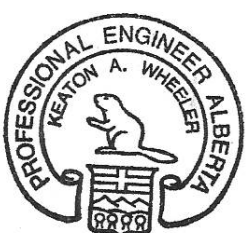
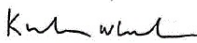



FortisAlberta Technical Interconnection Requirements for DER 150 kW and Greater

DER-02

Version No: 5.2



2024 / 03 / 13	2024 / 03 / 13		
Prepared	Approved	Owner	Authentication
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LIMITATION OF LIABILITY AND DISCLAIMER

This document is not a replacement for electrical codes or other applicable standards.

This document is not intended or provided as a design specification or as an instruction manual.

The DER owner, employees or agents recognize that they are, at all times, solely responsible for the generator plant design, construction and operation.

FortisAlberta Inc. (FAI), and any person employed on its behalf, makes no warranties or representations of any kind with respect to the DER requirements contained in this document, including, without limitation, its quality, accuracy, completeness or fitness for any particular purpose, and FAI will not be liable for any loss or damage arising from the use of this document, any conclusions a user derives from the information in this document or any reliance by the user on the information it contains. FAI reserves the right to amend any of the requirements at any time. Any person wishing to make a decision based on the content of this document should consult with FAI prior to making any such decision.

Revision History

Version	Date	Revision Details
5.0	December 2023/ (5.1) February 2024	<p>DNP map points added, removed, and updated. Annex B updated to include IPSC Section 3. Change to inverter unit certification being UL1741 SB or better. Clarity added to RVC requirements. Additions to harmonic distortion requirements. Changes to PQ reporting. Changes to energization package. Changes to commissioning requirements. Clarified power factor set points and FortisAlberta support in voltage requirements. Microgeneration intertie breaker requirements added. Updated DER isolating requirements. Added ICAP process requirements. DER Unit certifications sections split up with additions for wind and machine-based generation. Updated guidance on use of LEAs in the measurement accuracy clause. Updated overhead interconnection requirements for GFO facilities to include bird proofing. Updating requirements for isolating devices and separating loads from generation. Added requirements for lockout and tag procedures in commissioning. Added notice period for commissioning schedule changes. Added guidance on energizing as a load. Added requirement for IPSC Section 2 results being tested before FortisAlberta staff will be available to come to site. Changes to Energization Package Requirements. Clarification on close block requirements added. Data Concentrator file to be provided to FortisAlberta. (5.1) Minor adjustments to second PQ report in Section 6.6. (5.1) Clarification added to Section 7.2 on trip timings not be allowed to change with system frequency. (5.2) Directional overcurrent element requirements adjusted in Sections 7.1.2, 7.8.12, and 7.9.2.2. (5.2) Removed requirement to provide .exp and .par file from Section 8.2.</p>
4.0	November 2022/ (4.1) January 2023/ (4.2) March 2023	<p>Typical islanding detection methods added. Non-export mode requirements added. Added mirrored bits protocol required for a DTT. Microgeneration export limiter requirements added. Added clarity to RVC, Harmonic Distortion and power quality monitoring requirements for benchmark reporting. IPSC Section 2 review procedure added. Clarified that the DER equipment must be isolated when commissioning the PCC relay.</p>

		<p>Added requirements for sites that are rated higher than their export limit.</p> <p>Added requirements around equipment delivery schedules.</p> <p>Added clarification on machine-based DER certifications.</p> <p>Added clarification on AESO versus FAI anti-islanding.</p> <p>(4.1) Minor update to Power Quality monitor requirements (January 2023)</p> <p>(4.2) Clarification given in Section 7.4.8 DTT requirements (March 2023).</p> <p>(4.2) Clarification that MW are the required parameters in Annex C.</p> <p>(4.2) Addition/clarification that a transformer inrush study is required.</p> <p>(4.2) Clarification to GIS requirements added.</p> <p>(4.2) Clarification to DNP3 point mapping.</p> <p>(4.2) Clarification to commissioning.</p>
3.0	October 2021	<p>Updated Shall Trip Requirements for Voltage.</p> <p>Added Ride Through Requirements.</p> <p>Added a Guide for Engineering Study Requirements (DER-02A).</p> <p>Added Commissioning Document Package Requirements.</p> <p>Revised Commissioning Requirements.</p> <p>General Clarity Improvements.</p>
2.0	August 2020	<p>Alignment with CSA C22.3 No 9:20.</p> <p>Added Clarity on Engineering Studies.</p> <p>Added Transmission Study Requirement.</p> <p>Added Clarity on Anti-Islanding Requirements.</p> <p>Added Clarity on Breaker Failure Protection.</p> <p>Removed Requirement for PQ Monitor.</p> <p>Updated DNP3 Points List.</p> <p>Removed Annex A / B (Referred to CSA C22.3 No 9 and removed PQ Monitoring Requirement).</p>
1.0	January 2019	New Standard Issued.

Table of Contents

REVISION HISTORY 3

[1.](#) SCOPE 6

[2.](#) NORMATIVE REFERENCES 7

[3.](#) GLOSSARY 8

[4.](#) ENGINEERING STUDIES 11

[5.](#) INTERCONNECTION REQUIREMENTS 11

[6.](#) POWER QUALITY TECHNICAL REQUIREMENTS..... 15

[7.](#) RESPONSE TO ABNORMAL CONDITIONS REQUIREMENTS..... 18

[8.](#) MONITORING & CONTROL REQUIREMENTS 24

[9.](#) ENERGIZATION PACKAGE REQUIREMENTS 25

[10.](#) COMMISSIONING REQUIREMENTS 29

[11.](#) MAINTENANCE REQUIREMENTS 33

ANNEX A(NORMATIVE)..... 34

- TYPICAL ISLANDING DETECTION METHODS..... 34

ANNEX B(NORMATIVE)..... 35

- IPSC SECTION 2 REVIEW PROCEDURE..... 35

ANNEX C (NORMATIVE)..... 37

- SCADA REQUIREMENTS & DNP3 PARAMETER MAPPING..... 37

1. Scope

This document is prepared to assist DER owners understanding of their roles and responsibilities when connecting to the FortisAlberta electrical distribution system as a generator or aggregate of generation. The requirements listed in this document apply to the following:

1.1. DER System greater than or equal to 150 kW

- Classification - Distributed Generation (DG)
 - Export
 - Non-Export
- Classification - Micro-Generation (MG)
- Classification - Energy Storage

1.1.1. Examples of such DER systems may include:

- Inverter-based Generation
- Synchronous Generation
- Induction Generation
- Battery Energy Storage System (BESS)

1.2. This document does NOT apply to the following:

- DER systems less than 150 kW ¹
- Generators (Momentary Closed Transition) ² connecting momentarily (Parallel the distribution for 100 ms or less) through automatic transfer switches (such as back-up / standby generators).
- Generators which do not parallel with the distribution system. (Refer to the Canadian Electrical Code, Part I)

1.3. Technical Document Requirements

Technical documentation will be required through the interconnection process and may be required prior to energization.

1.4. Technical Standard Alignment

The technical requirements outlined in this document are in alignment with CSA C22.3 No. 9:20 - Interconnection of Distributed Energy Resources and Electricity Supply Systems.

CSA C22.3 No. 9:20 shall be the governing technical standard, unless otherwise specified in this document.

¹ For DER applications less than 150 kW, please review FortisAlberta Technical Interconnection Requirements for DER less than 150 kW [FortisAlberta.com \(Customer Service / Get Connected / Generation\)](#)

² For "Momentary Closed Transition" applications, please refer to the document "Interconnection Requirement Checklist - Standby or Backup Generator" [FortisAlberta.com \(Customer Service / Get Connected / Generation / Standby Generators\)](#)

2. Normative References

2.1. Familiarity, knowledge, and adherence to the following documents are prerequisites for the interconnection requirements cited in this document. There may be newer revisions of the following documents, in those cases the latest shall be applied.

2.2. Interconnection Standards

CSA C22.3 No. 9:20 – Interconnection of distributed resources and electricity supply system.

IEEE 1547-2018 – Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

C22.1 No. 1-2018 - Canadian Electrical Code (CEC), Part 1

Alberta Electrical Utility Code – 5th Edition

2.3. Equipment Standards

CSA C22.2 No. 107.1-16 – Power Conversion Equipment

IEEE 1547.1-2020 - IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces

UL 1741 (2018) – Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

UL 1741 Supplement B – Test methods for advanced inverter functions

CSA C61000-4-30-10 (R2014) – Testing and measurement techniques – Power quality measurement methods.

UL2200/ULC2200 – Stationary Engine Generator Assemblies

2.4. Other Technical Standards

IEEE 519-2014 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

CSA C235-19 – Preferred Voltage Levels for AC Systems, 0 to 50 000 V

IEEE 2030-2011 – Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads

NISTIR 7628 (2010) – Guidelines for Smart Grid Cyber Security

CAN/CSA C71-1-99-1/2 – Insulation Coordination Guidelines

CAN/CSA-C61000-3-7 – Assessment of Emission Limits for the Connection of Fluctuating Installations to MV, HV and EHV Power Systems

CSA C22.2 NO 14 - Industrial control equipment

CSA C22.2 NO. 100-14 (R2019) - Motors and generators

2.5. FortisAlberta Interconnection Documentation

Interconnection Protection Settings and Commissioning (IPSC) – Settings proposal and commissioning documentation for all proposed protection relays within a DER system.

Maintenance Verification Form – Annual maintenance submission form

FortisAlberta Power Quality Specifications

Refer to the [Get Connected](#) or [DER Documents](#) Libraries online for all the latest FortisAlberta documents.

3. Glossary

anti-islanding: a protective functionality aimed at preventing the continued existence of an unintentional electrical island (see “Islanding” below) to avoid safety concerns and potential damage to customer equipment.

backup generator: an independent reserve source of electric energy that, upon failure or outage of the normal source, automatically provides reliable electric power within a specified time.

certified: tested and approved and by an accredited certification organization such as CSA, UL, IEEE

cease to energize: cessation of active power delivery under steady-state and transient conditions and limitation of reactive power exchange.

clearing time: the time between the start of an abnormal condition and the DER ceasing to energize the distribution system. It is the sum of the detection time, any adjustable time delay, the operating time plus arcing time for any interposing devices (if used), and the operating time plus arcing time for the interrupting device. (used to interconnect the DER to the distribution system)

composite DER system: two or more individually compliant DER units which are connected in the same system. The overall system may need additional supplementary devices to ensure full compliance at the PCC.

dead band: a value by which a change in an analog point greater than its dead band will trigger a point update. Based on the raw value of an analog point and in engineering units.

distributed energy resource (DER): a source of electric power that is not directly connected to a bulk power system. DER includes both generators and energy storage technologies capable of exporting active power to an EPS. DER includes DG and MG.

distributed energy resource (DER) system: the DER Unit's, interconnection systems, control systems, sensing devices or functions, and protection devices or functions up to the point of the DER connection.

distributed energy resource (DER) unit: an individual DER device inside a group of DER that collectively form a system.

distributed generation (DG): power generators that are connected to a distribution system through a Point of Common Coupling (PCC).

non-export: a DER system which parallels with a distribution system for more than 100ms but does not export any generation to the distribution system.

export: a DER system which parallels and exports all or a portion of its generation to the distribution system.

distribution system: a system for distributing electricity, including any structures, equipment or other things used for that purpose. A distribution system is comprised of the main system capable of distributing electricity to many customers and the connection assets used to connect a customer to the main distribution system.

effectively grounded: distribution system or DER facility where the neutral conductor is grounded where:

Machine-Based Generation

$$\frac{X_0}{X_1} \leq 3, \quad \frac{R_0}{X_1} < 1$$

where

X₀ = zero sequence reactance

X₁ = positive sequence reactance

R₀ = zero sequence resistance

Inverter-Based Generation

$$0.01 \leq \frac{X_0}{R_0} \leq 0.3, \quad 1 \leq \frac{Z_0}{Z_{1Load}} \leq 2$$

Z₀ (R₀+jX₀) is the impedance of the supplemental grounding

Z_{1load} is the equivalent impedance of the grounded load of the network.

Source: EPRI (Effective Grounding for Inverter-Connected DER, Public Report 3002020130)

electric power system (EPS): facilities that deliver electric power to a load.

emergency generator: an independent reserve source of electric energy that, upon failure or outage of the normal source, automatically provides reliable electric power within a specified time to critical devices and equipment whose failure to operate satisfactorily would jeopardize the health and safety of personnel or result in damage to property. These systems may be legally required for the safety of human life, or to protect against economic loss or concerns around the disruption of national security.

energize: active power outflow of the DER to an EPS under any conditions (e.g., steady state and transient)

energization date: date at which the DER facility may start critical load facilities and testing procedures.

enter service: begin operation of the DER with an energized Area EPS

FAI: FortisAlberta Inc.

flicker: a perceptible change in electric light source intensity due to a fluctuation of input voltage. In the context of power supply disturbances, the term applies to perceptible, subjective, objectionable and random or periodic variations of the light output.

harmonics: sinusoidal voltages and currents at frequencies that are integral multiples of the fundamental power frequency which is 60 Hz in Alberta.

inverter: a machine, device, or system that changes direct-current power to alternating-current power

in-service date: date at which the DER facility may start to generate onto the distribution system, not to be confused with the energization.

islanding: a condition in which a portion of a transmission and/or distribution system is energized solely by one or more DERs, while that portion is electrically separated from the rest of the transmission or distribution system.

micro generation (MG): a DER system which meets the requirements of the Alberta Energy Micro-Generation Regulation, Section 1(1)(h).

measurement point: the location where the interconnection performance requirements specified in this standard apply.

momentary closed transition: a DER which parallels to the distribution system for less than 100ms. See CSA C22.3 No 9-08 (7.4.13)

non-detection zone: the loading condition for which an islanding detection method would fail to operate in a timely manner, and it is represented in terms of the load parameters.

point of common coupling/point of interconnection (PCC/POI): the point of connection between the wires owner and the a DER facility.

point of connection (PoC): the point of connection to where a DER unit is connected to a DER system.

return to service: enter service following recovery from a trip.

ride-through: ability to withstand voltage or frequency disturbances inside defined limits and to continue operating as specified

synchronization: the state and operation where the DER facility is connected to the distribution system and supplies loads along with the electric grid.

total harmonic distortion (THD): the ratio of the rms value of the sum of the squared individual harmonic amplitudes to the rms value of the fundamental frequency of a complex waveform.

wires owner: the entity who owns and/or operates a distribution system.

witness testing: the final stage of commissioning in which FortisAlberta's Field Technical Services and SCADA department test the functionality of the site's main breaker. To be done as part of the last steps of the final commissioning package, just prior to site energization.

4. Engineering Studies

Engineering studies are supplemental to ones performed by FortisAlberta and must adhere to the study requirements in the DER-02A – FortisAlberta Engineering Study Guide for DER Interconnections document.

All studies completed by the DER owner and/or consultant shall be submitted and authenticated by a professional engineer who is registered with APEGA.

5. Interconnection Requirements

5.1. Single Line Diagram (SLD)

Minimum requirements include but are not limited to the following:

- Measurement Point (PCC / PoC) Location
- Disconnect Switch
- All Electrical Equipment (transformers, switches, generators, PT/CT's, arresters)
 - Includes transformer configuration and any supplemental grounding devices.
- Revenue Meter
- Protective Relays ANSI Elements (Clearly identifying protective relay functions)
- Breaker Failure clearly identified if applicable, see section 7.6.
- Authentication by a Professional Engineer (P.Eng.)

Note: See Annex A, CSA C22.3 No 9:20 for example SLD's, including variations for different transformer winding configurations and measurement point requirements.

An authenticated SLD is required for the at the following stages of the project:

- Detailed Level Study
- 110 Day Package - Issued for Construction (IFC) SLD

5.2. Measurement Point

The measurement point is the location where the DER system measures power system quantities for the purpose of implementing the protection and control functions required by this standard.

- 5.2.1. DER System 150 kW – 249 kW – Measurement point may be between the point of common coupling (PCC) and the point of connection (PoC). Where zero sequence continuity can't be maintained between the PoC and PCC the measurement point shall be located at the PCC.¹
- 5.2.2. DER System 250 kW and Over – Measurement point must be at the point of common coupling (PCC)

Note: The minimum load of any local facility may be used to determine the measurement point location, where the local loads may offset the DER system contribution to the distribution system.

5.3. Insulation Coordination

The DER facility shall be protected from lightning, switching surges and temporary overvoltage (TOV). See CAN/CSA C71-1-99-1 and CAN/CSA C71-1-99-2 for insulation coordination guidelines.

5.4. Equipment Ratings

The DER system equipment standards shall align with FortisAlberta's equipment standards and shall not result in equipment on the distribution system to exceed its equipment ratings. This includes but not limited to the following:

- Maximum Voltage
- Basic Impulse Limit
- Short Circuit Ratings / Limits
 - DER system shall not increase FortisAlberta's short circuit levels beyond 5 kA single phase or 8 kA three phase at the upstream 25kV substation bus or at the PCC.
- Thermal loading limits

5.5. Isolating Device

DER systems shall follow the Canadian Electrical Code Part I and be capable of isolating from the distribution system during maintenance and emergency conditions. Section 84 of CEC, Part I provides information to enable determination of the appropriate disconnect / isolation means for DER facilities.

- 5.5.1. For all DER sites using built in inverter protection without a separate protection device, when an abnormal condition is detected by the inverter protection, a transfer trip signal shall be sent to DER isolating device to physically isolate the DER from the distribution system.
- 5.5.2. All DER sites with overhead connections shall have a gang-operated, visible disconnect switch where the electrical contacts of the switch are required to be visible. Flags, or visual indicators shall not be considered sufficient for this purpose.
- 5.5.3. DER facilities shall be designed to disconnect loads separately from the aggregated generation. The generation disconnect shall be equipped with sufficient means for a FortisAlberta Inc. representative to lock out and tag out the aggregated generation. The lock out shall not be directly connected to the bus work, circuit breaker high voltage parts, or within an energized electrical cabinet or switchgear.

5.6. Transformer Configuration

A wye/wye transformer winding configuration is preferred for DER interconnections, but other configuration types may be accommodated. Where there is a break in zero sequence continuity¹, additional equipment may be required to mitigate negative impacts to specific types of transformer configurations. Refer to CSA C22.3 No 9:20 (Annex C) and DER-02B – FortisAlberta Effective Grounding Study Requirements for more details.

Note: The following interconnection concerns are associated with delta (primary) / wye configurations:

- Damaging overvoltage (Single phase faults / Open phase conditions);
- DER facility cannot detect single phase faults with normal overcurrent protection; and
- High voltage concerns due to ferro-resonance.

¹ IEEE 1547-2018 - p28 – When the zero-sequence continuity is broken, for example by a delta-wye transformer between the PCC and the PoC, the voltages at the PoC may not be representative of the voltages at the PCC under abnormal voltage conditions. Examples of issues created by this condition include the following:

- Difficulty of 'sensing' single-phase-to-ground faults or failure to detect ground-fault over-voltages.
- Detecting abnormal voltage conditions when a DER back-feeds into the grid during a balanced open-phase condition.
- Ability of detecting a distribution system open-phase by the DER is diminished.

5.7. Interconnection Grounding

In accordance with CSA C22.3 No. 9:20, DER Systems must be grounded as per manufacturer's recommendations and CEC Part I. Transformer grounding systems shall be coordinated with FortisAlberta and shall not cause voltage disturbances or disrupt coordination of distribution system ground fault protection.

5.8. Effective Grounding

The DER facility shall meet the effective grounded requirements as defined in DER-02B – FortisAlberta – Effective Grounding Study Requirements for DER Interconnections

The DER interconnection (inclusive of DER assets and interconnecting transformer) must be compatible with the feeder grounding practice at the point of interconnection. With some exceptions, installations should meet the requirements for "effectively grounded" as described in IEEE/ANSI C62.92.2 for synchronous machines and C62.92.6 for inverters.

5.9. DER Unit Certification

For all individual DER systems and multiple unit DER systems:

5.9.1. Inverter based DER Systems Certification

- [UL 1741 SB certifications are required prior to energization.](#)
- Only inverters which are certified may be connected to the distribution system.

5.9.2. Machine Based DER Systems Certification

- [All Machine type generators must undergo an IEEE Conformity Assessment Program \(ICAP\) evaluation as per Section 5.9.4 of this standard. Machine type Generators certified to UL1741 SB are exempt from the ICAP evaluation.](#)
- [Machine type generators that have had their Detail Level Study application submitted prior to 1-January-2024 may have their machine type generators certified to CSA 22.2 No. 100 Motors and Generators, UL2200, or equivalent. UL1741 SB certification is still recommended as all requirements shall still be met in this standard.](#)

5.9.3. Wind Turbine Generators Certification

- [Type I and Type II Wind Turbine Generators shall be certified to applicable machine-based standards as per Section 5.9.2 of this standard.](#)
- [Type III and IV Wind Turbine Generators shall be certified to applicable inverter-based standards as per Section 5.9.1 of this standard.](#)

5.9.4. IEEE ICAP Evaluation

- [Wind turbine generators and some machine-based generation may be unable to meet certification requirements in Sections 5.9.1, 5.9.2 and 5.9.3. In these cases, the DER facility shall engage qualified contractors to perform the IEEE Conformity Assessment Program \(ICAP\) for evaluation of conformity to IEEE Std. 1547-2018.](#)
- [The qualified contractor performing the ICAP evaluation shall be independent of the DER project with no involvement in aspects including but not limited to design, testing and construction.](#)
- [The inspection and evaluation shall only be performed by individuals who are certified by the IEEE](#)

as Commissioning Conformance Evaluator (CCE) Master Level to Std. 1547-2018.

- As part of the ICAP evaluation, the qualified contractor shall perform a design evaluation.
- A report shall be provided to FAI outlining where non-conformances are found. For non-conformances, where applicable, mitigation measures shall be outlined. The report shall be signed and stamped by an engineer registered with APEGA.
 - The stamping engineer providing the ICAP report shall be certified by the IEEE as Commissioning Conformance Evaluator (CCE) Master Level to Std. 1547-2018.
 - The individual performing the ICAP evaluation shall be supervised by the stamping engineer where the evaluator and stamping engineer are not the same.
- ICAP can only be used for wind turbines or machine-based generation, it shall not be accepted for other DER types.
- FAI can deny connection of any non-certified DER for any non-conformance of standards. This will be at the discretion of FAI. Each site will be evaluated on a per case basis.

5.10. Measurement Accuracy

DER facility shall meet the accuracy requirements from CSA C22.3 No. 9:20 (Section, 7.1.3).

It should be noted that low energy analogue (LEA) voltage measurement devices may be unable to meet the necessary accuracy requirements. Owners should consult equipment specifications to ensure compliance.

5.11. Voltage/Power Control Requirements

DER facility shall meet the requirements of CSA C22.3 No. 9:20 (7.2.3 Voltage Regulation and Power factor)

The DER system shall be operating at an agreed power factor at the PCC, but also be capable of the modes of operation listed in CSA C22.3 No. 9:20 (Section 7.2.3). FortisAlberta shall provide a recommended power factor, however the DER owner can specify their own power factor set point. If the DER trips on overvoltage and was operating closer to a unity power factor than what was specified by FortisAlberta, FortisAlberta support will be limited.

DER Units may use different voltage control modes to manage voltage within the DER facility, but the DER system shall maintain constant power factor at the PCC, unless otherwise specified by FortisAlberta.

The DER operator shall be responsible for implementing setting modifications and mode selections, as specified by FortisAlberta and within a time acceptable to FortisAlberta. Under agreement between the FortisAlberta and the DER operator, control modes and implementations other than the ones listed above may be permitted.

5.12. Reactive Power Requirements

The DER facility shall meet the Reactive Power Requirements detailed in CSA C22.3 No. 9:20 (Section 7.2.3.2)

5.13. Cease to Energize Performance Requirement

DER facility shall meet the Cease to Energize requirements of CSA C22.3 No. 9:20 (Section 7.4.7.7)

If requested by FortisAlberta, the DER system shall provide reactive susceptance (sourcing and/or consumption) that remains connected to the distribution system in cease to energize state.

5.14. Equipment Delivery Schedule

The DER facility shall produce an equipment delivery schedule with supporting documentation for major components to validate the requested ISD and confirm the commissioning schedule dates, upon request. The ISD may be delayed if a schedule and/or supporting documentation cannot be produced or if the scheduled delivery does not accommodate for safe installation and testing of equipment. The ISD may also be delayed if not agreed to by the Alberta Electric System Operator.

5.15. Overhead DER Facilities

DER facilities that are overhead and interconnecting with FortisAlberta owned overhead infrastructure, shall be built to a standard equivalent to FortisAlberta standards, including bird proofing of the DER owned overhead facilities.

5.16. Microgeneration isolation requirements**5.16.1. For Microgeneration DER facilities that are utilizing built in inverter protection at the unit level:**

- An inter-tie breaker is required to separate the generation from the load of the customer facility.
- The inter-tie breaker shall trip when an abnormal system condition is detected. For example, if an overvoltage occurs and the inverter shuts down, a transfer trip signal shall be sent to the inter-tie breaker to physically isolate the DER from the distribution system.
- The inter-tie breaker shall be capable of being manually locked out.

5.16.2. For sites with generation 500kW or greater, the inter-tie breaker must be capable of open/close feedback and be capable of complying with monitoring and control requirements specified in Section 8 of this standard.**6. Power Quality Technical Requirements**

This section outlines the technical requirements for the DER system's owner to maintain satisfactory power quality at the PCC.

- I. If undesirable power quality on the FortisAlberta distribution system is being caused by the DER system not adhering to the requirements within this section, the DER owner will be required to cease the operation of the offending equipment. Disconnection may be required until satisfactory corrective action has been taken by the customer as per the "Customer Terms and Conditions of Electric Distribution Service" document Article 12.
- II. FortisAlberta will enforce all disconnections as per section 5.2.4 & 10.3.2 of the "FortisAlberta Inc. Customer Terms and Conditions of Distribution Access Service" document.

6.1. Voltage

Upon approval by FortisAlberta of control modes other than constant power factor mode, the DER owner is responsible to manage the voltage/power control modes of the DER system to ensure compliance to the range specified in C235-19.

6.1.1. Limitation of overvoltage contribution

The DER facility shall not cause the fundamental frequency voltage, line-to-ground or line to line, on any portion of the distribution system to exceed 138% of its nominal fundamental frequency voltage for a duration exceeding one fundamental frequency period.

6.1.2. Ramp Rate

During normal operation, active power output shall increase linearly on the DER system and shall not exceed the following rate of change:

- The nameplate active power rating divided by the enter service period of 300 seconds, with a maximum step increase not exceeding 20% of the DER nameplate active power rating. (i.e. A linear increase in active power over 5 minutes, where a step increase shall not exceed a 20% increase)

6.2. Voltage and Current Unbalance

- The DER facility shall be capable of operating under existing utility distribution system voltage and current unbalance conditions and protect itself from the unbalance.
- The DER facility shall not increase existing voltage unbalance levels at the PCC and in the distribution system.
- The DER facility shall comply with the voltage unbalance limits set out in the “FortisAlberta Power Quality Specification” document as amended from time to time.

6.3. Flicker and Rapid Voltage Change (RVC)

The DER system shall not introduce voltage fluctuations beyond the limits specified in the “FortisAlberta Power Quality Specifications” document. For details on how to perform flicker emission level evaluation, refer to CAN/CSA-C61000-3-7 “Limits - Assessment of Emission Limits for the Connection of Fluctuating Installations to MV, HV and EHV Power Systems”.

6.3.1. Customer Flicker Emission Limits

For each DER system, only a fraction of the global emission limit shall be allowed. The calculation for individual emission limits shall be determined with reference to the “FortisAlberta Power Quality Specifications” document.

6.3.2. Rapid Voltage Changes (RVC)

The RVC Limits as set out in the “FortisAlberta Power Quality Specifications” (PQ-SPEC-01) document shall not be exceeded at the PCC. These RVC limits shall apply to sudden changes due to frequent energization of transformers, switching of capacitors or from abrupt output variations caused by DER misoperation.

6.3.2.1. Any DER interconnection that has a total transformer capacity (sum of the capacities of all

the transformers) greater than 400 kVA shall not create an RVC greater than those specified in FortisAlberta’s PQ-SPEC-01. An engineering study as per DER-02A and commissioning tests are required to confirm compliance. Where DER facilities generate an RVC greater than those specified in PQ-SPEC-01, mitigation measures are required. NOTE: Operating procedures are considered an acceptable mitigation measure but must be submitted to as part of the engineering studies to be approved by FortisAlberta.

- 6.3.2.2. For sites that energize all interconnection transformers infrequently (such as annual maintenance), the engineering study as per DER-02A will be submitted to and approved by FortisAlberta on a case-by-case basis. If the RVC is deemed excessive by FortisAlberta, further mitigations are required.
- 6.3.2.3. If the transformer energizations cause power quality issues to the service area after the DER site has been energized and in operation, then it is solely the customer’s responsibility to mitigate regardless of the study.

6.4. Harmonic Distortion

Current harmonics limits shall comply with CSA C22.3 No 9:20., the DER system shall not inject a DC current greater than 0.5% of the DER system rated output current.

Inter-harmonic limits, and telephone interference limits as specified in the “FortisAlberta Power Quality Specifications” document shall be met by the DER system.

Note: FortisAlberta utilizes interharmonic frequencies inside the bandwidths listed in Table below for the purposes of the Automated Metering System (AMR). Customers shall not cause interference with the operation of the AMR by creating noise or by sinking the AMR signal. If FortisAlberta determines that a customer facility is interfering with the AMR signal, it is a customer’s responsibility to modify the service to correct the problem within a timely manner.

Table 1 – AMR bandwidths

AMR Bandwidth
>300 Hz to <800 Hz
>900 Hz to <1080 Hz
>2,000 Hz to <5,000 Hz

6.5. Telephone Interference

The DER customer’s facility at the PCC shall not have calculated or measured I-T product values exceed the limits as set out in the “FortisAlberta Power Quality Specifications” document.

6.6. Power Quality Monitor Requirements for Benchmark/Compliance Report

The power quality monitor equipment for the purpose of power quality benchmark/compliance report shall be installed at the PCC and conforming to the latest version/edition of IEC 61000-4-30 Class A measurement standards (10 Minutes interval). Revenue grade metering sensors shall be used.

The first report ([PQ Pre-Energization benchmark](#)) shall include 7-day monitoring results and raw data prior to the In-Service-Date for the initial benchmark purposes.

The second report ([PQ Post-Energization Compliance Report](#)) shall include 7-day of continuous monitoring results (must include normal generation periods) and raw data post energization of the generation facility to ensure compliance of the DER facility.

The report shall include tables/graphs of following parameters at a minimum:

- Voltage and current RMS (Line to Neutral), max/min/average
- Voltage unbalance
- Individual voltage and current harmonics (up to 50th harmonics as minimum)
- Individual voltage and current interharmonics (up to 50th harmonics as minimum)
- Flicker (Pst and Plt)
- Real power (P), Reactive Power (Q), and Power Factor (PF) of every phase
- [Transformer Energization RVC results \(must include both single and all transformer energization voltage and current RMS captures\) according to 61000-4-30 methods for measurements. Note, RVC tests are performed outside of the 7 days compliance period.](#)

Note: Refer to “DER PQ Benchmark/Compliance Report” template and the sample for detailed report format, instructions, and example.

6.6.1. Power Quality Data Exchange

All power quality raw data presented in both reports shall be send to FortisAlberta along with the report as attachments. [The data format could be in IEEE 1159.3 PQDIF file format or in excel files.](#) Refer to “DER Sample PQ data” excel template.

7. Response to Abnormal Conditions Requirements

All requirements specified in this section shall be met at the measurement point unless otherwise specified.

7.1. Microgeneration

7.1.1. MGs shall be treated as an export DER. The export amount is to be determined by the DER and submitted to FortisAlberta for evaluation. For example, a 1 MW MG that has a minimum load of 0.6 MW will export a maximum of 0.4 MW. The MG will be treated as a 0.4 MW DER within this standard, with exception any short circuit analysis. This export amount will be known as the export limit.

7.1.2. For MGs that have an export limit that is less than their rating, the following is required at the PCC relay:

- A 32R relay shall be set to trip within 1 second if the export power (flowing from the DER site to FortisAlberta) raises above the export limit.
- [A 67/67N relay may be required at the sole discretion of FortisAlberta. If required, the 67/67N relay shall be set to trip within 1 second \(unless otherwise specified by FortisAlberta\) if more than 1% rated current flows from the DER site to the FortisAlberta network more than the export limit.](#)

7.2. Shall Trip Requirements

All **DER Units** shall comply with the default shall trip requirements for Supplemental Grade as detailed in Table 11 and Table 13 of CSA C22.3 No. 9:20.

All **DER Systems** shall comply with the following trip requirements, where the measurement point is at the PCC.

NOTE: All voltage trip elements shall be measured and tripped based on line-to-neutral voltages.

NOTE: The clearing times specified in Section 7.2 must remain constant during system frequency deviations. A stand-alone SEL-351 relay, because it trips based on system cycles, does not meet this requirement as its trip times lengthen during frequency drops. An SEL-651 or SEL-751, utilizing time-based tripping, would be compliant with the shall trip requirements.

Table 2 – Voltage Trip Requirements @ PCC

Inverter-Based Generation			Machine-Based Generation		
Trip Function	Voltage (% of nominal voltage)	Clearing Time (s)	Trip Function	Voltage (% of nominal voltage)	Clearing Time (s)
OV3	120	0.16	OV3	120	0.16
OV2	110	2	OV2	110	2
OV1	106	45	OV1	106	45
UV1	88	10	UV1	88	2.0
UV2	45	0.16	UV2	45	0.16

Table 3 – Frequency Trip Requirements @ PCC

Trip Function	Frequency (Hz)	Clearing time (s)
OF2	62.0	0.16
OF1	61.2	300.0
UF1	58.5	300.0
UF2	56.5	0.16

7.3. Ride Through Requirements

All **DER Units** shall comply with the voltage and frequency ride-through requirements for Supplemental Grade for inverter interfaced generation or doubly fed induction generation and Baseline Grade for synchronous/induction generation per section 7.4.6.5 of CSA C22.3 No. 9:20.

Ride-through settings shall be submitted in the 110-day package and reviewed prior to commissioning of the DER facility.

Note – The design criteria shall match the default minimum ride-through time (s) and maximum

response time (s) identified in CSA C22.3 No 9:20 in Table, 12 / 13.

7.4. Anti-Islanding

- 7.4.1. All types of generation shall cease to energize and trip within 2 seconds of an island formation.
- 7.4.2. DER facilities shall meet the anti-islanding requirements listed below in Table 12.
- 7.4.3. Required anti-islanding studies shall be submitted to FAI for review. Based off the review FAI may require a transfer trip. Failure to provide the required studies will initiate a mandatory direct transfer trip requirement.
- 7.4.4. Anti-Islanding Studies may be required by the transmission owner, please refer to DER-02A - FortisAlberta Engineering Study Requirements.

Table 12 – DER Facility Anti-Islanding Requirements

Generation Type	Aggregate Capacity	Direct Transfer Trip (DTT)	Anti-Islanding Method
Synchronous	≤ 1 MW	FAI to Review	Passive ¹
	> 1 MW	Required	DTT
Inverter-Based	All	Not Required ⁴	Active ²
Induction	≤ 1 MW	Not Required	Passive ¹
	> 1 MW	Required	DTT ³

¹Anti-Islanding method must be reviewed and accepted by FAI. Direct transfer trip may be required upon review.

²Inverter-based generation shall meet the anti-islanding requirements of CSA C22.2 No. 107.1 and UL 1741 SB

³A Self-Excitation study may be accepted to remove a DTT requirement.

⁴In some cases, non-reclose on live line and sync checks may be used on the distribution system to mitigate islanding concerns.

7.4.5. Passive Anti-Islanding

Passive anti-islanding schemes shall use at the minimum the following elements:

- a) Rate Of Change Of Frequency (ROCOF); and
- b) Vector Shift or Reverse Reactive Power

The DER passive anti-islanding scheme (including protection set points) must be submitted to FAI for review and approval. A list of typical islanding detection methods is given in *Annex A*. If the scheme is not approved by FAI, a direct transfer trip will be required.

DER facilities containing passive anti-islanding schemes shall have provision for the capability to receive a transfer trip signal and cease generation. The actual implementation may not be required at time of DER energization and may be requested later at the DER owners' cost. The request would be initiated upon the emergence of a non-detection zone (i.e., the load to generation ratio is insufficient to provide an incremental change to frequency, power or vector shift that can be detected by the passive anti-islanding scheme).

7.4.6. Active Anti-Islanding

Method for active anti-islanding shall be provided to FortisAlberta for review. E.g., Sandia Frequency Shift (SFS), Active Frequency Drift (AFD), or other. A list of typical islanding detection methods is given in *Annex A*.

7.4.7. Transmission / Substation Anti-Islanding

Anti-islanding requirements proposed by the TFO or the AESO are separate requirements from FortisAlberta and are required as specified by the TFO and the AESO. Anti-islanding communication with the TFO or the AESO shall be the responsibility of the DER Owner.

7.4.8. Direct Transfer Trip

A direct transfer trip signal from the upstream protection devices (Breaker, MVI, Reclosers) will be required based on the following criteria:

- a) Requirements identified in Table 12; **or**
- b) Aggregate DER Facility capacity if greater than 33% of the minimum load downstream of recloser(s); (Not Inverter-Based) **or**
- c) Results from a transmission anti-islanding / protection study which identify DTT as a requirement for transmission protection **or**
- d) The emergence of a non-detection zone.

It is the responsibility of the DER owner to design and implement a DTT scheme. FAI will provide a DTT signal from all upstream protection devices (Reclosers, MVIs) as per FAI Standard D08-08.4. An informative demonstration of customer and FAI equipment responsibilities is given in Figure 1 and Figure 2. The DER owner is responsible to transmit the DTT signal from the FAI control box to the DER owner facility and initiate a Joint Use Agreement (JUA) with FAI as per D08-08.4.

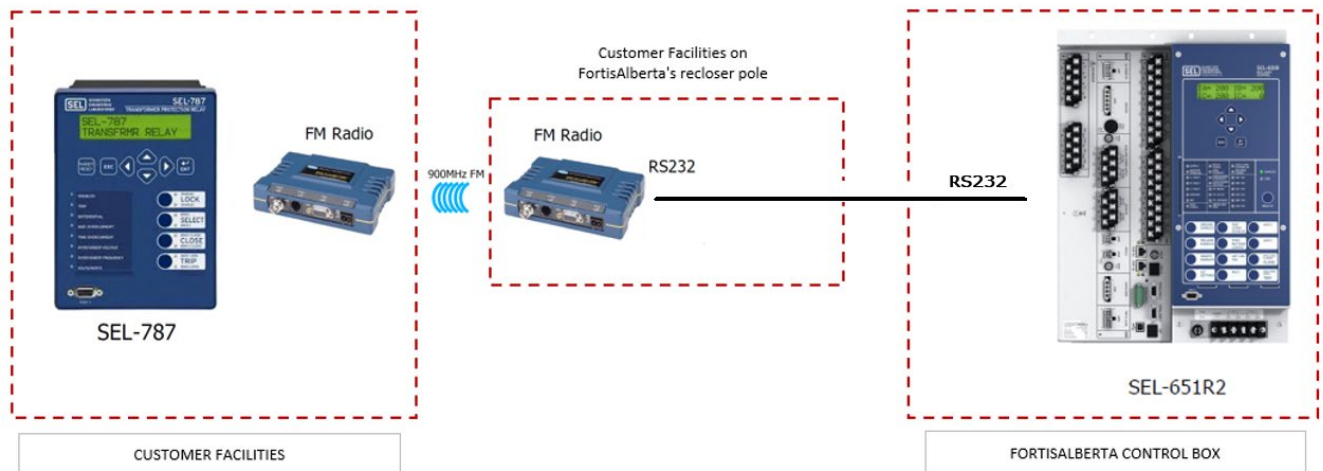


Figure 1 - Equipment Responsibilities DTT for Radio Signals

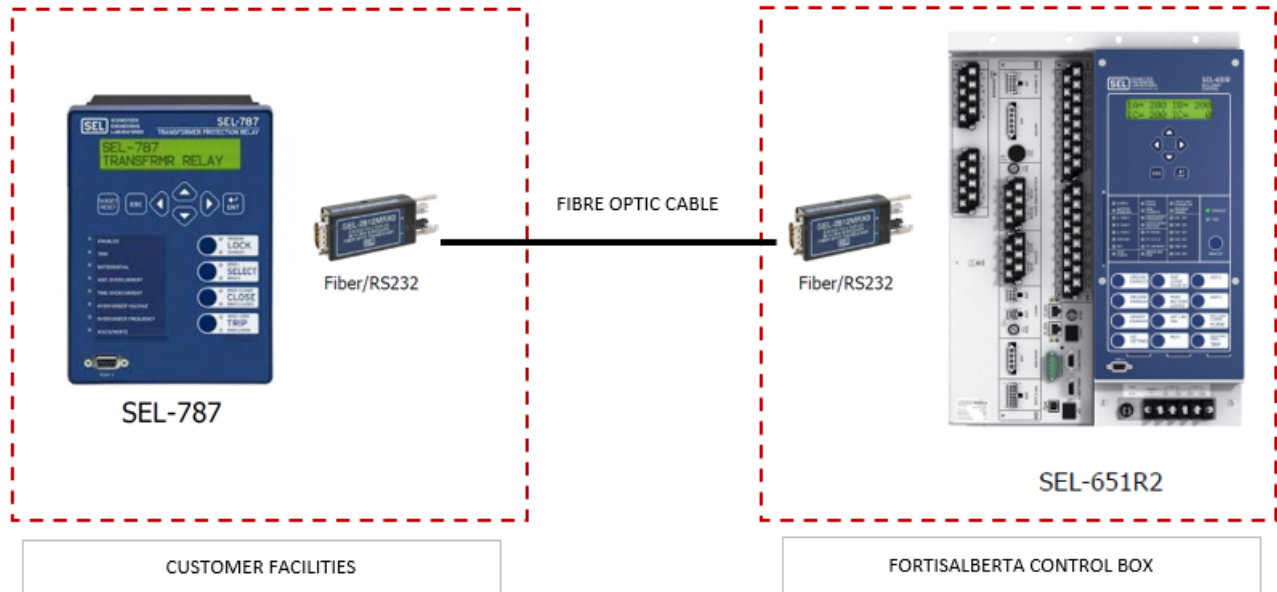


Figure 2 -Equipment Responsibilities DTT for Hardwired Fibre Optic Cables

The design for the DER owner shall include:

- a) DER site isolation from FAI's distribution system upon receiving a DTT signal.
- b) Communication design and protocol between DER facility and upstream distribution protection devices. FAI requires the use of *Mirrored Bits* (Schweitzer Relay Protocol) for a DTT.
- c) The DTT signal must be failsafe. Upon loss of DTT signal the DER facility shall disconnect from the distribution system within 2 seconds. The DER shall remain disconnected until the DTT signal is restored.
- d) Incorporate separate DTT signals from all FAI mainline protection equipment in series upstream from the DER facility. FAI to advise of the communication requirements for the DTT during detail level study.

Exception: Transmission DTT (if applicable) - Consultation with the transmission owner will be required to determine DTT communication requirements

The DTT scheme shall be submitted to FAI for approval prior to implementation.

7.5. Entering Service and Synchronization

DER facility shall meet the entering service and synchronization requirements from CSA C22.3 No. 9:20 (Section, 7.4.6.2).

7.5.1. Return to Service after Trip

After ceasing to energize the distribution system due to any abnormal condition, the DER system must wait 300 seconds before attempting to reconnect, unless otherwise specified by FortisAlberta.

7.6. Breaker Failure

- 7.6.1. DER facilities with an aggregate output > 500 kW shall provide breaker failure protection for the primary interrupting device that is responsible for disconnecting the generator and/or the HV ground sources from FortisAlberta's distribution system. This device must be able to interrupt on a fault.
- 7.6.2. In the event of a breaker fail condition at the primary interrupting device, the DER facility shall be capable of the following:
- a) Full isolation of the DER facility upstream from the breaker failure condition. This may include trips to multiple upstream protection devices or isolation of the prime mover / excitations system as needed to fully isolate from FAI's distribution system.
 - b) Failsafe protection relay configuration if the protection relay fails to trip the isolation device. This may include redundant relays and/or failsafe contacts.
- 7.6.3. The breaker failure protection shall have a maximum pickup time delay of 0.3 seconds after initiation. Full isolation shall take less than 2 seconds after breaker failure detection.
- 7.6.4. DER facilities ≤ 500 kW shall have an alternate means of disconnecting the DER energy source from the distribution system when a breaker fail condition is triggered. This can be achieved by opening of the isolation device, disabling an inverter, or removing the prime mover and excitation system as needed.
- 7.6.5. All Breaker Failure schemes shall be submitted to FAI for approval prior to implementation.

7.7. Distribution System Faults

- 7.7.1. The DER protection shall detect and isolate the facility from the distribution system for phase-phase and phase-ground:
- c) Internal faults within the DER facility **and**
 - d) External faults on the distribution system.
- 7.7.2. Fault protection shall be coordinated with the distribution upstream/downstream protection devices. For coordination, the FortisAlberta Interconnection Protection Settings and Commission (IPSC) document, Section 1, shall be completed and submitted to FortisAlberta for review.

7.8. Directional Protection

- 7.8.1. Non-Export DER systems shall have directional protection through utilization of a 67/67N/32R capable protective relay.
- 7.8.1.1. The 32R relay shall be set to trip within 1 second if the import power (flowing from FortisAlberta to the DER site) falls below 10% of the load demand.
 - 7.8.1.2. A 67/67N relay may be required at the sole discretion of FortisAlberta. If required, the 67/67N relay shall be set to trip within 1 second (unless otherwise specified by FortisAlberta) if more than 1% rated current flows from the DER site to the FortisAlberta network more than the export limit.
- 7.8.2. Directional protection may also be required on the distribution system to prevent mis-operation due to sympathetic tripping. This may be located at a substation breaker or an upstream recloser. FAI will assess this requirement during the detailed level study.

7.9. DERs rated higher than the export limit

- 7.9.1. DER sites that have a nameplate rating higher than their export limit shall install additional protective elements to prevent excess power delivery. For example, a site with a 20 MW DER with a 20 MW export limit that adds a 20 MW Battery Energy Storage System: the site is only allowed to export 20 MW at any time.
- 7.9.2. For DER sites that have an export limit that is less than their name plate rating, the following is required at the PCC relay:
- 7.9.2.1. A 32R relay shall be set to trip within 1 second if the export power (flowing from the DER site to FortisAlberta) raises above the export limit.
- 7.9.2.2. [The 67/67N relay may be required at the sole discretion of FortisAlberta. If required, the 67/67N relay shall be set to trip within 1 second \(unless otherwise specified by FortisAlberta\) if more than 1% rated current flows from the DER site to the FortisAlberta network more than the export limit.](#)

7.10. Open Phase Protection

The DER system must be capable of detecting any open phase condition on the distribution system and must cease to energize and trip all phases to which the DER is connected within 2 seconds.

7.11. Reclose Coordination

The DER system shall coordinate with FortisAlberta's protective devices to ensure distribution customers are not exposed to disturbances due to out-of-phase reclosing, or mis-coordinated tripping.

8. **Monitoring & Control Requirements**

8.1. Provisions for real-time operating are required at DER facilities connected to FortisAlberta's distribution system.

8.2. Monitoring Data Requirements

Real-time data to be provided to FortisAlberta by the DER owner is dependent on the output rating of the DER Facility as listed below:

8.2.1. Class 1 - Total DER System Generation < 500 kW

DER facilities shall have the provision for monitoring the disconnecting device at the PCC/PoC. (Refer to *Annex C* for data point requirements)

- I. SCADA connection is not required unless otherwise specified by FortisAlberta.

Provisions for other data points may be required if determined by FortisAlberta.

8.2.2. Class 2 - Total DER System Generation ≥ 500 kW

- A SCADA connection to FortisAlberta's shall be required.
- [A data concentrator is required. The data concentrator, typically an SEL RTAC, shall be capable of operating as a master controller to change voltage control modes for all inverters if the DER site is inverter based, i.e., solar sites.](#)
- [The data concentrator is required to be an SEL RTAC \(file extension .exp\) or an EATON \(file extension .par\).](#)

- All communication and parameter mapping requirements outlined in *Annex C* shall be met.
- Provisions for additional data points may be required if determined by FortisAlberta.
- ~~The DER owner shall provide the .exp (SEL RTAC) or .par (EATON) file from the DER data concentrator to FortisAlberta. Deviation from .par and .exp file types shall be up to the sole discretion of FortisAlberta.~~
- Other: AESO Communication is required for DER facilities that are 5MW or larger.

8.3. Control Requirements

Subject to the agreement between the DER Owner and FortisAlberta, the following controls shall be provided to FortisAlberta:

- a. Main interconnection breaker;
- b. Dynamic generator output control; (Refer to CSA C22.3 No 9:20, Table D.1).

8.4. Close Block Requirements

For Class 2 DER sites (greater than 500kW), when enabled by FortisAlberta, the main DER breaker on site cannot be closed. The close block functionality shall be interlocked to prevent closure of the breaker under any and all operating conditions when Close Block is enabled. Any attempt at breaker closure MUST FAIL when Close Block is enabled. No bypass functionality of any kind (e.g. maintenance bypass) shall be provided within the design and implementation. DER owners may not bypass this interlock for any reason without written approval from FortisAlberta. This function may be used by FortisAlberta for operational purposes.

9. **Energization Package Requirements**

- 9.1. During the construction phase of the project, there are 5 packages that are required before the in-service date (ISD) of the project and 1 required post.
- 9.2. The dates below are approval dates, DER owners should submit deliverables in advance to avoid delay of their ISD. For every day past an approval date, the DER ISD shall be delayed by the same number of days. As an example, submitting the 110-day package precisely 110 days before the ISD will likely delay the ISD. Therefore, it is strongly advised to submit all packages well in advance of cutoff dates to avoid pushing back the ISD.
- 9.3. If any deliverables are missing or FortisAlberta requests revisions before the deadlines, the full gates package must be resubmitted, pushing the process timeline by the number of days exceeded. For example, if a 110-day package is submitted at 130 days before the in-service date (ISD) and revisions are requested 100 days before, the ISD moves back 10 days.
- 9.4. For projects with AESO deliverables: All AESO deliverables shall be submitted to FortisAlberta who shall pass the deliverables to AESO. DER owners are shall not pass AESO deliverables directly to the AESO.
- 9.5. Each package below shall be treated as a stage. These stages must be completed, in order, for projects to continue its advancement towards interconnection. Signed gate letters shall be issued to DER owners by FortisAlberta following the completion of each stage's package allowing the project to progress.
- 9.6. For customers who do not request to be connected as a load the load energization and 30-day

package stage will be approved simultaneously.

9.7. The following packages/gates are required:

Construction Energization Packages		
Package	Required Approval Date	Required Items
110 Day	110 days prior to the In-Service-Date	<ul style="list-style-type: none"> - Authenticated SLD - Issued for Construction (IFC) - IFC Technical Data Form - Site Layout - Engineering Studies (as applicable) <ul style="list-style-type: none"> ▪ Final Effective Grounding Study ▪ Final Short Circuit Study ▪ Transformer Inrush/Rapid Voltage Change Study ▪ Self Excitation Study - Communication/Telecom Equipment Assessment - DER Unit Certifications - DER Inverter Settings (if applicable) (if not applicable submit a sheet stating not applicable and why) - IPSC – Section 1 – Proposed Settings - Final Commissioning plan & schedule - Power Quality Benchmark Monitoring Plan, refer to Section 6.6 - SCADA - Data Concentrator - DNP Points List - 100-day AESO deliverables
Load Energization	30 days prior to the In-Service-Date	<ul style="list-style-type: none"> - IPSC – Section 2 - Load Protection Performance and Equipment Commissioning - 110 day package gate letter - Electrical Services Agreement (for station service load) - Meter Verification Certificate - Proof of site IDs being enrolled with a retailer. - Proof that the electrical permit is on site and at the meter. - Electrical Permit - Complete and signed interconnection site work plan.
30 Day	30 days prior to the In-Service-Date	<ul style="list-style-type: none"> - Data Concentrator Bench Test Report - Data Concentrator file (.exp or .par) - Power Quality Pre-Energization Benchmark Report, refer to Section 6.6 - Operating Procedures - Switching Procedures Submitted - Certificate of Insurance - Joint Use agreement in place (if applicable) - AESO Asset ID - Load energization gate letter (if granted before the 30 day package) or load energization gate deliverables (if not previously approved to energize as a load) - 30 day AESO deliverables
Commissioning	Prior to commercial operation	<ul style="list-style-type: none"> - IPSC – Section 3 - Generation Protection Performance and Equipment Commissioning - Connection Authorization Form / Signed Permit - As built site SLD - 30 day package gate letter - EMTP-RV and PSCAD inverter models (for inverter-based generation) - Detailed modelling data (e.g., transient reactance, time constants etc.) for non-inverter based generation.

<p>Operations / Post in- service-date</p>	<p>Required no later than 45 days post commercial operation</p>	<ul style="list-style-type: none"> - Power Quality Post Energization Compliance Report, refer to Section 6.6 - Metering Field Installation Test Report - As-Built Communication Block Diagram - As-Built RAS Logic Diagram - Maintenance Verification Plan / Schedule (See section 10) - Commissioning gate letter
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Note: Failure to meet the required timelines above will result in a delay to the ISD.

Note: [FortisAlberta reserves the right to disconnect the DER owner’s generation assets should the Operations/ Post in-service-date deliverables not be provided, and an operations gate letter issued by FortisAlberta.](#)

10. Commissioning Requirements

- 10.1. The DER Owner is fully responsible for the inspection, testing, and calibration of its equipment, at the PCC.
- 10.2. A commissioning plan is required in the 110-day package and shall include the following:
- a. Testing SLD – Including test points, device(s) under testing (DUT) and PQ monitoring point(s).
 - a. Lock out and tag out procedures shall be provided in the commissioning plan.
 - b. Lock out and tag out points shall be highlighted on the SLD.
 - b. A list of DUTs and tests to be performed. *Refer to Clause 10.7*
 - c. Testing methodology for each test or reference to the applicable standard and section (e.g., NETA ECS, Section 10.1).
 - d. Tentative testing schedule.
 - e. Completed IPSC Section 1 – Proposed Settings
 - a. The IPSC Document should reference the facility PCC breaker relay. Inverters and/or generator protection do not require a completed IPSC form.
 - f. Commissioning parties responsible for the testing and their qualifications.
 - g. This plan shall confirm the contents above and provide a finalized commissioning schedule. The schedule must include a date and time for FortisAlberta SCADA commissioning and a date and time for witness testing. FortisAlberta must review and confirm this schedule prior to approval of the commissioning plan. *Review clause 10.7 for testing and witness activities.*
 - h. NOTE: the commissioning plan is a summary. It should only include applicable tests as specified in FortisAlberta's Interconnection Protection Settings and Commissioning Documents.
 - i. The IPSC Section 2 shall be completed with results prior to any FortisAlberta staff attending witness testing.
 - j. Changes to the commissioning plan require a minimum of 45 days notice before energization. FortisAlberta cannot guarantee representatives will be available if less than 30 days notice is provided.
 - k. FortisAlberta reserves the right to leave commissioning activities if the commissioning activities deviate from the submitted commissioning plan. FortisAlberta will require a minimum of 45 days to reschedule commissioning activities, from the date the new commissioning plan is received.
- 10.3. GIS Documents: The GIS documents shall contain the facility layout or site plan. GIS documents shall be provided with the 110-day package submission. The files shall be formatted as follows:
- 10.3.1. Shapefiles are to be provided with the below files – Files should use a common coordinate system/projection: UTM 11/12, 10TM, 3TM or Geographic.
- *.SHP
 - *.DBF

- *.SHX
- *.PRJ

10.3.2. The land base and equipment shall be provided on separate layers or levels for CAD files or have proper attribution in SHP files.

10.3.3. If shapefiles cannot be produced, .DGN or .DWG files will be acceptable and must be provided with the following:

- Coordinate system, projection, and units shall be embedded in the drawing metadata. Please ensure that the drawing's units match the coordinate system used.
- Land base and equipment shall be provided on separate layers/ levels
- Legal Land boundary must be clearly indicated in the file

10.4. ~~A final commissioning plan is required in the 30-day package. This plan shall confirm the contents of Clause 10.2 and provide a finalized commissioning schedule. The schedule must include a date and time for FortisAlberta SCADA commissioning and a date and time for witness testing. FortisAlberta must review and confirm this schedule prior to approval of the commissioning plan. Review clause 10.7 for testing and witness activities.~~ CLAUSE REMOVED.

10.5. The DER owner shall perform a bench test of the Data Concentrator (RTU). The results of the bench test shall be submitted to FortisAlberta in the 30-day Package and must be approved by FortisAlberta prior to point-to-point testing and witness testing. The RTU bench test shall include, but is not limited to, the following:

- a. Point-to-point testing, verifying signals from field devices back to the RTU. This testing cannot be simulated, all signals must be verified to the point of origin in real-time.
- b. A report shall be submitted to FortisAlberta, validating that the signals have been verified and the RTU signal mapping complies with the mapping presented in *Annex C*. The report shall also contain a copy of the configuration parameters of the RTU.

10.6. The DER generating equipment must be isolated until the PCC breaker is commissioned, IPSC Section 2 submitted and approved by FortisAlberta. All commissioning test results, supportive of Section 2, shall be recorded and made available to FortisAlberta upon request.

10.7. The IPSC [Section 2 and 3](#) will be reviewed in accordance with the procedure outlined in Annex B.

10.8. A Power Quality report confirming an initial benchmark and [7-days](#) review of the DER facility post energization shall be provided to FortisAlberta to ensure compliance with all PQ requirements.

10.9. Interconnection equipment, protection, and performance testing shall include, but is not limited to, the following:

*E – Interconnection Equipment

*Pr – Interconnection Protection

*Pf – System Performance

Equipment and System Performance Tests				
Item	Testing Reference	Requisite	Witness Testing	
E	Power Transformers (MV)	<ul style="list-style-type: none"> - Manufacturers Recommendations - Industry Acceptance Testing Standards. i.e. NETA 	<ul style="list-style-type: none"> - Documentation is not required to be submitted for energization approval. - Testing Documentation shall be made available upon request. 	Not Required
	Grounding Transformers / NGRs			
	Instrument Transformers (PT / CT)			
	Breakers / Isolation Devices			
	Cabling			
Pr	Interconnection Relay Trips / Alarms (Voltage / Current / Frequency Settings)	<ul style="list-style-type: none"> - Manufacturers Recommendations - Industry Acceptance Testing Standards. i.e. NETA - FortisAlberta DER-02 - <i>Section 7</i> Requirements 	<ul style="list-style-type: none"> - Complete IPSC Section 2 & 3. Document required for energization. - Testing Documentation shall be made available upon request. 	Required (Function Test)
	Breaker Failure (BF) Scheme			
	Transfer Trip (Including communication trip)			
	Anti-Islanding (3 Phase, Open Phase, Deadbus)			
	Return to Service			
	Remote Trips to FortisAlberta Device (Ground Fault, BF)			
Pr	SCADA Witness Testing	<ul style="list-style-type: none"> - Trip Breaker - Close Block - Supervisory Control 	<ul style="list-style-type: none"> - These points must be tested with the field technician after point-to-point testing is completed. 	
Pf	Transient Overvoltage (LROV, GFOV)	<ul style="list-style-type: none"> - FortisAlberta DER-02B – <i>Section 5</i> Requirements 	<ul style="list-style-type: none"> - Complete IPSC Section 3. May require energization of the DER facility and must be a part of the commissioning plan. (if required) Refer to DER-02B. - PQ Report Displaying Cease to Energize Performance 	Not Required
	Voltage / Frequency Ride Through	<ul style="list-style-type: none"> - FortisAlberta DER-02 - <i>Section 7</i> Requirements 	<ul style="list-style-type: none"> - Documentation is not required to be submitted for energization approval. - Testing Documentation shall be made available upon request. 	

	Power Quality	- FortisAlberta DER-02 - <i>Section 6</i> Requirements	- PQ Pre-Energization Benchmark Report - PQ Post-Energization Compliance Report	
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Any deficiencies in the above testing found during commissioning must be corrected by the DER owner prior to the DER interconnection approval by FortisAlberta and/or any generation output of the DER facility.

10.10. Recommissioning

Recommissioning is required, under certain circumstances, after the original commissioning and witness testing is completed. The extent of recommissioning is dependent on the reason for the commissioning and the effect on the DER interconnection.

Circumstances that will result in recommissioning of the DER system are:

- a) Operating modes or interconnection settings have been changed after the initial commissioning process.
- b) If any field operational and performance issues due to power quality arise.
- c) Replacement or changes of critical infrastructure.

10.11. Energizing as a Load

FortisAlberta representatives shall have the ability to place a lock out and tag out on the aggregated generation prior to energizing the facility as a load, as specified herein. The DER facility shall not energize as a load unless the generators have been isolated by physical locks which are in the control of FortisAlberta. This may be achieved using adequate controls and procedures which have been approved by FortisAlberta.

DER facilities that are not able to isolate the generation through lock out and tag out procedures shall not be able to connect to the distribution system until IPSC Section 2 has been approved. DER facilities owners, their consultants, and contractors shall make provisions for appropriately testing the facility without being connected to the distribution system, if the load and generation can not be isolated.

Lock out and tag out points shall be provided with the commissioning plan.

11. Maintenance Requirements

- 11.1. The DER Owner is responsible for all equipment maintenance within their facility. FortisAlberta requires the DER owner to perform annual maintenance of the equipment at the PCC. FortisAlberta’s Maintenance Verification Report must be filled out and signed off annually by a qualified worker.
- 11.2. Maintenance at the PCC shall include, but not limited to, the following equipment:
- a. Protection and control systems (including protective relays, transfer trips and control interlocks)
 - b. Power meter (when applicable)
 - c. Power transformer (if owned by the DG)
 - d. Instrumentation transformer (current and voltage transformers)
 - e. Isolation device (breakers and disconnect switches)
- 11.3. Inspection and testing for annual maintenance shall follow the schedule below:

Table 13 – Inspections and Tests

Inspection and Test	Frequency of Test
Visual	A visual inspection shall take place on an annual basis.
Visual / Mechanical	A visual inspection including mechanical operation shall take place every 3 years.
Visual / Mechanical / Electrical	A visual inspection including mechanical and electrical operation shall take place every 5 years.
Exceptions	When transfer trips are required, they must be verified on an annual basis.
Special Circumstances	If a power system event (transient over-voltage, fault, etc.) causes damage to equipment at the point of interconnection ALL equipment must undergo full visual / mechanical / electrical inspections and tests to ensure the integrity of the surrounding equipment.

Review FortisAlberta’s [Maintenance Verification Report](#) for all definitions of the above inspections and test.

Annex A (Normative)

Typical Islanding Detection Methods

Table A1 can be used as a reference when completing the IPSC form to submit to FortisAlberta.

Table A1 – Typical Islanding Detection Methods

	Islanding Detection Method	Characteristics
Passive	Rate of change of frequency (RoCoF) & vector shift	<p>Passive methods, not limited to RoCoF and vector shift, monitor specific power parameters to identify changes that indicate loss of the grid. There are no alterations to the output current for the purpose of islanding detection.</p> <p>Alterations include over/underfrequency, over/undervoltage, rate of change of frequency, vector shift (phase), harmonic level or negative sequence voltage.</p>
	Slip-mode frequency shift (SMS)	<p>SMS uses positive feedback to detect islanding conditions, a phase shift is introduced by changing the phase angle of the current waveform at the PCC.</p> <p>During islanding, there are perturbations in frequency of the PCC voltage. The phase shift causes phase error (function of the positive feedback) to increase until islanding is detected. It can be applied to the amplitude, frequency, and phase of the voltage.</p>
Active	Active frequency drift (AFD) or frequency bias	<p>AFD uses positive feedback and monitors any changes in the impedance at fundamental frequency through testing the drift between the current and voltage.</p> <p>Under islanding conditions, the frequency of utility voltage drifts up or down, increasing the natural frequency drift. Once the natural frequency drift exceeds a threshold, islanding is detected.</p>
	Sandia frequency shift (SFS)	<p>SFS uses frequency drift with positive feedback to monitor fluctuations in frequency. When there is a change in frequency, SFS tries to increase it.</p> <p>Under islanding conditions, the stiffness of the grid is no longer present to prevent SFS from increasing the frequency. Once the frequency has a large enough deviation, islanding is detected.</p>
	General Electric frequency shift (GEFS)	<p>GEFS uses positive feedback and varies the output power injected by the inverter and monitors the variation in voltage and frequency. GEFS increases the frequency under islanding conditions, allowing detection.</p>
	Sandia voltage shift (SVS)	<p>SVS uses positive feedback on the amplitude of the voltage at the PCC. Under islanding conditions, there is a reduction in voltage amplitude at the PCC due to the grid's absence. This leads to a reduction in the inverter output current, thus reducing the voltage further which indicates a loss of the grid.</p>
	Harmonic injection	<p>Harmonic injection method injects current (continuous or time-varying) at a specific frequency. Detection is based on the correlation between the injected current and the voltage at those harmonic frequencies.</p>
	Negative sequence current injection (NSCI)	<p>Negative sequence current injection manipulates the negative sequence current to detect islanding. This method applies positive feedback to the negative sequence current based on changes seen on the negative sequence voltage.</p>

Annex B (Normative)**IPSC SECTION 2 and 3 REVIEW PROCEDURE**

This is the procedure in place for collecting IPSC Section 2 documentation. The IPSC Section 2 must be submitted before the DER [may receive permission to generate](#).

B1. IPSC Section 2 Review

1. Following submission, FortisAlberta will review the IPSC Section 2.
2. The Generation Facility Operator (GFO) is not allowed to generate until the IPSC Section 2 is approved by FortisAlberta.
 - i) No point-to-point testing/commissioning is required for parts of a site that are to be connected strictly as a load.
3. The DER generating equipment must be isolated until the PCC breaker is commissioned, IPSC Section 2 submitted and approved by FortisAlberta.
4. If there are issues with, or clarifications required for, the Section 2, P&C will notify the GFO.
5. [IPSC Section 2 results shall be tested prior to FortisAlberta representatives being made available on site.](#)
6. [NOTE: Any issues identified by FAI with the IPSC Section 2 must be addressed by the GFO and approved by P&C before permission to generate may be granted.](#)

B2. Section 2 IPSC Review Procedure for Sites with Non-Compliant Results

This procedure is used for sites where the Section 2 has non-compliant results.

1. FortisAlberta may request Section 2 be recompleted.
2. FAI can request the relay commissioning documentation be submitted if the results are still non-compliant, or for validation.
3. Following a review of the relay commissioning documentation by FAI (or if the relay testing sheets are not provided), if the results are still non-compliant the site will require a new third-party tester to complete the results for the IPSC Section 2. The GFO will be responsible for arranging witness testing with member of FAIs team (the witness team). Results will need to be confirmed and signed off by the witness team before the site is permitted to re-submit results for approval.

B3. IPSC Section 3 Review

1. [Following submission, FortisAlberta will review the IPSC Section 3.](#)
2. [If there are issues with, or clarifications required for, the Section 3, P&C will notify the GFO.](#)
3. [NOTE: Any issues identified by FAI with the IPSC Section 3 must be addressed by the GFO and approved by P&C within 30 days following AESO ISD \(FAI energization date\), unless otherwise authorized by FortisAlberta.](#)
4. [If the GFO misses the 30-day timeline, FortisAlberta has the right to disconnect the site due to safety concerns. Written notice will be provided a week before the 30 days lapses as the site may be disconnected.](#)

B4. Section 3 IPSC Review Procedure for Sites with Non-Compliant Results

This procedure is used for sites where the Section 3 has non-compliant results.

1. FortisAlberta may request Section 3 be recompleted.
2. FAI can request the relay commissioning documentation be submitted if the results are still non-compliant, or for validation.
3. Following a review of the relay commissioning documentation by FAI (or if the relay testing sheets are not provided), if the results are still non-compliant the site will be turned off and the GFO will be responsible for arranging witness testing with member of FAIs team (the witness team). Results will need to be confirmed and signed off by the witness team before the site is permitted to reconnect.

Annex C (Normative)

SCADA Requirements & DNP3 Parameter Mapping

C1. Interoperability Requirements

Provisions shall be made by the DER for a local communication interface with FortisAlberta’s network that will support the information exchange requirements specified in this annex. The provisions shall include a FortisAlberta network communication module. The module will allow FortisAlberta to monitor, control and exchange information as needed.

The DER is responsible for the communication module equipment costs and the labour involved in installing and commissioning the device. FortisAlberta will own, operate, maintain, and supply the junction box.

C1.1. Fortis Alberta Communication Module Requirements (module supplied by FortisAlberta)

Table C1 – FA Communication Module Requirements

Requirements	
Module Interconnection	Refer to the Communication Interconnection diagram (Section C4) below for details.
Preferred Location	FortisAlberta’s preferred location is wall mounted on the exterior of the control cabinet or building containing the intertie relay
Accessibility	FortisAlberta requires full access to the module on a 24Hr. / 7D per week basis
Connection Points	The module shall be connected directly to the DER facility’s data concentrator (RTU).
Cables	DER facility shall provide the communication cable (RS232 DB9) from the facility RTU to the FortisAlberta external communication enclosure. DER facility shall provide 2C #14 copper 600V w/ ground conductor from the facility RTU to the FortisAlberta external communication enclosure.
Supply Power	120 VAC or 13-20 VDC

C1.2. Communication Protocol Requirements

The DER customer shall be capable of supporting FortisAlberta’s communication protocol at the local DER communication interface. The following protocol shall be supported:

Table C2 – Communication Protocol Requirements

Protocol	Transport	Physical Layer
IEEE Std. 1815 (DNP3)	None	Serial Baud Rate: 9600 Data Format: 8N1 Flow Control: CTS Framing Server DNP Address: 1 Client DNP Address: 65000

Protocols and physical layers within the DER facility can differ from the local DER communication interface.

C1.3. Communication Performance

The local DER communication interface shall always be active and responsive when in operation. The maximum allowable response time to read requests is 60 seconds.

C2. Monitoring and Control

All monitoring and control information shall be available through the local DER communication interface.

The DNP mapping below is required by FortisAlberta.

Monitoring requires read-only access to the intertie relay and power meter (if meter is required). Any configuration and setting changes are to be managed by the DER owner.

FortisAlberta requires the ability to open the main DER isolating device (i.e., breaker) remotely.

C2.1. Additional Requirements

In addition to the minimum signals identified in the DNP map below, FortisAlberta requires direct access to intertie relay event logs, trip logs and disturbance waveform captures.

All time stamps shall be Coordinated Universal Time (UTC).

C3. DNP3 MAPPING

Table D1.1 – DNP3 Mapping – Binary Inputs

DNP3 Index #	Signal	State 1 "0"	State 2 "1"	Class	Variation	Details
000	Trip / Fault Indication	NORMAL	TRIP	1	2	Trip indication of the main DER Facility breaker.
001	52A - Breaker Status (Open/Closed)	OPEN	CLOSE	1	2	Open/Closed status of the main DER Facility breaker.
002	Phase A Fault	NORMAL	FAULT	1	2	Overcurrent fault (A phase) anywhere in DER System.
003	Phase B Fault	NORMAL	FAULT	1	2	Overcurrent fault (B phase) anywhere in DER System.
004	Phase C Fault	NORMAL	FAULT	1	2	Overcurrent fault (C phase) anywhere in DER System.
005	Ground Fault	NORMAL	FAULT	1	2	Overcurrent fault (Ground/Neutral) anywhere in DER System.
006	Close Block (Enabled by FortisAlberta ONLY)	NORMAL	CLOSE BLOCK	1	2	When enabled by FortisAlberta, the main DER Facility breaker on site CANNOT be closed. This functionality must be available when the breaker is in LOCAL or REMOTE. Any breaker CLOSE command from on site or sent by FortisAlberta MUST FAIL when Close Block is enabled.
007	Aux. Battery Healthy (if applicable)	FAIL	NORMAL	1	2	Battery status for main DER facility controller.
008	RTU-Relay Healthy	FAIL	NORMAL	1	2	Indicator for any sort of failure of main DER facility relay.
009	Utility Fault	NORMAL	FAULT	1	2	A fault on the distribution system, i.e., FortisAlberta.
010	Supervisory Control	LOCAL	REMOTE	1	2	FortisAlberta Control Room Operators can only send commands to the main DER Facility breaker when the controller is in REMOTE. All commands aside from CLOSE BLOCK sent by FortisAlberta MUST FAIL when the controller is in LOCAL. A toggle for this point MUST be available locally on the controller.
011	Armed for FFR (if requested)	OFF	ACTIVE	1	2	Fast Frequency Response (FFR). Only required if requested.
012	Armed for CR (if requested)	OFF	ACTIVE	1	2	Contingency Reserve (CR). Only required if requested.
013+	Reserved Binary Inputs for future use					
100	Generator 1 - Status (On/Off)	OFF	ON	1	2	Required if the DER facility does not have a central controller.

DNP3 Index #	Signal	State 1 "0"	State 2 "1"	Class	Variation	Details
200	Generator 2—Status (On/Off)	OFF	ON	1	2	Required if the DER facility does not have a central controller.
300	Generator 3—Status (On/Off)	OFF	ON	1	2	Required if the DER facility does not have a central controller.
400+	Binary inputs for additional generators					

Table D1.2 – DNP3 Mapping – Analog Inputs

DNP3 Index #	Signal	Class	Variation	# of Decimal Points	Deadband	Details
000	Current Magnitude A (Amps)	2	3	1	1	A phase (Line to Neutral) current in Amps ¹ e.g., 20.1A
001	Current Magnitude B (Amps)	2	3	1	1	B phase (Line to Neutral) current in Amps ¹ e.g., 20.1A
002	Current Magnitude C (Amps)	2	3	1	1	C phase (Line to Neutral) current in Amps ¹ e.g., 20.1A
003	Current Magnitude N (Amps)	2	3	1	1	Neutral current in Amps ¹ e.g., 20.1A
004	Distribution – Voltage Magnitude A (kV)	2	3	2	±	Distribution A phase (Line to Neutral) Voltage in kV e.g., 14.41kV
005	Distribution – Voltage Magnitude B (kV)	2	3	2	±	Distribution B phase (Line to Neutral) Voltage in kV e.g., 14.41kV
006	Distribution – Voltage Magnitude C (kV)	2	3	2	±	Distribution C phase (Line to Neutral) Voltage in kV e.g., 14.41kV
007	Voltage Magnitude A (kV)	2	3	2	1	A phase (Line to Neutral) Voltage in kV ¹ e.g., 14.41kV
008	Voltage Magnitude B (kV)	2	3	2	1	B phase (Line to Neutral) Voltage in kV ¹ e.g., 14.41kV
009	Voltage Magnitude C (kV)	2	3	2	1	C phase (Line to Neutral) Voltage in kV ¹ e.g., 14.41kV
010	Active Power three-phase (MW)	2	3	3	1	Three phase Active Power in MW ¹ e.g., 5.023MW
011	Reactive Power three-phase (MVAR)	2	3	3	1	Three phase Reactive Power in MVAR ¹ e.g., 2.951MVAR
012	Apparent Power three-phase (MVA)	2	3	3	1	Three phase Apparent Power in MVA ¹ e.g., 8.644MVA
013	Frequency (Hz)	2	3	2	1	Frequency in Hz ¹ e.g., 60.01Hz
014	Power Factor (%)	2	3	2	1	Power Factor in % ¹ e.g., 99.92%
015	Fault Current A (Amps)	2	3	1	1	Most recent A phase overcurrent fault current in Amps ¹ e.g., 400.2A
016	Fault Current B (Amps)	2	3	1	1	Most recent B phase overcurrent fault current in Amps ¹ e.g., 400.2A
017	Fault Current C (Amps)	2	3	1	1	Most recent C phase overcurrent fault current in Amps ¹ e.g., 400.2A
018	Fault Current G (Amps)	2	3	1	1	Most recent Neutral overcurrent fault current in Amps ¹ e.g., 400.2A
90	Facility Master Controller Voltage Control Mode ²	2	3		0	The DER Facility central controller voltage control mode. Required if the DER Facility is inverter based (i.e., solar sites). See Voltage Control Modes below table for analog setpoints. ²

DNP3 Index #	Signal	Class	Variation	# of Decimal Points	Deadband	Details
91	Enter Service Delay (seconds) 1s – 600s (default 300s)	2	3		1	The DER facility must delay a specific time before closing the main DER Facility breaker to connect to the distribution system which has just recently energized. Minimum default delay is 300 seconds (5 minutes). As per IEEE 1547. Analog value indicates number of seconds to delay.
92+	Reserved Analog Inputs for future use					
100	Generator 1 – Control Mode	2	3		0	Required if the DER facility does not have a central controller.
101	Generator 1 – Active Power Output (MW)	2	3	3	1	Required if the DER facility does not have a central controller.
102	Generator 1 – Reactive Power Output (MVAR)	2	3	3	1	Required if the DER facility does not have a central controller.
100 to 199	Reserved Analog Inputs for future use					
200	Generator 2 – Control Mode	2	3		0	Required if the DER facility does not have a central controller.
201	Generator 2 – Active Power Output (MW)	2	3	3	1	Required if the DER facility does not have a central controller.
202	Generator 2 – Reactive Power Output (MVAR)	2	3	3	1	Required if the DER facility does not have a central controller.
200 to 299	Reserved Analog Inputs for future use					
300	Generator 3 – Control Mode	2	3		0	Required if the DER facility does not have a central controller.
301	Generator 3 – Active Power Output (MW)	2	3	3	1	Required if the DER facility does not have a central controller.
302	Generator 3 – Reactive Power Output (MVAR)	2	3	3	1	Required if the DER facility does not have a central controller.
300 to 399	Reserved Analog Inputs for future use	2	3	3		
400+	Analog Inputs for additional generators					

¹ All Analogs must be measured at the PCC.

² Voltage Control Modes:

- Constant Power Factor Mode = 0
- Voltage-Reactive Power Mode = 1
- Active Power-Reactive Power Mode = 2
- Constant Reactive Power Mode = 3
- Voltage-Active Power Mode = 4

Table D1.3 – DNP3 Mapping – Binary Outputs

DNP3 Index #	Signal Type (Analog/Binary)	Signal	Command Out On Output Type	Command Out Off Output Type	Details
000	Binary Output	52A – Main Breaker Open		Trip/Pulse-On	FortisAlberta command to open the DER Facility main breaker. Based on SEL Object 12 Control Relay Operations.
001	Binary Output	52A – Main Breaker Closed	Close/Pulse-On		FortisAlberta command to close the DER Facility main breaker. Based on SEL Object 12 Control Relay Operations.
002	Binary Output	FortisAlberta – Close Block	Close/Pulse-On	Trip/Pulse-On	When enabled by FortisAlberta, the main breaker on site CANNOT be closed. This functionality must be available when the breaker is in LOCAL or REMOTE. Any breaker CLOSE command from on site or sent by FortisAlberta MUST FAIL when Close Block is enabled. May be used for operational purposes.

Table D1.4 – DNP3 Mapping – Analog Outputs

DNP3 Index #	Signal Type (Analog/Binary)	Signal	Details
90	Analog Output	Facility Master Controller - Control Mode ¹	The DER Facility central controller voltage control mode. Required if the DER Facility is inverter based (i.e., solar sites). See Voltage Control Modes below table for analog setpoints. ¹
91	Analog Output	Enter Service Delay (seconds) 1s – 600s (default 300s)	The DER facility must delay a specific time before closing the main DER Facility breaker to connect to the distribution system which has just recently energized. Minimum default delay is 300 seconds (5 minutes). As per IEEE 1547. Analog value indicates number of seconds to delay.
100	Analog Output	Generator 1 – Mode Selection	Required if the DER facility does not have a central controller.
101-199	Analog Output	Reserved Analog Outputs for future use	
200	Analog Output	Generator 2 – Mode Selection	Required if the DER facility does not have a central controller.
201-299	Analog Output	Reserved Analog Outputs for future use	
300	Analog Output	Generator 3 – Mode Selection	Required if the DER facility does not have a central controller.
301-399	Analog Output	Reserved Analog Outputs for future use	
400+	Analog Output	Reserved Analog Outputs for additional generators	

¹ Voltage Control Modes:

Constant Power Factor Mode	= 0
Voltage-Reactive Power Mode	= 1
Active Power-Reactive Power Mode	= 2
Constant Reactive Power Mode	= 3
Voltage-Active Power Mode	= 4

D2. Communication Interconnection Diagram

