INTERCONNECTION PROTECTION SETTINGS & COMMISSIONING

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, operation and maintenance.

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SAMPLE - SECTION 1: Protection Settings

Interconnection Protective Equipment Nameplate Information

Use a separate form for each piece of equipment providing protective functions.
Note: Individual inverters only require certification

Device Identifier (as per SLD)	**14-BK-101 (see sample SLD)**		**Associated Relay Identifier (as per SLD)**	**14-RLY-101 (see sample SLD)**	
Relay Manufacturer	**GENERAL ELECTRIC**		**Relay Model**	**MULTILIN 350**	
Aggregate Generation Capacity	**1.5 MW (Future 4.5 MW)**	**Generation Type**	**SYNCHRONOUS**	**System Certification Std.**	**N/A**
System Nominal Voltage (VAC)	**4160 V_{LL}**	**System Frequency (Hz)**	**60 Hz**	**Number of Phase**	☐ **SINGLE** ☒ **THREE**

Overcurrent Trip Settings

Provide below the intended overcurrent settings for FortisAlberta to review and assess the protection coordination with the current utility system. (Use 14kV / 25kV as the base for all proposed settings)

Settings to be reviewed and signed off by a Professional Engineer.

(50/51) Overcurrent Trip Settings

Current Pickup (Amps)	**Phase**	**800 A (4.16kV Base) 133.1 A (25kV Base)**	**CT Ratio**	**Ground**	**50 A (4.16kV Base) 8.32 A (25kV Base)**	**CT Ratio**
Curve Type		**Extremely Inverse**	**800 : 5**		**Definite Time**	**50 : 5**
Time Dial/Modifier		**1.00**			**1.00**	
Instantaneous Trip (Amps)		**1000 A (4.16kV Base) 166.4 A (25kV Base)**			**N/A**	

(67/67N/32R) Directional Overcurrent / Reverse Power Trip Settings

Element Pickup (Amps or Watts)	**67P**	**10 A (4.16kV Base) 1.66 A (25kV Base)**	**67N**	**5 A (4.16kV Base) 0.83 A (4.16kV Base)**	**32R**	**50 W**
Curve Type		**Definite Time**		**Definite Time**		**Definite Time**
Time Dial/Modifier		**1.00**		**1.00**		**1.00**
Instantaneous Trip (Amps)		**N/A**		**N/A**		**N/A**
Trip Direction		**Reverse**		**Reverse**		**Reverse**

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Required Protection Settings

The following are the **required** protection settings for any interconnection to FortisAlberta's distribution system. Any variance to the below settings must be approved by FortisAlberta. If settings cannot be met please provide justification in the comments section.

(81U) Under-Frequency Trip		(81O) Over-Frequency Trip	
Required Setting	**Required Trip (cycles)**	**Required Setting**	**Required Trip (cycles)**
59.5 - 58.5 Hz	10800	60.5 - 61.5 Hz	10800
58.5 - 57.9 Hz	1800	61.5 - 61.7 Hz	1800
57.9 - 57.4 Hz	450	> 61.7 Hz	Inst
57.4 - 56.9 Hz	45		
56.9 - 56.5 Hz	7.2		
< 56.5 Hz	Inst		

Anti-Islanding	
Requirements	
Loss of Utility Voltage	Immediate trip
Unit Restart Delay after Utility Voltage Returns	≥ 5 minutes
Dead Bus	No start
Communication Failure	Disconnect Time: 600ms

(27) Under-Voltage Trip		(59) Over-Voltage Trip	
Required Setting	**Required Trip (cycles)**	**Required Setting**	**Required Trip (cycles)**
V = 50%	Inst.	V = 106%	2700 (45sec)
V = 90%	120	V = 110%	30
		V = 120%	Inst.

(25) Synchronizing			
Requirements	**< 0.5 MVA**	**0.5 – 1.5 MVA**	**> 1.5 MVA**
Frequency Difference	0.3 Hz	0.2 Hz	0.1 Hz
Voltage Difference	10 %	5 %	3 %
Phase Angle Difference	20 Degrees	15 Degrees	10 Degrees

Additional Comments / Protection Variances:

- Provide justification for any variances to the required settings.
- Provide any details to discussed with a FortisAlberta representative.
- Any changes to the proposed settings.
- References to DWGs or other documents.

Provided by:	Approved by:
John Smith / XYZ	John Deere
Power Producer (name / company)	FortisAlberta
Electrical Engineer	P&C Engineer
Title (P.Eng Required)	Title
John Smith	John Deere
Signature	Signature
January 05, 2019	January 06, 2019
Date	Date

- Protection settings to be reviewed and signed off by an engineering

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SAMPLE - SECTION 2: Protection and Equipment Commissioning

Protection Testing – Indicate with check mark or 'passed' if tests meet the required settings within equipment accuracies

Verify that the equipment detects and ceases to energize for the following protection functions.
Use actual set points in fields below.

(59) Over-Voltage Trip Function

Voltage to trip (% of Nominal)					Duration to trip (cycles)				
Required Setting	As Left Setting	Tested			Required Trip (cycles)	As Left Setting	Tested		
		A	B	C			A	B	C
V > 106% V ≤ 110%	106%	✓	✓	✓	2700 (45sec)	2700	✓	✓	✓
V > 110% V ≤ 120%	110%	✓	✓	✓	30 (0.5sec)	30	✓	✓	✓
V > 120%	120%	✓	✓	✓	Inst	Inst.	✓	✓	✓

(27) Under-Voltage Trip Function

Voltage to trip (% of Nominal)					Duration to trip (cycles)				
Required Setting	As Left Setting	Tested			Required Trip (cycles)	As left Setting	Tested		
		A	B	C			A	B	C
V ≤ 50%	50%	✓	✓	✓	Inst	Inst.	✓	✓	✓
50% < V ≤ 90%	90%	✓	✓	✓	120 (2sec)	120	✓	✓	✓

(81O) Over-Frequency Trip Function

Voltage to trip					Duration to trip (cycles)				
Required Setting	As Left Setting	Tested			Required Trip (cycles)	As Left Setting	Tested		
		A	B	C			A	B	C
60.5 - 61.5 Hz	60.5	✓	✓	✓	10800 (180sec)	10800	✓	✓	✓
61.5 - 61.7 Hz	61.5	✓	✓	✓	1800 (30sec)	1800	✓	✓	✓
> 61.7 Hz	61.7	✓	✓	✓	Inst	Inst.	✓	✓	✓

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(81U) Under-Frequency Trip Function

Frequency to trip (Hz)					Duration to trip (cycles)				
Required Setting	As Left Setting	Tested			Required Trip (cycles)	As Left Setting	Tested		
		A	B	C			A	B	C
59.5 - 58.5 Hz	**59.5**	✓	✓	✓	10800 (180sec)	**10800**	✓	✓	✓
58.5 - 57.9 Hz	**58.5**	✓	✓	✓	1800 (30sec)	**1800**	✓	✓	✓
57.9 - 57.4 Hz	**57.9**	✓	✓	✓	450 (7.5sec)	**450**	✓	✓	✓
57.4 - 56.9 Hz	**57.4**	✓	✓	✓	45 (0.75sec)	**45**	✓	✓	✓
56.9 - 56.5 Hz	**56.9**	✓	✓	✓	7.2 (0.12sec)	**7.2**	✓	✓	✓
< 56.5 Hz	**56.5**	✓	✓	✓	Inst	**Inst.**	✓	✓	✓

(50/51) Overcurrent Trip

Current Pickup (Amps)	**Phase**	**Passed**	**Ground**	**Passed**
Curve Type		**Passed**		**Passed**
Time Dial/Modifier		**Passed**		**Passed**
Instantaneous Trip (Amps)		**Passed**		**N/A**
☒ Pass			**☐ Fail**	

(67/67N/32R) Directional Overcurrent / Reverse Power Trip

Current Pickup (Amps)	**Phase**	**Passed**	**Ground**	**Passed**
Curve Type		**Passed**		**Passed**
Time Dial/Modifier		**Passed**		**Passed**
Instantaneous Trip (Amps)		**N/A**		**N/A**
☒ Pass			**☐ Fail**	

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Anti-Islanding Function

Test	Requirement	Result of test
Loss of utility voltage	Immediate trip / Transfer Trip	**Passed**
Unit restart delay after utility voltage returns	≥ 5 minutes	**Passed**
Dead bus test	No start	**Passed**
Communication failure test	Disconnect time: 600ms	**Passed**

(25) Synchronizing Limits

	Required Setting	As Left Setting	Document Synchronizing Method
Frequency Difference	0.1 – 0.3 Hz	**0.3 Hz**	**Auto Synch**
Voltage Difference	3 – 10 %	**10%**	**Auto Synch**
Phase Angle Difference	10 – 20 Degrees	**20°**	**Auto Synch**
☒ Pass		**☐ Fail**	

Equipment Testing Requirements

Outlined below are the minimum inspections and tests that must be performed at the PCC prior to interconnection energization. All tables must be filled out below, confirming the tests were completed with no deficiencies. Any test that does not apply can be represented as *Not Applicable*. Test results shall be recorded and made available upon the request of FortisAlberta. Refer to manufacturer for equipment testing and expected values. In the absence of the manufacturer's information, refer to the latest NETA Acceptance Testing Standard (ATS) for equipment test requirements and expected values.

Interrupting and Isolation Equipment

Equipment	End-to-End Wire Checks	Insulation-Resistance / Dielectric Withstand	Contact Resistance	Timing Test	Electrical / Mechanical Interlocks	Functional Tests
Breaker(s)	✓	✓	✓	✓	✓	✓
Disconnect Switch(es)	N/A	N/A	N/A	N/A	N/A	N/A

Instrumentation Transformers (protection & metering)

Equipment	End-to-End Wire Checks	Insulation-Resistance Test	Ratio / Polarity Test	Excitation Current	Burden
Current Transformers (All Phases)	✓	(If Bar-type) N/A	✓	✓	✓
Potential Transformers (All Phases)	✓	✓	✓	N/A	✓

Power Transformers (if owned by customer)

Equipment	End-to-End Wire Checks	Insulation-Resistance	Power Factor Test	Ratio Test	Winding Resistance	Excitation Current	Alarm / Control / Trip Checks
Main Power Transformer(s)	✓	✓	✓	✓	✓	✓	✓

Power Quality Meter (if DER System ≥ 5MW)

Manufacturer	N/A	**Model**	N/A
Meter Checks			
End-to-End Wire Checks	**Analog Inputs**	**Configuration**	
N/A	N/A	N/A	

Note: Power Quality meter shall comply and be configured to meet 'Annex B' of FortisAlberta's Technical Interconnection Requirements Standard (DER-02).

This section above is for DER customers who export to FortisAlberta's distribution system with an aggregate power output above 5MW.

Export Only - Communications (Fortis Alberta's SCADA Network)

Indicate below that all SCADA points have been mapped and verified back to FortisAlberta's SCADA network. Refer to *Annex C* of FortisAlberta's *Technical Interconnection Requirements Standard* (DER-02) for the required SCADA parameters. Verification will require direct coordination with FortisAlberta's SCADA team.

SCADA Parameter Verification

Date of Testing:	N/A		**FAB SCADA Witness:**	N/A
Signals	**Analog**	N/A		
	Binary	N/A		
	Control	N/A		

This section above is for customers who export to FortisAlberta's distribution system and whom are required to install a FortisAlberta SCADA link.

Protection & Equipment Commissioning Certification:

Date of Equipment Testing: **April 10, 2019**	Wire Owner Field Witness: ☒Yes ☐No
Additional Notes/Comments: **- Any discrepancies in the test results.** **- Details discussed with a FortisAlberta representative.** **- Equipment requiring additional attention.** **- References to DWGs or other documents.**	

Provided by:	Witnessed by:
Don Mayfield / XYZ	**Jason Dolly**
Power Producer (name / company)	FortisAlberta
Commissioning Specialist	**Metering Technician**
Title	Title
Don Mayfield	*Jason Dolly*
Signature	Signature
April 11, 2019	**April 11, 2019**
Date	Date

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REFERENCE MATERIAL

Inspections and Tests

The following are the minimum expectations for each type of inspection and test. Refer to the equipment manufacturer for recommended routine maintenance tests, if not available use the latest NETA Acceptance Testing Standard (ATS) as a reference for applicable inspections, test procedures and expected results.

End-to-End Wire Checks:

- Verify tightness of accessible bolted connections by use of a calibrated torque wrench. Use manufacturer specifications for required torque levels.
- Inspect, tug test and tighten all loose circuit wiring connections.
- Confirm each wire is terminated as indicated in vendor / engineered drawings.
- Verify end-to-end continuity.
- Verify single point grounding.
- Ensure proper phasing.

Insulation-Resistance & Dielectric Withstand Testing:

- One-minute insulation resistance on each phase. Shall include both phase-to-phase and phase-to-ground tests.
- Insulation-resistance tests shall be conducted when the breaker or isolation switch is in the closed position.
- For required test voltages and expected values refer to manufacturer data, Table 100.1 or Table 100.5 (Transformers) in NETA ATS.
- Isolation switches requiring dielectric withstand tests shall be conducted with the switch in the closed position, testing each phase, phase-to-phase and phase-to-ground. Refer to manufacturer recommendations.
- Breakers requiring dielectric withstand testing (for vacuum bottle integrity) shall be conducted across the vacuum bottle when the breaker is in the open position.

Contact Resistance Tests:

- Tests to be conducted across switchblades, fuse holders and breaker contacts in the closed position. Each phase shall be tested and compared. A low-ohm meter shall be used for each test.
- Comparing each phase, at a maximum, test values shall not differ by more than 50 percent of the lowest phase.

Breaker Timing Tests:

- Verification of when the breaker receives an open / close signal to the actual mechanical open / close of the breaker contacts.
- Test values shall reflect manufacturers specification. In the absence of manufacturer data values times shall be recorded for maintenance purposes.

Breaker / Isolation Switch Function Tests:

- Verify that breaker functions electrically via protection controller (inter-tie relay).
- Breaker open and close functions shall be verified manually by push button and/or mechanical lever.
- When applicable both the undervoltage and anti-pump functions of the breaker shall be tested.
- Manually operate switches to verify proper engagement of switchblades.

Inspections and Tests Cont'd

Analog Inputs / Configuration:

- Inject voltage and current into meter inputs to ensure accuracy.
- Confirm voltage and current ratios configured directly reflect instrument ratios and system parameters.
- Verify / configure meter for event capturing that complies to 'Annex B' of FortisAlberta's *Technical Interconnection Requirements Standard* (DER-02).

Transformers

Ratio / Polarity:

- (Power) Perform turns ratio test on the nominal operating tap and for each winding.
  (Instrument) Perform turns ratio test on each PT and CT at the PCC.
- (Power) Ratios shall not differ by more than 0.5% on each winding pair.
- (Instrument) Ratio errors shall conform to ANSI/IEEE C57.13

Winding Resistance:

- (Power) Resistance shall be measured on both the high and low voltage windings at the operating tap.
- (Power) Temperature corrected winding resistance shall be compared within one percent of factory or previously obtained results.

Excitation Current:

- (Power) Excitation current shall be measured on both the high and low voltage windings at the nominal operating tap.
- (Power) Excitation current pattern for a 2-winding transformer shall have two similar readings and one lower current reading.
- (Instrumentation - CT) Testing shall be in accordance to ANSI/IEEE C57.13.1.
- (Instrumentation - CT) Excitation results shall match the curve supplied by the manufacturer or be in accordance with ANSI/IEEE C57.13.1.

Power Factor:

- (Power) Insulation Power Factor tests shall be performed on all windings of the transformer as per testing equipment manufacturers recommendation.
- (Power) Expected CHL values shall be less than:
  Oil (Power) = 0.5%
  Dry (Power) = 2.0%
  Dry (Distribution) = 5.0%
- (Power) Insulation Power Factor tests shall be performed on all windings of the transformer as per testing equipment manufacturers recommendation.

Burden:

- (Instrumentation) Measured transformer burdens shall not exceed instrument transformer name-plate rating.