TasNetworks Standard

Embedded Generation Anti-Islanding Scheme

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Responsibilities

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Please contact the Asset Strategy and Performance Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

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1 Purpose

The purpose of this document is to define a standardised approach for anti-islanding protection associated with embedded generators (EGs), connected to TasNetworks MV and LV networks, that can result in the formation of a viable island.

This standard is intended for an internal TasNetworks audience to develop Anti-Islanding Schemes (AISs) for new customer connections.

Reference should be made to the 'National Distributed Energy Resources Grid Connection Guidelines' developed by the Energy Networks Australia[1] and TasNetworks 'Technical Requirements for the Connection of Embedded Generation' guideline[2].

2 Background

An electrical island is created when an EG is disconnected from the Distribution Network Service Provider's (DNSP) network but remains in-service maintaining supply to local islanded loads.

If an EG remains connected, following the creation of an electrical island, voltage and/or frequency within the island may not remain within acceptable limits. Additionally, protection functions that rely on connection to the national grid may not function as intended. This may result in significant damage to the EG, islanded network, and/or customer plant connected to the islanded network.

After an electrical island is formed, any embedded generation within the island will lose the frequency reference provided by the national grid. Consequently, the island will lose synchronisation with the remainder of the network. The reconnection of the unsynchronised electrical island, to the remainder of the electrical network, may result in significant damage to the EG, network, and/or customer plant connected to the network.

These outcomes can be mitigated with the disconnection of the EG by means of an AIS. An AIS is comprised of one or more types of anti-islanding protection functions to detect when a generator has become disconnected from the network and initiate actions to isolate the generator from the island.

Anti-islanding protection can be grouped into three main types:

- Passive anti-islanding protection
- Active anti-islanding protection
- Communications based anti-islanding protection

2.1 Passive anti-islanding protection

Passive anti-islanding protection monitors the electrical output of the generator at the power station. Passive anti-islanding protection elements include:

- under and over frequency,
- under and over voltage,
- rate of change of frequency, and
- voltage vector shift protection

The passive protection elements operate by detecting a change in the output of the generator in response to an islanding event. If the load present on the island is perfectly matched to the load being supported by the generator, prior to the islanding event, the output of the generator will not change. If this was to occur the islanding event would not be visible by the passive anti-islanding protection. Additionally, this form of

1 ENA DOC 041-2019: https://www.energynetworks.com.au/resources/guidelines/national-distributed-energy-resources-grid-connection-guidelines/

2 Revision 08 November 2017.

protection also includes an inherent time delay for the change in generators response to reach predefined thresholds.

The application of voltage vector shift, and rate of change of frequency, protection is not recommended, as it has been found that selection of a setting that is sensitive for island events, but stable for adjacent network faults, is difficult to achieve in the Tasmanian Network.

2.2 Active anti-islanding protection

Active anti-islanding protection detects the absence of a connected grid by injecting or changing the performance of the EG then monitoring the impact to the connected network. For example if an EG was able to shift the frequency of the power network it would signify that it was islanded. Active anti-islanding protection is well developed within solar panel inverters, and forms part of Australian Standards for inverter design[3,4]. Typical methods for this type of protection include:

- frequency shift,
- frequency instability,
- power variation and
- current injection.

The application of this form of protection at any point other than the generator has not been proven reliable. Therefore, its implementation is reliant on the correct operation of the proponent's equipment.

2.3 Communications based anti-islanding protection

Communication based anti-islanding protection utilises communication systems to monitor aspects of the network to which the generator is connected to, then initiates the isolation of the generator when an island condition is asserted by an island detection algorithm. Examples of communications based anti-islanding protection include inter-trips and synchro-phasors[5].

3 Protection policy

As provided for under S5.2.5.8(c) of the National Electrical Rules, TasNetworks (as the connecting DNSP) require that the connection of embedded generation be supported by the availability of an AIS to prevent sustained operation of the embedded generation following its separation from the national grid.

The standard TasNetworks AIS requires the following protection functions:

- All EGs be fitted with passive anti-islanding protection including under and over frequency, and under and over voltage protection. Passive anti-islanding protection is to be duplicated at the Point of Connection (POC). Voltage vector shift and rate of change of frequency protection are not recommended as discussed above in section 2.1.
- All inverter based EGs be fitted with active anti-islanding protection compliant with Australian Standards.
- TasNetworks Network Planning team, in consultation with Network Performance (for EG ≥ 5MW), will undertake a connection assessment for all embedded generation. If the assessment

3 AS/NZ:4777.1 (2016) and AS/NZ:4777.2 (2015).

4 There are currently no Australian Standards that have been developed for active anti-islanding protection of synchronous generators. If the synchronous EG is capable of active anti-islanding protection its implementation will be assessed by TasNetworks.

5 If requested by the proponent the use of phasor measurement units will be considered by TasNetworks as a non-standard solution.

determines that the EG is capable of forming a viable island a communications based AIS will be required[6].

- The communications based AIS is to be supported by Live Load blocking (LLB)[7] on the upstream circuit breaker and reclosers as discussed below in section 4.3.

The proponent will be financially responsible for any costs incurred resulting from the network augmentations required to facilitate the connection.

4 Standard Communication based AIS

This standard defines the standardised TasNetworks approach for the implementation of communication based anti-islanding protection to ensure ongoing prudent asset management.

Where a communications anti-islanding protection is required to be installed, it will be designed, procured and installed and commissioned by TasNetworks, and funded by the EG developer as part of the connection charges.

The design of a communications based AIS is dependent on a number of site specific attributes including:

- Distribution Network topology and ratings
- Capability of upstream feeder reclosers and substation equipment
- Availability of communication bearers
- Characteristics of the generator
- Proponent preferences

The standard approach will leverage the capability of existing TasNetworks SCADA and substation assets to develop a cost effective solution. However, all new costs incurred will be funded as part of the proponent's connection application.

The standard TasNetworks communications based AIS is to be comprised of the following elements:

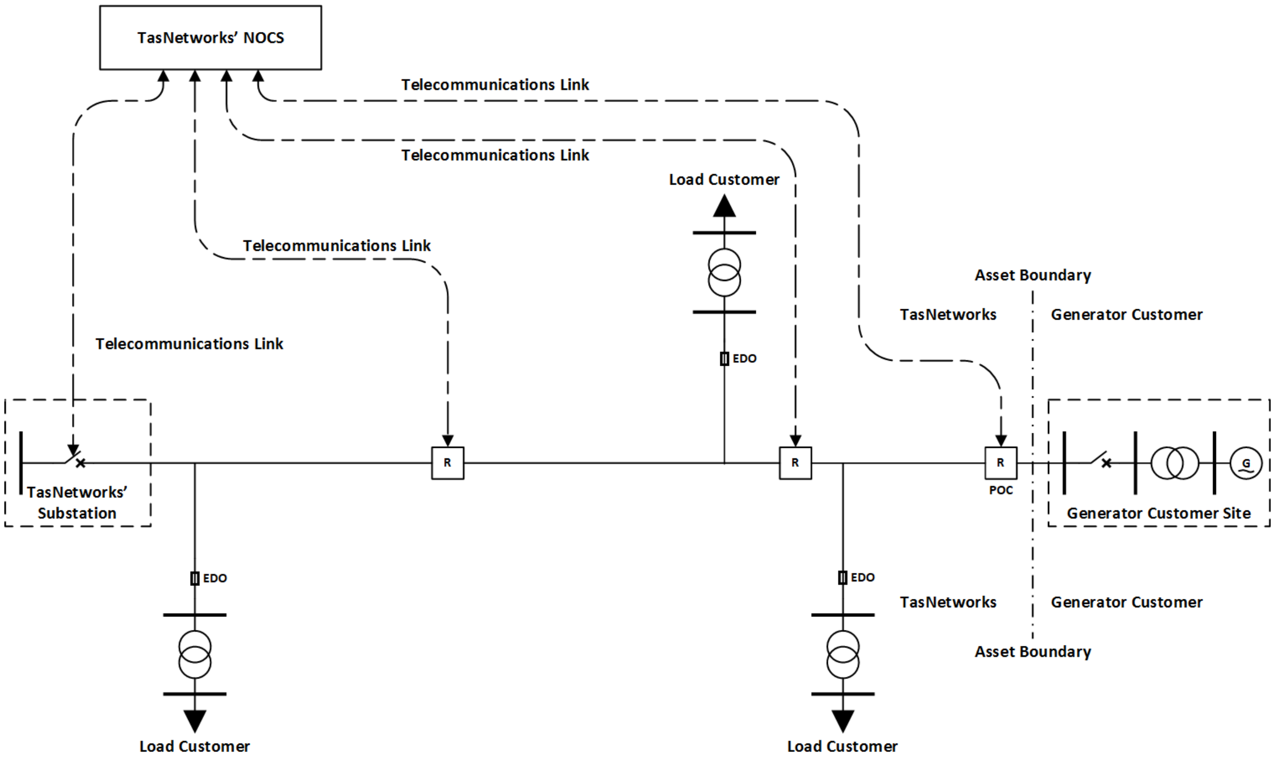
- Island detection algorithm
- Plant status
- Communications
- Consideration for auto re-close and Live Load Blocking (LLB) functions

The diagram below represents a typical application of a TasNetworks communications based AIS.

6 This assessment will determine if it is possible to form an island in which the load is equal to the generation been provided by the EG.

7 Live load blocking is also known as live line checking or a check synchronisation depending on the protection relay and measurement equipment being utilised.

Figure 1 Communication based AIS



4.1 Island algorithm

Where the scheme is required to monitor existing TasNetworks assets, the logical location of the island algorithm is within the Network Operational Control System (NOCS).

Site specific logic will be configured in TasNetworks NOCS to identify when the EG has been islanded based on the status of the upstream circuit breaker and reclosers.

The algorithm will only be implemented for 'normal' operating conditions. If TasNetworks requires alternative switching arrangements, or the network is experiencing outages, the generator will be constrained to zero.

The health of all equipment and communications that the AIS is reliant on should be continuously monitored by self-supervision functions and alarmed at NOCS.

4.2 Point of connection

TasNetworks policy is to install an enclosed switch, typically a recloser[8], at the Point of Connection (POC) of all EGs. This recloser will form an integral part of the communications based AIS by tripping when an island has been asserted.

The POC recloser shall be set with protection settings to back-up the generator protection as well as to detect faults on the upstream feeder fed from the EG.

The POC recloser shall include passive anti-islanding protection to duplicate to the passive islanding protection installed within the EG protection relay.

LLB is to be enabled to prevent the POC recloser for closing if the EG is still connected to the feeder.

The point of connection recloser will provide the following points back to the NOCS SCADA system:

8 Depending on local network topology TasNetworks may require a HV CB, or a Load Break Switch, to be installed at the POC in place of a recloser.

- 3 phase currents
- 3 phase voltages – Generator side
- 3 phase voltages – Network site
- kW, kVars and kVA
- System Frequency
- Trip alarms for all enabled protection functions
- Controller watchdog alarm

4.3 Network auto re-close and LLB

Automatic feeder restoration schemes comprising of reclosers (known as Loop Automation schemes) are commonly installed on the overhead distribution system. Automatic re-energisation of the feeder during this process opens the nearest upstream device (being either the feeder breaker or feeder recloser) with minimum delay following a power system fault, and then attempts to automatically re-energise the tie recloser after a predefined disconnected time (dead time)[9]. Automatic reclosing can occur multiple times depending on the design of the Loop Automation scheme.

A failure of the communications based AIS is a credible contingency event which may prevent the EG from being disconnected following an islanding event. This failure presents a risk that Loop Automation Schemes may close onto an unsynchronised island. To ensure that the power system remains in a secure operating state, following a communications based AIS failure, TasNetworks require that the upstream circuit breaker and reclosers are fitted with LLB. This function will prevent the upstream device from closing if voltage is present on its downstream terminals.

Check synchronisation may also be required on the upstream substation bus section circuit breakers if an auto close scheme is implemented to restore load when a supply transformer is tripped.

Typically no additional hardware is required to enable LLB on reclosers. However, feeder circuit breakers located in the upstream substation typically do not have VTs installed on their load side. If required the installation of a VT to enable LLB will form part of the connections charges incurred by the proponent[10].

4.4 Telecommunications

The telecommunications required for the implementation of the standard communications base AIS shall include the following:

- SCADA communications to the upstream distribution substation, usually connected to NOCS via the main TasNetworks Multiplexed communication network[11],
- Communications to existing intermediate feeder reclosers. These would be connected via 3G/4G links[12],
- Communications to the POC.

The cost and availability of a communications bearer to the POC would be location dependent, hence would require a study conducted by the TasNetworks Telecommunications team.

9 The minimum operation time for a TasNetworks' recloser is 5 seconds (A-Type), TasNetworks Protection of Transmission Lines Standard, R246427 v3.1, clause 9.2.4(a).

10 If a high reliability communication path exists between the POC and the NOCS, and the upstream feeder circuit breaker and the NOCS, TasNetworks may choose to waive the requirement for LLB at the upstream feeder circuit breaker.

11 TasNetworks typically has an operational communications presence at all transmission substations (excluding Savage River, Derwent Bridge and Triabunna – refer TasNetworks Drawing No. A2-06644). This is considered a high reliability communication path. The use of the TasNetworks telecommunication network requires a commercial contract to be negotiated.

12 Communications paths provided by third parties such as 3G/4G single carrier are not considered reliable as they are prone to congestion delays and outages.

4.5 Operate time

The communication based AIS is required to detect and isolate an EG from an islanded within the feeder automatic re-close dead time. A review of the automatic protection scheme is to be undertaken to ensure that the dead time on each device is set higher than the operate time of the communication based AIS. If communications based AIS does not operate before the reclose operation LLB will block the operation to prevent the reconnection of an unsynchronised island.

The SCADA data upon which the NOCS algorithm needs to be configured to report the change of status instantaneously, instead of waiting to be polled.

4.6 Plant status

TasNetworks will utilise existing SCADA systems to monitor the status of intermediate reclosers and substation switchgear that may island the EG when opened.

The TasNetworks SCADA undergoes weekly scheduled database maintenance, typically each Tuesday[13], during regular business hours. This maintenance includes a SCADA rebuild that will, typically, take the system out of services for 20-30 seconds. Additionally, server fail over tests are, typically, conducted once a month during the weekly scheduled maintenance. However, they may also be unplanned resulting from equipment failures. Server fail over tests will may increase the outage duration to approximately 90 seconds.

The status of the EG is to be monitored at TasNetworks NOCS via SCADA points polled from the point of connection recloser.

Where the status of any plant is not available the communications based AIS will be deemed to have failed.

4.7 Availability

The health of the communications based anti-islanding scheme is required to be continuously monitored, with a failure of the scheme becoming asserted for the following conditions:

- A sustained loss of communications to point of connection recloser from the TasNetworks NOCS SCADA;
- The NOCS SCADA cannot detect or poll the status of any switching equipment that may cause an island condition;
- There is an unplanned NOCS SCADA outage rendering remote anti-islanding protection inoperable.

A failure of the communications based anti-islanding scheme shall result in the tripping of the POC, hence isolation of the EG, when asserted for the following periods:

- 60 seconds[14] – if, due to availability of high reliability communications, TasNetworks has provided an exception and LLB has not been enabled on the upstream feeder circuit breaker; or
- 30 minutes[15] – if the risk of closing onto an unsynchronised island is mitigated by the installation of LLB on all upstream circuit breakers and reclosers.

If the proponent opts to utilise a communication path that is not highly reliable, TasNetworks recommends that the proponent commissions a study to gain confidence that the level of reliability achieved through their proposed telecommunications provider meets the service level they require.

13 TasNetworks will notify embedded generators of changes to scheduled maintenance that will affect their connection.

14 The minimum time setting available for the standard Noja recloser to detect a loss of communications and initiate a trip is 60 seconds.

15 Clause 4.8.15(iv) of the National Electrical Rules.

4.8 Redundancy

Redundancy of systems is provided by the installation of duplicate passive anti-islanding protection within the EGs protection relays and the point of connection recloser, in addition to a communications based protection, if required by the TasNetworks planning team.

To increase reliability elements of the communications based AIS, such as communications bearers, may be duplicated if requested and funded by the proponent.

Appendix A – Communications based AIS Requirement – Flow Chart