Company Standard

Conditions Governing the Connection and Operation of Small Scale Generation (50 kW - 200 kW)

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Foreword

This document has been produced to facilitate a more efficient connection of the two categories of synchronous and inverter connected generation in the premises of demand customers with an installed generation capacity above the levels set out in 'Conditions Governing the Connection and Operation of Mini-generation' (DOC-030221-GAP), termed 'Small Scale Generation (SSG)', as defined in Section 1.1.1.

In this document the requirements for Generation installations set out in 'Conditions Governing Connections to the Distribution System at MV' (DTIS-250701-BDW), have been simplified in their application here for Small Scale Generation. The main change is that the requirements for use of Export Limiting Schemes for Small Scale Generation installations are provided in the associated document 'Conditions Governing the Connection and Operation of Export Limiting Schemes at LV and MV' (DOC-250221-GBT)

Generation which is not categorised as Micro-Generation (DTIS-230206-BRL), Mini-Generation (DOC-030221-GAP) or Small Scale Generation (DOC-310522-HLU), is covered under 'Conditions Governing Connection to the Distribution System at MV'[1] (DTIS-250701-BDW).

i. Scope

This document sets out ESB Networks standard on the connection and operation of Small Scale Generation (SSG). It specifies the connection requirements for synchronous and inverter connected generation installations as defined in Section 1.1.1, in demand installations connected to the DSO network.

The size of the generation is defined:

- for inverter-connected generation as the sum of the inverter ratings,

or

- for synchronous generation as the sum of the generator ratings.

This document does not cover synchronous or induction generation connections which are in excess of Small Scale Generation (SSG), to which the existing company standard 'Connections Governing Connections to the Distribution System' (DTIS-250701-BDW) continues to apply.

Generation connections which are not covered in either the Micro-Generation document (DTIS-230206-BRL), the Mini-Generation document (DOC-030221-GAP), or this Small Scale Generation (SSG) document, are by default covered in 'Conditions Governing Connections to the Distribution System at MV' (DTIS-250701-BDW).

The following documents cover the conditions governing the connection and operation of generator installations to the Distribution System Operator (DSO) network:

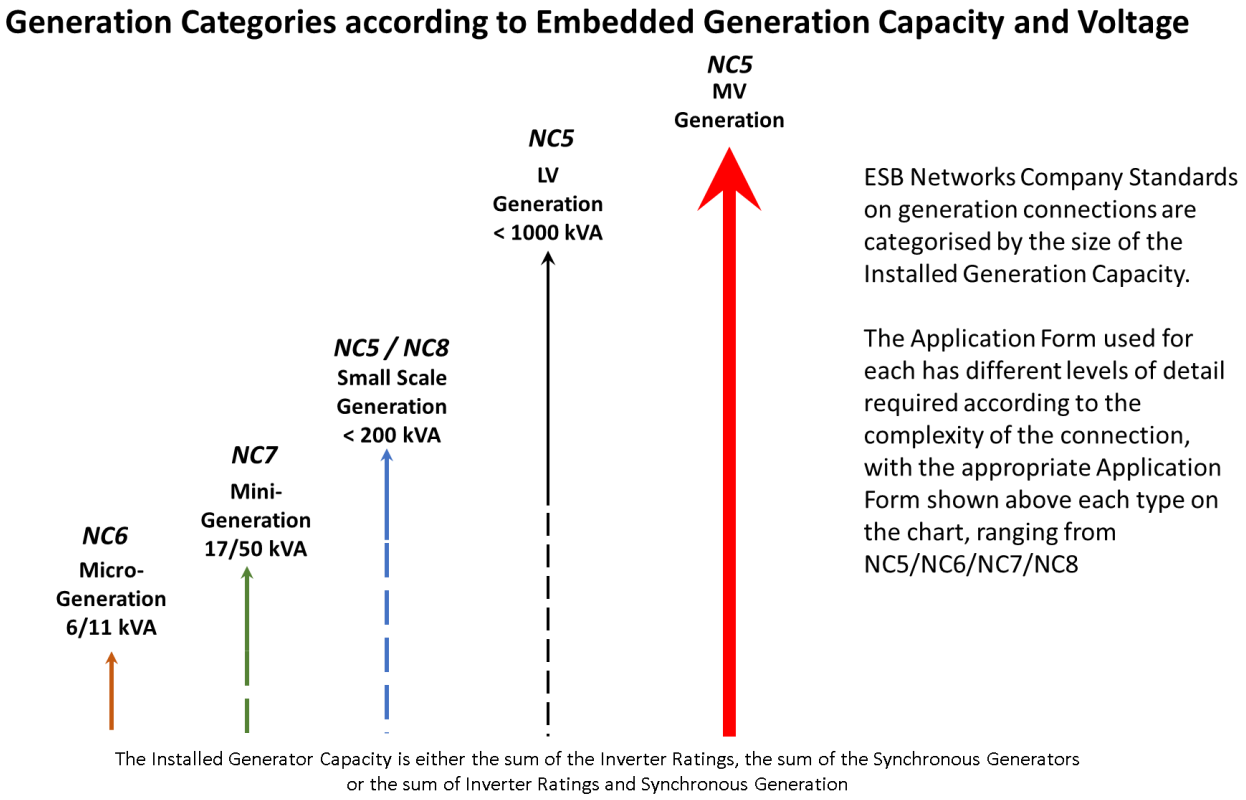
Table 1: Conditions governing the connection and operation of generator installations documents

Generation Installation	Document Title	Ref. No.
Micro-Generation: Up to and including 25 A single-phase / 16 A three-phase (c. 6 kVA/11 kVA, LV)	Conditions Governing the Connection and Operation of Micro-Generation	DTIS-230206-BRL
Mini-Generation: (Inverter Connected) Above Micro-Generation, up to and including 72 A single-phase / 72 A three-phase (c. 17 kVA/50 kVA, LV)	Conditions Governing the Connection and Operation of Mini-Generation	DOC-030221-GAP

[1] 'Conditions Governing Connection to the Distribution System at Medium Voltage; Connections at MV and 38kV; Embedded Generators at LV, MV and 38kV'

Export Limiting Schemes for Generator installations at LV and MV	Conditions Governing the Connection and Operation of Export Limiting Schemes at LV and MV	DOC-250221-GBT
Small Scale-Generation: Above Mini-Generation, up to 200 kVA installed capacity	Conditions Governing the Connection and Operation of Small Scale Generation	DOC-310522-HLU
All other generation	Conditions Governing Connections to the Distribution System at Medium Voltage	DTIS-250701-BDW

Figure 1:Categories of generation installations



ii. Mandatory References

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

Table 2: Mandatory References

Document No.	Title
DOC-230206-BRL	Conditions Governing the Connection and Operation of Micro-Generation
DOC-030221-GAP	Conditions Governing the Connection and Operation of Mini-Generation
DTIS-250701-BDW	Connections Governing Connection to the Distribution System at Medium Voltage
DOC-060416-EEY	Distribution Code
DOC-250221-GBT	Conditions Governing the Connection and Operation of Export Limiting Schemes at LV and MV

Document No.	Title
I.S. EN 50549-1	Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B
I.S. EN ISO/IEC 17065	Conformity Assessment – Requirements for bodies certifying products, processes and services
DOC-030303-AEN	ESB Networks National Code of Practice for Customer Interface
I.S. 10101	National Rules for Electrical Installations

1. Requirements for Small Scale Generation Installations on ESB Networks

1.1 Definitions

1.1.1 Small Scale Generation

For the purposes of this document, Small Scale Generation is defined as:

- a source of connected electrical energy and all associated equipment,

and

- designed to operate in parallel with the DSO network
  - continuously, or
  - for longer than 3 minutes at any start up/shutdown, or
  - for longer than 6 minutes during test/maintenance or any other purpose.

and

- in the following ranges, where the Installed Capacity is less than or equal to the MIC:

  - Where the site is connected at LV from the DSO LV network, then the installed capacity can be up to the following limits:
    - Synchronous Installed Capacity greater than 11 kVA and up to 170 kVA, or
    - Inverter-connected Installed Capacity greater than 50 kVA and up to 170 kVA, or

  - Where the site is connected at LV directly to the customer switchroom circuit breaker from an ESB Networks substation building via ESB Networks 400 sq.mm aluminium cable, or connected at Medium Voltage (MV) or High Voltage (HV), then the installed capacity can be up to the following limits:
    - Synchronous Installed Capacity greater than 11 kVA up to 200 kVA, or
    - Inverter-connected Installed Capacity greater than 50 kVA and up to 200 kVA.

In all cases, the Installed Capacity shall be less than or equal to the MIC of the customer

Note: The unbalance between phases due to generation should not be more than 25 A single-phase (c. 6 kVA). This can be achieved by the installation of a current unbalance relay or by ensuring that no more than three individual 25 A single-phase generators connected evenly over the three phases are installed on a three-phase connection

Where multiple generating sources [of the same or varied technologies] are on the same site **and** share access to the same DSO network connection point, the aggregate rating shall not exceed the limits as defined in Section 1.1.1.

1.1.2 Installed Capacity:

Throughout this document reference is made to ‘Installed Capacity’.

For the purpose of defining the scope of the ‘Small Scale Generation’ connection process, the Installed Capacity shall be one of the following:

- The total of the aggregate of the continuous steady state rating of the energy sources' inverters[2] where the generation is inverter connected, or.
- The sum of the generator ratings for synchronous generators, or.
- The sum of the continuous steady state rating of the energy sources' inverters plus the synchronous generator(s) ratings, where there is a combination of the two categories.

In cases where the amount of generation or battery export installed behind an inverter is greater than the inverter rating, the Installed Capacity shall still be taken as equal to the inverter rating. In all cases (where no ELS is deployed), the inverter shall operate to ensure that its output is never greater than the MEC.

On a three-phase connected installation, either:

- Current unbalance shall be limited to no more than 25 A between phases by means of a current unbalance relay, or,
- No more than 3 x 25 A[3] single-phase generators shall be installed; Any generation in excess of this shall be three-phase generation. Three-phase units shall have a maximum unbalance between phases no more than 25 A.

1.1.3 Maximum Export Capacity (MEC):

The Maximum Export Capacity (MEC) is defined as the maximum power, expressed in kVA, that is permitted by ESB Networks to transfer from the Customer's Point of Connection to the DSO network.

In all cases, the MEC shall be less than or equal to the Installed Capacity.

The Installed Capacity shall be less than or equal to the MIC of the site.

The installed capacity, as defined in Section 1.1.2 (deemed to be the amount of generation seen by the DSO network), shall not be greater than the MEC, unless there is an Export Limiting Scheme in place (see Section 1.1.4). This is to prevent any incident of the total installed energy sources exporting in an unconstrained fashion onto the grid in the event of the customer load being turned off, which would result in standards being breached.

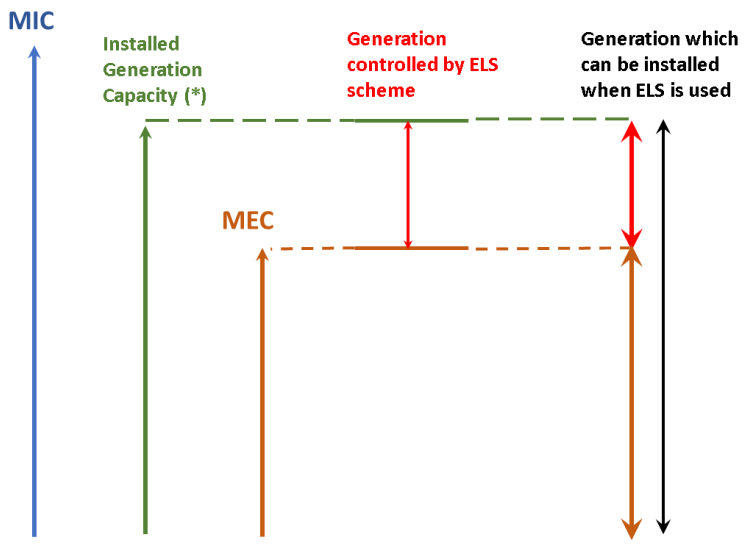
In the case of synchronous generation, there may be additional constraints imposed by ESB Networks via the Distribution Code caused by associated inrush currents in terms of voltage dips and short circuit impacts.

1.1.4 Export Limiting Scheme

See 'Conditions Governing the Connection and Operation of Export Limiting Schemes at LV and MV' (DOC-250221-GBT) (available on www.esbnetworks.ie) which is applicable to the types of generator installations outlined in this document.

[2] Generation and battery export
[3] c. 6kVA

Figure 2: Functional representation of an ELS



The Installed Generation Capacity (*) is less than or equal to the MIC.

The MEC is less than or equal to the Installed Generator Capacity.

The Installed Generator Capacity installed will all export unless controlled by an ELS.

Using an ELS the Installed Generation will be controlled so that the export does not exceed MEC.

In this way the Installed Generator Capacity can be allowed exceed the MEC.

1.1.5 Distinction between Installed Capacity and Maximum Export Capacity:

MEC is distinct from Installed Capacity and is separately defined in the ESB Networks Connection Agreement. These definitions make no explicit reference to any specific form of generating technology.

2. Applicable Technical Standards

2.1 Interface Protection Settings

Interface protection should be checked by the customer at regular intervals (at least every 5 years) and on any occasion when revised protection settings are advised by ESB Networks.

Where changes to protection settings are required, the customer shall be notified in writing by ESB Networks. The customer shall then confirm the required changes have been made within twenty working days to dsosmallscalegeneration@esb.ie.

For the avoidance of doubt, integrated inverter protection shall not be acceptable for Small Scale Generation

2.1.1 Inverter-Connected Small Scale Generation

- LV Connected Sites:

  The interface protection settings for inverter connected Small Scale Generation shall be those stated in Table 3, Annex A.

- MV and Higher Voltage Connected Sites:

  The interface protection settings for inverter connected Small Scale Generation shall be those stated in Table 4M of 'Conditions Governing Connection to the Distribution System at Medium Voltage'[4] (DTIS-250701-BDW)

2.1.2 Synchronous Small Scale Generation

The protection settings for Synchronous Small Scale Generation shall be those stated in Table 4N of 'Conditions Governing Connection to the Distribution System at Medium Voltage'[5] (DTIS-250701-BDW)

[4] Conditions Governing Connection to the Distribution System at Medium Voltage; Connections at MV and 38kV; Embedded Generators at LV, MV and 38kV

[5] Conditions Governing Connection to the Distribution System at Medium Voltage; Connections at MV and 38kV; Embedded Generators at LV, MV and 38kV

3. Common Considerations

3.1 Metering

Metering requirements are outside the scope of this document, and are covered in the ESB Networks Code of Practice at the Customer Interface (DOC-030303-AEN).

CT Metering shall only be used for Small Scale Generation.

3.2 Interface Protection

Each Small Scale Generator shall have independent protection as set out in accordance with 'Conditions Governing Connections to the Distribution System at Medium Voltage'[6] (DTIS-250701-BDW); usually referred to as 'G10' protection.

Note: For the avoidance of doubt, integrated inverter protection **shall not be** acceptable for Small Scale Generation.

Interface protection settings shall be as specified in Section 2.1.

3.3 Cease energise / Disconnection

The interface protection shall cease energisation of the DSO network when any parameter exceeds the applied operating setting.

Automatic disconnection shall be required in case of any hardware malfunctioning.

3.4 Accessibility of Isolation Switching Devices

Under the I.S.HD 384 series there is a requirement that a means of isolating the generator from the public supply shall be provided. This means of isolation shall be accessible to ESB Networks at all times. At least one of the means of disconnection shall be provided by the separation of mechanical contacts.

3.5 Changing settings of the interface protection

The interface protection settings shall only be altered, from those in place at the time of commissioning, with the written agreement of ESB Networks, or where ESB Networks instruct the customer to update the settings to required levels, and then only in accordance with the manufacturer instructions.

It shall not be possible for the user to alter the interface protection settings without the use of special tools or techniques, such as password protection.

3.6 Automatic reconnection after a network outage

The interface protection and control shall ensure that feeding power to the DSO network shall only commence after the voltage and frequency on the DSO network have been within the limits of the interface protection settings for a

[6] Conditions Governing Connection to the Distribution System at Medium Voltage; Connections at MV and 38kV; Embedded Generators at LV, MV and 38kV

minimum of 5 minutes for both inverter-connected and synchronous based systems as set out in 'Conditions Governing Connections to the Distribution System at Medium Voltage' (DTIS-250701-BDW)

In order to facilitate such automatic reconnection, power input to the interface protection equipment and sensing connections to the interface protection (that is initiated by the G10 interface protection) shall be restored on both

- the ESB Networks' side of the disconnector, and
- on the Small Scale Generator side of the isolator.

CAUTION:
Manufacturers should give consideration to limiting the number of attempted reconnections within any one period of time, as not doing so may result in voltage disturbances on the customer's network and would be a more onerous duty cycle on the equipment

The interface with the DSO network shall not be capable of connecting the generation source to the DSO network if the DSO grid supply is not present and within parameters given in Section 2.1. Any form of generation whose interface with the DSO network does not comply with this provision is considered outside the scope of this standard.

3.7 Network sizing considerations

No allowance for import reduction shall be taken into consideration in the determination of the sizing of network components.

All designs shall be based upon the MIC or MEC stated in the application, and the more onerous condition shall determine the design.

3.8 Means to Detect Islanding situation

For a generation to load mismatch of 75% and 125% or greater, a means of detecting islanding situations (known as 'Loss of Mains' or 'anti-islanding protection') shall operate to cease energising or to disconnect, within the prescribed clearance time, irrespective of where the interruption takes place on the DSO network.

This functionality shall be demonstrated and explicitly stated in Type Testing certification.
The operation of this protection at any given site shall not in and of itself disturb or cause spurious operation of interface protection at any other site.

3.9 Rate of Change of Frequency [ROCOF] immunity requirements

The Small Scale Generator module shall stay connected to the distribution system when the frequency of the power system changes at a rate of up to 1 Hz/s. This rate is defined with a sliding measurement window of 500 ms.

This functionality shall be explicitly demonstrated in Type testing. If ROCOF is used as the means of detecting island situations, then the settings for the demonstration of compliance with this clause shall be as close as practicable to 1 Hz/s.

3.10 Safety of ESB Networks Personnel

To safeguard against electrical hazards being presented to persons working on or in close proximity to DSO network, compliance with this standard, with the National Rules for Electrical Installations (I.S. 10101), and with the ESB Networks Code of Practice at the Customer Interface (DOC-030303-AEN), shall be required.

3.11 Labelling

Where an item of equipment contains live parts connected to more than one source of supply, a warning notice shall be fitted in a position that warns any person gaining access to live parts in advance, and of the need to isolate those parts from the various supplies.

However, this shall not be required if an interlocking arrangement is provided to ensure that all circuits concerned are isolated.

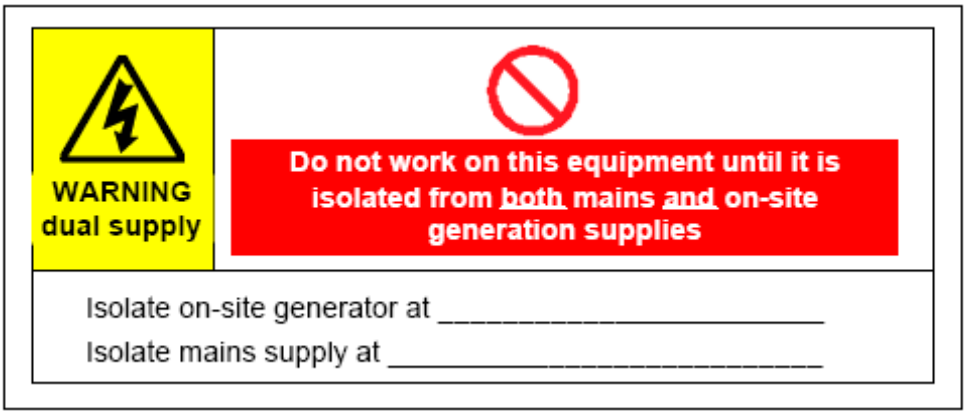
Special attention shall be paid to the possibility of the power supply, measuring circuits [sense lines] and other parts not being isolated from the grid when the switching device[s] associated with the interface are open.

As a minimum, warning notices shall be placed:

- At the ESB Networks metering position of a location where a Small Scale Generator is installed
- At the consumer unit position of a location where a Small Scale Generator is installed
- On all switchboards between the consumer unit and the Small Scale Generator itself
- At all points of isolation for the Small Scale Generator

An acceptable format is given in Figure 3

Figure 3: Suggested format of warning notice



3.12 Power and Voltage control

Subject to agreement with ESB Networks, generators may be directed to use voltage related active power reduction to avoid the likelihood of tripping for high voltage events.

In normal operation voltage control shall be enabled to maintain Q-U control as set out in I.S. EN 50549, Section 4.7, with reactive power limits as defined in the Distribution Code.

ESB Networks may in the future seek to invoke or apply some of the additional voltage control capabilities of the equipment where cited in 'Conditions Governing Connections to the Distribution System at Medium Voltage' (DTIS-250701-BDW). Where this arises, ESB Networks shall communicate such proposed changes with industry and stakeholders. Any applicable changes to the Distribution Code shall be progressed through the Distribution Code Review Panel (DCRP).

The generator shall be capable of receiving and acting on an analogue or digital signal, as set out in I.S. EN 50549 , to limit the kW output. ESB Networks may specify the means by which to achieve this at some point in the future.

Note: for the avoidance of doubt, this clause does not in and of itself mandate or specify what form the means of achieving such kW control will be; rather that the Generating Unit shall be capable of acting on such an analogue or digital signal.

It is likely that both a wired **and** a wireless communication method to the inverter may be required to have the necessary level of communications redundancy built-in, with possible examples being:

- Wired Communication Interface – RS485 to typically support a communication protocol like the ModBus RTU
- Wireless Communications Interface – Embedded TCP/IP to typically support a communication protocol such as ModBus TCP

3.13 Overvoltage 10 minute mean protection

Generators may, based on a 10 minute average, and on the overvoltage being set at 112% of nominal (258 V / 448 V):

- create an alert to indicate the need for some mitigating action to avoid increasing the voltage, or
- trip for overvoltage, subject to 'Conditions Governing Connections to the Distribution System at Medium Voltage' (DTIS-250701-BDW).

4. Connection Offer Process for Small Scale Generation.

4.1 Description

The Small Scale Generation process shall require an application for connection to ESB Networks, whereupon a network study shall be carried out and the conditions for connection advised in the Connection Offer.

4.2 Implementation of Connection Offer Procedure for Small Scale Generation

4.2.1 Application and Connection Offer

For Small Scale Generation installations in existing premises, the customer shall complete:

- For Inverter-Connected Small Scale Generation

  The **NC8** application form (available on www.esbnetworks.ie). With the application form, the customer shall provide a Type Test Certificate from a recognised laboratory[7] listing the harmonic currents produced up to the 50th harmonic.

- For Synchronous Small Scale Generation:

  The **NC5** application form (available on www.esbnetworks.ie) .

The

- name,
- e-mail address,
- postal address and
- phone number

of the installer shall also be provided in the NC8 or the NC5.

Following receipt of the application and the application fee, ESB Networks shall assess the network for the proposed connection and issue a connection offer.

The customer shall not commence the generator connection works until the conditions in the Connection Offer have been met and any ESB Networks construction works have been completed.

4.2.2 Installation of Small Scale Generation

Following acceptance of the Connection Offer, and after the generator installation has been completed, the installer shall carry out any on-site commissioning tests to ensure satisfactory operation of the generator, with the installation conforming to the National Rules for Electrical Installations (I.S. 10101) and the ESB Networks Code of Practice at the Customer Interface (DOC-030303-AEN).

The installer shall also confirm that:

a) Any applicable on-site commissioning tests have been completed successfully, and;
b) That interface protection settings are in compliance with Section 2.1 of this document, or as otherwise agreed via derogation with ESB Networks

ESB Networks shall carry out a witness test to ensure the correct operation of the G10 Interface Protection with the installer, as set out in Section 4.2.3.

[7] Type test certificate shall be from a body certified to I.S.EN ISO/IEC 17065

Until Witness Testing has been successfully completed by ESB Networks, the offered MEC (and ELS, if applicable) shall not become active.

The period of validity of the Connection Offers shall be as stated in the Connection Offer

4.2.3 Witness Testing

ESB Networks shall carry out witness testing of the relevant elements [such as, but not limited to, under/over voltage/frequency and Loss of Mains] of interface protection. This shall be arranged by the installer twenty business days in advance of the installation by contacting ESB Networks through EGIPWitnesstesting@esb.ie .

Until witness testing is completed the generator shall not be connected to the DSO network.

The witness testing requirements shall be as set out in 'Conditions Governing Connections to the Distribution System at MV' (DTIS-250701-BDW).

Further details on the process are available on the ESB Networks website (www.esbnetworks.ie).

Annex A.(Mandatory): Interface Protection Settings, Inverter Connected LV Small Scale Generation

		LV Single Phase	LV 3 Phase
Under Voltage			
Stage 1		29 V 0.5 s	52 V 0.5 s
Stage 2		191 V 3 s	332 V 3 s
Over Voltage			
I.S. EN 50549-1 Installations (2 Stage Settings)	Stage 1	269 V 70 s	468 V 70 s
	Stage 2	281 V 0.7 s	488 V 0.7 s
Under Frequency			
Stage 1 47 Hz		47 Hz 0.5 s	47 Hz 0.5 s
Stage 2 47.5 Hz (Use if only single stage)		47.5 Hz 20 s	47.5 Hz 20 s
Over Frequency			
Stage 1 52 Hz		52 Hz 20 s	52 Hz 20 s
Stage2 52.5 Hz		52.5 Hz 0.5 s	52.5 Hz 0.5 s
RoCoF		1 Hz / s 0.6 s	
Vector Shift		Not Allowed	

Table 3: Inverter Connected Small Scale Generation Interface Protection Settings

Derogations

No Derogations are recorded against the Requirements of this document.

Terms, Definitions & Symbols Used

For the purposes of this document, the following terms and definitions apply.

Table 4: Terms & Definitions

Term / Symbol	Definition
Shall	Designates a Company Requirement, hence conformance is mandatory.
Should	Designates a Company Recommendation where conformance is not mandatory, but is recognised as best practice.
May	Designates a Permissive Statement - an option that is neither mandatory nor specifically recommended.

CAUTION: Used to give the end user information on what can happen, why and the consequences of ignoring the caution.

Used to give the end user specific, important information to help complete the task or procedure correctly.

This is a stop or critical point in the procedure.
It contains a rule that shall be followed by the end user.

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