltage



Section A.2.2.3 (Over / Under Frequency) has had the following text removed and minor editorial changes made,

~~In addition to the EN 50438 over / under frequency tests the tests in this paragraph shall be taken into account.~~

The **Interface Protection**shall be tested by operating the ~~**Controller**~~**Micro-generator** in parallel with a low impedance, variable frequency test supply system, as an example see Figure A2.2. Correct protection and ride-through operation should be confirmed during the test. The set points for over and under frequency at which the **Interface Protection** disconnects from the supply will be established by varying the test supply frequency.

The title to figure A2.1. has been amended as shown below,

Figure A2.2~~.~~ ~~Test~~test set up – ~~Over / Under~~over / under Frequency

Section A.2.2.4 (Loss of mains protection) has been amended as shown below,

The test described in ~~EN 50438~~this Annex should be completed at 10%, 55%, and 100% of the **Registered Capacity**. In both cases a subset of results should be recorded as indicated in the Protection – Loss of Mains test section of the **Type Test Verification Report**, Appendix 3 Form C. Note that if the suggested loading points are below the **Micro-generator**'s minimum stable operating level the test should be completed at 100%, and at least one loading level below 100%, of the **Registered Capacity**. It is recommended that a power level is chosen that is 5% of the difference between the **Registered Capacity** and the minimum stable operating level above the minimum stable operating level:

Power level = Minimum stable operating level + (**Registered Capacity** – minimum stable operating level) x 5%

The resonant test circuit specified in this test has been designed to model the interaction of the directly coupled **Micro-generator** under test with the local load including multiple directly coupled connected **Micro-generator**s in parallel.

The directly coupled **Micro-generator**s output shall be connected to a network combining a resonant circuit with a Q factor of >0.5 and a variable load. The value of the load is to match the directly coupled **Micro-generator** output. To facilitate the test for LoM there shall be a switch placed between the test load/directly coupled **Micro-generator** combination and the **DNO**'s **Distribution Network**, as shown in Figure A2.3.

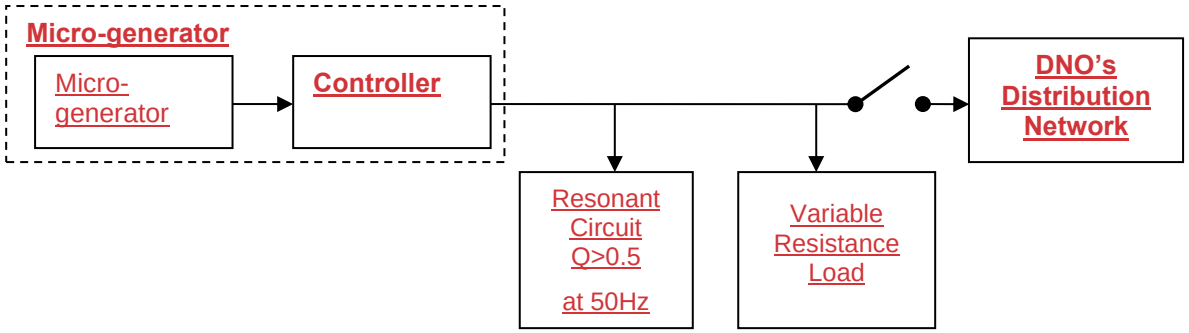


Figure A2.3 test set up – Loss of Mains

The directly coupled **Micro-generator** is to be tested at three levels of the directly coupled **Micro-generator**'s output power: 10%, 55% and 100%. For each test the load match is to be within ± 5%. Each test is to be repeated five times.

Load match conditions are defined as being when the current from the directly coupled **Micro-generator** meets the requirements of the test load ie there is no export or import of supply frequency current to or from the **DNO**'s **Distribution Network**.

The tests will record the directly coupled **Micro-generator**'s output voltage and frequency from at least 2 cycles before the switch is opened until the protection system operates and disconnects itself from the **DNO**'s **Distribution Network**, or for five seconds whichever is the lower duration.

The time from the switch opening until the protection disconnection occurs is to be measured and must comply with the requirements in Table 2.

Section A.2.2.7 (Active power feed-in at under-frequency) title and text has been amended as shown below,

A.2.2.7 Active ~~power~~Power feed-in at under-frequency

~~EN 50438~~The tests detailed in A 1.2.7 shall be ~~complied with in respect of active power~~undertaken to verify the **Active Power** feed-in at under-frequency.

Section A.2.2.8 (Power response to over-frequency) has been amended as shown below,

~~EN 50438~~The tests detailed in A 1.2.8 shall be ~~complied with in respect of~~undertaken to verify the power ~~response~~reduction to over-frequency using a specific standard frequency threshold of 50.4 Hz and a **Droop** ~~setting~~ of 10%.

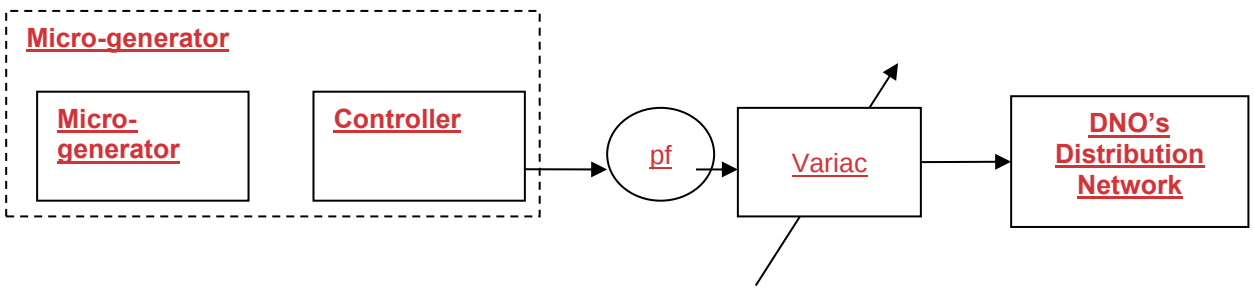
The power quality section – A.2.3.1 (Harmonics) has had the following text amendments,

The tests should be carried out as specified in BS EN 61000-3-2 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of **Registered Capacity**. Note that if the suggested power levels are below the **Micro-generator**'s minimum stable operating level the test should be carried out at 100%, and at least one stable loading level below 100%, of **Registered Capacity**. It is recommended that a power level is chosen that is 5% of the difference between the **Registered Capacity** and the minimum stable operating level above the minimum stable operating level:

Power level = Minimum stable operating level + (**Registered Capacity** – minimum stable operating level) x 5%

Section A.2.3.2 (Power factor) has been amended as shown below,

The test set up shall be such that the directly coupled **Micro-generator** supplies full load to the **DNO**'s **Distribution Network** via the power factor (pf) meter and the variac as shown below in figure A2.3. The directly coupled **Micro-generator** power factor should be ~~undertaken as laid out in EN 50438 with the following~~within the limits given in paragraph 9.6 for the three test voltages 230 V –6%, 230 V and 230 V +10%. The voltage shall be maintained within ±1.5% of the stated level during the test.



NOTE 1. For reasons of clarity the points of isolation are not shown
NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown

Figure A2.3 test set up – Power Factor

Section A.2.3.4 (Short circuit current contribution for directly coupled technology) has had the follow text removed, and amended as shown,

~~The tests in EN 50438 shall apply.~~

For rotating machines BS EN 60034-4:1995 Methods for determining synchronous machine quantities from tests shall be used to establish the parameters required to be recorded in **Type Test Verification Report** Appendix 3 Form C under the section fault level contribution.

For rotating machines and linear piston machines the test ~~should~~shall produce a 0 – 2 s plot of the short circuit current as seen at the **Micro-generator** terminals.

The short circuit current contribution shall be measured upon application of a short circuit on the **Micro-generator** terminals (all phases / phase to neutral) with the **Micro-generator(**s) operating at rated output steady state conditions.

Current measurements shall be taken from application of fault until the time the fault has been disconnected, following operation of the **Micro-generator** protection. A current decay plot shall be produced for each phase from inception of the fault until the **Micro-generator** has been disconnected – trip time. The plot shall show the highest value of peak short circuit current, eg for a **Micro-generator** supplying a purely inductive load the highest value of peak short circuit current will result when the fault is applied at a voltage zero. Where practicable the tests will need to determine values for all of the relevant parameters listed in Table A.1.

Table A.1 Micro-generator Short Circuit Parameters

Parameter	Symbol	Method of Determination
Peak short-circuit current	i_p	Direct measurement
Initial value of aperiodic component	A	Direct measurement
Initial symmetrical short-circuit current	Ik"	Interpolation of plot
Decaying (aperiodic) component of short- circuit current	i_{dc}	Interpolation of plot & calculation
Reactance / Resistance ratio of source	i.X/R	Calculation

~~**A.2.3.5 Electromagnetic Compatibility (EMC)**~~

~~**All equipment shall conform to the generic EMC standards: BS EN61000-6-3: Electromagnetic Compatibility, Generic Emission Standard; and BS EN61000-6-1: Electromagnetic Compatibility, Generic Immunity Standard.**~~

1.3 G99 Issue 1 Amendment 7 Modifications

1.3.1 Foreword

The foreword has had the following text removed,

~~**Power Generating Modules** that fully comply with this EREC G99 can be commissioned in advance of 27 April 2019 as they also comply with the pre-existing EREC G59 requirements.~~

1.3.2 Section 2 – Scope and structure

There has been a minor editorial change to section 2.12 as shown below,

2.12 Except for **Limited Frequency Sensitive Mode –** ~~**Over-frequency**~~**Overfrequency** and the requirements relating to output power with falling frequency or where otherwise stated, requirements of this EREC G99 relating to the capability to maintain constant **Active Power** output or to modulate **Active Power** output shall not apply to **Power Generating Module**s of facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met:

(d) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned;

(e) heat and power generating is inextricably interlinked, that is to say any change of heat generation results inadvertently in a change of **Active Power** output and vice versa;

1.3.3 Section 3 – Normative references

The following editorial changes have been made to section 3 of G99, listed below,

3.2 **Regulations and Directives**

~~COMMISSION REGULATION~~Commission Regulation (EU) No 2016/631
Establishing a network code on Requirements for Grid Connection of Generators.

Directive 2009/72/EC ~~OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL~~of the European Parliament and of the Council
Concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

3.3 **Standards publications**

BS 7671: Requirements for Electrical Installations
~~IEE~~IET Wiring Regulations.

BS EN 50549 series
Requirements for generating plants to be connected in parallel with distribution networks.

3.4 **Other Publications**

ENA Engineering Recommendation G5
~~Planning levels for harmonic~~ Harmonic voltage distortion and the connection of ~~non-linear equipment~~harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom.

ENA Engineering Recommendation P28
~~Planning limits for voltage~~Voltage fluctuations ~~caused by industrial, commercial~~ and ~~domestic~~the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom.

ENA Engineering ~~Technical r~~Report E~~REP~~TR 124
Guidelines for actively managing power flows associated with the connection of a single distributed generation plant.

ENA Engineering ~~Technical report ETR~~Report EREP 126
Guidelines for actively managing voltage levels associated with the connection of a single distributed generation plant.

ENA and Department for Business, Energy and Industrial Strategy (BEIS) Distributed Energy Resources (DER) – Cyber Security Connection Guidance
Guidance to support users in the design, development, deployment, connection and maintenance of new and existing DERs to the distribution networks to improve their cyber security.

Publicly Available Specification (PAS) 1879
Energy smart appliances – Demand side response operation – Code of practice.

1.3.4 Section 4 – Terms and definitions

The following terms and definitions have been amended,

Connection Agreement
A contract between the **Distribution Network Operator** and the **Generator**, which includes the ~~relevant site and~~ specific technical requirements for the **Power Generating Module** and the relevant requirements for the **Power Generating Facility**.

Droop
The ratio of the per unit steady state change in speed~~,~~ (or frequency), to the per unit steady state change in ~~**power**~~ **Active Power** output. Whilst not mandatory, it is often common practice to express **Droop** in percentage terms.

Fully Type Tested
A **Power Generating Module** with a **Registered Capacity** ≤ 50 kW which has been tested to ensure that the design meets the relevant technical and compliance requirements of this EREC G99, and for which the **Manufacturer** has declared that all similar **Power Generating Module**s supplied will be constructed to the same standards and will have the same performance. In the case where **Interface Protection** functionality is included in the tested equipment, all similar products will be manufactured with the same protection settings as the tested product.

Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency (LFSM-O)
A **Power Generating Module** operating mode which will result in **Active Power** output reduction in response to a change in system frequency once the system frequency exceeds a certain value.

Limited Frequency Sensitive Mode – ~~Under frequency~~Underfrequency (LFSM-U)
A **Power Generating Module** operating mode which will result in **Active Power** output increase in response to a change in system frequency once the system frequency falls below a certain value.

Minimum ~~Stable Operating~~Regulating Level (MRL)
The minimum **Active Power** output ~~which a **Power Generating Module** can reasonably generate as registered under the Distribution Data Registration Code.~~

~~**Minimum Regulating Level**~~
~~The minimum Active Power, as agreed between the DNO and the Generator,~~ down to which the **Power Generating Module** can control **Active Power**.

Minimum Stable Operating Level (MSOL)
The minimum **Active Power** output at which the **Power Generating Module** can be operated stably for an unlimited time.

1.3.5 Section 6 – Connection application

The section below outlines the amendments made to the text, as well as sections removed and renumbered accordingly.

6.3.7 ~~This document includes the requirement to~~In general detailed models of a **Type A** or **Type B Power Generating Module** are not required. Where the **DNO** deems it necessary to ensure **System Stability** and security appropriately detailed models of **Type A** or **Type B Power Generating Module**s shall be supplied. Detailed models are always required for **Type C** and **Type D Power Generating Module**s. **Generator**s shall submit ~~validated~~ detailed models in respect of ~~asynchronous **Power**~~ **Generating** ~~**Modules**~~**Units** which are aggregated into a **Power Park Module**.

~~6.3.8~~ ~~Where the **DNO** deems it necessary to ensure **System Stability** and security, validated detailed models of the **Power Generating Module** are required, in accordance with the **Distribution Code** DDRC.~~

6.3.8 **DNO**s will need appropriate modelling data from **Power Generating Module Manufacturer**s to undertake system analysis. Note that it is the **Generator**'s responsibility to ensure the necessary information is submitted to the **DNO**.

All subsequent sub-sections of text have been re-numbered from 9.1> to 8.1> to allow for the text removal of the original 6.3.8

6.3.8.1 All simulation models used to demonstrate compliance with this EREC G99 ~~must~~shall be validated before the final submission of the **PGMD** to the **DNO**.

6.3.8.4 **Generator**s with **Type C** and **Type D Power Generation Module**s will need to submit appropriate simulation models of the **Power Generating Module**. The model will normally be requested in a compiled form suitable for use with the particular variety of power system analysis software used by the **DNO** or the **NETSO**. Recently there is a move by **Manufacturer**s to create 'black-box' models of their **Power Generating Module**s (see Section 21). These are programmed for compatibility with industry standard power analysis modelling packages. This is in order to protect the **Manufacturer**'s intellectual property and so lessen the need for confidentiality agreements between parties. There are potential advantages and disadvantages to this approach, but it must be generally welcomed provided that the two main disadvantages of this approach, as described below, can be resolved:

(a) The model shall not be software 'version' specific ie will work in all future versions, or has an assurance of future upgrades for a particular software package;

(b) The **Manufacturer** shall provide assurance that the black box model correctly represents the performance of the **Power Generating Module** for load flow, fault level and transient analysis for the typical range of faults experienced by **DNO**s. This includes providing guidance on the model or study cases and scenarios, should the **DNO** request such information.

1.3.6 Section 9 – Network connection design and operation

New text has been added to sections 9.1.6 > 9.1.8 as shown,

9.1.6 The **Reactive Power** and voltage control requirements are given in Section 11, Section 12 and Section 13 for **Type A Power Generating Module**s, **Type B Power Generating Module**s, and **Type C** and **Type D Power Generating Module**s respectively. They are summarised in Table D.4 for information.

9.1.7 Every **Power Generating Module** and any associated equipment shall be designed and operated appropriately to comply with cyber security requirements. The **Generator** shall consider all cyber

security risks applicable to the **Power Generating Module** in terms of the communication between any energy management system etc and also in terms of interaction with any system of the **Manufacturer** for product management.

9.1.8 The **Generator** shall provide information describing the high level cyber security approach, as well as the specific cyber security requirements complied with. The statement will make appropriate reference to the **Power Generating Facilities** compliance with ETSI EN 303 645, relevant aspects of PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice" and also to "Distributed Energy Resources – Cyber Security Connection Guidance" published by BEIS and the ENA.

The titles for sections 9.1.6, 9.2, 9.3, 9.3.1 > 9.3.4, 9.4 and 9.5 has been re-numbered to 9.2, 9.3, 9.4, 9.4.1 > 9.4.4, 9.5 and 9.6 respectively. and As shown below,

~~9.1.6~~9.2 **Network Connection Design for Power Generating Modules**

~~9.2~~9.3 **Step Voltage Change and Rapid Voltage Change**

~~9.3~~9.4 **Power Quality**

~~9.3.1~~9.4.1 Introduction

~~9.3.2~~9.4.2 Flicker

~~9.3.3~~9.4.3 Harmonic Emissions

~~9.3.4~~9.4.4 Voltage imbalance

~~9.4~~9.5 **System Stability**

~~9.5~~9.6 **Island Mode**

9.6.1 There are two specific instances of island mode to be considered:

(a) where the **Generator** wishes to deliberately move from the long-term parallel mode of operation to the situation where the **Generator**'s **Power Generating Module**(s) is arranged to supply just the load presented by the **Customer's Installation**, with the **Customer's Installation** disconnected from the **DNO**'s **Distribution Network**; or

(b) where one or more **Power Generating Module**s, belonging to one or more **Generator**s, support an isolated part of the **DNO**'s **Distribution Network**, maintaining supplies to other **Customer**s of the **DNO**.

9.6.2 **Customer's Installation** Island

9.6.2.1 Wherever a **Generator**'s **Power Generating Module** runs in parallel with the **DNO**'s **Distribution Network** for more than 5 minutes per month, the design of the **Power Generating Module** and the **Customer's Installation** must meet the requirements for long-term parallel operation and comply with all the appropriate requirements of this EREC G99.

9.6.2.2 Where a **Generator** intends to operate the **Power Generating Module** so that it supplies just the **Customer's Installation**, it is the **Generator**'s responsibility to ensure the safety of the **Customer's Installation** in respect of electrical and general safety.

9.6.2.3 The arrangements of Figures 8.6 (HV) and 8.9 (LV) will generally be appropriate for earthing and switching arrangements. Exact designs of **Customer's Installation**s will vary, but the functional requirements of these figures should be implemented.

9.6.2.4 It is the **Generator**'s responsibility to ensure appropriate and safe synchronisation to, and disconnection from, the **DNO**'s **Distribution Network**, respecting the requirements of EREC P28 on voltage disturbances on the **DNO**'s **Distribution Network**.

9.6.3 **DNO**'s **Distribution Network** Island

Some further editorial changes and re-numbering due to the additional text shown below,

~~9.5.1.1~~9.6.3.1

~~9.5.1.2~~9.6.3.2 When considering whether **Power Generating Module**s can be permitted to operate in island mode, detailed studies need to be undertaken to ensure that the islanded system will remain stable and comply with all statutory obligations and relevant planning standards when separated from the remainder of the **Total System**. Before operation in island mode can be allowed, a contractual agreement between the **DNO** and **Generator** shall be in place and the legal liabilities associated with such operation shall be carefully considered by the **DNO** and the **Generator**. Consideration should be given to the following areas:

(a) load flows, voltage regulation, frequency regulation, voltage unbalance, voltage flicker and harmonic voltage distortion;

(b) earthing arrangements;

(c) short circuit currents and the adequacy of protection arrangements;

(d) **System Stability**;

(e) ~~resynchronisation~~re-synchronisation to the **Total System**;

(f) safety of personnel.

~~9.5.1.3~~9.6.3.3

~~9.5.1.4~~9.6.3.4

~~9.5.1.5~~9.6.3.5

~~9.5.1.6~~9.6.3.6

~~9.5.1.7~~9.6.3.7

~~9.5.1.8~~9.6.3.8 It will generally not be permissible to interrupt supplies to **DNO Customer**s for the purposes of ~~resynchronisation~~re-synchronisation. The design of the islanded system shall ensure that synchronising facilities are provided at the point of isolation between the islanded network and the **DNO** supply. Specific arrangements for this should be agreed and recorded in the **Connection Agreement** with the **DNO**. If no facilities exist for the subsequent ~~resynchronisation~~re-synchronisation with the rest of the **DNO**'s **Distribution Network** then the **Generator** will, under **DNO instruction**, ensure that the **Power Generating Module** is disconnected for ~~resynchronisation~~re-synchronisation.

~~9.6~~9.7 **Fault Contributions and Switchgear Considerations**

1.3.7 Section 10 - Protection

The following sections of text have undergone minor editorial changes,

10.2 ~~Co-ordinating~~Coordinating with DNO's Distribution Network's Existing Protection

10.2.1 It will be necessary for the protection associated with **Power Generating Module**s to ~~co-ordinate~~coordinate with the **Protection** associated with the **DNO**'s **Distribution Network** as follows:-

a) For **Power Generating Module**s **directly** connected to the **DNO**'s **Distribution Network** the **Power Generating Module** shall meet the target clearance times for fault current interchange with the **DNO**'s **Distribution Network** in order to reduce to a minimum the impact on the **DNO**'s **Distribution Network** of faults on circuits owned by **the Generator**. The **DNO** will ensure that the **DNO** protection settings meet its own target clearance times.
The target clearance times are measured from fault current inception to arc extinction and will be specified by the **DNO** to meet the requirements of the relevant part of the **Distribution Network**.

b) The settings of any protection controlling a circuit breaker or the operating values of any automatic switching device at any point of connection with the **DNO**'s **Distribution Network**, as well as the **Generator**'s maintenance and testing regime, shall be agreed between the **DNO** and the **Generator** in writing during the connection consultation process.

It will be necessary for the **Power Generating Module** protection to ~~co-ordinate~~coordinate with any auto-reclose policy specified by the **DNO**. In particular **the Power Generating Module** protection should detect a loss of mains situation and disconnect the **Power Generating Module** in a time shorter than any auto reclose dead time. This should include an allowance for circuit breaker operation and generally a minimum of 0.5 s should be allowed for this. For auto-reclosers set with a dead time of 3 s, this implies a maximum **Interface Protection** response time of 2.5 s. Where auto-reclosers have a dead time of less than 3 s, there may be a need to reduce the operating time of the **Interface Protection**. For **Type Tested Power Park Module**s no changes are required to the operating times irrespective of the auto-reclose times. In all other cases where the auto-recloser dead time is less than 3 s the **Generator** will need to agree site-specific **Interface Protection** settings with the **DNO**.

10.2.2 Specific protection required for **Power Generating Module**s

In addition to any protection installed by the **Generator** to meet the requirements of the **Power Generating Facility** and statutory obligations, the **Generator** shall install protection to achieve the following objectives:

a) For all **Power Generating Module**s:

i. To disconnect the **Power Generating Module** from the system when a system abnormality occurs that results in an unacceptable deviation of the frequency or voltage at the **Connection Point**, recognizing the requirements to ride through faults as detailed in Sections 12.3 and 13.4;

ii. To ensure the automatic disconnection of the **Power Generating Module**~~,~~ or **Generating Unit**, or where there is constant supervision of an installation, the operation of an alarm with an audio and visual indication, in the event of any failure of supplies to the protective equipment that would inhibit its correct operation.

10.3.5 If automatic resetting of the protective equipment is used, there shall be a time delay to ensure that healthy supply conditions exist for a minimum continuous period of 20 s. Reset times may need to be ~~co-ordinated~~coordinated where more than one **Power Generating Module** is connected to the same feeder. The automatic reset shall be inhibited for faults on the **Generator's Installation**.

10.3.8 The health of protection tripping and/or auxiliary supplies must be monitored such that any failure of these supplies is either brought to the immediate attention of the **Generator** via an automatic alarm that is monitored by the **Generator** in real time, or the failure of the protection tripping and/or auxiliary supplies causes the **Power Generation Module** or **Generating Unit** to be tripped, and reconnection prevented before restoration of the protection tripping and/or auxiliary supplies that have been lost.

10.6.16 Whilst the protection schemes and settings for internal electrical faults should mitigate any damage to the **Power Generating Module** they shall not jeopardise the performance of a **Power Generating Module**, in line with the requirements set out in this EREC G99.

1.3.8 Section 11 – Type A power generating module technical requirements

The following amendments have been made, and text added. Shown below,

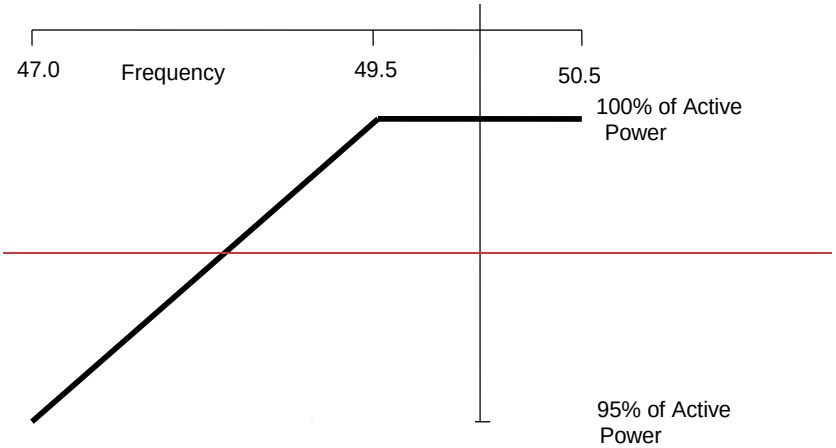
11.2.1 Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**'s **Distribution Network**

could rise above 50.5 Hz. Therefore all **Power Generating Module**s ~~should~~shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

(a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range.
(b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
(c) 49.0 Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required.
(d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
(e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.

11.2.3.1 Each **Power Generating Module**, shall be capable of:

(a) continuously maintaining constant **Active Power** output for system frequency changes within the range 50.5 to 49.5 Hz; and
(b) (subject to the provisions of paragraph 11.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 11.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 11.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.



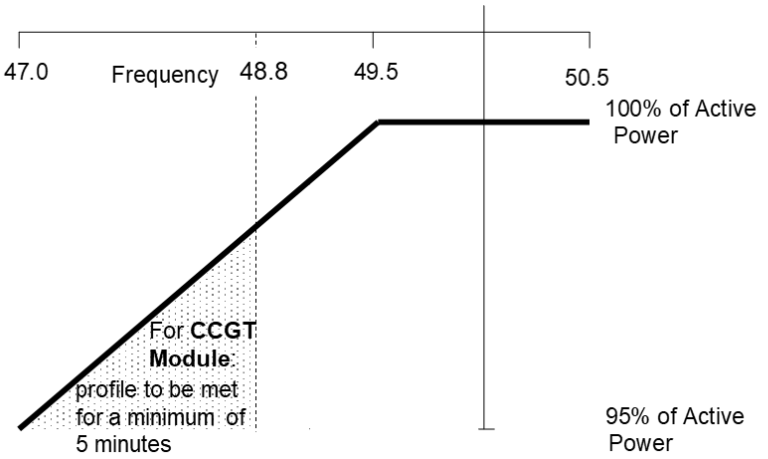


Figure 11.1 Change in Active Power with falling frequency

11.2.4 **Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**

11.2.4.2 When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode ~~Over frequency~~Overfrequency (LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to, or is below, 50.4 Hz.

11.4.2 The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. ~~ETR~~EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.

11.4.5 **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. ~~ETR~~EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.

1.3.9 Section 12 – Type B power generating module technical requirements

The exerts below show the minor editorial changes and sections of text added/removed.

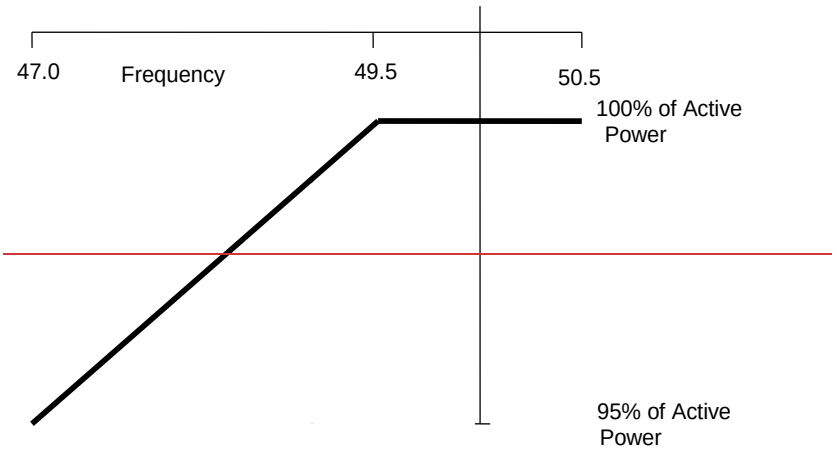
12.2.1 Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**'s **Distribution Network** could rise above 50.5 Hz. Therefore all **Power Generating Module**s ~~should~~shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

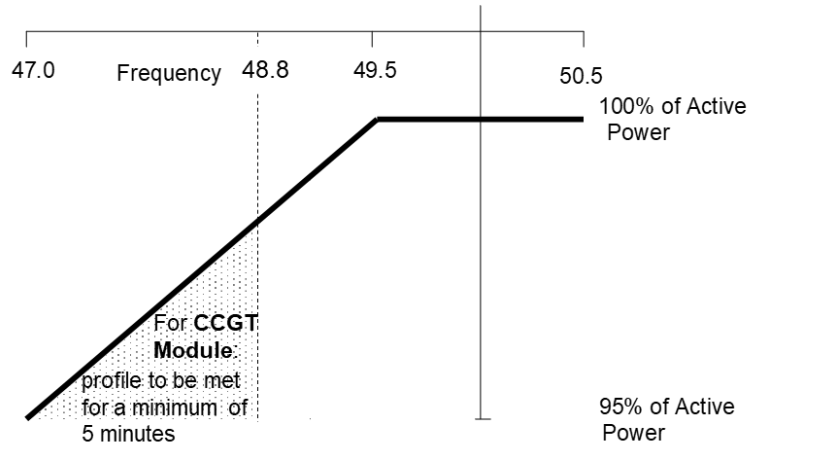
(a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range.
(b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
(c) 49.0Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required.
(d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
(e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.

12.2.3.1 Each **Power Generating Module**, shall be capable of:

(a) continuously maintaining constant **Active Power** output for system frequency changes within the range 50.5 to 49.5 Hz; and

(b) (subject to the provisions of paragraph 12.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 12.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8 Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 12.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.





(a) Figure 12.1 Change in Active Power with falling frequency

12.2.4 Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency

12.2.4.2 When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode** ~~**Over frequency**~~**Overfrequency** **(LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to or is below 50.4 Hz.

12.4.2 The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. ~~ETR~~EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.

12.4.6 **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. ~~ETR~~EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.

12.5.1 When supplying **Registered Capacity** all **Power Generating Module**s shall be capable of continuous operation at nominal voltage at any points between the limits of 0.95 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Connection Point** or the **Generating Unit** terminals as appropriate for the **Power Generating Facility** and as agreed with the **DNO**.

12.6.2 Each **Power Park Module** shall be required to satisfy the following requirements:

(f) Each **Power Park Module** shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. **Generators** shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figures 12.6 (a) and Figure 12.6 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The **DNO** may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the **Connection Agreement**. Where the **Generator** is able to demonstrate to the **DNO** that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions **Generators** are required to both advise and agree with the **DNO** the control strategy, which ~~must~~shall also include the approach taken to de-blocking.

1.3.10 Section 13 – Type C and D power generating module technical requirements

Below are listed the amendments made to the document,

13.2.1 Under abnormal conditions automatic low-frequency load-shedding provides for load reduction down to 47 Hz. In exceptional circumstances, the frequency of the **DNO**'s **Distribution Network** could rise above 50.5 Hz. Therefore all **Power Generating Module**s ~~should~~shall be capable of continuing to operate in parallel with the **Distribution Network** in accordance with the following:

a) 47 Hz – 47.5 Hz Operation for a period of at least 20 s is required each time the frequency is within this range.
b) 47.5 Hz – 49.0 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
c) 49.0 Hz – 51.0 Hz Continuous operation of the **Power Generating Module** is required.
d) 51.0 Hz –51.5 Hz Operation for a period of at least 90 minutes is required each time the frequency is within this range.
e) 51.5 Hz – 52 Hz Operation for a period of at least 15 minutes is required each time the frequency is within this range.

13.2.3.1 Each **Power Generating Module**, shall be capable of:

(a) continuously maintaining constant **Active Power** output for system frequency changes within the range 50.5 to 49.5 Hz; and

(b) (subject to the provisions of paragraph 13.2.1) maintaining its **Active Power** output at a level not lower than the figure determined by the linear relationship shown in Figure 13.1 for system frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the system frequency drops to 47 Hz the **Active Power** output does not decrease by more than 5%. In the case of a **CCGT Module** this requirement shall be retained down to 48.8 Hz, which reflects the first stage of the automatic Low Frequency Demand Disconnection scheme. For system frequency below 48.8 Hz, the existing requirements shall be retained for a minimum period of 5 minutes while system frequency remains below 48.8 Hz, and any special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minute period, if system frequency remains below the 49.5 Hz threshold, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measure(s) is linked to the inherent Gas Turbine **Active Power** output reduction caused by reduced shaft speed due to falling system frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure 13.1 these measures should still be continued at ambient temperatures above 25°C maintaining as much of the **Active Power** achievable within the capability of the plant.

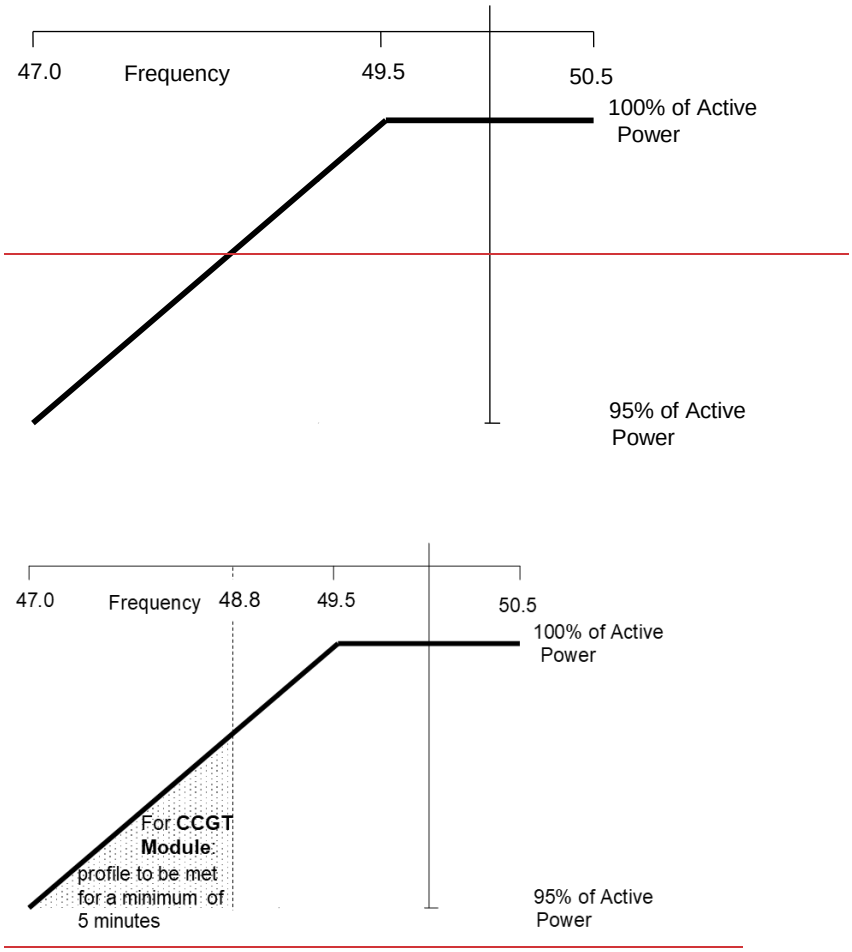
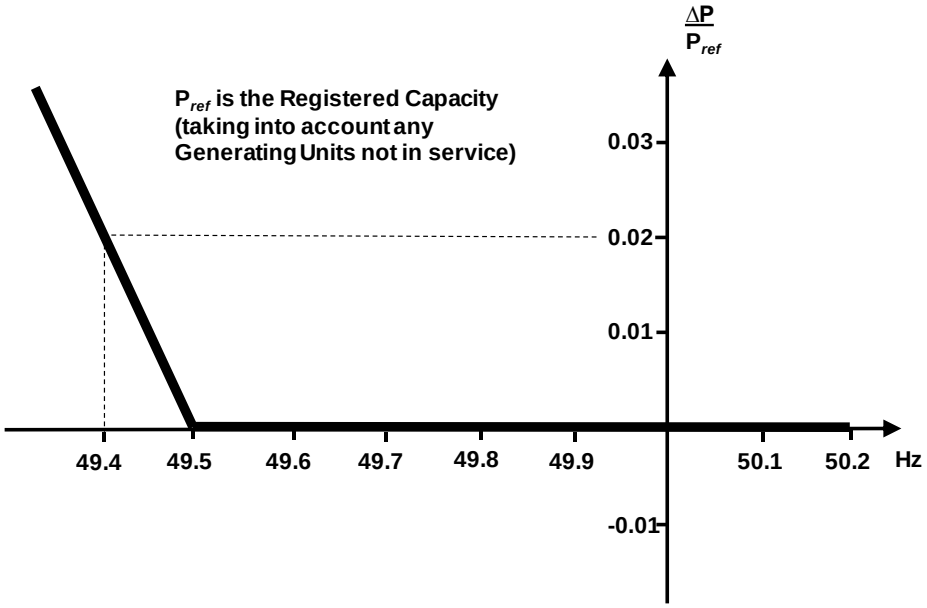


Figure 13.1 Change in Active Power with falling frequency

13.2.4 **Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**

13.2.4.2 When the **Power Generating Module** is providing **Limited Frequency Sensitive Mode ~~Over frequency~~Overfrequency (LFSM-O)** response it shall continue to provide the frequency response until the frequency has returned to or below 50.4 Hz.

13.2.5 **Limited Frequency Sensitive Mode – ~~Under frequency~~Underfrequency (LFSM-U)**



P_{ref} is the **Registered Capacity**, taking into account any **Interface Protection**s not in service to which ΔP is related and ΔP is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide a positive **Active Power** output change with a **Droop** of 10% or less based on P_{ref}.

Figure 13.3 - Limited Frequency Sensitive Mode – ~~Under frequency~~Underfrequency capability of Power Generating Modules

13.2.6.3 The frequency control device (or speed governor) in ~~co-ordination~~coordination with other control devices shall control each **Power Generating Module Active Power** output with stability over the entire operating range of the **Power Generating Module**; and

13.2.6.4 **Power Generating Module**s shall also **meet** the following minimum requirements:

b) In satisfying the performance requirements specified in paragraph 13.2.6.2 **Generator**s in respect of each **Power Generating Module** should be aware:-
   i. in the case of over frequency, the **Active Power Frequency Response** is limited by the **Minimum ~~Stable Operating~~Regulating Level**.~~,~~

(f) ~~with~~With regard to disconnection due to under frequency, **Generator**s responsible for **Power Generating Module**s capable of acting as a load, including but not limited to pumped-storage **Power Generating Module**s, shall be capable of disconnecting their load in case of under frequency which will be agreed with the **DNO**. For the avoidance of doubt, this requirement does not apply to station auxiliary supplies.

13.4.2 The connection of a **Power Generating Module** to the **Distribution Network** shall be designed in such a way that operation of the **Power Generating Module** does not adversely affect the voltage profile of and voltage control employed on the **Distribution Network**. ~~ETR~~EREP 126 provides **DNO**s with guidance on active management solutions to overcome voltage control limitations. Information on the voltage regulation and control arrangements will be made available by the **DNO** if requested by the **Generator**.

13.4.7 Automatic Voltage Control (AVC) schemes employed by the **DNO** often assume that power flows from parts of the **Distribution Network** operating at a higher voltage to parts of the **Distribution Network** operating at lower voltages. Export from **Power Generating Module**s in excess of the local loads may result in power flows in the reverse direction. In this case AVC referenced to the **Low Voltage** side may not operate correctly without an import of **Reactive ~~power~~Power** and relay

settings appropriate to this operating condition. When load current compounding is used with the AVC and the penetration level of **Power Generating Module**s becomes significant compared to normal loads, it may be necessary to switch any compounding out of service.

13.4.8 **Power Generating Module**s can cause problems if connected to networks employing AVC schemes which use negative reactance compounding and line drop compensation due to changes in **Active Power** and **Reactive Power** flows. ~~ETR~~EREP 126 provides guidance on connecting generation to such networks using techniques such as removing the generation circuit from the AVC scheme using cancellation CTs.

13.6.2 Each **Power Park Module** shall be required to satisfy the following requirements.

(f) Each **Power Park Module** shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault and in order to mitigate the risk of any form of instability which could result. **Generators** shall be permitted to block or employ other means where the anticipated transient over voltage would otherwise exceed the 1.05 pu of nominal. Figures 13.15 (a) and Figure 13.15 (b) show the impact of variations in fault clearance time which shall be no greater than 140 ms. The **DNO** may agree requirements for the maximum transient over voltage withstand capability and associated time duration. Such capability and parameters will be recorded in the **Connection Agreement**. Where the **Generator** is able to demonstrate to the **DNO** that blocking or other control strategies are required in order to prevent the risk of transient over voltage excursions **Generators** are required to both advise and agree with the **DNO** the control strategy, which ~~must~~shall also include the approach taken to de-blocking.

13.7 **Black Start Capability and rapid re-synchronisation**

13.7.1 The **National Electricity Transmission System** ~~will~~is ~~be~~ equipped with **Black Start Station**s. It will be necessary for each **Generator** to notify the **DNO** if its **Power Generating Module** has a restart capability without connection to an external power supply, unless the **Generator** shall have previously notified the **NETSO** accordingly under the **Grid Code**. Such generation may be registered by the **NETSO** as a **Black Start Station**.

13.7.2 In case of disconnection of the **Power Generating Module** from the **Distribution Network**, the **Power Generating Module** shall be capable of quick re-synchronisation if required by the **NETSO**. If the **NETSO** requires rapid re-synchronisation it will agree the strategy with the **DNO** and the **Generator**. Where rapid re-synchronisation is required:

(a) A **Power Generating Module** with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be capable of houseload operation from any operating point on its **Power Generating Module Generator Performance Chart**. In this case, the identification of houseload operation must not be based solely on the **DNO**'s switchgear position signals; and

(b) **Power Generating Module**s shall be capable of houseload operation, irrespective of any auxiliary connection to the **Distribution Network**. The minimum operation time shall be specified by the **NETSO**, taking into consideration the specific characteristics of prime mover technology.

13.9.3 Additionally each **Power Generating Facility** shall;

(a) be fitted with fault recording and dynamic system monitoring facilities which shall be capable of recording ~~System~~system data including voltage, **Active Power**, **Reactive Power** and frequency in accordance with Annex C.6.

1.3.11 Section 14 – Installation operation and control interface

This section has 1 addition added to it, a new footnote (12 has been added to accompany section 14.1.4 (e), it reads as follows,

Reference shall be made to the Distributed Energy Resources – Cyber Security Connection Guidance published by the ENA and the Department for Business, Energy and Industrial Strategy (BEIS) and the PAS 1879 Energy smart appliances – Demand side response operation – Code of practice.

1.3.12 Section 15 – Common compliance and commissioning requirements for all power generating modules

The sections that have been amended are shown below,

13.3.1 The following checks shall be carried out by the **Installer** at all **Power Generating Facilities** and on all **Power Generating Module**s irrespective of whether they have been ~~fully~~**Fully Type Tested** or ~~partially~~ **Type Tested**:

(a) Inspect the **Power Generating Facility** to check compliance with BS7671. Checks should consider:
Protection

Earthing and bonding

Selection and installation of equipment

(b) Check that suitable lockable points of isolation have been provided between the **Power Generating Module**s and the rest of the installation;

(c) Check that safety labels have been installed in accordance with paragraph 14.2;

(d) Check interlocking operates as required. Interlocking should prevent **Power Generating Module**s being connected to the **DNO**'s **Distribution Network** without being synchronised; and

(e) Where possible undertake a visual check that the correct protection settings have been applied in accordance with Table 10.1 or Form A2-4 Site Compliance and Commissioning test requirements Form (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D Power Generating Module**s respectively.

13.3.2 The following tests shall be carried out by the **Installer** at all **Power Generating Facilities** and on all **Power Generating Module**s irrespective of whether they have been ~~fully~~**Fully Type Tested** or ~~partially~~ **Type Tested**:

(a) Complete functional tests to ensure each **Power Generating Module** synchronises with, and disconnects from, the **DNO**'s **Distribution Network** successfully and that it operates without tripping under normal conditions;

(b) Carry out an appropriate functional test to confirm that the **Interface Protection** operates when all phases are disconnected between the **Power Generating Module** and the **DNO**'s **Distribution Network**. For installations where the **Power Generating Module** is not designed to automatically switch to support the installation's demand in island mode, this test can be carried out by opening a suitably rated switch between the **Power Generating Module** and the **Connection Point** and checking that the supplies are disconnected between the **Power Generating Module** and the **DNO**'s **Distribution Network** quickly (eg within 1 s);

(c) Where the **Power Generating Module** is designed to support the demand of the installation automatically in island mode on failure of the incoming supply, the **Generator** will undertake a suitable test as agreed with the **DNO** (such as removing one or all of the voltage sensing supplies to the **Interface Protection** relay) to prove that under these conditions that the supplies are disconnected between the **Power Generating Module** and the **DNO**'s **Distribution Network** quickly (eg within 1 s);

(d) Check that once the phases are restored following the functional test described in (b) at least 20 s elapses before the **Power Generating Module**s re-connect to the **DNO**'s **Distribution Network** where automatic re-connection is permitted under 10.3.3;

(e) For any installations using an export limitation scheme, including those connecting under the **Integrated Micro Generation and Storage** procedure, the commissioning tests detailed in EREC G100 shall be carried out for the export limitation scheme, with the results recorded in the form contained in the relevant EREC G100 appendix. This is in addition to the **Power Generating Module** compliance and commissioning tests required by EREC G98 and EREC G99.

15.4.1 Where **Type Testing** or **Manufacturers' Information** is not being used to demonstrate **Interface Protection** compliance, on site protection commissioning tests are required and the following describes how these should be carried out for the standard range of protection required. Where additional protection is fitted then this should also be tested, additional test requirements are to be agreed between the **DNO** and **Generator**.

The results of these tests shall be recorded in the schedule provided in the Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D Power Generating Module**s respectively; using the relevant sections for **HV** and **LV** protection along with any additional test results required.

(d) RoCoF and vector shift stability tests shall be performed on all **Interface Protection** relays irrespective of the type of loss of mains protection employed for a particular **Power Generating Module** or **Power Generating Facility**. These tests are defined in the commissioning test record, Form A2-4 (Annex A.2), Form B2-2 (Annex B.2) or Form C2-2 (Annex C.2) as applicable to **Type A**, **Type B** and **Type C** or **Type D Power Generating Module**s respectively. The protection shall not trip during these tests.

15.5 **[V2G text proposed in storage mods in 15.5]**

15.6 **Family approach to Type Testing**

15.6.1 A family approach to type testing is acceptable, whereby **Generating Units** that are the same model and produced by the same **Manufacturer** but vary in electrical output can be considered to be **Type Tested** once one **Generating Unit** in the family has been shown to be compliant. The approach is permissible in the following range of **Generating Unit** electrical output:

- For **Synchronous Generating Units**:
  - Lower limit: 1/√10 (0.3162) times the tested **Generating Unit** nameplate rating (W)
  - Upper limit: √10 (3.162) times the tested **Generating Unit** nameplate rating (W)
- For all other **Generating Units**:
  - Lower limit: 1/√10 (0.3162) of tested **Generating Unit** nameplate rating (W)
  - Upper limit: 2 times tested **Generating Unit** nameplate rating (W)

15.6.2 All absolute values (e.g. operating range tests) shall be transferred directly in the compliance forms of an assumed compliant **Generating Unit** of the same family. All relative results related to design **Active Power** or current (e.g. power quality fluctuation and flicker) from the tested **Generating Unit** shall be transferred to the compliance form of a **Generating Unit** in the same family according to the ratio of the respective nameplate rating (W)of the tested **Generating Unit** and the assumed compliant **Generating Unit**. For the avoidance of doubt, the **Manufacturer** shall register each **Generating Unit** in the family on the Energy Networks Association **Type Test** register.

15.6.3 It is the responsibility of the **Manufacturer** to provide technical justification that the results are transferable. For example, the **Generating Unit**s have the same control systems.

15.7 **Compliance demonstration for Infrequent Short-Term Parallel Power Generating Modules**

15.7.1 Compliance of a **Power Generating Module** designed to operate in infrequent short-term parallel operation mode should be demonstrated for the applicable requirements and design variations as detailed in Section 7.3. As a minimum this shall include:

- Provision of a Standard Application Form
- Compliance with Section 8 (Earthing)
- Compliance with Section 9 (Network Connection Design and Operation)
- Compliance with Section 10 (Protection)
- Compliance with Section 14 (Installation, Operation and Control Interface)

- Compliance with Section 15 (Common Compliance and Commissioning Requirements)

15.7.2 It is recommended that the certification, connection and notification process for the applicable **Power Generating Module** type is followed, whilst taking into account the technical exclusions detailed in Annex A.4.3. Thus some rows in the compliance forms A2-1, A2-2, A2-3, B2 and C2 can be marked as exempt; for example in form B2, rows associated with **Reactive Power** capability and frequency performance can be noted "E" for exempt.

A new footnote (14) has been added to accompany section 15.6.1, it reads,

This approach is taken in Germany by VDE, a standards, testing and certification institution.

1.3.13 Section 16 – Type A compliance testing, commissioning and operational notification

Some minor editorial changes have been made to this section, they are listed below,

16.1.2 **Type Tested** certification is the responsibility of the **Manufacturer**. The **Manufacturer** shall submit the Type Test Verification Report confirming that the product has been **Type Tested** to satisfy the requirements of this EREC G99 to the Energy Networks Association (ENA) Type Test Verification Report Register. The report shall detail the type and model of the product tested, the test conditions and results recorded. The report can include reference to **Manufacturers' Information**. Examples of the combination of the use of type testing and the provision of **Manufacturers' Information** are given in Section 22.1. Further information about **Manufacturers' Information** in respect of **Power Park Module**s is given in Section 21. A **Manufacturer** of a **Type Tested** product should allocate a **Manufacturer**'s reference number, which should be registered on the ENA Type Test Verification Report Register as the ~~Product ID~~system reference.

16.2.1 The **Installer** shall discuss the installation project with the local **DNO** at the earliest opportunity. The connection application will need to be in format as shown in Form A1-1 (Annex A.1) for **Power Generating Module**s less than 50 kW, Form A1-2 (Annex A.1) for **Integrated Micro Generation and Storage** installations, or for **Power Generating Module**s greater than 50 kW by using the Standard Application Form (generally available from the **DNO**'s website). Where a **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association Type Test Verification Report Register, the application should include the **Manufacturer**'s reference number (the ~~Product ID~~system reference), and the compliance test results do not need to be submitted as part of the application.

16.2.5 Where **Power Generating Module**s require connection to the **DNO**'s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be ~~co-ordinated~~coordinated.

1.3.14 Section 17 – Type B compliance testing, commissioning and operational notification

Section 17 has one minor editorial change, shown below,

17.1.1 Where **Power Generating Module**s require connection to the **DNO**'s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be ~~co-ordinated~~coordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.

1.3.15 Section 17 – Type C compliance testing, commissioning and operational notification

There is one minor editorial within this section, as follows,

18.1.1 Where **Power Generating Module**s require connection to the **DNO**'s **Distribution Network** in advance of the commissioning date, for the purposes of testing, the **Power Generating Facility** shall comply with the requirements of the **Connection Agreement**. The **Generator** shall provide

the **DNO** with a commissioning programme, which will be approved by the **DNO** if reasonable in the circumstances, to allow commissioning tests to be ~~co-ordinated~~coordinated. The tests shall take account of the requirements in Section 15.3 and Section 15.4 where applicable.

1.3.16 Section 20 – Ongoing obligations

The amendments added to this section are listed below,

20.3.3 Where one or more **Power Generating Module**s are to be added or replaced at an existing ~~**Generator's**~~**Customers Installation** which were installed prior to the introduction of this EREC G99, it is not necessary to modify any other existing **Power Generating Module**s to comply with this document. For the avoidance of doubt, this also applies where the changes increase the ~~capacity~~aggregate **Registered Capacity** of the ~~**Generator's**~~ **Power Generating Module**(s) in the **Customers Installation** above the 16 A per phase threshold; in this case a new EREC G99 application is required.

20.3.4 Where ~~a~~an existing **Power Generating Module** installed under EREC G59 is substantially modified (which generally results in a modified **Connection Agreement**) then it will be necessary for that **Power Generating Module** to be modified to be compliant with this EREC G99. Modifications to an existing **Power Generating Module** which complies with the requirements of EREC G59 that are not considered to be substantial do not change the compliance requirements of that **Power Generating Module**, ie it can remain compliant with EREC G59. Annex A.6 provides guidance on what modifications are considered substantial.

1.3.17 Section 22 – Type testing annex information

The amendments to the section 22 tables are as follows,

22.1 **Fully Type Tested and ~~Partially~~ Type Tested equipment**

	Manufacturers' Information	**Power Quality Assessment and Site Tests**
Fully Type Tested (~~assumed~~ **Type A** only ≤ 50 kW)	Registered as **Fully Type Tested** information on ENA website via the Compliance Verification Report (Form A2-1, A2-2 or A2-3 as appropriate)	An assessment of compliance with EREC G5 and EREC P28 is necessary. This will generally allow connection of a **Fully Type Tested** device with no need for mitigation. However, where the fault level is unusually low (eg in remote rural locations) mitigation measures might be needed Only installation checks required – as on the Installation Document (Form A3-1 or A3-2)
~~Partially~~ **Type Tested** (**Type A**)	Registered as product or component Type Test information on ENA Website using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3); and/or Supplied by the **Generator** using applicable parts of Compliance Verification Report (Form A2-1, A2-2 or A2-3)	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form A3-1 or A3-2) Standard installation checks (Form A3-1 or A3-2). Additional Site Compliance and

		Commissioning Checks (Form A2-4) may also be required
~~Partially~~ **Type Tested** (B, C, D)	Registered as product or component Type Test information on ENA Website; and/or Supplied by the **Generator**	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form B2-1 or Form C2-1) Standard installation checks (Form B3 or Form C3). Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required
One off installation (B, C, D)	To be provided by the **Generator** for those aspects that cannot be demonstrated on site (including simulations etc)	Compliance of the installation with EREC G5 and EREC P28 Demonstration of technical requirements not covered by **Manufacturers' Information**. (Form B2-1 or Form C2-1) Standard installation checks also required (Form B3 or Form C3). Additional Site Compliance and Commissioning Checks (Form B2-2 or Form C2-2) may also be required

22.2 **Annex Contents and Form Guidance**

Annex	**Application**	**Form Title**
A.6	~~Not used~~Scenario examples in respect of the application of EREC G59 and EREC G99 to new or modified sites after 27/04/19	
D.~~1~~0	Decommissioning of any **Power Generating Module**	Form D1**: Decommissioning Confirmation**
D.~~2~~1	Additional Information Relating to **System Stability** Studies	
D.~~3~~2	Loss of Mains Protection Analysis	
D.~~4~~3	Main Statutory and other Obligations	
D.4	Summary of **Reactive Power** and voltage control requirements	

1.3.18 G99 Annex A – Type A

The following table has had a slight editorial change,

A.0 Type A Power Generating Module Forms Cover Sheet

Stage	Form	Notes / Description	Complete Y/N
1. Find an **Installer**	N/A	No form required – see ENA Distributed Generation Connection Guides for more information. Outside of the scope of this document.	
2. Discuss with the **DNO**	N/A	As above.	
3. Submit application	Form A1-1: Application Form (< 50 kW) OR Form A1-2: Application Form (**Integrated Micro Generation and Storage**) OR Standard Application Form (> 50 kW)	Submit an application, so that the **DNO** can assess whether there is a requirement for network studies and network reinforcement, and whether it wants to witness the commissioning. For **Power Generating Module**s < 50 kW three phase or 17 kW single phase, Form A1-1 should be used. For **Integrated Micro Generation and Storage** installations, Form A1-2 should be used. For larger schemes, the Standard Application Form should be used, which is generally available on **DNO** websites.	
4. Application acceptance	N/A	If the **DNO** determines that network reinforcement is required to facilitate connecting your **PGM**s, it will make you a Connection Offer. Once you have accepted the **DNO**'s Connection Offer, construction can begin. See ENA Distributed Generation Connection Guides for more information.	
5. Compliance	Form A2: Compliance Verification Report	To be provided, unless a **Manufacturer's** reference number (the ~~Product ID~~system reference) is available for **Fully Type Tested PGM**s (see Section 16.2.1). See the text at the start of Annex A.2 regarding the options for the Compliance Verification Report Form. One Compliance Verification Report is required for each type / model of **Power Generating Module**. Form A2-1 is suitable for **Synchronous Power Generating Module**s less than 50 kW and greater than 16 A per phase. Form A2-2 is suitable for **Power Generating Module**s greater than 50 kW or for **Synchronous Power Generating**	

		Modules <50 kW where this approach is preferred to Form A2-1. Form A2-3 is designed for **Power Park Module**s (excepting induction generators who are advised to use A2-1 or A2-2 as appropriate).	
6. Construction and commissioning	Form A2-4 Site Compliance and Commissioning test requirements	Where the **DNO** does not witness commissioning, the form should be submitted within 28 days. Where the **DNO** does witness, the forms can be signed and submitted on the day.	
7. Inform the **DNO**	Form A3-1 Installation Document for **Type A Power Generating Module**s OR Form A3-2 Installation Document for **Integrated Micro Generation and Storage** installations	Submit one form per **Power Generating Facility**, signed by the owner and **Installer**, with declarations signed by the **Generator** or **Generator**'s Technical Representative, (and the **DNO** Witness Representative where the **DNO** has elected to witness).	
8. Ongoing responsibilities	**Modification**	If a **Modification** is made to the **PGM** that affects its technical capabilities and compliance with this document, the **Generator** should inform the **DNO** who may require compliance tests.	
9. Decommissioning	(D0) Notification of decommissioning	Notify the **DNO** about the permanent decommissioning of a **PGM**.	

Below are the sections of Forms A1-1 and A 1-2 which have been amended,

A.1 Connection Application Forms for Type A Power Generating Facility (< 50 kW) (Form A1-1) and Integrated Micro Generation and Storage (Form A1- 2)

Form A1-1 : Application for connection of Power Generating Module(s) with Total Aggregate Capacity <50 kW 3-phase or 17 kW single phase

For **Power Generating Module**s with an aggregate capacity < 50 kW 3-phase or 17 kW single-phase, this simplified application form can be used. For **Power Generating Module**s with an aggregate capacity > 50 kW 3-phase, the connection application should be made using the Standard Application Form (generally available from the **DNO** website).

If the **Power Generating Module** is **Fully Type Tested** and registered in the ENA Type Test Verification Report Register, this application form should include the **Manufacturer**'s reference number (the ~~Product ID~~system reference).

If part of the **Power Generating Module** is **Type Tested** and registered with the ENA Type Test Verification Report Register, this application form should include the **Manufacturer**'s reference number (the ~~Product ID~~system reference) and Form A2-1 or A2-2 or A2-3 (as appropriate) should be submitted to the **DNO** with this form.

If the **Power Generating Module** is neither **Fully Type Tested** or **Type Tested** then and Form A2-1 or A2-2 or A2-3 should be submitted to the **DNO** with this form. Alternatively the Standard Application Form should be submitted instead of this form.

Details of Existing PGMs – where applicable:

Manufacturer	Approximate Date of Installation	~~Technology Type~~Energy source and energy conversion technology (enter codes from tables 1 and 2 below Form A1-2)	**Manufacturer**'s Ref No. where available	**PGM Registered Capacity** (kW)				~~**Power Factor**~~Energy storage capacity for **Electricity Storage** devices (kWh)
				3-phase units	Single Phase Units			
					PH1	PH2	PH3	

Details of Proposed Additional Generating Unit(s):

Manufacturer	Approximate Date of Installation	~~Technology Type~~Energy source and energy conversion technology (enter codes from tables 1 and 2 below Form A1-2)	**Manufacturer**'s Ref No. where available	**Generating Unit** Capacity (kW~~)~~)*				~~**Power Factor**~~Energy storage capacity for **Electricity Storage** devices (kWh)
				3-phase units	Single Phase Units			
					PH1	PH2	PH3	

Form A1-2 : Application for connection of Fully Type Tested Integrated Micro Generation and Storage installations

For **Integrated Micro Generation and Storage** installations, this simplified application form can be used where all of the following eligibility criteria apply:

- The **Power Generating Module**s are located in a single **Generator's Installation**;
- The total aggregate capacity of the **Power Generating Module**s (including **Electricity Storage** devices) is between 16 A and 32 A per phase;
- The total aggregate capacity of the **Power Generating Module**s that are **Electricity Storage** devices do not exceed 16 A per phase and the total aggregate capacity of the **Power Generating Module**s that are not **Electricity Storage** devices do not exceed 16 A per phase. Note that if the total aggregated capacity of **Electricity Storage** and non-**Electricity Storage** devices is no greater than 16 A per phase, the single premises procedure described in EREC G98 applies;
- All of the **Power Generating Module**s (including **Electricity Storage** units) are connected via EREC G98 **Type Tested Inverter**s (or EREC G83 **Type Tested Inverter**s, where the **Power Generating Module** was installed prior to 27 April 2019)
- An EREC G100 compliant export limitation scheme is present that limits the export from the **Generator's Installation** to the **Distribution Network** to 16 A per phase; and
- The **Power Generating Module**s will not operate when there is a loss of mains situation.

DNOs may have their own forms; refer to the **DNO**'s websites and online application tools. If the **Power Generating Module** is registered with the ENA Type Test Verification Report Register, the application should include the **Manufacturer's** reference number (the ~~Product ID~~system reference).

If all the eligibility criteria apply the **DNO** will confirm that the installation can proceed. The planned commissioning date stated on the application shall be within 10 working days and 3 months from the date the application is submitted.

On completion of the installation the **Installer** shall submit the commissioning sheets, as required in EREC G100 alongside the EREC G99 forms.

Details of Existing PGMs – where applicable:

Manufacturer	Approximate Date of Installation	~~Technology Type (e.g. Solar, Wind, Biomass, Diesel/CHP)~~Energy source and energy conversion technology (enter codes from tables 1 and 2 below form)	**Manufacturer**'s Ref No. where available	**PGM Registered Capacity** (kW~~)~~)*				~~**Power Factor**~~Energy storage capacity for **Electricity Storage** devices (kWh)
				3 - phase units	Single Phase Units			
					PH1	PH2	PH3	

Details of Proposed Additional Generating Unit(s) (including Electricity Storage):

Manufacturer	Approximate Date of Installation	~~Technology Type (e.g. Solar, Wind,~~	**Manufacturer**'s Ref No. where available	**Generating Unit Capacity** (kW~~)~~)*		~~**Power Factor**~~Energy storage capacity
					Single Phase Units	

		~~Biomass, Diesel/CHP, **Electricity Storage**)~~Energy source and energy conversion technology (enter codes from tables 1 and 2 below)		3-phase units	PH1	PH2	PH3	for **Electricity Storage** devices (kWh)

Use continuation sheet where required.

Record **Power Generating Module Registered Capacity** kW at 230 AC, to one decimal place, under PH1 for single phase supplies and under the relevant phase for two and three phase supplies.

Include a schematic diagram for the proposed scheme.

~~*~~***The planned commissioning date shall be at least 10 working days from the date of application but not more than 3 months in advance (connection offers are only valid for 3 months).

Two tables have been added to cover energy source and resource types,

Table 1

	Energy Source
A	Advanced Fuel (produced via gasification or pyrolysis of biofuel or waste)
B	Biofuel - Biogas from anaerobic digestion (excluding landfill & sewage)
C	Biofuel - Landfill gas
D	Biofuel - Sewage gas
E	Biofuel - Other
F	Biomass
G	Fossil - Brown coal/lignite
H	Fossil - Coal gas
I	Fossil - Gas
J	Fossil - Hard coal
K	Fossil - Oil
L	Fossil - Oil shale
M	Fossil - Peat
N	Fossil - Other
O	Geothermal
P	Hydrogen
Q	Nuclear
R	Solar
S	Stored Energy (all stored energy irrespective of the original energy source)
T	Waste

	Energy Source
U	Water (flowing water or head of water)
V	Wind
W	Other

Table 2

	Energy Conversion Technology
1	Engine (combustion / reciprocating)
2	Fuel Cell
3	Gas turbine (OCGT)
4	Geothermal power plant
5	Hydro - Reservoir (not pumped)
6	Hydro - Run of river
7	Hydro - Other
8	Interconnector
9	Offshore wind turbines
10	Onshore wind turbines
11	Photovoltaic
12	Steam turbine (thermal power plant)
13	Steam-gas turbine (CCGT)
14	Tidal lagoons
15	Tidal stream devices
16	Wave devices
17	Storage - Chemical - Ammonia
18	Storage - Chemical - Hydrogen
19	Storage - Chemical - Synthetic Fuels
20	Storage - Chemical - Drop-in Fuels
21	Storage - Chemical - Methanol
22	Storage - Chemical - Synthetic Natural Gas
23	Storage - Electrical - Supercapacitors
24	Storage - Electrical - Superconducting Magnetic ES (SMES)
25	Storage - Mechanical - Adiabatic Compressed Air
26	Storage - Mechanical - Diabatic Compressed Air
27	Storage - Mechanical - Liquid Air Energy Storage
28	Storage - Mechanical - Pumped Hydro
29	Storage - Mechanical - Flywheels
30	Storage - Thermal - Latent Heat Storage
31	Storage - Thermal - Thermochemical Storage
32	Storage - Thermal - Sensible Heat Storage
33	Storage - Electrochemical Classic Batteries -Lead Acid
34	Storage - Electrochemical Classic Batteries -Lithium Polymer (Li-Polymer)
35	Storage - Electrochemical Classic Batteries -Metal Air

	Energy Conversion Technology
36	Storage - Electrochemical Classic Batteries -Nickle Cadmium (Ni-Cd)
37	Storage - Electrochemical Classic Batteries -Sodium Nickle Chloride (Na-NiCl2)
38	Storage - Electrochemical Classic Batteries -Lithium Ion (Li–ion)
39	Storage - Electrochemical Classic Batteries -Sodium Ion (Na–ion)
40	Storage - Electrochemical Classic Batteries -Lithium Sulphur (Li-S)
41	Storage - Electrochemical Classic Batteries -Sodium Sulphur (Na-S
42	Storage - Electrochemical Classic Batteries -Nickle –Metal Hydride (Ni-MH)
43	Storage - Electrochemical Flow Batteries - Vanadium Red-Oxide
44	Storage - Electrochemical Flow Batteries - Zinc – Iron (Zn –Fe)
45	Storage - Electrochemical Flow Batteries - Zinc – Bromine (Zn –Br)
46	Storage - Other
47	Other

The sections of form A2-1 which have been amended are as follows,

Form A2-1: Compliance Verification Report for Synchronous and Asynchronous (non inverter) Power Generating Modules up to and including 50 kW

This form should be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G99. The form can be used in a variety of ways as detailed below:

1. To obtain **Fully Type Tested** status

   The **Manufacturer** can use this form to obtain **Fully Type Tested** status for a **Power Generating Module** by registering this completed form with the Energy Networks Association (ENA) Type Test Verification Report Register. Tests 1 – 14 must all be completed and compliant for the **Power Generating Module** to be classified as **Fully Type Tested**.

2. To obtain **Type Tested** status for a product

   This form can be used by the **Manufacturer** to obtain **Type Tested** status for a product which is used in a **Power Generating Module** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Verification Report Register.
   Where the **Manufacturer** is seeking to obtain **Type Tested** status for an **Interface Protection** device the appropriate section of Form A2-4 should be used.

3. One-off Installation

   This form can be used by the **Manufacturer** or **Installer** to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99. This form shall be submitted to the **DNO** as part of the application.

A combination of (2) and (3) can be used as required, together with Form A2-4 where compliance of the **Interface Protection** is to be demonstrated on site.

Note:

If the **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Verification Report Register, the Installation Document (Form A3-1 or A3-2) should include the **Manufacturer**'s reference number (the ~~Product ID~~system reference), and this form does not need to be submitted.

Where the **Power Generating Module** is not registered with the ENA Type Test Verification Report Register or is not **Fully Type Tested** this form (all or in parts as applicable) needs to be completed and provided to the **DNO**, to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99.

There are four options for Testing: (1) **Fully Type Tested**, (2) **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A2-4). Include reference(s) for **Manufacturers' Information** including the ENA Type Test Verification Report Register ~~Product ID~~system reference number where applicable.				
Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-Off Manufactures'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
0. **Fully Type Tested**- all tests detailed below completed and evidence attached to this submission		**N/A**	**N/A**	**N/A**
1. Operating Range	**N/A**			
2. PQ – Harmonics				
3. PQ – Voltage Fluctuation and Flicker				
4. **Power Factor** (PF)				
5. Frequency protection trip and ride through tests				
6. Voltage protection trip and ride through tests				
7. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test				
8. **LFSM-O** Test				
9. Power Output with Falling Frequency Test				
10. Protection – Reconnection Timer				
11. Fault Level Contribution				
12. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)				

There are four options for Testing: (1) **Fully Type Tested**, (2) **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A2-4).
Include reference(s) for **Manufacturers' Information** including the ENA Type Test Verification Report Register ~~Product ID~~system reference number where applicable.

Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-Off Manufactures'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
13. Logic Interface (input port)				
14. Cyber security				

Manufacturer compliance declaration - I certify that all products supplied by the company with the above **Type Tested Manufacturer**'s reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site **Modification**s are required to ensure that the product meets all the requirements of EREC G99.

Signed		On behalf of	

Note that testing can be done by the **Manufacturer** of an individual component (ie product) or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

A2-1 Compliance Verification Report –Tests for Type A Synchronous Power Generating Modules up to and including 50 kW – test record	
1. Operating Range: ~~Four t~~Tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply, grid simulation set or load bank. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence. Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time. The **Interface Protection** shall be disabled during the tests. Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred.	
Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz**,** **Power Factor** = 1, Period of test 20 s	Test results or chart to confirm operation
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Test results or chart to confirm operation
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Test results or chart to confirm operation
Test 6 RoCoF withstand Confirm that the **Power Generating Module** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	Test results or chart to confirm operation

2. Power Quality – Harmonics: The test requirements are specified in A.7.2.5. These tests should be carried out as specified in BS EN 61000-3-12~~.~~, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Module**s, measurements for all phases should be provided.

The rating of the **Power Generating Module** (per phase) should be provided below and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)				kVA			Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below)								
Harmonic	At 45-55% of **Registered Capacity** ~~100% of **Registered Capacity**~~[1]						Limit in BS EN 61000-3-12	
	Measured ~~Value (A)~~value (MV) in Amps			Measured ~~Value (A)~~value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2							8%	8%
3							21.6%	Not stated
4							4%	4%
5							10.7%	10.7%
6							2.67%	2.67%
7							7.2%	7.2%
8							2%	2%
9							3.8%	Not stated
10							1.6%	1.6%
11							3.1%	3.1%
12							1.33%	.33%

[1] See the note in A.7.2.5.1 if 45-55% of **Registered Capacity** is below the **Minimum Stable Operating Level**. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated in the box at the end of this section.

13							2%	2%
THD							23%	13%
PWHD							23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2							8%	8%
3							21.6%	Not stated
4							4%	4%
5							10.7%	10.7%
6							2.67%	2.67%
7							7.2%	7.2%
8							2%	2%
9							3.8%	Not stated
10							1.6%	1.6%
11							3.1%	3.1%
12							1.33%	.33%
13							2%	2%
THD							23%	13%
PWHD							23%	22%
Reason for not testing at 45-55% **Registered Capacity** (if applicable):								

Two new footnotes (20 and 21) have been added to outline the acronyms ‘THD’ and ‘PWHD’ within the harmonics section, they read as follows,

THD = Total Harmonic Distortion

PWHD = Partial Weighted Harmonic Distortion

3. Power Quality – Voltage fluctuations and Flicker: These tests should be undertaken in accordance with Annex A.7.2.5.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable maximum impedance.

The standard test impedance is 0.4 Ω for a single phase **Power Generating Module** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the standard impedance.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date		Test end date	
Test location			

	Starting			Stopping		Running		
	d max	d c	d(t)	d max	d c	d(t)	P st	P lt 2 hours
Measured Values at test impedance								
Normalised to standard impedance								
Normalised to required maximum impedance								
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R		Ω	X		Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R		Ω	X		Ω

* Applies to three phase and split single phase **Power Generating Module**s. Delete as appropriate.

^ Applies to single phase **Power Generating Module** and **Power Generating Module**s using two phases on a three phase system.

~~For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the **Power Factor** of the generation output is 0.98 or above.~~

~~Normalised value = Measured value x reference source resistance/measured source resistance at test point.~~

~~Single phase units reference source resistance is 0.4 Ω.~~

~~Two phase units in a three phase system reference source resistance is 0.4 Ω.~~

~~Two phase units in a split phase system reference source resistance is 0.24 Ω.~~

~~Three phase units reference source resistance is 0.24 Ω.~~

~~Where the **Power Factor** of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the Standard Impedance.~~

Delete as appropriate.~~The stopping test should be a trip from full load operation.~~

~~The duration of these tests need to comply with the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below.~~

~~Test start date~~		~~Test end date~~	
~~Test location~~			

4. Power Factor: The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity**~~.~~ and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.2.5.2.

Voltage	0.94 pu (216.2 V)	1.0 pu (230 V)	1.1 pu (253 V)
Measured value			
Power Factor Limit	>0.95	>0.95	>0.95

5. Protection – Frequency tests: These tests should be carried out in accordance with Annex A.7.2.2.3. For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip

U/F stage 1	47.5 Hz	20 s			47.7 Hz 30 s	
					47.2 Hz 19.5 s	
U/F stage 2	47 Hz	0.5 s			46.8 Hz 0.45 s	
O/F	52 Hz	0.5 s			51.8 Hz 120 s	
					52.2 Hz 0.45 s	
6. Protection – Voltage tests: These tests should be carried out in accordance with Annex A.7.2.2.2. For trip tests, voltage and time delay should be stated. For "no trip tests", "no trip" can be stated.						
Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s			188 V 5.00 s	
					180 V 2.45 s	
O/V stage 1	1.14 pu (262.2 V)	1.0 s			258.2 V 5.0 s	
					269.7 V 0.95s	
O/V stage 2	1.19 pu (273.7 V)	0.5 s			277.7 V 0.45s	
7. Protection – Loss of Mains test: The tests are to be carried out at three output power levels ±5%. These tests should be carried out in accordance with Annex A.7.2.2.4.						
To be carried out at three output power levels with a tolerance of ± 5% in Test Power levels.						
Test Power (% of **Registered**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Limit is 0.5 s						
For Multi phase **Power Generating Module**s confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						

Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph1 fuse removed						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph2 fuse removed						
Test Power (% of **Registered Capacity)**	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of Test Power	95% of Test Power	95% of Test Power	105% of Test Power	105% of Test Power	105% of Test Power
Trip time. Ph3 fuse removed						

Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.

Indicate additional shut down time included in above results.	ms

Reason for not testing at suggested loading levels (if applicable):

Loss of Mains Protection, Vector Shift Stability test: This test should be carried out in accordance with Annex A.7.2.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	
Negative Vector Shift	50.5 Hz	- 50 degrees	

Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.2.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.

Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0Hz to 51.0Hz	+0.95 Hzs^{-1}	2.1 s	

51.0Hz to 49.0Hz	-0.95 Hzs^{-1}	2.1 s	

8. Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency test: The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.

This test should be carried out in accordance with Annex A.7.2.4~~.~~.

Active Power response to rising frequency/time plots are attached	**Y/N**

9. Power output with falling frequency test

Tests should prove that the **Power Generating Module** does not reduce output power as the frequency falls. These tests should be carried out in accordance with Annex A.7.2.3.

Test sequence	Measured **Active Power** Output	Acceptable **Active Power**	Primary power source (if applicable)
49.5 Hz for 5 minutes		100% **Registered Capacity**	
49.0 Hz for 5 minutes		99% **Registered Capacity**	
48.0 Hz for 5 minutes		97% **Registered Capacity**	
47.6 Hz for 5 minutes		96.2% **Registered Capacity**	
47.1 Hz for 20 s		95% **Registered Capacity**	

10. Protection – Re-connection timer.

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.

Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
		At 1.16 pu (266.2 V)	At 0.78 pu (180.0 V)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.					

11. Fault level contribution: **Manufacturers' Information** in respect of the fault level contribution shall be provided.

12. Wiring functional tests: If required by para 15.2.1,	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	Yes / NA
13. Logic interface (input port)	
Confirm that an input port is provided and can be used to shut down the module.	Yes / NA
Provide high level description of logic interface, eg details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes / NA
14. Cyber security	
Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7 and 9.1.8	Yes / NA
Additional comments	

A new footnote (22) has been added to accompany the text box within section 7 (To be carried out at three output power levels with a tolerance of ± 5% in Test Power levels), it reads,

> See the note in A.7.2.2.4 if the suggested loading levels are below the **Minimum Stable Operating Level**. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated in the box at the end of this section.

Form A2-2 has been amended as shown,

Form A2-2: Compliance Verification Report for Synchronous and Asynchronous (non inverter) Power Generating Modules > 50 kW and also for Synchronous and Asynchronous (non inverter) Power Generating Modules ≤ 50 kW where the approach of this form is preferred to that in Form A2-1

This form should be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G99. The form can be used in a variety of ways as detailed below:

1. To obtain **Fully Type Tested** status (≤ 50 kW)

   The **Manufacturer** can use this form to obtain **Fully Type Tested** status for a **Power Generating Module** by registering this completed form with the Energy Networks Association (ENA) Type Test Verification Report Register~~.~~. Tests 1 – 14 must all be completed and compliant for the **Power Generating Module** to be classified as **Fully Type Tested**.

2. To obtain **Type Tested** status for a product

   This form can be used by the **Manufacturer** to obtain **Type Tested** status for a product which is used in a **Power Generating Module** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Verification Report Register.
   Where the **Manufacturer** is seeking to obtain **Type Tested** status for an **Interface Protection** device the appropriate section of Form A2-4 should be used.

3. One-off Installation

   This form can be used by the **Manufacturer** or **Installer** to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99. This form shall be submitted to the **DNO** as part of the application.

A combination of (2) and (3) can be used as required, together with Form A2-4 where compliance of the **Interface Protection** is to be demonstrated on site.

Note:

If the **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Verification Report Register, the Installation Document (Form A3-1 or A3-2) should include the **Manufacturer**'s reference number (the ~~Product ID~~system reference), and this form does not need to be submitted.

Where the **Power Generating Module** is not registered with the ENA Type Test Verification Report Register or is not **Fully Type Tested** this form (all or in parts as applicable) needs to be completed and provided to the **DNO**, to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99.

PGM technology			
Manufacturer name			
Address			
Tel		Web site	
E:mail			
Registered Capacity, use separate sheet if more than one connection option.			kW

There are four options for Testing: (1) **Fully Type Tested**~~,~~ (≤ 50 kW), (2) ~~Partially~~ **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert reference for **Manufacturers' Information** including the ENA Type Test Verification Report Register ~~Product ID~~system reference number where applicable:

Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-Off Manufacturers'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
0. **Fully Type Tested** - all tests detailed below completed and evidence attached to this submission		**N/A**	**N/A**	**N/A**
1. Operating Range	**N/A**			
2. PQ – Harmonics				
3. PQ – Voltage Fluctuation and Flicker				
4. **Power Factor** (PF)				
5 Frequency protection trip and ride through tests				
6 Voltage protection trip and ride through tests				
7. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test				
8.**LFSM-O** Test				
9. Power Output with Falling Frequency Test				
10. Protection – Reconnection Timer				
11. Fault Level Contribution				

There are four options for Testing: (1) **Fully Type Tested**~~,~~ (≤ 50 kW), (2) ~~Partially~~ **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert reference for **Manufacturers' Information** including the ENA Type Test Verification Report Register ~~Product ID~~system reference number where applicable:

Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-Off Manufacturers'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
12. Wiring functional test if required by paragraph 15.2.1 (attach relevant schedule of tests)				
13. Logic Interface (input port)				
14. Cyber security				

Manufacturer compliance declaration. - I certify that all products supplied by the company with the above **Type Tested Manufacturer**'s reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site **Modification**s are required to ensure that the product meets all the requirements of EREC G99.

Signed		On behalf of		

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

A2-2 Compliance Verification Report –Tests for Type A Synchronous Power Generating Modules > 50 kW and also for Synchronous Power Generating Modules ≤ 50 kW where the approach of this form is preferred to that in Form A2-1 – ~~Test~~test record	
1. Operating Range: ~~Five t~~Tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable load bank, test supply, or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence. Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time. The **Interface Protection** shall be disabled during the tests. Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred. Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.	
Test 1 Voltage = 85% of nominal (~~(~~195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Test results or chart to confirm operation
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Test results or chart to confirm operation
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Test results or chart to confirm operation
Test ~~5~~6 RoCoF withstand Confirm that the **Power Generating Module** is capable of staying connected to the **Distribution Network** and operate at rates of change of frequency up to 1 Hzs^{-1} as	Test results or chart to confirm operation

measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	

2. Power Quality – Harmonics:

The installation shall be designed in accordance with EREC G5. For **Power Generating Module**s of up to 17 kW per phase or 50 kW three phase harmonic measurements as required by BS EN 61000-3-12 shall be made and recorded in a test declaration as in Form A2-1. The relevant part of Form A2-1 can be used for this purpose.

3. Power Quality – Voltage fluctuations and Flicker:

The installation shall be designed in accordance with EREC P28.

For **Power Generating Module**s of up to 17kW per phase or 50kW three phase the voltage fluctuations and flicker emissions from the **Generating Unit** shall be measured in accordance with BS EN 61000-3-11. The relevant part of Form A2-1 can be used for recording the measurements.

4. Power Factor: **Manufacturers' Information** shall be provided or factory test results or on site testing in respect of the operation of the control system at 0.94 pu V, 1.0 pu V and 1.1 pu V shall be undertaken. The test can be undertaken by stepping the network voltage such as via an appropriate transformer/tap changer, or alternatively by injecting a test voltage signal into the **Controller**.

This test shall be undertaken with the **Controller** in constant **Power Factor** mode and a set point of 1.0.

The tests are successful if the **Power Factor** is > 0.95 (leading and lagging).

5. Protection operation and stability– Frequency tests: See Form A2-4.

6. Protection operation and stability – Voltage tests: See Form A2-4 for **LV** or **HV** as applicable.

7. Protection – Loss of Mains test and Vector Shift and RoCoF Stability test: See Form A2-4.

8. Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency test: The tests below should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10% in accordance with paragraph 11.2.4.

The tests should be carried out in accordance with Annex A.7.2.4

Active Power response to rising frequency/time plots are attached	**Y/N**

9. Power output with falling frequency test~~.~~

Tests should prove that the **Power Generating Module** does not reduce output power as the frequency falls. These tests should be carried out in accordance with Annex A.7.2.3.

Test sequence	Measured **Active Power** Output	Acceptable **Active Power**	Primary power source (if applicable)
49.5 Hz for 5 minutes		100% **Registered Capacity**	
49.0 Hz for 5 minutes		99% **Registered Capacity**	
48.0 Hz for 5 minutes		97% **Registered Capacity**	
47.6 Hz for 5 minutes		96.2% **Registered Capacity**	

47.1 Hz for 20 s		95% **Registered Capacity**	

10. Protection – Re-connection timer~~.~~

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.

Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
		At 1.16 pu (266.2 V **LV** connection, 127.6 V **HV** connection assuming 110 V ph-ph VT)	At 0.78 pu (180.0 V **LV** connection, 85.8 V **HV** connection assuming 110 V ph-ph VT)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.					

11. Fault level contribution: **Manufacturers' Information** in respect of the fault level contribution shall be provided.

12. Wiring functional tests: If required by para 15.2.1.

Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	Yes / NA

13. Logic interface (input port~~).~~)

Confirm that an input port is provided and can be used to shut down the module~~.~~	Yes / NA
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes / NA

14. Cyber security

Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7 and 9.1.8	Yes / NA

Additional comments.

Form A2-3 has been amended as follows,

Form A2-3: Compliance Verification Report for Type A Inverter Connected Power Generating Modules

This form should be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G99. The form can be used in a variety of ways as detailed below:

1. To obtain **Fully Type Tested** status (≤ 50 kW)

   The **Manufacturer** can use this form to obtain **Fully Type Tested** status for a **Power Generating Module** by registering this completed form with the Energy Networks Association (ENA) Type Test Verification Report Register. Tests 1 – 15 must all be completed and compliant for the **Power Generating Module** to be classified as **Fully Type Tested**.

2. To obtain **Type Tested** status for a product

   This form can be used by the **Manufacturer** to obtain **Type Tested** status for a product which is used in a **Power Generating Module** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Verification Report Register.
   Where the **Manufacturer** is seeking to obtain **Type Tested** status for an **Interface Protection** device the appropriate section of Form A2-4 should be used.

3. One-off Installation

   This form can be used by the **Manufacturer** or **Installer** to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99. This form shall be submitted to the **DNO** as part of the application.

A combination of (2) and (3) can be used as required, together with Form A2-4 where compliance of the **Interface Protection** is to be demonstrated on site.

Note:

Within this Form A2-3 the term **Power Park Module** will be used but its meaning can be interpreted within Form A2-3 to mean **Power Park Module**, **Generating Unit or Inverter** as appropriate for the context. However, note that compliance shall be demonstrated at the **Power Park Module** level.

If the **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Verification Report Register, the Installation Document (Form A3-1 or A3-2) should include the **Manufacturer's** reference number (the ~~Product ID~~system reference), and this form does not need to be submitted.

Where the **Power Generating Module** is not registered with the ENA Type Test Verification Report Register or is not **Fully Type Tested** this form (all or in parts as applicable) needs to be completed and provided to the **DNO**, to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99.

PGM technology	
Manufacturer name	

Address			
Tel		Web site	
E:mail			
Registered Capacity			kW
Energy storage capacity for **Electricity Storage** devices			kWh

There are four options for Testing: (1) **Fully Type Tested**(≤ 50 kW), (2) ~~Partially~~ **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-off Manufacturers'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
0. **Fully Type Tested** - all tests detailed below completed and evidence attached to this submission		**N/A**	**N/A**	**N/A**
1. Operating Range	**N/A**			
2. PQ – Harmonics				
3. PQ – Voltage Fluctuation and Flicker				
4. PQ – DC Injection (**Power Park Module**s only)				
5. **Power Factor** (PF)				
6. Frequency protection trip and ride through tests				
7. Voltage protection trip and ride through tests				
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test				
9. **LFSM-O** Test				
10. Protection – Reconnection Timer				
11. Fault Level Contribution				
12. Self-monitoring Solid State Switch				

There are four options for Testing: (1) **Fully Type Tested**(≤ 50 kW), (2) ~~Partially~~ **Type Tested** product, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGM**s tests may be carried out at the time of commissioning (Form A4). **Type Tested** status is suitable for devices > 50 kW where the power quality aspects need consideration on a site by site basis in accordance with EREC G5 and EREC P28.
Insert Document reference(s) for **Manufacturers' Information**

Tested option:	**1. Fully Type Tested**	**2. ~~Partially~~ Type Tested product**	**3. One-off Manufacturers'~~.~~ Info.**	**4. Tested on Site at time of Commissioning**
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)				
14. Logic Interface (input port)				
15. Cyber security				

Manufacturer compliance declaration. - I certify that all products supplied by the company with the above **Type Tested Manufacturer**'s reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site **Modification**s are required to ensure that the product meets all the requirements of EREC G99.

Signed		On behalf of	

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

A2-3 Compliance Verification Report –Tests for Type A Inverter Connected Power Generating Modules – test record	
1. Operating Range: ~~Five tests~~Tests should be carried with the **Power Generating Module** operating at **Registered Capacity** and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence. Frequency, voltage and **Active Power** measurements at the output terminals of the **Power Generating Module** shall be recorded every second. The tests will verify that the **Power Generating Module** can operate within the required ranges for the specified period of time. The **Interface Protection** shall be disabled during the tests. In case of a PV **Power Park Module** the PV primary source may be replaced by a DC source. In case of a full converter **Power Park Module** (eg wind) the primary source and the prime mover I**nverter**/rectifier may be replaced by a DC source. Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement "Pass", "No disconnection occurs", etc. Graphical evidence is preferred. Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.	
Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Test results or chart to confirm operation
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Test results or chart to confirm operation
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Test results or chart to confirm operation
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Test results or chart to confirm operation
Test ~~5~~6 RoCoF withstand Confirm that the **Power Generating Module** is capable of staying connected to the **Distribution Network** and operate at rates of change of	Test results or chart to confirm operation

frequency up to 1 Hzs^{-1} as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	

2. Power Quality – Harmonics:

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Module**s, measurements for all phases should be provided.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)						kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).								
Harmonic	At 45-55% of **Registered Capacity** ~~100% of **Registered Capacity**~~						Limit in BS EN 61000-3-12 ~~1 phase~~ ~~3 phase~~	
	Measured Value (MV) in Amps ~~%~~			Measured Value (MV) in ~~Amps~~ %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2							8%	8%
3							21.6%	Not stated
4							4%	4%
5							10.7%	10.7%
6							2.67%	2.67%
7							7.2%	7.2%
8							2%	2%
9							3.8%	Not stated
10							1.6%	1.6%

11							3.1%	3.1%
12							1.33%	1.33%
13							2%	2%
THD[2]							23%	13%
PWHD[3]							23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2							8%	8%
3							21.6%	Not stated
4							4%	4%
5							10.7%	10.7%
6							2.67%	2.67%
7							7.2%	7.2%
8							2%	2%
9							3.8%	Not stated
10							1.6%	1.6%
11							3.1%	3.1%
12							1.33%	.33%
13							2%	2%
THD[4]							23%	13%
PWHD[5]							23%	22%

[2] THD = Total Harmonic Distortion

[3] PWHD = Partial Weighted Harmonic Distortion

[4] THD = Total Harmonic Distortion

[5] PWHD = Partial Weighted Harmonic Distortion

3. Power Quality – Voltage fluctuations and Flicker:

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC P28.

The standard test impedance is 0.4 Ω for a single phase **Power Generating Module** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the standard impedance.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date		Test end date	
Test location			

	Starting			Stopping			Running	
	d max	d c	d(t)	d max	d c	d(t)	P st	P lt 2 hours
Measured Values at test impedance								
Normalised to standard impedance								
Normalised to required maximum impedance								
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

Test Impedance	R		Ω	XI		Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	XI	0.15 * 0.25 ^	Ω
Maximum Impedance	R		Ω	XI		Ω

* Applies to three phase and split single phase **Power Generating Module**s. Delete as appropriate.

^ Applies to single phase **Power Generating Module** and **Power Generating Module**s using two phases on a three phase system

~~For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the **Power Factor** of the generation output is 0.98 or above.~~

~~Normalised value = Measured value x reference source resistance/measured source resistance at test point~~

~~Single phase units reference source resistance is 0.4 Ω~~

~~Two phase units in a three phase system reference source resistance is 0.4 Ω~~

~~Two phase units in a split phase system reference source resistance is 0.24 Ω~~

~~Three phase units reference source resistance is 0.24 Ω~~

~~Where the **Power Factor** of the output is under 0.98 then the Xl to R ratio of the test impedance should be close to that of the Standard Impedance.~~

. Delete as appropriate.~~The stopping test should be a trip from full load operation.~~

~~The duration of these tests need to comply with the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below~~

~~Test start date~~		~~Test end date~~	
~~Test location~~			

4. Power quality – DC injection: The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / Vphase. The % DC injection should not be greater than 0.25%.

Test power level	10%	55%	100%
Recorded DC value in Amps			
as % of rated AC current			
Limit	0.25%	0.25%	0.25%

5. Power Factor: The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity**~~.~~ and the measured **Power Factor** must be

greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value			
Power Factor Limit	>0.95	>0.95	>0.95

6. Protection – Frequency tests: These tests should be carried out in accordance with the Annex A.7.1.2.3. For trip tests, frequency and time delay should be stated. For "no trip tests", "no trip" can be stated.

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5 Hz	20 s			47.7 Hz 30 s	
U/F stage 2	47 Hz	0.5 s			47.2 Hz 19.5 s	
					46.8 Hz 0.45 s	
O/F	52 Hz	0.5 s			51.8 Hz 120.0 s	
					52.2 Hz 0.45 s	

Note. For frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The "No trip tests" need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

7. Protection – Voltage tests: These tests should be carried out in accordance with Annex A.7.1.2.2. For trip tests, voltage and time delay should be stated. For "no trip tests", "no trip" can be stated.

Note that the value of voltage stated below assumes a **LV** connection This should be adjusted for **HV** taking account of the VT ratio as required.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s			188 V 5.0 s	
					180 V 2.45 s	
O/V stage 1	1.14 pu (262.2 V)	1.0 s			258.2 V 5.0 s	

O/V stage 2	1.19 pu (273.7 V)	0.5 s			269.7 V 0.95 s	
					277.7 V 0.45 s	

Note for Voltage tests the Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

8.Protection – Loss of Mains test: These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.

The following sub set of tests should be recorded in the following table.

Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5	33% +5% Q Test 31	66% +5% Q Test 21	100% +5% P Test 10
Trip time. Limit is 0.5s						

Loss of Mains Protection, Vector Shift Stability test: This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	
Negative Vector Shift	50.5 Hz	- 50 degrees	

Loss of Mains Protection, RoCoF Stability test: This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.

Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	

9. Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency test: The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.

This test should be carried out in accordance with Annex A.7.1.3~~.~~, which also contains the measurement tolerances.

Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.	**Y/N**
Alternatively, test results should be noted below:	

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz				-
Step b) 50.45Hz ±0.05Hz				-
Step c) 50.70Hz ±0.10Hz				-
Step d) 51.15Hz ±0.05Hz				-
Step e) 50.70Hz ±0.10Hz				-
Step f) 50.45Hz ±0.05Hz				-
Step g) 50.00Hz ±0.01Hz				
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient
Step a) 50.00Hz ±0.01Hz				-
Step b) 50.45Hz ±0.05Hz				-
Step c) 50.70Hz ±0.10Hz				-
Step d) 51.15Hz ±0.05Hz				-
Step e) 50.70Hz ±0.10Hz				-
Step f) 50.45Hz ±0.05Hz				
Step g) 50.00Hz ±0.01Hz				
10. Protection – Re-connection timer				
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of “no reconnection” can be made.				

Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
		At 1.16 pu (266.2 V **LV** connection, 127.6 V **HV** connection assuming 110 V ph-ph VT)	At 0.78 pu (180.0 V **LV** connection, 85.8 V **HV** connection assuming 110 V ph-ph VT)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.					

11. Fault level contribution: These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms		
100ms		
250ms		
500ms		
Time to trip		In seconds

12. Self-Monitoring solid state switching: No specified test requirements. Refer to Annex A.7.1.7.	
It has been verified that in the event of the solid state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	Yes/ NA
13. Wiring functional tests: If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	Yes / NA
14. Logic interface (input port~~).~~)	
Confirm that an input port is provided and can be used to shut down the module~~.~~	Yes / NA
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes / NA
15. Cyber security	
Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7 and 9.1.8	Yes / NA
Additional comments.	

A new footnote (27 has been added to accompany the section of table (Trip time limit is 0.5s) it reads,

If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

The amendments to form A2-4 are as shown below,

Form A2-4: Site Compliance and Commissioning test requirements for Type A Power Generating Modules

(b) This form should be completed ~~if~~:

- If site compliance tests are being undertaken for some or all of the **Interface Protection** where it is not **Type Tested** and ~~for~~
- For other compliance tests that have been identified in Form A2-1, Form A2-2 or Form A2-3 as being undertaken on site~~.~~ (details shall be provided in the "Other onsite tests" part at the end of this form).

Generator Details:	
Generator (name)	
Installation details:	
Address	
Post Code	
Date of commissioning	

Requirement	Compliance by provision of **Manufacturers' Information** or type test reports. Reference number should be detailed and **Manufacturers' Information** attached.	Compliance by commissioning tests Tick if true and complete relevant sections of form below
Over and under voltage protection **LV** –calibration test		
Over and under voltage protection **LV** –stability test		
Over and under voltage protection **HV** –calibration test		
Over and under voltage protection **HV** – stability test		

Over and Under Frequency protection – calibration test		
Over and Under Frequency protection - stability test		
Loss of mains protection – calibration test		
Loss of mains protection – stability test		
Wiring functional tests: If required by para 15.2.1		

Over and Under Voltage Protection Tests LV

Where the **Connection Point** is at **LV** the **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Voltage Protection by provision of **Manufacturers' Information,** type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time - step from 230 V to test value**				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - N	**262.2 V** 230 V system	**1.0 s**	*258.75*		*265.65*	Pass/ Fail	266.2	*1.0 s*		*1.1 s*	Pass/ Fail
L2 - N						Pass/ Fail					Pass/ Fail
L3 - N						Pass/ Fail					Pass/ Fail
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - N	**273.7 V** 230 V system	0.5s	*270.25*		*277.15*	Pass/ Fail	277.7	*0.5 s*		*0.6 s*	Pass/ Fail
L2 - N						Pass/ Fail					Pass/ Fail
L3 - N						Pass/ Fail					Pass/ Fail
Under Voltage			Lower Limit	Measured Value	Upper Limit		Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - N	**184.0 V** 230 V system	2.5 s	*180.55*		*187.45*	Pass/ Fail	180	*2.5 s*		*2.6 s*	Pass/ Fail
L2 - N						Pass/ Fail					Pass/ Fail
L3 - N						Pass/ Fail					Pass/ Fail

Over and Under Voltage Protection Tests LV

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition (3-Phase Value)	Test Voltage all phases ph-n	Test Duration	Confirm No Trip	Result
Inside Normal band	---	---	< OV Stage 1	258.2 V	5.00 s		Pass/ Fail
Stage 1 Over Voltage	**262.2 V**	**1.0 s**	> OV Stage 1	269.7 V	0.95 s		Pass/ Fail
Stage 2 Over Voltage	**273.7 V**	**0.5 s**	> OV Stage 2	277.7 V	0.45 s		Pass/ Fail
Inside Normal band	---	---	> UV	188 V	5.00 s		Pass/ Fail
Under Voltage	**184.0 V**	**2.5 s**	< UV	180 V	2.45 s		Pass/ Fail

Over voltage test - Voltage shall be stepped from 258 V to the test voltage and held for the test duration and then stepped back to 258 V.

Under voltage test – Voltage shall be stepped from 188 V to the test voltage and held for the test duration and then stepped back to 188 V

Additional Comments / Observations:

Over and Under Voltage Protection HV

Where the **Connection Point** is at **HV** the **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Voltage Protection by provision of **Manufacturers' Information,** type test reports or by undertaking the following tests on site.

Tests referenced to 110 V ph-ph VT output

Calibration and Accuracy Tests

Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time** measured value ± 2 V				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**121 V** 110 V VT secondary	**1.0 s**	*119.35*		*122.65*	Pass/ Fail	Measured value plus 2 V	*1.0 s*		*1.1 s*	Pass /Fail
L2 - L3						Pass/ Fail					Pass/ Fail
L3 - L1						Pass/ Fail					Pass/ Fail
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**124.3 V**	0.5 s	*122.65*		*125.95*	Pass/ Fail		*0.5 s*		*0.6 s*	Pass/Fail

L2 - L3	110 V VT secondary					Pass/ Fail	Measured value plus 2 V				Pass/Fail
L3 - L1						Pass/ Fail					Pass/Fail
Under Voltage			Lower Limit	Measured Value	Upper Limit		Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**88.0 V** 110 V VT secondary	2.5s	*86.35*		*89.65*	Pass/ Fail	Measured value minus 2 V	*2.5 s*		*2.6 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass / Fail
L3 - L1						Pass/ Fail					Pass/ Fail

Over and Under Voltage Protection Tests HV

referenced to 110 V ph-ph VT output

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition (3-Phase Value)	Test Voltage All phase s ph-ph	Test Duration	Confirm No Trip	Result
Inside Normal band	---	---	< OV Stage 1	119 V	5.00 s		Pass/Fail
Stage 1 Over Voltage	**121 V**	**1.0 s**	> OV Stage 1	122.3 V	0.95 s		Pass/Fail
Stage 2 Over Voltage	**124.3 V**	**0.5 s**	> OV Stage 2	126.3 V	0.45 s		Pass/Fail
Inside Normal band	---	---	> UV	90 V	5.00 s		Pass/Fail
Under Voltage	**88 V**	**2.5 s**	< UV	86 V	2.45 s		Pass/Fail

Additional Comments / Observations:

Over and Under Frequency Protection

The **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Frequency Protection by provision of **Manufacturers' Information**, type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Setting	Time Delay	**Pickup Frequency**				**Relay Operating Time**				
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result

52 Hz	0.5 s	*51.90*		*52.10*	Pass/ Fail	51.7-52.3 Hz	*0.50 s*		*0.60 s*	Pass/ Fail
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47.5 Hz	20	*47.40*		*47.60*	Pass /Fail	47.8-47.2 Hz	*20.0 s*		*20.2 s*	Pass/ Fail
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47 Hz	0.5 s	*46.90*		*47.1*	Pass/ Fail	47.3-46.7 Hz	*0.50 s*		*0.60 s*	Pass /Fail

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition	Test Frequency	Test Duration	Confirm No Trip	Result
Inside Normal band	---	---	< OF	51.8 Hz	120 s		Pass/ Fail
Over Frequency	52 Hz	0.5 s	> OF	52.2 Hz	0.45 s		Pass/ Fail
Inside Normal band	---	---	> UF Stage 1	47.7 Hz	30 s		Pass/ Fail
Stage 1 Under Frequency	47.5 Hz	20 s	< UF Stage 1	47.2 Hz	19.5 s		Pass/ Fail
Stage 2 Under Frequency	47 Hz	0.5 s	< UF Stage 2	46.8 Hz	0.45 s		Pass/ Fail

Over frequency test - Frequency shall be stepped from 51.8 Hz to the test frequency and held for the test duration and then stepped back to 51.8 Hz.

Under frequency test - Frequency shall be stepped from 47.7 Hz to the test frequency and held for the test duration and then stepped back to 47.7 Hz.

Additional Comments / Observations:

Details of Loss of Mains Protection

Manufacturer	**Manufacturer**'s type	Date of Installation	Settings	Other information

Loss-of-Mains (LOM) Protection Tests

The **Generator** shall demonstrate compliance with this EREC G99 in respect of LOM Protection by either providing the **DNO** with appropriate **Manufacturers' Information,** type test reports or by undertaking the following tests on site

Calibration and Accuracy Tests

Ramp in range 49.0 - 51.0 Hz									
	Pickup (± 0.025 Hzs^{-1})				**Relay Operating Time** RoCoF= ±**0.10 Hzs^{-1}** above setting				
Setting = 1.0 Hzs^{-1}	Lower Limit	Measured Value	Upper Limit	Result	Test Condition	Lower Limit	Measured Value	Upper Limit	Result
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Reducing Frequency	*0.975*		*1.025*	Pass/Fail	1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Ramp in range 48.5-51.5 Hz									
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Reducing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail

Stability Tests (confirm no trip of **Interface Protection**)

Ramp in range 49.0-51.0 Hz					
	Test Condition	Test frequency ramp	Test Duration	Confirm No Trip	Result
Inside Normal band	< RoCoF setting (increasing f)	+0.95 Hzs^{-1}	2.1 s		Pass/Fail
Inside Normal band	< RoCoF setting (reducing f)	-0.95 Hzs^{-1}	2.1 s		Pass/Fail
Ramp as shown					
Inside Normal band	> RoCoF setting (increasing f)	+1.20 Hzs^{-1} (ramp between 49.80 and 50.34 Hz)	0.45 s		Pass/Fail
Inside Normal band	> RoCoF setting (reducing f)	- -1.20 Hzs^{-1} (ramp between 50.30 and 49.76 Hz	0.45 s		Pass/Fail

Additional Comments / Observations:

LoM Protection - Stability test (confirm no trip of **Interface Protection**)

	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	
Negative Vector Shift	50.5 Hz	- 50 degrees	

Wiring functional tests~~:~~

If required by para 15.2.1, confirm that wiring functional tests have been carried out in accordance with the instructions below	Yes/ NA

Where components of a **Power Generating Module** are separately **Type Tested** and assembled into a **Power Generating Module**, if the connections are made via loose wiring, rather than specifically designed error-proof connectors, then it will be necessary to prove the functionality of the components that rely on the connections that have been made by the loose wiring.

As an example, consider a **Type Tested** alternator complete with its control systems etc. It needs to be connected to a **Type Tested Interface Protection** unit. In this case there are only three voltage connections to make, and one tripping circuit. The on-site checks need to confirm that the **Interface Protection** sees the correct three phase voltages and that the tripping circuit is operative. It is not necessary to inject the **Interface Protection** etc to prove this. Simple functional checks are all that are required.

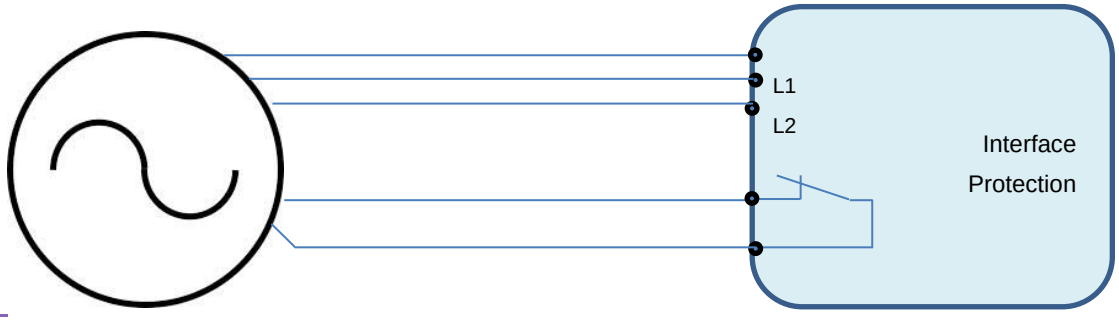
Test schedule:

With **Generating Unit** running and energised, confirm L1, L2, L3 voltages on **Generating Unit** and on **Interface Protection**.

Disconnect one phase of the control wiring at the **Generating Unit**. Confirm received voltages at the **Interface Protection** have one phase missing.

Repeat for other phases.

Confirm a trip on the **Interface Protection** trips the ~~**Interface Protection**~~appropriate circuit breaker.



~~(b)~~(c)

Logic Interface Port~~:~~

Confirm that an input port is provided and can be used to shut down the module	

Other onsite tests: Provide details here of any additional tests which have been carried out (as identified as being required by Form A2-1, A2-2 or A2-3)

Form A3-1 has been amended as follows,

Form A3-1 : Installation Document for Type A Power Generating Modules
Please complete and provide this document for every **Power Generating Facility**. Part 1 should be completed for the **Power Generating Facility**. Part 2 should be completed for each of the **Power Generating Module**s being commissioned. Where the installation is phased the form should be completed on a per **Generating Unit** basis as each part of the installation is completed in accordance with EREC G99 paragraph 15.3.3. For phased installations reference to **PGM** in this form should be read as reference to **Generating Unit**s.
Form A3-1 Part 1
To ABC electricity distribution **DNO** 99 West St, Imaginary Town, ZZ99 9AA abced@wxyz.com

Generator Details:	
Generator (name)	
Address	
Post Code	
Contact person (if different from **Generator**)	
Telephone number	
E-mail address	
MPAN(s)	
Generator signature	
Installer Details:	
Installer	
Accreditation / Qualification	
Address	
Post Code	
Contact person	

Telephone Number	
E-mail address	
Installer signature	
Installation details:	
Address	
Post code	
Location within **Generator's Installation**	
Location of Lockable Isolation Switch	

Summary details of Power Generating Modules **-** where multiple **Power Generating Module**s will exist within one **Generator's Installation**.

Manufacturer / Reference	Date of Installation	Technology Type	**Manufacturer**s Ref No. ~~(Product ID~~(system reference) or Reference to Form A2-1/2/3 or combination of above as applicable	**Power Generating Module Registered Capacity** in kW				
				3-Phase Units	Single Phase Units			**Power Factor**
					PH 1	PH 2	PH 3	

Emerging technology classification (if applicable~~),~~)

Commissioning Checks.	
Description	**Confirmation**
Generator's Installation satisfies the requirements of BS7671 (IET Wiring Regulations).	Yes / No*
Suitable lockable points of isolation have been provided between the **PGMs** and the rest of the **Generator's Installation**.	Yes / No*
Labels have been installed at all points of isolation in accordance with EREC G99.	Yes / No*

Interlocking that prevents **PGM**s being connected in parallel with the **DNO**'s **Distribution Network** (without synchronising) is in place and operates correctly.	Yes / No*
Balance of Multiple Single Phase **PGMs**. Confirm that design of the **Generator's Installation** has been carried out to limit output power imbalance to below 16 A per phase, as required by EREC G99.	Yes / No*
PGM installation complies with cyber security requirements	Yes / No*

Form A3-1 Part 2	
Power Generating Module reference or name	

Information to be enclosed	
Description	Confirmation *
Schedule of protection settings (may be included in circuit diagram)	Yes / No*
As installed Standard Application Form data, unless already provided.	Yes / No*
Final copy of circuit diagram	Yes / No*

Commissioning Checks	
The **Interface Protection** settings have been checked and comply with EREC G99.	Yes / No / N/A (**Type Tested**)*
The **PGM** successfully synchronises with the **DNO**'s **Distribution Network** without causing significant voltage disturbance.	Yes / No*
The **PGM** successfully runs in parallel with the **DNO**'s **Distribution Network** without tripping and without causing significant voltage disturbances.	Yes / No*
The **PGM** successfully disconnects without causing a significant voltage disturbance, when it is shut down.	Yes / No*
Interface Protection operates and disconnects the **DNO**'s **Distribution Network** quickly (within 1 s) when a suitably rated switch, located between the **PGM** and the **DNO**'s incoming connection, is opened.	Yes / No*
The **PGM** remains disconnected for at least 20 s after switch is reclosed.	Yes / No*
Loss of tripping and auxiliary supplies. Where applicable, loss of supplies to tripping and protection relays results in either **PGM** or **Generating Unit** forced trip or an alarm to a 24 hour manned control centre.	Yes / No*

*Circle as appropriate. If "No" is selected the **Power Generating Facility** is deemed to have failed the commissioning tests and the **Power Generating Module** shall not be put in service.

Additional comments / observations:

Declaration – to be completed by **Generator** or **Generator's** Appointed Technical Representative.
I declare that for the **Type A Power Generating Module** within the scope of this EREC G99, and the installation: 1. Compliance with the requirements of EREC G99 is achieved. 2. The commissioning checks detailed in Form A2-4 have been successfully completed*. 3. The commissioning checks detailed in this Form A3-1 have been successfully completed. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**.
Name:
Signature: / Company Name: — Date:
Position:
Declaration – to be completed by **DNO** Witnessing Representative if applicable. Delete if not witnessed by the **DNO**.
I confirm that I have witnessed: 1. The commissioning checks detailed in Form A2-4 *; 2. The commissioning checks detailed in this Form A3-1 on behalf of and that the results are an accurate record of the checks. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**
Name:
Signature: / Company Name: — Date:

Form A3-2 has been amended as follows,

Form A3-2: Installation Document for Integrated Micro Generation and Storage

Please complete and provide this document for each **Integrated Micro Generation and Storage** installation.

Part 1 should be completed for the **Integrated Micro Generation and Storage** installation.

Part 2 should be completed for each of the **Power Generating Module**s (ie for the **Electricity Storage Inverter**s and non-**Electricity Storage Power Generating Module Inverter**s) being commissioned. Where the installation is phased the form should be completed on a per **Generating Unit** basis as each part of the installation is completed in accordance with EREC G99 paragraph 15.3.3. For phased installations reference to **PGM** in this form should be read as reference to **Generating Unit**s.

Form A3-2 Part 1

To ABC electricity distribution **DNO**
99 West St, Imaginary Town, ZZ99 9AA abced@wxyz.com

Generator Details:	
Generator (name)	
Address	
Post Code	
Contact person (if different from **Generator**)	
Telephone number	
E-mail address	
MPAN(s)	
Generator signature	
Installer Details:	
Installer	
Accreditation / Qualification	
Address	
Post Code	

Contact person	
Telephone Number	
E-mail address	
Installer signature	
Installation details:	
Address	
Post code	
Location within **Generator's Installation**	
Location of Lockable Isolation Switch	

Summary details of Power Generating Modules (including **Electricity Storage**) ~~-~~ where multiple **Power Generating Module**s will exist within one **Generator's Installation**~~.~~

Manufacturer / Reference	Date of Installation	Technology Type	**Manufacturer**s Ref No. ~~(Product ID~~(system reference) or Reference to Form A2-3	**Power Generating Module Registered Capacity** in kW				
				3-Phase Units	Single Phase Units			**Power Factor**
					PH 1	PH 2	PH 3	

Emerging technology classification (if applicable~~):~~)

Commissioning Checks~~:~~

Description	**Confirmation**
Generator's Installation satisfies the requirements of BS7671 (IET Wiring Regulations).	Yes / No*
Suitable lockable points of isolation have been provided between the **PGM**s and the rest of the **Generator's Installation**.	Yes / No*

Labels have been installed at all points of isolation in accordance with EREC G99.	Yes / No*
Interlocking that prevents **PGM**s being connected in parallel with the **DNO**'s **Distribution Network** (without synchronising) is in place and operates correctly.	Yes / No*
Balance of Multiple Single Phase **PGM**s. Confirm that design of the **Generator's Installation** has been carried out to limit output power imbalance to below 16 A per phase, as required by EREC G99.	Yes / No*
PGM installation complies with cyber security requirements	Yes / No*
Export limitation scheme meets the requirements of EREC G100 and has been commissioned in accordance with EREC G100.	Yes / No*
Information to be enclosed~~:~~	
Description	Confirmation *
As installed Standard Application Form data, unless already provided.	Yes / No*
Final copy of circuit diagram	Yes / No*
EREC G100 Export limitation scheme installation and commissioning test form.	Yes / No*

Part 2 of Form A3-2 has the following amendments,

Form A3-2 Part 2	
Power Generating Module reference or name	
Information to be enclosed~~.~~	
Description	Confirmation *
Schedule of protection settings (may be included in circuit diagram)	Yes / No*
Commissioning Checks~~.~~	
The **Interface Protection** settings have been checked and comply with EREC G99.	Yes / No*
The **PGM** successfully synchronises with the **DNO**'s **Distribution Network** without causing significant voltage disturbance.	Yes / No*
The ~~**PGM**successfully~~**PGM** successfully runs in parallel with the **DNO**'s **Distribution Network** without tripping and without causing significant voltage disturbances.	Yes / No*
The **PGM** successfully disconnects without causing a significant voltage disturbance, when it is shut down.	Yes / No*
Interface Protection operates and disconnects the **DNO**'s **Distribution Network** quickly (within 1 s) when a suitably rated switch, located between the **PGM** and the **DNO**'s incoming connection, is opened.	Yes / No*

The **PGM** remains disconnected for at least 20 s after switch is reclosed.	Yes / No*
Loss of tripping and auxiliary supplies. Where applicable, loss of supplies to tripping and protection relays results in either **PGM** or **Generating Unit** forced trip or an alarm to a 24 hour manned control centre.	Yes / No*
*Circle as appropriate. If "No" is selected the **Power Generating Facility** is deemed to have failed the commissioning tests and the **Power Generating Module** shall not be put in service.	
Additional comments / observations:	
Declaration – to be completed by **Generator** or **Generator's** Appointed Technical Representative.	
I declare that for the **Power Generating Module** within the scope of this EREC G99, and the installation: 1. Compliance with the requirements of EREC G99 and EREC G100 is achieved. 2. The **Power Generating Module** is **Fully Type Tested**. 3. The commissioning checks detailed in this Form A3-2 Part 2 have been successfully completed.	
Name:	
Signature:	Date:
Company Name:	
Position:	

The text within section A.4 which has been amended is shown below,

A.4 Emerging Technologies and other Exceptions

A.4.1 **Emerging Technologies**

For **Power Generating Module**s classified as an emerging technology at the time of their connection to a **DNO**'s **Distribution Network**, the following sections of EREC G99 do not apply.

11.2.1 (frequency withstand capability);

11.2.2 (rate of change of frequency);

11.2.3 (constant **Active Power** output);

11.2.4 (**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**);

10.6.7 (**Interface Protection** settings).

A.4.4.2 **Electricity Storage**

For **Electricity Storage** devices the following sections of EREC G99 do not apply:

Type A - less than 1 MW:

- 11.2.3 (constant **Active Power** output); and
- 11.2.4 (**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**).

Type B - 1 MW or greater but less than 10 MW:

- 12.2.3 (constant **Active Power** output);
- 12.2.4 (**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**); and
- 12.3.1 – 12.3.1.7 inclusive, 12.3.4 and 12.6 (**Fault Ride Through**, **Fast Fault Current** injection).

Type C and **Type D** - 10 MW or greater and / or with a **Connection Point** at greater than 110 kV:

- 13.2.3 (constant **Active Power** output);
- 13.2.4 (**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**);
- 13.2.5 (**Limited Frequency Sensitive Mode – ~~Under frequency~~Underfrequency**);

The title text to table A6 has been amended to read,

A6 Scenario examples in respect of the application of EREC G59 and EREC G99 to new or modified sites after ~~24/4~~27/04/19

In Section A7 of 'Type A' the following amendments have been made,

A7.1.3 **Limited Frequency Sensitive Mode – Over (LFSM-O)**

The frequency at each step should be maintained for at least one minute as illustrated in figure A.7.3 and the **Active Power** reduction in the form of a gradient determined and assessed for compliance with paragraph 11.2.3.

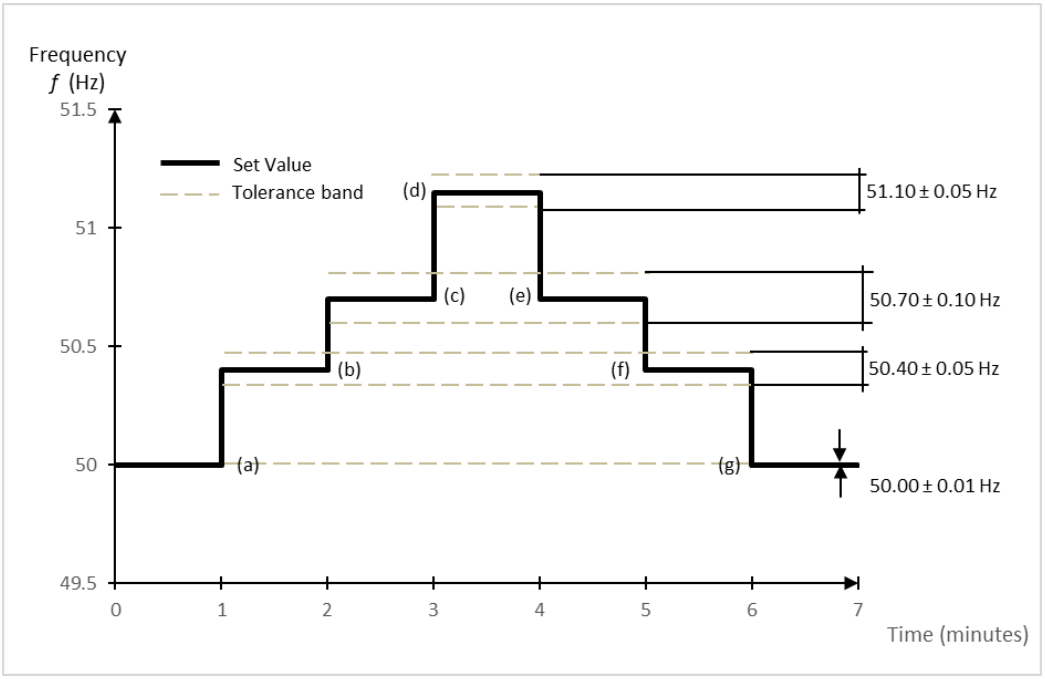
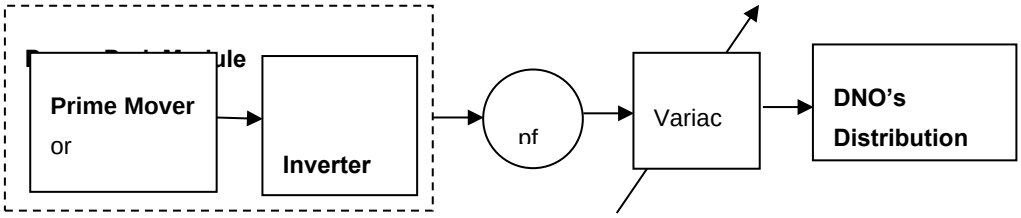


Figure A.7.3 Testing the Active Power feed-in of the Power Generating Module at over frequency

A.7.1.4.2 Power Factor

The test set up shall be such that the **Power Park Module** supplies full load to the **DNO**'s **Distribution Network** via the **Power Factor** (pf) meter and the variac as shown below in Figure A.7.~~3~~4. The **Power Park Module Power Factor** should be within the limits given in paragraph 11.1.5, for three test voltages 0.94 pu, 1 pu and 1.1 pu V.



NOTE 1 For reasons of clarity the points of isolation are not shown.
NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown.

(a) Figure A.7.~~3~~4 Power Park Module test set up – Power Factor

A footnote (28) accompanying section A7.1.4.2 reads,

For a **LV** connected **Power Generating Module** 1 pu V = 230 V

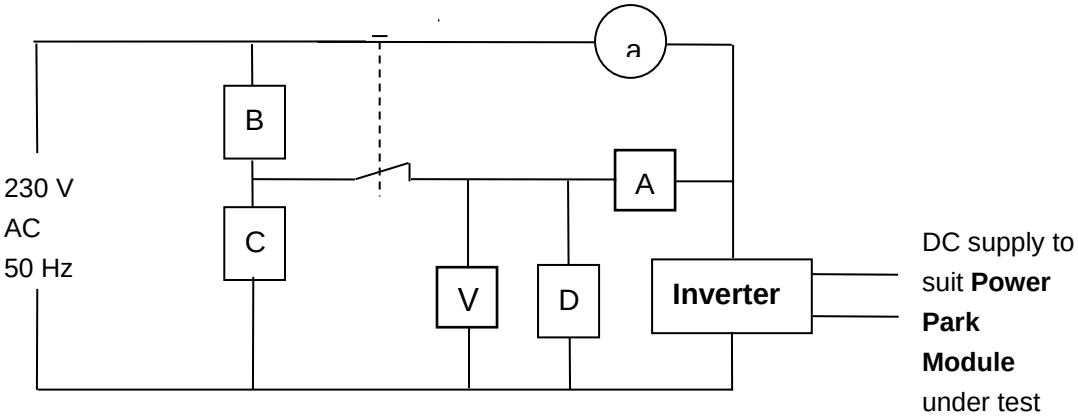


Figure A.7.~~4~~5 Power Park Module short circuit test circuit

Test procedure

In Figure A.7.~~4~~5 'A' and 'V' are ammeters and voltmeters used to record the test data required. Component 'D' is a resistive load plus resonant circuit as required for the loss of mains test as specified in BS EN 62116 set up to absorb 100% **Registered Capacity** of the **Power Park Module**. Component 'a' is an ammeter used to confirm that all the output from the **Inverter** is being absorbed by component D. Components 'B' and 'C' are set up to provide a voltage of between 10% and 40% of nominal when component 'C' carries the **Registered Capacity** of the **Power Park Module** in Amps.

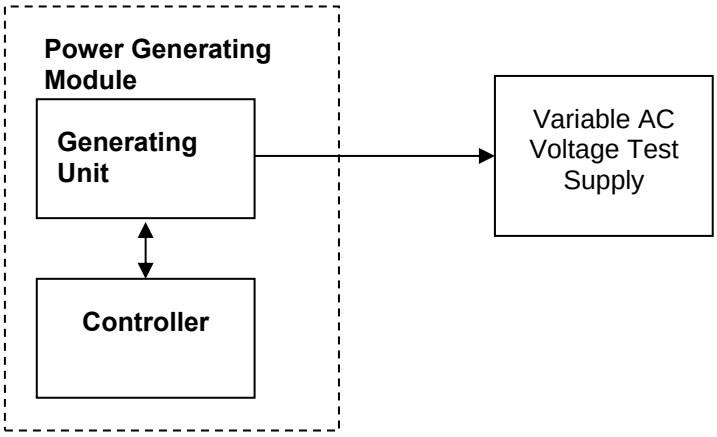


Figure A.7.~~5.~~6 Power Generating Module test set up – over / under voltage

A7.2.2.3 Over / Under Frequency

The **Interface Protection** shall be tested by operating the **Power Generating Module** in parallel with a low impedance, variable frequency test supply system, as an example, see Figure A.7.~~6~~7. Correct protection and ride-through operation should be confirmed during the test. The set points for over and under frequency at which the **Interface Protection** disconnects from the supply will be established by varying the test supply frequency.

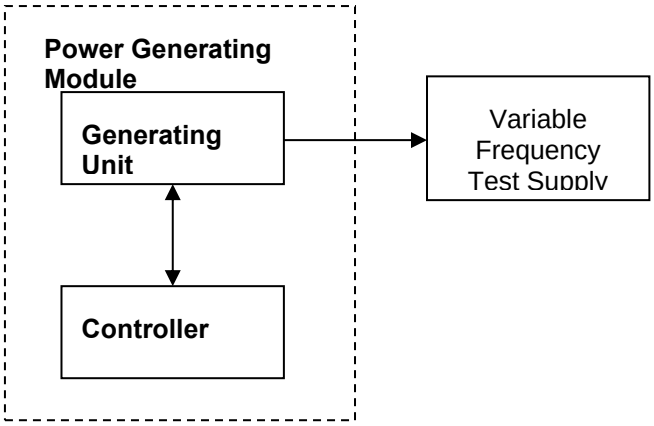


Figure A.7.~~6.~~7 Power Generating Module test set up – over / under frequency

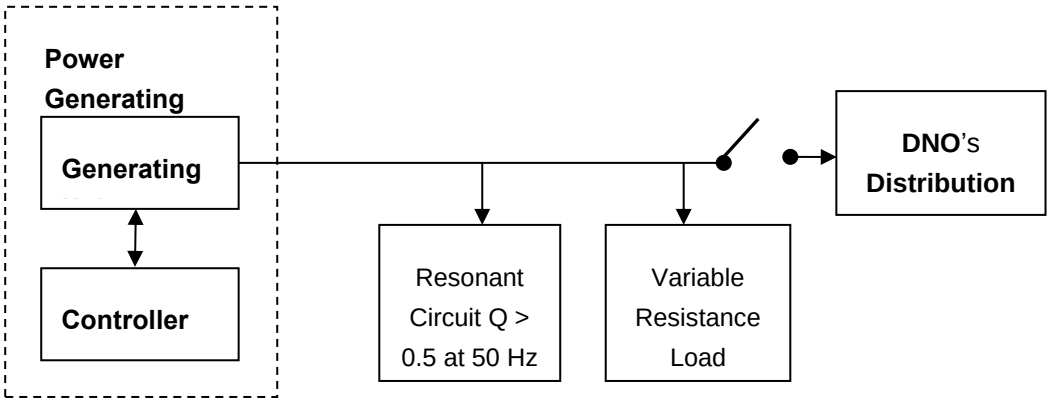


Figure A.7.~~7~~ 8 Power Generating Module test set up - loss of mains

The **Power Generating Module** is to be tested at three levels of the **Power Generating Module**'s **Registered Capacity**: 10%, 55% and 100% and the results recorded on the test sheet of Annex A.2-1. Note that if the suggested output level is below the **Power Generating Module**'s **Minimum Stable Operating Level** the test should be completed at 100%, and at least one output level below 100% of the **Registered Capacity**. It is recommended that an output level is chosen that is 5% of the difference between the **Registered Capacity** and the **Minimum Stable Operating Level** above the **Minimum Stable Operating Level**:

Output level = **Minimum Stable Operating Level** + (**Registered Capacity** – **Minimum Stable Operating Level**) x 5%

A.7.2.3 **Power Output with Falling Frequency**

The **Generator** will propose and agree a test procedure with the **DNO**, which will demonstrate how the **Synchronous Power Generating Module Active Power** output responds to changes in system frequency.

The tests can be undertaken by the **Synchronous Power Generating Module** powering a suitable load bank, or alternatively using the test set up of Figure A.7.~~6~~7. In both cases a suitable test could be to start the test at nominal frequency with the **Synchronous Power Generating Module** operating at 100% of its **Registered Capacity**.

A7.2.4.1 The two frequency response tests in **Limited Frequency Sensitive Mode (LFSM)** to demonstrate **LFSM-O** capability to a frequency injection as shown by Figures A.7.~~8~~9 and Figures A.7.~~9~~10 are to be conducted at **Registered Capacity** (although a lower power output may be agreed with the **DNO** if site conditions preclude attaining **Registered Capacity**, such as an absence of adequate wind).

There should be sufficient time allowed between tests for control systems to reach steady state. The injection signal should be maintained until the **Active Power** (MW) output of the **Power Generating Module** has stabilised. The **DNO** may require repeat tests should the tests give unexpected results.

The frequency input and the expected **Active Power** response are illustrated for different periods from 0 s to 130 s in Figure A.7.~~8~~9 for a step change in frequency and in Figures A.7.~~9~~10 for a ramp change in frequency. This should be in accordance with Section 11.2.4 (a threshold frequency of 50.4 Hz and a **Droop** of 10%) and undamped oscillations should not occur after the step or ramp frequency change. Note for diagram purposes only a short interval is shown between the frequency increase and decrease for each test. In practice the return step or ramp can start any time after the output has stabilized after the first step or ramp.

The response should commence within 2 s and shall be to the left of the red line (ie between the green line and the red line) and be as close to the green line as possible when following the frequency step or ramp. Note that the red line represents the 0.5% s^{-1} specified in 11.2.4.1.

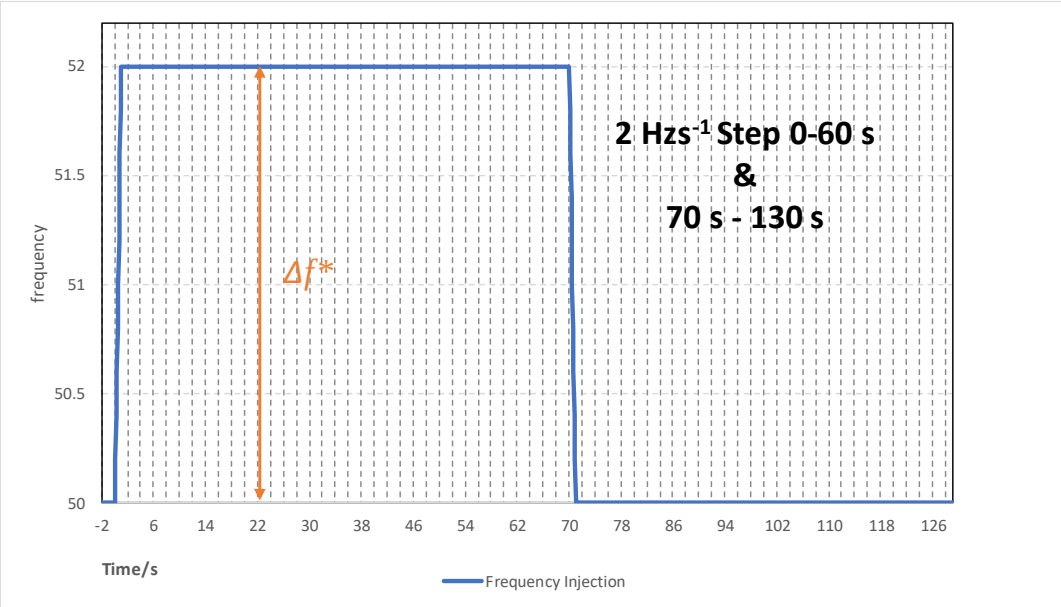


Figure A.7.89(i): LFSM-O step response test – frequency injection

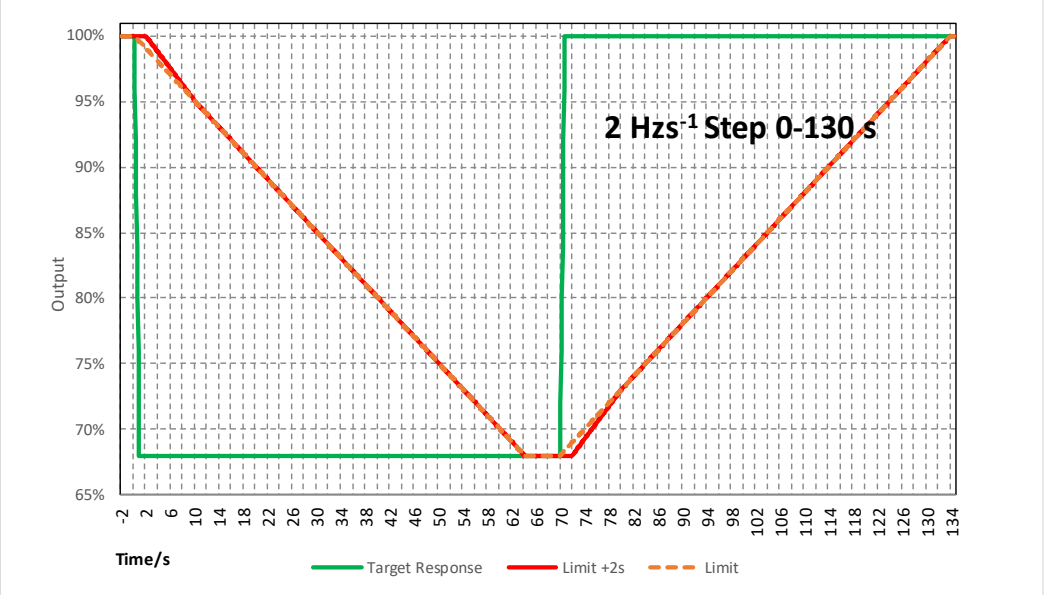


Figure A.7.89(ii): LFSM-O step response test – target response and limits

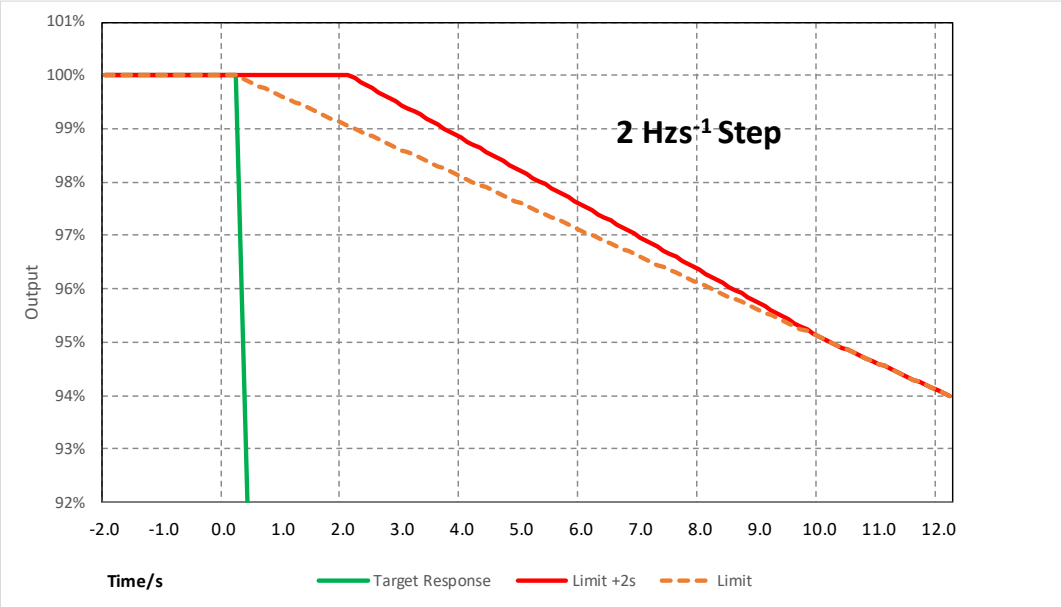


Figure A.7.~~8~~9(iii): LFSM-O step response test – expansion of the allowed 2 s response delay (frequency increase)

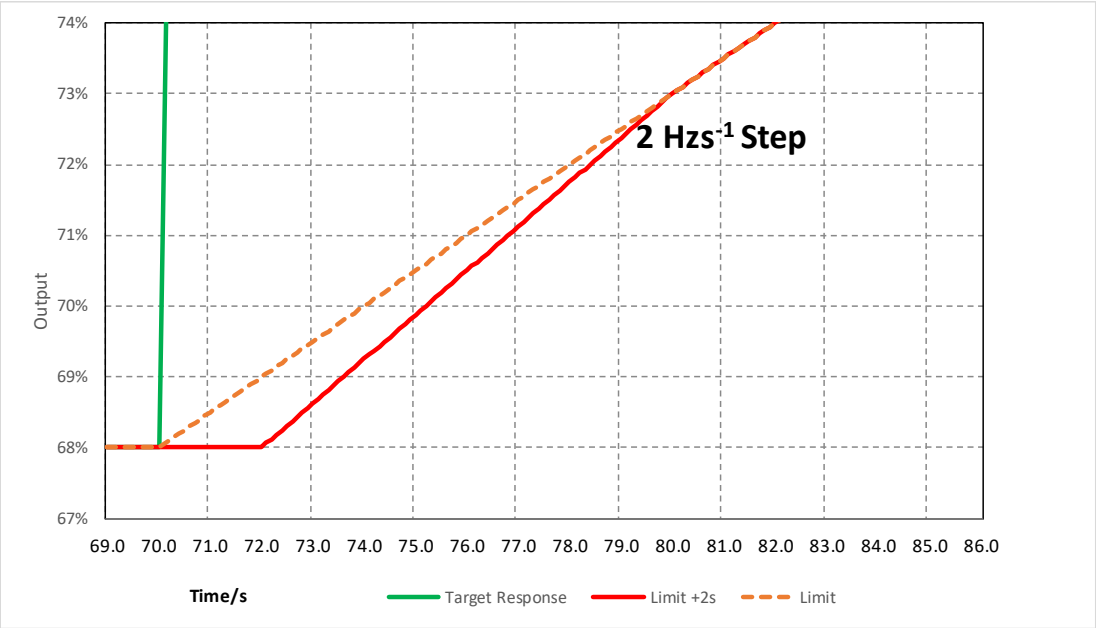


Figure A.7.~~8~~9(iv): LFSM-O step response test – expansion of the allowed 2 s response delay (frequency decrease)

* This frequency step *Δf* will generally be +2.0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Minimum ~~Stable Operating~~Regulating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 1.5 Hz is needed to take an initial output of 100% to a final output of 70%. If the initial output is not 100% and the **Minimum ~~Stable Operating~~Regulating Level** is not 70% then the injected step should be adjusted accordingly as shown in the example given below:

Initial output	100%
Minimum ~~Stable Operating~~Regulating Level	70%

Frequency controller **Droop**	10%
Frequency to be injected	= (1.00 – 0.70) x 0.1 x 50 = 1.5Hz

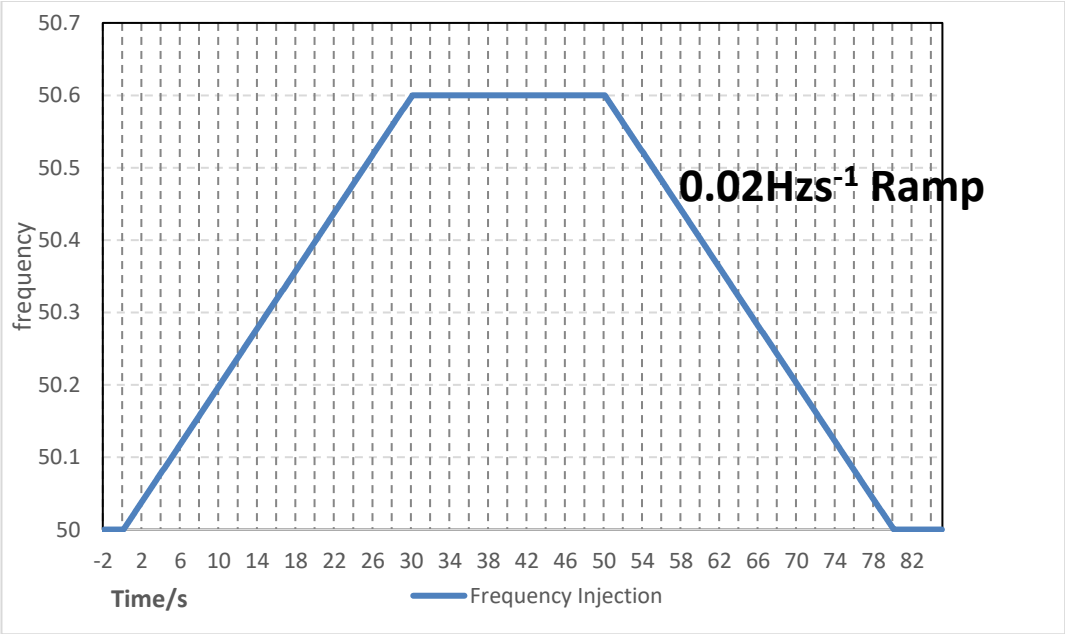


Figure A.7.~~9~~10(i): LFSM-O ramp response test – frequency injection

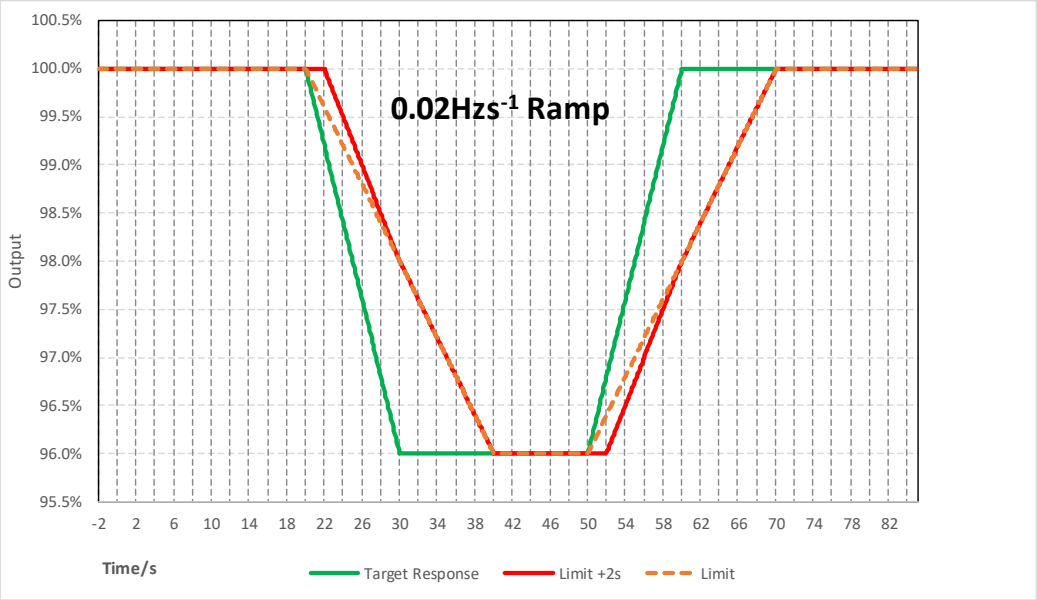


Figure A.7.~~9~~10(ii): LFSM-O – target response and limits

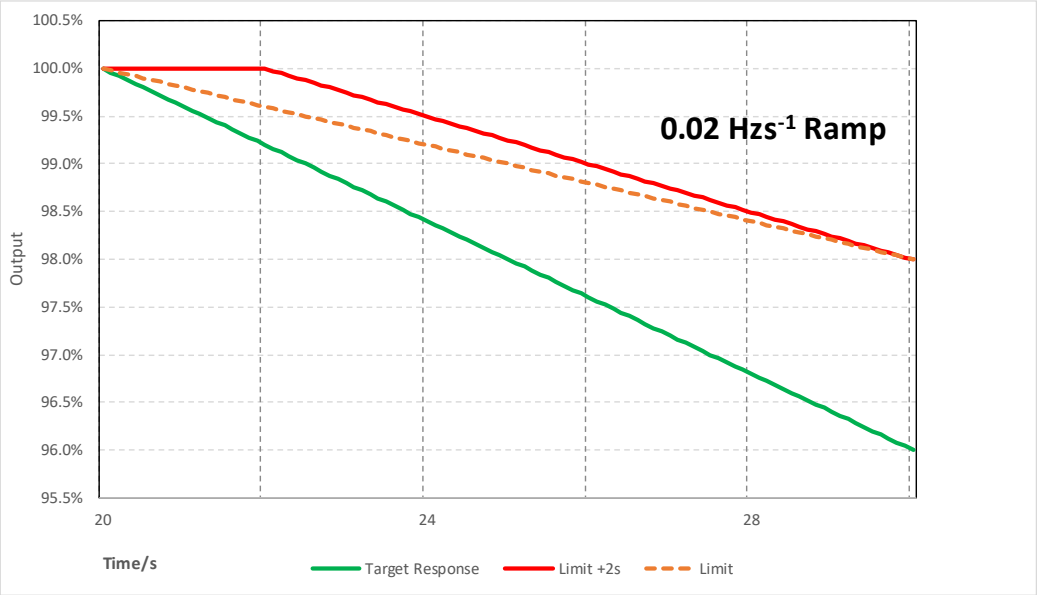


Figure A.7.~~9~~10(iii): LFSM-O ramp response test – expansion (frequency increase)

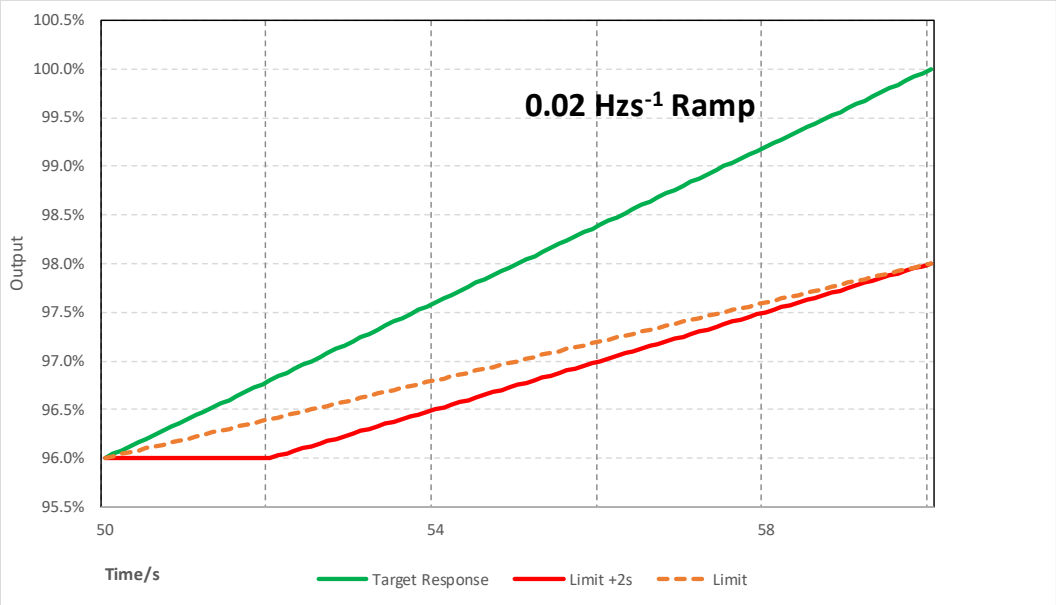


Figure A.7.~~9~~10(iv): LFSM-O ramp response test – expansion (frequency decrease)

A.7.2.4.2 A single frequency response step test (ie no ramp test) is required in **Limited Frequency Sensitive Mode (LFSM)** to demonstrate the **LFSM-O** capability in response to a frequency injection of 2.0 Hzs^{-1} for 1 s as shown by the Figures A.7.~~10~~11 below. The test is to be conducted at **Registered Capacity** (although a lower power output may be agreed with the **DNO** if site conditions preclude attaining **Registered Capacity**, such as an absence of adequate water flow rate). Similarly if the frequency step takes the operating point below the **Minimum Stable Operating Level** an alternative appropriate injection should be calculated that demonstrates **LFSM-O** across the range that is available without breaching the **Minimum Stable Operating Level**.

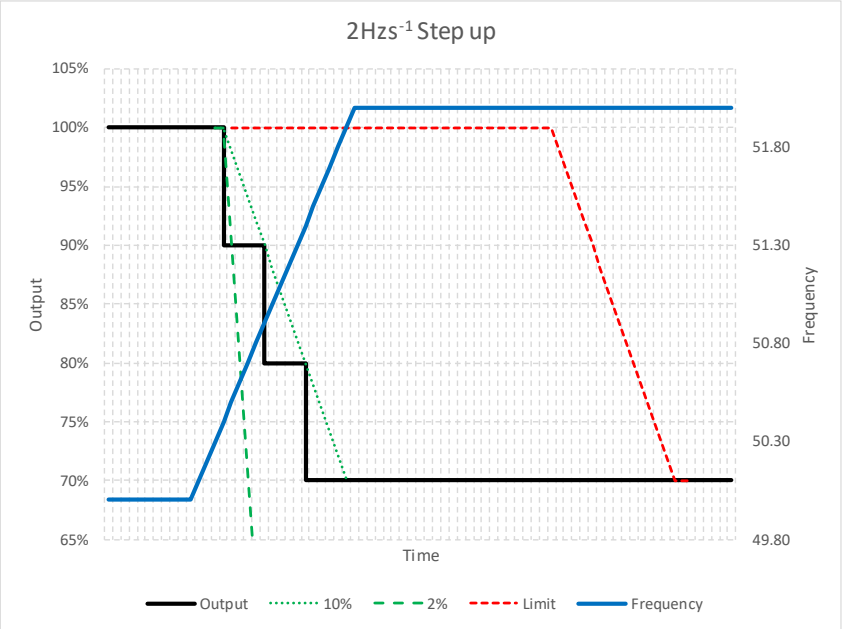


Figure A.7.~~10~~11(i): LFSM-O step response test (frequency increase) for slow acting micro hydro

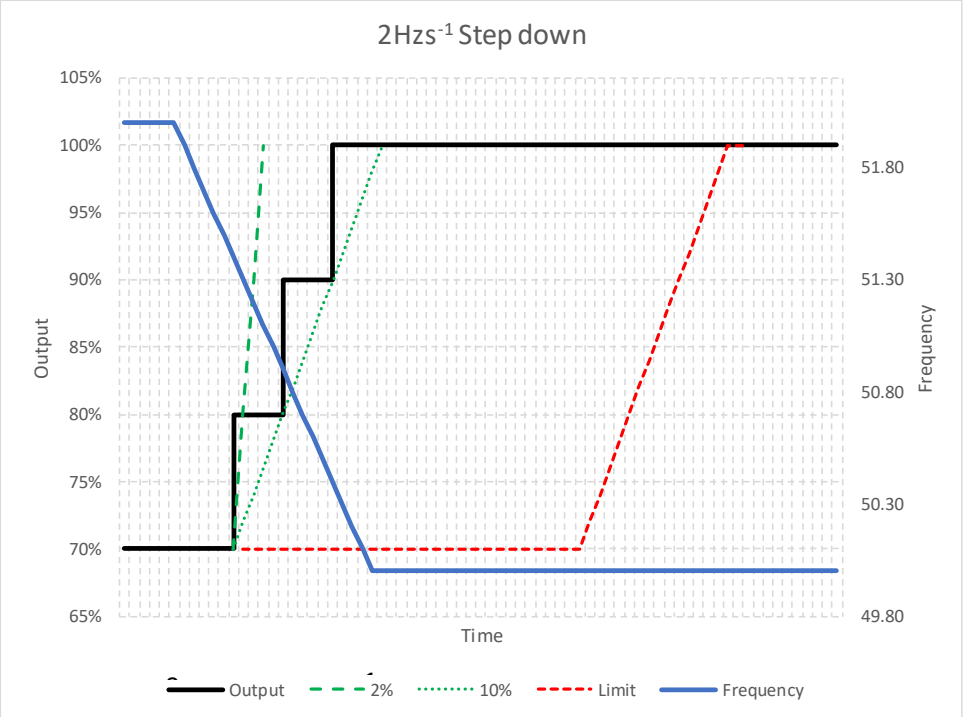


Figure A.7.~~10~~11(ii): LFSM-O step response test (frequency decrease) for slow acting micro hydro

Annex B Power Quality

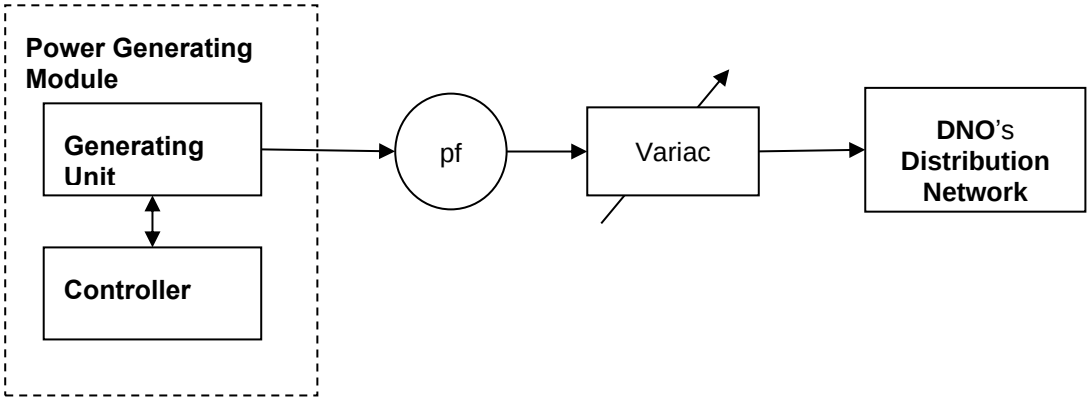
A.7.2.5.1 Harmonics

The tests should be carried out as specified in BS EN 61000-3-12 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of maximum export capacity. Note that if the suggested output level is below the **Power Generating Module**'s **Minimum Stable Operating Level** the test should be carried out at 100%, and at least one stable output level below 100%, of **Registered Capacity**. It is recommended that an output level is chosen that is 5% of the difference between the **Registered Capacity** and the **Minimum Stable Operating Level** above the **Minimum Stable Operating Level**:

Power level = Minimum Stable Operating Level + (Registered Capacity – Minimum Stable Operating Level) x 5%

Power Factor

The test set up shall be such that the **Power Generating Module** supplies full load to the **DNO**'s **Distribution Network** via the **Power Factor** (pf) meter and the variac as shown below in Figure A.7.~~10~~12. The **Power Generating Module** pf should be within the limits given in paragraph 11.1.5, for three test voltages 230 V –6%, 230 V and 230 V +10%.



NOTE 1. For reasons of clarity the points of isolation are not shown

NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown

Figure A.7.~~10~~12 Power Generating Module test set up – Power Factor

1.3.19 G99 Annex B – Type B

Form B2-1 has been amended as follows,

Form B2-1 Power Generating Module Document for Type B Power Generating Modules **Compliance Statement** This document shall be completed by the **Generator**. Note: For phased installations reference to **PGM** in this form should be read as reference to **Generating Units** and the project phase noted.	
Power Generating Module (PGM) **PGM Name:** **Compliance Contact** (name/tel/email)**:**	**Distribution Network Operator (DNO)**: **DNO Name**: ABC electricity distribution **Compliance Contact** (name/tel/email):
Key to Submission Stage **A – Application:** Submission of the Standard Application Form. **E – Energisation:** Documentation required prior to Energisation. **IS – Initial Submission:** The programme of initial compliance document submission to be agreed between the **Generator** and the **DNO** as soon as possible after acceptance of a Connection Offer. The **Power Generating Module Document** shall be completed as agreed in accordance with paragraph 17.2.2 at least 28 days before the **Generator** wishes to synchronise its **Power Generating Module** for the first time. **FONS – Final Operational Notification Submission:** The **Generator** shall submit post energisation verification test documents within 28 days of synchronising in accordance with paragraph 17.4.2 to obtain **Final Operational Notification** from the **DNO**.	

Key to evidence requested	**Key to Compliance**
S - Indicates that **DNO** would expect to see the results of a simulation study P - **Generating Unit** or **Power Generating Module** design data MI - **Manufacturers' Information**, generic data or test results as appropriate D - Copies of correspondence or other documents confirming that a requirement has been met T - Indicates that the **DNO** would expect to see results of, and/or witness, tests or monitoring which demonstrates compliance TV - Indicates Type Test reports (if **Generator** pursues this compliance option) Note that where multiple types of evidence are indicated in the "compliance" column in the **Power Generating Module Document**, this indicates that the evidence could be provided in a number of different formats, as determined by the **Generator** and/or **Manufacturer**.	Y = Yes (Compliant), O = Outstanding (outstanding submission) UR= Unresolved issue N = No (Non-Compliant) E = Exempt

Note that the second part of this form is split into two Parts~~, the~~: Part 1 is applicable to **Synchronous Power Generating Module**s~~,~~ and Part 2 is applicable to **Power Park Module**s.

Issue	Date of Issue	Compliance Declaration Signatory Name	Compliance Declaration Signature	Issue Notes (completed by the **Generator**)	**DNO** review date and comment
Issue #	DD/MM/YY		I declare that the details provided in this issue of this **Power Generating Module Document** comply with the requirements of G99	Insert brief description of amendment	**DNO** comments on evidence provided and any outstanding issues
1					

Final Issue Prior to **FON**					
Details of Power Generating Module					
Connection Voltage					
Registered Capacity					
Manufacturer / Reference					
Technology Type					

Form B2-1 Part 1 has the following amendments,

Form B2-1 Part 1 - Compliance Requirements for Synchronous Power Generating Modules				**Response**	
G99 Reference	**Compliance Requirement of the Power Generating Module**	**Submission Stage**	**Evidence Requested (and / or)**	**Compliance** **Y, O, UR, N, E**	**Generator's Statement** *(Provide document references with any additional comments)*

17.2.1, 17.2.3, 17.4.1	Confirmation that a completed Standard Application Form has been submitted to the **DNO**	A, IS, FONS	P, MI, D		
14.3	Site Responsibility Schedule	E	D		
9.4.2	**Power Quality – Voltage fluctuations and Flicker**: The installation shall be designed in accordance with EREC P28	IS, FONS	MI, D, ~~TV~~T, S		
9.4.3	**Power Quality – Harmonics**: The installation shall be designed in accordance with EREC G5	IS, FONS	MI, D, ~~TV~~T, S		
12.5	**Reactive Power capability** Confirm compliance with Section 12.5 by carrying out simulation study in accordance with B.4.2 and by submission of a report	IS	S, MI		
12.2	Confirm that the plant and apparatus is able ~~of~~to continue to operate ~~during~~in the frequency ranges specified in 12.2.1 and to withstand the rate of change of frequency specified ~~in 12.2.1 and~~ 12.2.2	IS	MI, TV		
12.2.4	**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency** Confirm the compliance with 12.2.4 by carrying out simulation study in	IS	S, TV		

	accordance with B.4.5 and by submission of a report				
12.1.3	Confirm the **Active Power** set point can be adjusted in accordance with instructions issued by the **DNO**	IS	MI, TV		
9.1.7	Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7 and 9.1.8	IS	MI, D		
12.3	**Fault Ride Through** Confirm the compliance with 12.3 by carrying out simulation study in accordance with B.4.4 and by submission of a report. Testing of **Fault Ride Through** is not required.	IS	MI, TV, S		
Section10 and Form B2-2	**Interface Protection:** Over and under voltage protection Over and Under Frequency protection Loss of mains protection Other protection: Details of any special protection, eg Pole Slipping or islanding As an alternative to demonstrating protection compliance with Section 10 using **Manufacturers' Information** or type test reports, site tests can be undertaken at the time of commissioning the **Power Generating Module**	IS, FONS	MI, TV, T		

12.2.4	**Frequency Response Tests** Confirm the **Synchronous Power Generating Module** meets the requirements of 12.2.4 by testing in accordance with B.5.2	FONS	T, MI, TV		
12.2.3	**Output Power with falling frequency** Confirm the **Synchronous Power Generating Module** meets the requirements of 12.2.3 by testing in accordance with B.5.3	FONS	T, MI, TV		
10.3.3	**Automatic reconnection** Confirm by testing that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency in accordance with paragraph 10.3.3 and 10.3.4	FONS	T, MI, TV		
B3	Installation and Commissioning Form B3 completed with signed acceptance from the **DNO** representative	FONS	D		

Form B2-1 Part 12 has the following amendments,

Form B2-1 Part 2 - Compliance Requirements for Power Park Module				**Response**	
G99 Reference	**Compliance Requirement of the Power Generating Module**	**Submission Stage**	**Evidence Requested (and / or)**	**Compliance** **Y, O, UR, N, E**	**Generator's Statement** *(Provide document references with any additional comments)*
17.2.1, 17.2.3, 17.4.1	Confirmation that a completed Standard Application Form has been submitted to the **DNO**	A, IS, FONS	P, MI, D		
14.3	Site Responsibility Schedule	E	D		
9.4.2	**Power Quality – Voltage fluctuations and Flicker**: The installation shall be designed in accordance with EREC P28.	IS, FONS	MI, D, ~~TV~~T, S		
9.4.3	**Power Quality – Harmonics**: The installation shall be designed in accordance with EREC G5	IS, FONS	MI, D, ~~TV~~T, S		
12.5	**Reactive Power capability** Confirm compliance with Section 12.5 by carrying out simulation study in accordance with B.4.2 and by submission of a report	IS	S, MI		
12.2.4	**Limited Frequency Sensitive Mode – ~~Over frequency~~Overfrequency**	IS	S, MI, TV		

	Confirm the compliance with 12.2.4 by carrying out simulation study in accordance with B.4.5 and by submission of a report				
12.2	Confirm that the plant and apparatus is able ~~of~~to continue to operate ~~during~~in the frequency ranges specified in 12.2.1 and to withstand the rate of change of frequency specified in 12.2.~~1 and 12.2.~~2	IS	MI, TV		
12.1.3	Confirm the **Active Power** set point can be adjusted in accordance with instructions issued by the **DNO**	IS	MI, TV		
9.1.7	Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7.	IS	MI, D		
12.3 and 12.6	**Fault Ride Through and Fast Fault Current Injection** Confirm the compliance with 12.3 and 12.6 by carrying out simulation study in accordance with B.4.4 and by submission of a report. Testing of **Fault Ride Through** is not required.	IS	MI, TV, S		
Section 10 and Form B2-2	**Interface Protection:** Over and under voltage protection Over and Under Frequency protection Loss of mains protection Other protection:	IS, FONS	MI, TV, T		

	Details of any special protection, eg Pole Slipping or islanding As an alternative to demonstrating protection compliance with Section 10 using **Manufacturers' Information** or type test reports, site tests can be undertaken at the time of commissioning the **Power Generating Module**				
12.2.4	**Frequency Response Test** Confirm the **Power Park Module** meets the requirements of 12.2.4 by testing in accordance with B.6.2	FONS	T, MI, TV		
10.3.3	**Automatic reconnection** Confirm by testing that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency in accordance with paragraph 10.3.3 and 10.3.4	FONS	T, MI, TV		
~~B.3~~B3	Installation and Commissioning Form B3 completed with signed acceptance from the **DNO** representative	FONS	D		

Form B2-2 has been amended as shown below,

Form B2-2: Site Compliance and Commissioning test requirements for Type B Power Generating Modules

~~(c)~~(d) This form should be completed if site compliance tests are being undertaken for some or all of the **Interface Protection** where it is not **Type Tested**.

Generator Details:	
Generator (name)	
Installation details:	
Address	
Post Code	
Date of commissioning	

Requirement	Compliance by provision of **Manufacturers' Information** or type test reports. Reference number should be detailed and **Manufacturers' Information** attached.	Compliance by commissioning tests. Tick if true and complete relevant sections of form below.
Over and under voltage protection **HV** –calibration test		
Over and under voltage protection **HV** – stability test		
Over and Under Frequency protection – calibration test		
Over and Under Frequency protection - stability test		
Loss of mains protection – calibration test		
Loss of mains protection – stability test		
Wiring functional tests: If required by para 15.2.1		

Over and Under Voltage Protection HV~~.~~

Where the **Connection Point** is at **HV** the **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Voltage Protection by provision of **Manufacturers' Information,** type test reports or by undertaking the following tests on site.

Tests referenced to 110 V ph-ph VT output.

Calibration and Accuracy Tests~~.~~

Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time** measured value ± 2 V				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**121 V** 110 V VT secondary	**1.0 s**	*119.35*		*122.65*	Pass/ Fail	Measured value plus 2 V	*1.0 s*		*1.1 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass/ Fail
L3 - L1						Pass/ Fail					Pass/ Fail
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**124.3 V** 110 V VT secondary	0.5 s	*122.65*		*125.95*	Pass/ Fail	Measured value plus 2 V	*0.5 s*		*0.6 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass/ Fail
L3 - L1						Pass/ Fail					Pass/ Fail
Under Voltage			Lower Limit	Measured Value	Upper Limit		Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**88.0 V** 110 V VT secondary	2.5s	*86.35*		*89.65*	Pass/ Fail	Measured value minus 2 V			*2.6 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass / Fail
L3 - L1						Pass/ Fail					Pass/ Fail

Over and Under Voltage Protection Tests HV

referenced to 110 V ph-ph VT output

Stability Tests. (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition (3-Phase Value)	Test Voltage All phases ph-ph	Test Duration	Confirm No Trip	Result
Inside Normal band	---------	---------	< OV Stage 1	119 V	5.00 s		Pass/ Fail
Stage 1 Over Voltage	**121 V**	**1.0 s**	> OV Stage 1	122.3 V	0.95 s		Pass/ Fail
Stage 2 Over Voltage	**124.3 V**	**0.5 s**	> OV Stage 2	126.3 V	0.45 s		Pass/ Fail

Inside Normal band	---	---	> UV	90 V	5.00 s		Pass/ Fail
Under Voltage	**88 V**	**2.5 s**	< UV	86 V	2.45 s		Pass/ Fail
Additional Comments / Observations:							

Over and Under Frequency Protection

The **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Frequency Protection by provision of **Manufacturers' Information**, type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Setting	Time Delay	**Pickup Frequency**				**Relay Operating Time**				
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
52 Hz	0.5 s	*51.90*		*52.10*	Pass/ Fail	51.7-52.3 Hz	*0.50 s*		*0.60 s*	Pass/ Fail
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47.5 Hz	20	*47.40*		*47.60*	Pass /Fail	47.8-47.2 Hz	*20.0 s*		*20.2 s*	Pass/ Fail
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47 Hz	0.5 s	*46.90*		*47.1*	Pass/ Fail	47.3-46.7 Hz	*0.50 s*		*0.60 s*	Pass /Fail

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition	Test Frequency	Test Duration	Confirm No Trip	Result
Inside Normal band	---	---	< OF	51.8 Hz	120 s		Pass/ Fail
Over Frequency	52 Hz	0.5 s	> OF	52.2 Hz	0.45 s		Pass/ Fail
Inside Normal band	---	---	> UF Stage 1	47.7 Hz	30 s		Pass/ Fail
Stage 1 Under Frequency	47.5 Hz	20 s	< UF Stage 1	47.2 Hz	19.5 s		Pass/ Fail
Stage 2 Under Frequency	47 Hz	0.5 s	< UF Stage 2	46.8 Hz	0.45 s		Pass/ Fail

Over frequency test - Frequency shall be stepped from 51.8 Hz to the test frequency and held for the test duration and then stepped back to 51.8 Hz.

Under frequency test - Frequency shall be stepped from 47.7 Hz to the test frequency and held for the test duration and then stepped back to 47.7 Hz.

Additional Comments / Observations:

Details of Loss of Mains Protection

Manufacturer	**Manufacturer**'s type	Date of Installation	Settings	Other information

Loss-of-Mains (LOM) Protection Tests

The **Generator** shall demonstrate compliance with this EREC G99 in respect of LOM Protection by either providing the **DNO** with appropriate **Manufacturers' Information,** type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Ramp in range 49.0-51.0 Hz									
	Pickup (±0.025 Hzs^{-1})				**Relay Operating Time** RoCoF= ±**0.10** Hzs^{-1} above setting				
Setting = 1.0 Hzs^{-1}	Lower Limit	Measured Value	Upper Limit	Result	Test Condition	Lower Limit	Measured Value	Upper Limit	Result
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Reducing Frequency	*0.975*		*1.025*	Pass/Fail	1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Ramp in range 48.5-51.5 Hz									
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Reducing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail

Stability Tests (confirm no trip of **Interface Protection**)

Ramp in range 49.0-51.0 Hz					
	Test Condition	Test frequency ramp	Test Duration	Confirm No Trip	Result
Inside Normal band	< RoCoF setting (increasing f)	+0.95 Hzs^{-1}	2.1 s		Pass/Fail

Inside Normal band	< RoCoF setting (reducing f)	-0.95 Hzs^{-1}	2.1 s		Pass/Fail
Ramp as shown					
Inside Normal band	> RoCoF setting (increasing f)	+1.20 Hzs^{-1} (ramp between 49.80 and 50.34 Hz)	0.45 s		Pass/Fail
Inside Normal band	> RoCoF setting (reducing f)	- -1.20 Hzs^{-1} (ramp between range 50.30 and 49.76 Hz	0.45 s		Pass/Fail
Additional Comments / Observations:					

LoM Protection - Stability test~~.~~ (confirm no trip of **Interface Protection**)				
	Start Frequency	Change		Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees		
Negative Vector Shift	50.5 Hz	- 50 degrees		

Wiring functional tests~~:~~	
If required by para 15.2.1, confirm that wiring functional tests have been carried out in accordance with the instructions below.	Yes/ NA

Where components of a **Power Generating Module** are separately **Type Tested** and assembled into a **Power Generating Module**, if the connections are made via loose wiring, rather than specifically designed error-proof connectors, then it will be necessary to prove the functionality of the components that rely on the connections that have been made by the loose wiring.

As an example, consider a **Type Tested** alternator complete with its control systems etc. It needs to be connected to a **Type Tested Interface Protection** unit. In this case there are only three voltage connections to make, and one tripping circuit. The on-site checks need to confirm that the **Interface Protection** sees the correct three phase voltages and that the tripping circuit is operative. It is not necessary to inject the **Interface Protection** etc to prove this. Simple functional checks are all that are required.

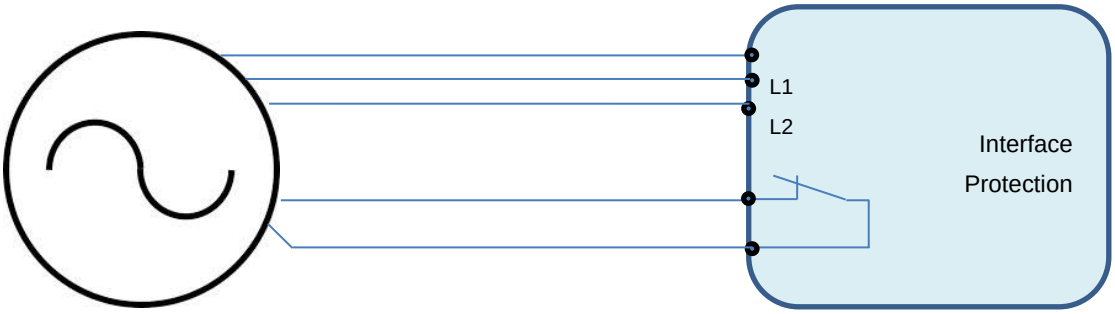
Test schedule:

With **Generating Unit** running and energised, confirm L1, L2, L3 voltages on **Generating Unit** and on **Interface Protection**.

Disconnect one phase of the control wiring at the **Generating Unit**. Confirm received voltages at the **Interface Protection** have one phase missing.

Repeat for other phases.

Confirm that a trip on the **Interface Protection** trips the ~~**Generating Unit**~~appropriate circuit breaker.



Any other comments or notes:

Form B3 has been amended as shown,

Form B3- Installation and Commissioning Confirmation Form for Type B PGMs

Please complete and provide this document for every **Power Generating Facility**.

Part 1 should be completed for the **Power Generating Facility**.

Part 2 should be completed for each of the **Power Generating Module**s being commissioned. Where the installation is phased the form should be completed on a **Generating Unit** basis as each part of the installation is completed in accordance with EREC G99 paragraph 15.3.3. For phased installations reference to **PGM** in this form should be read as reference to **Generating Unit**s.

Form B3 Part 1

To ABC electricity distribution **DNO**

99 West St, Imaginary Town, ZZ99 9AA abced@wxyz.com

Installer or Generator Details:	
Installer	
Accreditation/Qualification	
Address	
Post Code	
Contact person	
Telephone Number	
E-mail address	
Installation Details:	
Site Contact Details	
Address	
Post Code	
Site Telephone Number	
MPAN(s)	

Location within **Generator's Installation**	
Location of Lockable Isolation Switch	

Details of Power Generating Module(s):

Manufacturer / Reference	Date of Installation	Technology Type	**Manufacturer**s Reference Number (~~Product id~~system reference on ENA database) and or Equipment Certificate references as applicable	**Power Generating Module**	
				Registered Capacity in kW	**Power Factor**

Commissioning Checks:

Description~~.~~	**Confirmation**
Generator's Installation satisfies the requirements of BS7671 (IET Wiring Regulations).	Yes / No*
Suitable lockable points of isolation have been provided between the **PGM**s and the rest of the **Generator's Installation**.	Yes / No*
Labels have been installed at all points of isolation in accordance with EREC G99.	Yes / No*
Interlocking that prevents the **PGM**s being connected in parallel with the **DNO**'s **Distribution Network** (without synchronising) is in place and operates correctly.	Yes / No*
PGM installation complies with cyber security requirements.	Yes / No*

Form B3 Part 2

Power Generating Module reference or name	

Information to be enclosed~~.~~

Description~~.~~	**Confirmation**
Final copy of circuit diagram.	Yes / No*
Schedule of protection settings (may be included in circuit diagram).	Yes / No*

Commissioning Checks~~.~~

The **Interface Protection** settings have been checked and comply with EREC G99.	Yes / No / N/A (**Type Tested**)*

The **PGM** successfully synchronises with the **DNO**'s **Distribution Network** without causing significant voltage disturbance.	Yes / No*
The **PGM** successfully runs in parallel with the **DNO**'s **Distribution Network** without tripping and without causing significant voltage disturbances.	Yes / No*
The **PGM** successfully disconnects without causing a significant voltage disturbance, when it is shut down.	Yes / No*
Interface Protection operates and disconnects the **PGM** quickly (within 1s) when a suitably rated switch, located between the **PGM** and the **DNO**'s incoming connection, is opened.	Yes / No*
The **PGM** remains disconnected for at least 20s after switch is reclosed.	Yes / No*
Loss of tripping and auxiliary supplies. Where applicable, loss of supplies to tripping and protection relays results in either **PGM** or **Generating Unit** forced trip or an alarm to a 24 hour manned control centre.	Yes / No*
*Circle as appropriate. If "No" is selected the **Power Generating Facility** is deemed to have failed the commissioning tests and the **Power Generating Module** shall not be put in service.	
Additional Comments / Observations:	
Declaration – to be completed by Generator or Generators Appointed Technical Representative	
I declare that for the **Type B Power Generating Module** within the scope of this EREC G99, and the installation: 1. The commissioning checks detailed in Form B2-2 have been successfully completed*. 2. The commissioning checks detailed in this Form B3 have been successfully completed. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**.	
Name:	
Signature:	Date:
Company	
Position:	
Declaration – to be completed by DNO Witnessing Representative	
I confirm that I have witnessed: 1. The commissioning checks detailed in Form B2-2 *; 2. The commissioning checks detailed in this Form B3 and that the results are an accurate record of the checks. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**	
Name:	
Company Name	
Signature:	Date:

Section B.4 has the following amendments,

B.4.1.3 Where the **Power Generating Module** will be connected to a substantial **Customer's Installation** that will have an effect on the simulation modelling the **Generator** should include relevant equivalents to adequately represent the effect of the **Customer's Installation** and its equipment. Note that most rotating plant will tend to make issues such as **Fault Ride Through** less onerous so modelling without including other equipment in the **Customer's Installation** will generally be more conservative for compliance purposes. The **DNO** will agree with the **Generator** the extent to which substantial and complex **Customer's Installation**s will need to be modelled.

The existing section of text for B.4.1.3 has been re-numbered to B1.4.1.4.

B.4.2.1 ~~If specified by the **DNO** the~~The **Generator** shall ~~supply simulation studies to~~ demonstrate the capability to meet Section 12.5 by submission of a report containing~~:~~

~~(i)~~ ~~a~~ load flow simulation study ~~result to demonstrate~~ results showing:

(i) the maximum lagging **Reactive Power** capability ~~of the **Synchronous Power Generating Module** or **Power Park Module** at **Registered Capacity**~~ when the **Connection Point** voltage is at nominal (1 pu).

(ii) ~~a load flow simulation study result to demonstrate~~ the maximum leading **Reactive Power** capability ~~of the **Synchronous Power Generating Module** or **Power Park Module** at **Registered Capacity**~~ when the **Connection Point** voltage is at nominal (1 pu).

B.4.4.3 The simulation study should be completed with the **Power Generating Module** operating at full **Active Power** and maximum leading **Reactive Power** and the fault level at the **Connection Point** at minimum as notified by the **DNO**. A minimum short circuit power of 50 MVA is a generic minimum fault level that should be assumed. For the few cases where the fault level is lower than this the **DNO** will advise the **Generator** the regarding the fault level assumptions to be used.

B.4.5 **Limited Frequency Sensitive Mode – ~~Over Frequency~~Overfrequency (LFSM-O)**

B4.5.2 Simulation studies shall be undertaken to demonstrate the governor or controller model response to increasing frequency.

The simulation study event shall be equivalent to:

(i) a sufficiently large increase in the measured system frequency ramped over 10 s to cause a decrease in **Active Power** output in accordance with the **Droop** setting followed by

(ii) 60 s of steady state with the measured system frequency increased to the same level as in B.4.5.~~4~~2 (i) as illustrated in Figure B.4.1 below

A new footnote (29) has been added to accompany section B.4.2.1 (i and ii), it reads,

This report may include reference to the **Generator Performance Chart**.

Section B5 has had the following minor editorial change to text, below figure B.5.1(vi) and reads,

* The frequency step Δf will generally be +2.0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Minimum ~~Stable Operating~~Regulating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 1.5 Hz is needed to take an initial output 100% to a final output of 70%. If the initial output is not 100% and the **Minimum ~~Stable Operating~~Regulating Level** is not 70% then the injected step should be adjusted accordingly as shown in the example given below:

Initial output	100%
Minimum ~~Stable Operating~~Regulating Level	70%
Frequency controller **Droop**	10%
Frequency to be injected	= (1.00 – 0.70) x 0.1 x 50 = 1.5Hz

Section B6 has had the following minor editorial change to text, below figure B.6.1(vi) and reads,

* The frequency step *Δf* will generally be +2.0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Minimum ~~Stable Operating~~Regulating Level** in which case an appropriate injection should

For example, 1.5 Hz is needed to take an initial output 100% to a final output of 70%. If the initial output is not 100% and the **Minimum ~~Stable Operating~~Regulating Level** is not 70% then the injected step should be adjusted accordingly as shown in the example given below:

Initial output	100%
Minimum ~~Stable Operating~~Regulating Level	70%
Frequency controller **Droop**	10%
Frequency to be injected	= (1.00 – 0.70) x 0.1 x 50 = 1.5Hz

1.3.20 G99 Annex C – Type C and type D

Below are shown all the amendments to Annex C within G99,

Form C2-1 Power Generating Module Document for Type C and Type D Power Generating Modules **Compliance Statement** This document shall be completed by the **Generator**. Note: For phased installations reference to **PGM** in this form should be read as reference to **Generating Units** and the project phase noted.	
Power Generating Module (PGM) **PGM Name:** **Compliance Contact** (name/tel/email)**:**	**Distribution Network Operator (DNO)**: **DNO Name**: ABC electricity distribution **Compliance Contact** (name/tel/email):
Key to Submission Stage **A – Application:** Submission of the Standard Application Form. For **Type C: IS – Initial Submission:** The programme of initial compliance document submission to be agreed between the **Generator** and the **DNO** as soon as possible after acceptance of a Connection Offer. The **Power Generating Module Document** shall be completed as agreed in accordance with paragraph 18.2.2 at least 28 days before the **Generator** synchronising the **Power Generating Module** for the first time. **E – Energisation:** Documentation required prior to Energisation. For **Type D: ION** – **Interim Operational Notification:** The programme of initial compliance document submission to be agreed between the **Generator** and the **DNO** as soon as possible after acceptance of a Connection Offer. The **Power Generating Module Document** shall be completed as agreed in accordance with paragraph 19.3.2 at least 28 days before the **Generator** synchronising the **Power Generating Module** for the first time. **FONS – Final Operational Notification Submission:** The **Generator** shall submit post energisation verification test documents within 28 days of synchronising in accordance with paragraph 18.4.2 or 19.5.4 to obtain **Final Operational Notification** from the **DNO**.	

Key to evidence requested	**Key to Compliance**
S - Indicates that **DNO** would expect to see the results of a Simulation study P - **Generating Unit** design data MI - **Manufacturer** Information, generic data or test results as appropriate D - Copies of correspondence or other documents confirming that a requirement has been met T - Indicates that **DNO** would expect to see results of, and/or witness, tests or monitoring which demonstrates compliance TV - Indicates Type Test reports (if **Generator** pursues this compliance option) Note that where multiple types of evidence are indicated in the "compliance" column in the **Power Generating Module Document**, this indicates that the evidence could be provided in a number of different formats, as determined by the **Generator** and/or **Manufacturer**.	Y = Yes (Compliant), O = Outstanding (outstanding submission) UR= Unresolved issue N = No (Non-Compliant) E = Exempt

Note that the second part of this form is split into two Parts~~, the~~: Part 1 is applicable to **Synchronous Power Generating Module**s~~, the~~ and Part 2 is applicable to **Power Park Module**s.

Issue	Date of Issue	Compliance Declaration Signatory Name	Compliance Declaration Signature	Issue Notes (completed by the **Generator**)	**DNO** review date and comment
Issue #	DD/MM/YY		I declare that the details provided in this issue of this **Power Generating Module Document** comply with the requirements of G99	Insert brief description of amendment	**DNO** comments on evidence provided and any outstanding issues

Final Issue Prior to **FON**					

Details of Power Generating Module	
Connection Voltage	
Registered Capacity	
Manufacturer / Reference	
Technology Type	
Form C2-1 Part 1 - Compliance Requirements for Synchronous Power Generating Modules	Response

G99 Reference	**Compliance Requirement of the Power Generating Module**	**Submission Stage**	**Evidence Requested (and / or)**	**Compliance** **Y, O, UR, N, E**	**Generator's Statement** *(Provide document references with any additional comments)*

18.2.1, 18.2.3, 18.4.1	Confirmation that a completed Standard Application Form has been submitted to the **DNO**	A, IS, ION, FONS	P, MI, D		
14.3	Site Responsibility Schedule	E	D		
9.4.2	**Power Quality – Voltage fluctuations and Flicker**: The installation shall be designed in accordance with EREC P28	IS, ION	MI, D, TV, S		
9.4.3	**Power Quality – Harmonics**: The installation shall be designed in accordance with EREC G5	IS, ION	MI, D, TV, S		
13.5	**Reactive Power capability** Confirm compliance with Section 13.5 by carrying out simulation study in accordance with C.7.3 and by submission of a report	IS, ION	S, MI		
~~13.4~~	~~**Voltage Control and Reactive Power Stability**~~ ~~Confirm compliance with Section 13.4 by carrying out simulation study in accordance with C.7.4 and by submission of a report~~	~~IS, ION~~	~~S, MI~~		

13.2	Confirm that the plant and apparatus is capable of continue to operate ~~during~~ in the frequency ranges specified in 13.2.1 and to withstand the rate of change of frequency specified in ~~13.2.1 and~~ 13.2.2	IS	MI, TV		
13.2.4	**Limited Frequency Sensitive Mode – Over frequency and Frequency Sensitive Mode** Confirm ~~the~~ compliance with 13.2.4 by carrying out simulation study in accordance with C.7.6 and by submission of a report.	IS, ION	S, MI, TV		
13.2.5	**Limited Frequency Sensitive Mode – Under frequency** Confirm ~~the~~ compliance with 13.2.5 by carrying out simulation study in accordance with C.7.7 and by submission of a report.	IS. ION	S, MI, TV		
C.10	Confirm compliance with minimum frequency response requirements in Annex C.10 by testing in accordance with C.10.4.	IS, ION	MI, TV, T		

13.1.3	Confirm the **Active Power** set point can be adjusted in accordance with instructions issued by the **DNO**	IS, ION	MI, TV		
9.1.7	Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7 and 9.1.8	IS, ION	MI, D		
13.3	**Fault Ride Through** Confirm ~~the~~ compliance with 13.3 by carrying out simulation study in accordance with C.7.5 and by submission of a report.	IS, ION	S, MI, TV		
18.2.3 (e)	Confirm a detailed schedule of tests and test procedures have been provided.	IS, ION	D		
Section 10 and Form C2-2	**Interface Protection:** Over and under voltage protection Over and Under Frequency protection Loss of mains protection Other protection: Details of any special protection, eg Pole Slipping or islanding	IS, ION, FONS	MI, TV, T		

	As an alternative to demonstrating protection compliance with Section 10 using **Manufacturers' Information** or type test reports, site tests can be undertaken at the time of commissioning the **Power Generating Module**				
C.7.8	**Model validation** Demonstration of the frequency control or governor/load controller/plant model, **Excitation System** and voltage controller by carrying out simulation studies in accordance with C.7.8	FONS	S, MI, TV		
C.4	**Excitation System Open Circuit Step Response Tests** Confirm the performance requirements of a continuously acting voltage control system compliant with C.4 by testing in accordance with C.8.2	FONS	T, MI, TV		
C.4	**Open & Short Circuit Saturation Characteristics** Confirm the performance requirements of a continuously acting voltage control system compliant with C.4 by testing in accordance with C.8.3	FONS	T, MI, TV		

13.4.3	**Excitation System On-Load Tests** Confirm the operation of the **Excitation System** on load is compliant with paragraph 13.4.3 and Annex C.4 by testing in accordance with C.8.4	FONS	T, MI, TV		
13.5	**Reactive Capability Test** Confirm the **Reactive Power** capability of the **Synchronous Power Generating Module** to meet the requirements of Section 13.5 by testing in accordance with C.8.5	FONS	T, MI, TV		
13.2	**Frequency Response Tests** Confirm the **Synchronous Power Generating Module** meets the requirements of 13.2 by testing in accordance with C.8.6	FONS	T, MI, TV		
13.2.3	**Output Power with falling frequency** Confirm the **Synchronous Power Generating Module** meets the requirements of 13.2.3 by testing in accordance with C.8.7	FONS	T, MI, TV		
10.3.3	**Automatic reconnection** Confirm by testing that the reconnection	FONS	T, MI, TV		

	sequence starts after a minimum delay of 20 s for restoration of voltage and frequency in accordance with paragraph 10.3.3 and 10.3.4				
13.7.2	Where rapid re-synchronisation is required, confirm capability to supply houseload operation, as per 13.7.2	FONS	T, MI, TV		
C.6	Confirm that the dynamic system monitoring, fault recording and power quality monitoring equipment is provided, installed and functioning in accordance with Annex C.6	ION, FONS	MI, TV, T		
C.3	Installation and Commissioning Form C3 completed with signed acceptance from the **DNO** representative	ION, FONS	D		

Form C2-1 Part 2 - Compliance Requirements for Power Park Module				**Response**	
G99 Reference	**Compliance Requirement of the Power Generating Module**	**Submission Stage**	**Evidence Requested (and / or)**	**Compliance** **Y, O, UR, N,**	**Generator's Statement** *(Provide document references with any additional comments)*

18.2.1, 18.2.3, 18.4.1	Confirmation that a completed Standard Application Form has been submitted to the **DNO**	A, IS, FONS	P, MI, D		
14.3	Site Responsibility Schedule	E	D		
9.4.2	**Power Quality – Voltage fluctuations and Flicker**: The installation shall be designed in accordance with EREC P28	IS, ION	MI, D, TV, S		
9.4.3	**Power Quality – Harmonics**: The installation shall be designed in accordance with EREC G5	IS, ION	MI, D, TV, S		
13.5	**Reactive Power capability** Confirm compliance with Section 13.5 by carrying out simulation study in accordance with C.7.3 and by submission of a report	IS, ION	S, MI		
13.4	**Voltage Control and Reactive Power Stability** Confirm compliance with Section 13.4 by carrying out simulation study in	IS, ION	S, MI		

	accordance with C.7.4 and by submission of a report				
~~13.3~~	~~**Fault Ride Through capability** Confirm compliance with Section13.3 by carrying out time series simulation study in accordance with C.7.5 and by submission of a report.~~	~~IS, ION~~	~~MI, TV, S~~		
13.2	Confirm that the plant and apparatus is capable of continuinge to operate ~~during~~ in the frequency ranges specified in 13.2.1 and to withstand the rate of change of frequency specified in ~~13.2.1 and~~ 13.2.2	IS	MI, TV		
13.2.4	**Limited Frequency Sensitive Mode – Over frequency and Frequency Sensitive Mode** Confirm the compliance with 13.2.4 by carrying out simulation study in accordance with C.7.6 and by submission of a report	IS, ION	S, MI, TV		
13.2.5	**Limited Frequency Sensitive Mode – Under frequency** Confirm the compliance with 13.2.5 by carrying out simulation study in	IS, ION	S, MI, TV		

	accordance with C.7.7 and by submission of a report				
C.10	Confirm compliance with minimum frequency response requirements in Annex C.10 by testing in accordance with C.10.4.	IS, ION, FONS	MI, TV, T		
13.1.3	Confirm the **Active Power** set point can be adjusted in accordance with instructions issued by the **DNO**	IS, ION	MI, TV		
9.1.7	Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7	IS, ION	MI, D		
13.3 and 13.6	**Fault Ride Through and Fast Fault Current Injection** Confirm the compliance with 13.3 and 13.6 by carrying out simulation study in accordance with C.7.5 and by submission of a report	IS, ION	S, MI, TV		

~~12.2.1~~	~~Confirm that the plant and apparatus is able of continue to operate during frequency ranges specified in 12.2.1~~	~~IS, ION~~	~~MI, TV~~		
18.2.3 (e)	Confirm a detailed schedule of tests and test procedures have been provided	IS, ION	D		
Section 10 and Form C2-2	**Interface Protection:** Over and under voltage protection Over and Under Frequency protection Loss of mains protection Other protection: Details of any special protection, eg Pole Slipping or islanding As an alternative to demonstrating protection compliance with Section 10 using **Manufacturers' Information** or type test reports, site tests can be undertaken at the time of commissioning the **Power Generating Module**	IS, ION, FONS	MI, TV, T		
C.7.8	**Model validation** Demonstration of the frequency control or governor/load controller/plant model, **Excitation System** and voltage controller	FONS	S, MI, TV		

	by carrying out simulation studies in accordance with C.7.8				
C.5	**Voltage Control Test (pre 20%)** Confirm the performance requirements of a continuously acting voltage control system compliant with C.5 by testing in accordance with C.9.2 ~~and C.9.4~~	ION, FONS	T, MI, TV		
C.5	**Voltage Control Test** Confirm the performance requirements of a continuously acting voltage control system compliant with C.5 by testing in accordance with C.9.4	FONS	T, MI, TV		
13.5	**Reactive Capability Test** Confirm the **Reactive Power** capability of the **Power Park Module** meet the requirements of Section 13.5 by testing in accordance with C.9.3	FONS	T, MI, TV		
C.9.5	**Frequency Response Test** Confirm the **Generator** meets the requirements of 13.2 by testing in accordance with C.9.5	FONS	T, MI, TV		

10.3.3	**Automatic reconnection** Confirm by testing that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency in accordance with paragraph 10.3.3 and 10.3.4	FONS	T, MI, TV		
13.7.2	Where rapid re-synchronisation is required, confirm capability to supply houseload operation, as per 13.7.2	FONS	T, MI, TV		
C.6	Confirm that the dynamic system monitoring, fault recording and power quality monitoring equipment is provided, installed and functioning in accordance with Annex C.6	ION, FONS	MI, TV, T		
C.3	Installation and Commissioning Form C3 completed with signed acceptance from the **DNO** representative	ION, FONS	D		

Form C2-2 has been amended as follows,

Form C2-2: Site Compliance and Commissioning test requirements for Type C and Type D Power Generating Modules ~~(d)~~(e) This form should be completed if site compliance tests are being undertaken for some or all of the **Interface Protection** where it is not **Type Tested**.		
Generator Details:		
Generator (name)		
Installation details:		
Address		
Post Code		
Date of commissioning		
Requirement	Compliance by provision of **Manufacturers' Information** or type test reports. Reference number should be detailed and **Manufacturers' Information** attached.	Compliance by commissioning tests Tick if true and complete relevant sections of form below
Over and under voltage protection **HV** –calibration test		
Over and under voltage protection **HV** – stability test		
Over and Under Frequency protection – calibration test		
Over and Under Frequency protection - stability test		
Loss of mains protection – calibration test		
Loss of mains protection – stability test		
Wiring functional tests: If required by para 15.2.1		
Over and Under Voltage Protection HV~~.~~ Where the **Connection Point** is at **HV** the **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Voltage Protection by provision of **Manufacturers Information,** type test reports or by undertaking the following tests on site. Tests referenced to 110 V ph-ph VT output.		
Calibration and Accuracy Tests		

Phase	Setting	Time Delay	**Pickup Voltage**				**Relay Operating Time** measured value ± 2 V				
Stage 1 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**121 V** 110 V VT secondary	**1.0 s**	*119.35*		*122.65*	Pass/ Fail	Measured value plus 2 V	*1.0 s*		*1.1 s*	Pass /Fail
L2 - L3						Pass/ Fail					Pass/ Fail
L3 - L1						Pass/ Fail					Pass/ Fail
Stage 2 Over Voltage			Lower Limit	Measured Value	Upper Limit	Result	Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**124.3 V** 110 V VT secondary	0.5 s	*122.65*		*125.95*	Pass/ Fail	Measured value plus 2 V	*0.5 s*		*0.6 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass/ Fail
L3 - L1						Pass/ Fail					Pass/ Fail
Under Voltage			Lower Limit	Measured Value	Upper Limit		Test Value	Lower Limit	Measured Value	Upper Limit	Result
L1 - L2	**88.0 V** 110 V VT secondary	2.5s	*86.35*		*89.65*	Pass/ Fail	Measured value minus 2 V	*2.5 s*		*2.6 s*	Pass/ Fail
L2 - L3						Pass/ Fail					Pass / Fail
L3 - L1						Pass/ Fail					Pass/ Fail

Over and Under Voltage Protection Tests HV

referenced to 110 V ph-ph VT output

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	est Condition (3-Phase Value)	est Voltage All phases ph-ph	Test Duration	Confirm No Trip	Result
Inside Normal band	---	---	< OV Stage 1	119 V	5.00 s		Pass/ Fail
Stage 1 Over Voltage	**121 V**	**1.0 s**	> OV Stage 1	122.3 V	0.95 s		Pass/ Fail
Stage 2 Over Voltage	**124.3 V**	**0.5 s**	> OV Stage 2	126.3 V	0.45 s		Pass/ Fail

Inside Normal band	---------	---------	> UV	90 V	5.00 s		Pass/ Fail
Under Voltage	**88 V**	**2.5 s**	< UV	86 V	2.45 s		Pass/ Fail
Additional Comments / Observations:							

Over and Under Frequency Protection

The **Generator** shall demonstrate compliance with this EREC G99 in respect of Over and Under Frequency Protection by provision of **Manufacturers Information**, type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Setting	Time Delay	**Pickup Frequency**				**Relay Operating Time**				
Over Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
52 Hz	0.5 s	*51.90*		*52.10*	Pass/ Fail	51.7-52.3 Hz	*0.50 s*		*0.60 s*	Pass/ Fail
Stage 1 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47.5 Hz	20	*47.40*		*47.60*	Pass /Fail	47.8-47.2 Hz	*20.0 s*		*20.2 s*	Pass/ Fail
Stage 2 Under Frequency		Lower Limit	Measured Value	Upper Limit	Result	Freq step	Lower Limit	Measured Value	Upper Limit	Result
47 Hz	0.5 s	*46.90*		*47.1*	Pass/ Fail	47.3-46.7 Hz	*0.50 s*		*0.60 s*	Pass /Fail

Stability Tests (confirm no trip of **Interface Protection**)

Test Description	Setting	Time Delay	Test Condition	Test Frequency	Test Duration	Confirm No Trip	Result
Inside Normal band	---------	---------	< OF	51.8 Hz	120 s		Pass/ Fail
Over Frequency	52 Hz	0.5 s	> OF	52.2 Hz	0.45 s		Pass/ Fail
Inside Normal band	---------	---------	> UF Stage 1	47.7 Hz	30 s		Pass/ Fail

Stage 1 Under Frequency	47.5 Hz	20 s	< UF Stage 1	47.2 Hz	19.5 s		Pass/ Fail
Stage 2 Under Frequency	47 Hz	0.5 s	< UF Stage 2	46.8 Hz	0.45 s		Pass/ Fail

Over frequency test - Frequency shall be stepped from 51.8 Hz to the test frequency and held for the test duration and then stepped back to 51.8 Hz.

Under frequency test - Frequency shall be stepped from 47.7 Hz to the test frequency and held for the test duration and then stepped back to 47.7 Hz

Additional Comments / Observations:

Details of Loss of Mains Protection

Manufacturer	**Manufacturer**'s type	Date of Installation	Settings	Other information

Loss-of-Mains (LOM) Protection Tests

The **Generator** shall demonstrate compliance with this EREC G99 in respect of LOM Protection by either providing the **DNO** with appropriate **Manufacturers' Information,** type test reports or by undertaking the following tests on site.

Calibration and Accuracy Tests

Ramp in range 49.0-51.0 Hz									
	Pickup (±0.025 Hzs^{-1})				**Relay Operating Time** RoCoF= **±0.10 Hzs^{-1}** above setting				
Setting = 1.0 Hzs^{-1}	Lower Limit	Measured Value	Upper Limit	Result	Test Condition	Lower Limit	Measured Value	Upper Limit	Result
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Reducing Frequency	*0.975*		*1.025*	Pass/Fail	[1] 1.10 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail
Ramp in range 48.5-51.5 Hz									
Increasing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail

Reducing Frequency	*0.975*		*1.025*	Pass/Fail	3.00 Hzs^{-1}	*>0.5 s*		*<1.0 s*	Pass/Fail

Stability Tests (confirm no trip of **Interface Protection**)					
Ramp in range 49.0-51.0 Hz					
	Test Condition	Test frequency ramp	Test Duration	Confirm No Trip	Result
Inside Normal band	> RoCoF setting (increasing f)	+0.95 Hzs^{-1}	2.1 s		Pass/Fail
Inside Normal band	< RoCoF setting (reducing f)	-0.95 Hzs^{-1}	2.1 s		Pass/Fail
Ramp as shown					
Inside Normal band	> RoCoF setting (increasing f)	+1.20 Hzs^{-1} (ramp between 49.80 and 50.34 Hz)	0.45 s		Pass/Fail
Inside Normal band	> RoCoF setting (reducing f)	- -1.20 Hzs^{-1}(ramp between 50.30 and 49.76 Hz	0.45 s		Pass/Fail
Additional Comments / Observations:					

LoM Protection - Stability test (confirm no trip of **Interface Protection**)				
	Start Frequency	Change		Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees		
Negative Vector Shift	50.5 Hz	- 50 degrees		

Wiring functional tests	
If required by para 15.2.1, confirm that wiring functional tests have been carried out in accordance with the instructions below.	Yes/ NA

Where components of a **Power Generating Module** are separately **Type Tested** and assembled into a **Power Generating Module**, if the connections are made via loose wiring, rather than specifically designed error-proof connectors, then it will be necessary to prove the functionality of the components that rely on the connections that have been made by the loose wiring.

As an example, consider a **Type Tested** alternator complete with its control systems etc. It needs to be connected to a **Type Tested Interface Protection** unit. In this case there are only three voltage connections to make, and one tripping circuit. The on-site checks need to confirm that the **Interface Protection** sees the correct three phase voltages and that the tripping circuit is operative. It is not necessary to inject the **Interface Protection** etc to prove this. Simple functional checks are all that are required.

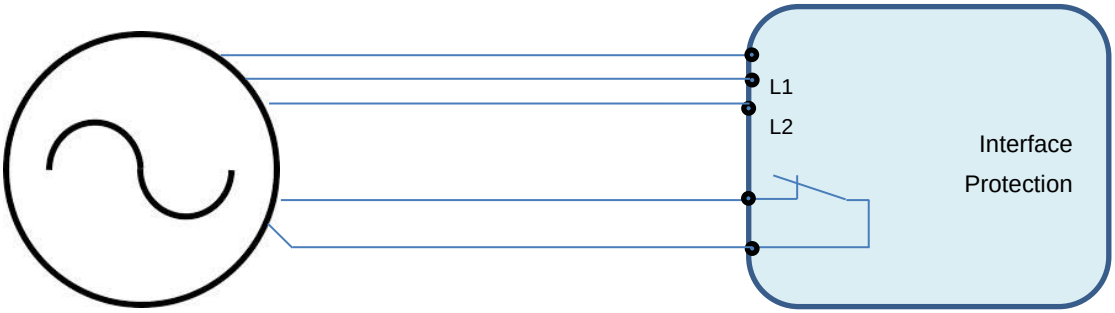
Test schedule:

With **Generating Unit** running and energised, confirm L1, L2, L3 voltages on **Generating Unit** and on **Interface Protection**.

Disconnect one phase of the control wiring at the **Generating Unit**. Confirm received voltages at the **Interface Protection** have one phase missing.

Repeat for other phases.

Confirm a trip on the **Interface Protection** trips the ~~**Interface Protection**~~appropriate circuit breaker.



Any other comments or notes:

Form C3 has the following amendments,

Form C3 Installation and Commissioning Confirmation Form for Type C and Type D PGMs

Please complete and provide this document for every **Power Generating Facility**.

Part 1 should be completed for the **Power Generating Facility**.

Part 2 should be completed for each of the **Power Generating Module**s being commissioned. Where the installation is phased the form should be completed on a **Generating Unit** basis as each part of the installation is completed in accordance with EREC G99 paragraph 15.3.3. For phased installations reference to **PGM** in this form should be read as reference to **Generating Unit**s.

Form C3 Part 1

To	ABC electricity distribution	**DNO**	
	99 West St, Imaginary Town, ZZ99 9AA		abced@wxyz.com

Installer or Generator Details

Installer	
Accreditation/Qualification	
Address	
Post Code	
Contact person	

Telephone Number	
E-mail address	
Installation Details	
Site Contact Details	
Address	
Post Code	
Site Telephone Number	
MPAN(s)	
Location within **Generator's Installation**	
Location of Lockable Isolation Switch	

Details of Power Generating Module(s)

Manufacturer / Reference	Date of Installation	Technology Type	**Manufacturers** Reference Number (~~Product id~~system reference on ENA database) and or Equipment Certificate references as applicable	**Power Generating Module**	
				Registered Capacity in kW	**Power Factor**

Commissioning Checks

Description	**Confirmation**
Generator's Installation satisfies the requirements of BS7671 (IET Wiring Regulations).	Yes / No*
Suitable lockable points of isolation have been provided between the **PGM**s and the rest of the **Generator's Installation**.	Yes / No*
Labels have been installed at all points of isolation in accordance with EREC G99.	Yes / No*
Interlocking that prevents the **PGM** being connected in parallel with the **DNO**'s **Distribution Network** (without synchronising) is in place and operates correctly.	Yes / No*

PGM installation complies with cyber security requirements	Yes / No*

Form C3 Part 2	
Power Generating Module reference or name	
Information to be enclosed	
Description	**Confirmation**
Final copy of circuit diagram	Yes / No*
Schedule of protection settings (may be included in circuit diagram)	Yes / No*
Commissioning Checks	
The **Interface Protection** settings have been checked and comply with EREC G99.	Yes / No / N/A (**Type Tested**)*
The **PGM** successfully synchronises with the **DNO**'s **Distribution Network** without causing significant voltage disturbance.	Yes / No*
The **PGM** successfully runs in parallel with the **DNO**'s **Distribution Network** without tripping and without causing significant voltage disturbances.	Yes / No*
The **PGM** successfully disconnects without causing a significant voltage disturbance, when it is shut down.	Yes / No*
Interface Protection operates and disconnects the **PGM** quickly (within 1s) when a suitably rated switch, located between the **PGM** and the **DNO**'s incoming connection, is opened.	Yes / No*
The **PGM** remains disconnected for at least 20s after switch is reclosed.	Yes / No*
Loss of tripping and auxiliary supplies. Where applicable, loss of supplies to tripping and protection relays results in either **PGM** or **Generating Unit** forced trip or an alarm to a 24 hour manned control centre.	Yes / No*
*Circle as appropriate. If "No" is selected the **Power Generating Facility** is deemed to have failed the commissioning tests and the **Power Generating Module** shall not be put in service.	
Additional Comments / Observations:	
Declaration – to be completed by Generator or Generators Appointed Technical Representative.	
I declare that for the **Type C or Type D**# **Power Generating Module** within the scope of this EREC G99, and the installation: 1. The commissioning checks detailed in Form C2-2 have been successfully completed*. 2. The commissioning checks detailed in this Form C3 have been successfully completed. # delete **Type C** or **Type D** as applicable. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**.	
Name:	

Signature:	Date:
Company:	
Position:	

Declaration – to be completed by DNO Witnessing Representative	
I confirm that I have witnessed: 1. The commissioning checks detailed in Form C2-2 *; 2. The commissioning checks detailed in this Form C3 and that the results are an accurate record of the checks. *delete if not applicable ie if the **Interface Protection** and ride through capabilities are **Type Tested**	
Name:	
Company Name:	
Signature:	Date:

Section C4 within the annex has had the following amendments,

Type of **Exciter**	Typical rise time
Static **Excitation** ~~system~~System fed from machine terminals DC supply via power electronics	50 ms
Rotating Brushless **Excitation** ~~system~~System fed from separate DC machine fixed to rotor of main generator	300 ms

Table C.4.1 Typical rise times for types of Exciter

Type of **Exciter**	Normal ceiling voltage
Static **Excitation** ~~system~~System fed from machine terminals DC supply via power electronics	2 pu
Rotating Brushless **Excitation** ~~system~~System fed from separate DC machine fixed to rotor of main generator	2 pu
• If short circuit level is low the ceiling voltage may need to be 3 pu – this can be determined by stability study to ensure 2pu excitation system is stable. • Significant improvements in stability occur between from 2 pu to 3 pu, The improvement is limited between 3 pu and 4 pu. • Increase insulation is required for higher pu excitation systems which has a cost implication	

Table C.4.2 Normal ceiling voltages

C.4.2.6.1 The settings of the **Over-excitation Limiter** and stator current limiter, shall ensure that the **Synchronous Generating ~~Unit~~Unit**'s excitation is not limited to less than the maximum value that can be achieved whilst ensuring the **Synchronous Generating Unit** is operating within its design limits. If the **Synchronous Generating ~~Unit~~Unit**'s excitation is reduced following a period of operation at a high level, the rate of reduction shall not exceed that required to remain within any time dependent operating characteristics of the **Synchronous Power Generating Module**.

Section C.5 has been amended as shown below,

C.5.3.1 The **Power Park Module** shall provide continuous steady state control of the voltage at the **Connection Point** with a ~~Setpoint Voltage~~setpoint voltage and **Slope** characteristic as illustrated in Figure C.5.1.

NOT TO SCALE

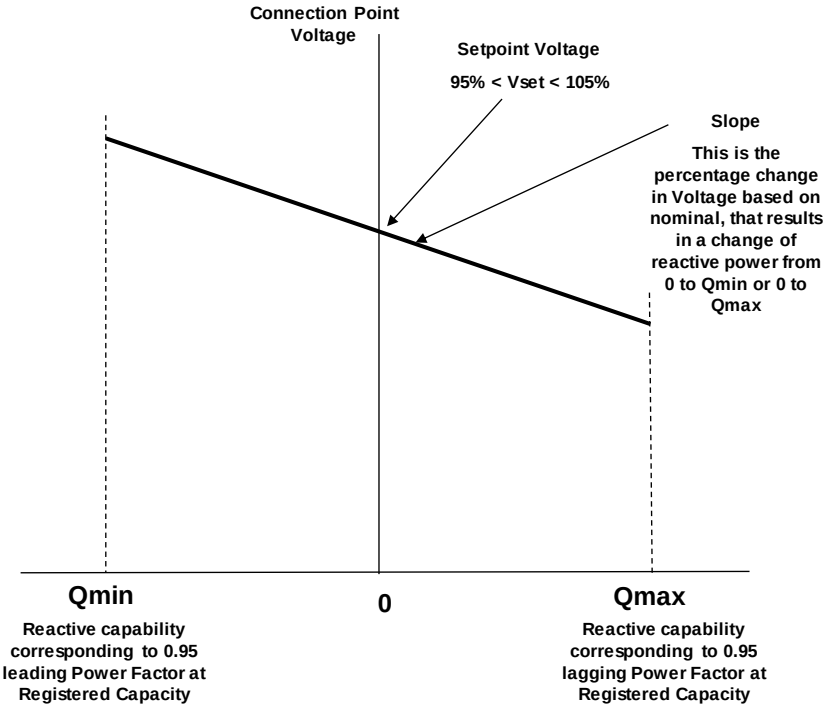


Figure C.5.1 Setpoint Voltage and Slope Characteristic

C.5.3.2 The continuously acting automatic control system shall be capable of operating to a ~~Setpoint Voltage~~setpoint voltage between 95% and 105% with a resolution of 0.25% of the nominal voltage. For the avoidance of doubt, values of 95%, 95.25%, 95.5% may be specified, but not intermediate values. The initial ~~Setpoint Voltage~~setpoint voltage will be 100%. The tolerance within which this ~~Setpoint Voltage~~setpoint voltage shall be achieved is 0.25% and a ~~Setpoint Voltage~~setpoint voltage of 100%, the achieved value shall be between 99.75% and 100.25%. The **DNO** may request the **Generator** to implement an alternative ~~Setpoint Voltage~~setpoint voltage within the range of 95% to 105%.

C.5.3.4 Figure C.5.2 shows the required envelope of operation for **Power Park Module**s connected above 33 kV. The enclosed area within points ABCDEFGH is the required capability range within which the **Slope** and ~~Setpoint Voltage~~setpoint voltage can be changed. Figure C.5.3 shows the required envelope of operation for **Power Park Module**s connected at 33 kV and below. The enclosed area within points ABCEFG is the required capability range within which the **Slope** and ~~Setpoint Voltage~~setpoint voltage can be changed.

C.5.3.5 Should the operating point of the **Power Park Module** deviate so that it is no longer a point on the operating characteristic (Figure C.5.1) defined by the target ~~Setpoint Voltage~~setpoint voltage and **Slope**, the continuously acting Automatic Voltage Control system shall act progressively to return the value to a point on the required characteristic within 5 s.

C.5.6.1 ~~As defined in~~For **Power Generating Modules** that are required to comply with applicable parts of the **Grid Code**, **Grid Code** ECC.6.3.8.3.4~~,~~ states that **Reactive Power** control mode of operation is not required in respect of **Power Park Module**s unless otherwise specified by the **DNO** (in coordination with the **NETSO** ~~for **Power Park Modules** that need to comply with the **Grid Code**). However~~). However, where there is a requirement for **Reactive Power** control mode of operation, the following requirements shall apply.

C.5.6.1 ~~As defined in~~For **Power Generating Modules** that are required to comply with applicable parts of the **Grid Code**, **Grid Code** ECC.6.3.8.3.4~~,~~ states that **Reactive Power** control mode of operation is not required in respect of **Power Park Module**s unless otherwise specified by the **DNO** (in coordination with the **NETSO** ~~for **Power Park Modules** that need to comply with the **Grid Code**). However~~). However, where there is a requirement for **Reactive Power** control mode of operation, the following requirements shall apply.

C.5.7.1 ~~As defined in~~For **Power Generating Modules** that are required to comply with applicable parts of the **Grid Code**, **Grid Code** ECC.6.3.8.4.3~~,~~ states that **Power Factor** control mode of operation is not required in respect of **Power Park Module**s unless otherwise specified by the **DNO** (in coordination with the _**NETSO** ~~for **Power Park Modules** that need to comply with the **Grid Code**).~~). However, where there is a requirement for **Power Factor** control mode of operation, the following requirements shall apply.

Section C.7 has the following amendments,

C.7.3.1 For **Synchronous Power Generating Modules** the **Generator** shall ~~supply simulation studies to~~ demonstrate the capability to meet Section 13.5 by submission of a report containing~~:~~

~~(i) a~~ load flow simulation study ~~result to demonstrate~~ results showing:

(i) the maximum lagging **Reactive Power** capability ~~of the **Power Generating Module** at **Registered Capacity**~~ when the **Connection Point** voltage is at 105% of nominal.

(ii) ~~a load flow simulation study result to demonstrate~~ the maximum leading **Reactive Power** capability ~~of the **Power Generating Module** at **Registered Capacity**~~ when the **Connection Point** voltage is at 95% of nominal.

(iii) ~~a load flow simulation study result to demonstrate~~ the maximum lagging **Reactive Power** capability ~~of the **Power Generating Module**~~ at the **Minimum Stable Operating Level** when the **Connection Point** voltage is at 105% of nominal.

(vi) ~~a load flow simulation study result to demonstrate~~ the maximum leading **Reactive Power** capability ~~of the **Power Generating Module**~~ at **the Minimum Stable Operating Level** when the **Connection Point** voltage is at 95% of nominal.

The terminal voltage in the simulation should be the nominal voltage for the machine.

C.7.3.2 For **Power Park Modules** with a **Connection Point** voltage above 33 kV the **Generator** shall demonstrate the capability to meet paragraph 13.5.4 by submission of a report containing load flow simulation studies to demonstrate operation at points A, B, E and F in accordance with Figure C.5.2. The studies shall be undertaken with the **Power Park Module** operating at **Registered Capacity** and **Minimum Stable Operating Level**.

C.7.3.3 For **Power Park Modules** with a **Connection Point** voltage at or below 33 kV the **Generator** shall demonstrate the capability to meet paragraph 13.5.5 by submission of a report containing load flow simulation studies to demonstrate operation at points A, B, E and F in accordance with

Figure C.5.3. The studies shall be undertaken with the **Power Park Module** operating at **Registered Capacity** and **Minimum Stable Operating Level**.

~~For **Power Park Modules** the **Generator** shall supply simulation studies to demonstrate the capability to meet Section 13.5 by submission of a report containing:~~

~~(i) a load flow simulation study result to demonstrate the maximum lagging **Reactive Power** capability of the **Power Park Module** at **Registered Capacity** when the **Connection Point** voltage is at 103% of nominal.~~

~~(ii) a load flow simulation study result to demonstrate the maximum leading **Reactive Power** capability of the **Power Park Module** at **Registered Capacity** when the **Connection Point** voltage is at 97% of nominal.~~

~~(iii) a load flow simulation study result to demonstrate the maximum lagging **Reactive Power** capability of the **Power Park Module** at the **Minimum Stable Operating Level** when the **Connection Point** voltage is at 103% of nominal.~~

~~(vi) a load flow simulation study result to demonstrate the maximum leading **Reactive Power** capability of the **Power Park Module** at **the Minimum Stable Operating Level** when the **Connection Point** voltage is at 97% of nominal.~~

C.7.3.~~3~~4 In the case of a **Power Park Module** where the load flow simulation studies show that the individual **Generating Unit**s deviate from nominal voltage to meet the **Reactive Power** requirements then evidence shall be provided from factory (eg **Manufactures Information**) or site testing that the **Generating Unit** is capable of operating continuously at the operating points determined in the load flow simulation studies.

A new footnote (30) has been added to accompany section C.7.3.1 (i), it reads,

This report may include reference to the **Generator Performance Chart**.

C.7.5.3 The simulation study should be completed with the **Power Generating Module** operating at full **Active Power** and maximum leading **Reactive Power** and the fault level at the **Connection Point** at minimum as notified by the **DNO**. A minimum short circuit power of 50 MVA is a generic minimum fault level that should be assumed. For the few cases where the fault level is lower than this the **DNO** will advise the **Generator** regarding the fault level assumptions to be used.

C.7.5.4 The simulation study will show acceptable performance providing compliance with the requirements of paragraph 13.3.1.11 (e) are demonstrated.

C.7.5.5 In the case of **Power Generating Module**s comprised of **Generating Units** in respect of which the **Generator's** reference to **Manufacturers' Information** has been accepted by the **DNO** (or by the **NETSO** as **Grid Code** compliant and confirmed by the **NETSO** to the **DNO**) for **Fault Ride Through**, C.7.5.2 will not apply provided:

(i) the **Generator** demonstrates by load flow simulation study result that the faults and voltage dips at either side of the **Generating Unit** transformer corresponding to the required faults and voltage dips in C.7.5.2 applied at the **Connection Point** are less than those included in the **Manufacturers' Information**, or;

(ii) the same or greater percentage faults and voltage dips in C.7.5.2 have been applied at either side of the **Generating Unit** transformer in the **Manufacturers' Information**.

C.7.6 **Limited Frequency Sensitive Mode – ~~Over Frequency~~Overfrequency (LFSM-O)**

C.7.6.5 Simulation studies shall be performed for **Type C** and **Type D Power Generating Modules** in **Limited Frequency Sensitive Mode** (**LFSM**) and for **Type C** and **Type D Power Generating Modules** in **Frequency Sensitive Mode** (**FSM**). The simulation study results should indicate **Active Power** and frequency.

C.7.6.6 To allow validation of the model used to simulate load rejection in accordance with paragraph 13.2.4 ~~as described,~~ a further simulation study is required ~~to represent~~that shows simulation results for the largest positive frequency injection step or fast ramp (BC1 and BC3 of Figure C.8.1 and or Figure C.9.3) that will be applied ~~as a test~~during compliance tests as described in C.8.6 and C.9.5.

C.7.7 **Limited Frequency Sensitive Mode – ~~Under Frequency~~Underfrequency (LFSM-U)**

Section C.8 amendments are shown below,

C.8.4.3.1 Initially the performance of the **Under-excitation Limiter** should be checked by moving the limit line close to the operating point of the **Generating Unit** when operating close to unity **Power Factor**. The operating point of the **Generating Unit** is then stepped into the limit by applying a 2% decrease in **Automatic Voltage Regulator** ~~Setpoint Voltage~~setpoint voltage.

C.8.4.3.2 The final performance of the **Under-excitation Limiter** shall be demonstrated by testing its response to a step change corresponding to a 2% decrease in **Automatic Voltage Regulator** ~~Setpoint Voltage~~setpoint voltage when the **Generating Unit** is operating just off the limit line, at the designed setting as indicated on the **Performance Chart** [P-Q Capability Diagram] submitted to the **DNO** under DDRC Schedule 5.

Test	Injection	Notes
	Generating Unit running at **Registered Capacity** and unity **Power Factor**. Under-excitation limit temporarily moved close to the operating point of the **Generating Unit**.	
1	• **PSS** on (if applicable). • Inject -2% voltage step into **AVR** ~~Voltage Setpoint~~voltage setpoint and hold at least for 10 s until stabilised • Remove step returning **AVR** ~~Voltage Setpoint~~voltage setpoint to nominal and hold for at least 10 s	
	• Under-excitation limit moved to normal position. **Generating Unit** running at **Registered Capacity** and at leading **Reactive Power** close to Under-excitation limit.	
2	• **PSS** on (if applicable). • Inject -2% voltage step into **AVR** ~~Voltage Setpoint~~voltage setpoint and hold at least for 10 s until stabilised • Remove step returning **AVR** ~~Voltage Setpoint~~voltage setpoint to nominal and hold for at least 10 s	

C.8.4.4 **Over-excitation Limiter Performance Test**

C.8.4.1 The performance of the **Over-excitation Limiter**, where it exists, shall be demonstrated

by testing its response to a step increase in the **Automatic Voltage Regulator** ~~Setpoint Voltage~~setpoint voltage that results in operation of **the Over-excitation Limiter**. Prior to application of the step the **Generating Unit** shall be generating **Registered Capacity** and operating within its continuous **Reactive Power** capability. The size of the step will be determined by the minimum value necessary to operate the **Over-excitation Limiter** and will be agreed by the **DNO** and the **Generator**. The resulting operation beyond the **Over-excitation Limit** shall be controlled by the **Over-excitation Limiter** without the operation of any protection that could trip the **Power Generating Module**. The step shall be removed immediately on completion of the test.

Test	Injection	Notes
	Generating Unit running at **Registered Capacity** and maximum lagging **Reactive Power**.	
	Over-excitation Limit temporarily set close to this operating point. **PSS** on (if applicable).	
1	• Inject positive voltage step into **AVR** voltage setpoint and hold • Wait ~~till~~until **Over-excitation Limiter** operates after sufficient time delay to bring back the excitation back to the limit. • Remove step returning **AVR** voltage setpoint to nominal.	
	Over-excitation Limit restored to its normal operating value. **PSS** on (if applicable).	

Module Load Point 6 (**MEL**)	100% MEL
Module Load Point 5	95% MEL
Module Load Point 4 (Mid-point of Operating Range)	80% MEL
Module Load Point 3	70% MEL
Module Load Point 2 (**Minimum Stable Operating Level**)	MG
Module Load Point 1 (**Minimum ~~Stable Operating~~Regulating Level**)	**MRL**

The following exerts (* and **) accompany figure C.8.1.

* This will generally be +2.0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Minimum ~~Stable Operating~~Regulating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 0.9 Hz is needed to take an initial output 65% to a final output of 20%. If the initial output was not 65% and the **Minimum ~~Stable Operating~~Regulating Level** is not 20% then the

injected step should be adjusted accordingly as shown in the example given below

Initial Output 65%

Minimum ~~Stable Operating~~Regulating Level ~~20%~~ 20%

Frequency Controller **Droop** ~~4%~~ 4%

Frequency to be injected = (0.65-0.20) x 0.04 x 50 = 0.9 Hz

** Tests L and M in Figure C.8.1 shall be conducted if in this range of tests the system frequency feedback signal is replaced by the injection signal rather than the injection signal being added to the system frequency signal. The tests will consist of monitoring the **Synchronous Power Generating Module and CCGT Module** in **Frequency Sensitive Mode** during normal system frequency variations without applying any injection. Test N in Figure C.8.1 shall be conducted in all cases. Both tests should be conducted for a period of at least 10 minutes.

C.8.6.6 The target frequency adjustment facility should be demonstrated from the normal control point within the range of 49.9 Hz to 50.1 Hz by step changes to the target frequency setpoint~~.~~ while operating at MLP4 (Figure C.8.1).

Section C9 has had the following amendments,

C.9.3.3 The following tests shall be completed:

(i) Operation in excess of 60% **Registered Capacity** and maximum continuous lagging **Reactive Power** for 30 minutes.

(ii) Operation in excess of 60% **Registered Capacity** and maximum continuous leading **Reactive Power** for 30 minutes.

(iii) Operation at 50% **Registered Capacity** and maximum continuous leading **Reactive Power** for 30 minutes.

(iv) Operation at 50% **Registered Capacity** and maximum continuous lagging **Reactive Power** for 30 minutes.

~~(iv)~~(v) Operation at 20% **Registered Capacity** and maximum continuous leading **Reactive Power** for 60 minutes.

~~(v)~~(vi) Operation at 20% **Registered Capacity** and maximum continuous lagging **Reactive Power** for 60 minutes.

~~(vi)~~(vii) Operation at less than 20% **Registered Capacity** and unity **Power Factor** for 5 minutes. This test only applies to systems which do not offer voltage control below 20% of **Registered Capacity**.

~~(vii)~~(viii) Operation at the lower of the **Minimum Stable Operating Level** or 0% **Registered Capacity** and maximum continuous leading **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

~~(viii)~~(ix) Operation at the lower of the **Minimum Stable Operating Level** or 0% **Registered Capacity** and maximum continuous lagging **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

C.9.4.2 The voltage control system shall be perturbed with a series of step injections to the **Power Park Module** voltage ~~Setpoint~~setpoint, and where possible, multiple up-stream transformer taps.

C.9.4.4 For a step injection into the **Power Park Module** voltage ~~Setpoint~~setpoint, steps of ±1% and

±2% (or larger if required by the **DNO**) shall be applied to the voltage control system ~~Setpoint~~setpoint summing junction. The injection shall be maintained for 10 s as per Figure C.9.2.

C.9.5.1 This section describes the procedure for performing frequency response testing on a **Power Park Module**. These tests should be scheduled at a time where there are at least 95% of the **Generating Unit**s within the **Power Park Module** in service. There should be sufficient MW resource ~~forecasted~~forecast in order to generate at least 65% of **Registered Capacity** of the **Power Park Module**.

C.9.5.3 In addition to the frequency response requirements it is necessary to demonstrate the **Power Park Module** ability to deliver a requested steady state power output which is not affected by power source variation as per paragraph 13.~~12~~2.3.1. This test shall be conducted in **Limited Frequency Sensitive Mode** at a part-loaded output for a period of 10 minutes as per C.9.5.6.

C.9.5.4 The frequency response tests are to be conducted at a number of different Module Load Points (MLP) based on the maximum export limit (MEL). In the case of a **Power Park Module** the module load points are conducted as shown below unless agreed otherwise by the **DNO**.

Module Load Point 6 (~~**Maximum** Export Limit~~maximum export limit)	100% MEL
Module Load Point 5	90% MEL
Module Load Point 4 (Mid point of Operating Range)	80% MEL
Module Load Point 3	**MRL**+20%
Module Load Point 2 Lower of **Minimum Regulating Level** + 10% or **Minimum Stable Operating Level**	**MRL**+10% o **MSOL**
Module Load Point 1 (**Minimum ~~Stable Operating~~Regulating Level**)	**MRL**

C.9.5.5 The tests are divided into the following two types;

(i) Frequency response tests in **Limited Frequency Sensitive Mode (LFSM)** to demonstrate **LFSM-O** and **LFSM-U** capability as shown by Figure C.9.3.
(ii) System islanding and step response tests as shown by Figure C.9.3.

C.9.5.6 There should be sufficient time allowed between tests for control systems to reach steady state (depending on available power resource). Where the diagram states 'HOLD' the injection signal should be maintained until the **Active Power** (MW) output of the **Power Park Module** has stabilised. All frequency response tests should be removed over the same timescale for which they were applied. ~~the~~The **DNO** may require repeat tests should the response volume be affected by the available power, or if tests give unexpected results.

* This will generally be +2.0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below the **Minimum ~~Stable Operating~~Regulating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example, 0.9 Hz is needed to take an initial output 65% to a final output of 20%. If the initial output was not 65% and the **Minimum ~~Stable Operating~~Regulating Level** is not 20% then the injected step should be adjusted accordingly as shown in the example given below:

Initial Output	65%
Minimum ~~Stable Operating~~Regulating Level	20%
Frequency controller **Droop**	4%

Frequency to be injected = (0.65-0.20) x 0.04x50 = 0.9 Hz

C.9.5.7 The target frequency adjustment facility should be demonstrated from the normal control point within the range of 49.9 Hz to 50.1 Hz by step changes to the target frequency setpoint~~.~~ while operating at MLP4 (Figure C.9.3).

1.3.21

1.3.22