# TS132- F1 Embedded Generation Commissioning Witnessing Checklist above 30kVA to 500kVA

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**Empowering South Australia** 

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# **Revision Notice:**

### **SA Power Networks:**

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### Instruction

This document is a witnessing and commissioning checklist for Medium Embedded Generation (above 30kVA to 500kVA) units only.

The following aspects requirements must be compliant to all applicable standards and requirements prior to SA Power Networks witnesser attending the customer's site:

- All isolation equipment (main switches, main isolators etc.);
- Labelling;
- Shutdown procedure; and
- Any other requirements stipulated by SA Power Networks.

Please note that the grey text in each table only serves as a placeholder, and these entries will vary from site to site.

The **BLUE** highlighted sections are to be completed by the customer.

The **ORANGE** highlighted sections below are to be completed by the SA Power Networks' witnesser.

# 1. Pre-Commissioning Checks

#### Table 1: General Project Information

\* A person who understands the operation and configuration of the system and can demonstrate all aspects of this plan

#### Table 2: NMI Information

NMI 1	
NMI 1 Solar PV Approved Capacity	
NMI 1 Battery Approved Capacity	
NMI 1 Synchronous Approved	
Capacity	
NMI 1 Voltage and Reactive Power	
Control	
NMI 1 Maximum Export (AC)	
NMI 1 Minimum Import (AC)	
Site Agreed Demand	

#### For any additional NMIs, please complete an additional table for each NMI - refer Appendix A.

#### Table 3: SA Power Networks Site Information

Witnessing Officer	
Order Number	
Transformer Number(s)	
Site Number	

#### Table 4: Smarter Homes Requirements

Pre-Commissioning Compliance Checks	Response
Relevant Agent appointed for the generating system	
Technical solution used for Remote disconnection and reconnection	

# 2. On-Site Commissioning Checks

Section 2 pre-connection checks must be witnessed by the SA Power Networks Witnesser prior to proceeding to compliance testing in section 3.

Table 5: On-Site Commissioning Checks

On-Site Pre-Commissioning Checks	Check
New plant installed is as per the original approved application. The customer accepts responsibility	
to rectify this if found to be incorrect.	
Bi-directional/import/export meter installed and aligns with NMI	
Revenue meter aligns with NMI	
Site additional NMIs (parent/meshed) (Refer Appendix A for additional NMI details if applicable)	

#### SA Power Networks Officer Comments:

# 3. Compliance Testing

### **3.1** Settings Compliance Testing

Section 3 Compliance Testing checks must be witnessed by the SA Power Networks Witnesser prior to proceeding to System On-line Commissioning in section 5.

Table 6, 7 and 8 detail the inverter model, type and required anti-islanding protection setting check on the installed inverters to ensure compliance to AS4777.2. All of the following settings must be visually verifiable.

Please ensure the setting and trip time values are correct to TS132. Please see Appendix B and TS133 when the inverters are connected at HV.

#### Table 6: Inverter Model and Type Check

Inverter Model	Inverter Type

#### Table 7: Inverter Regulatory Settings Check

Inverter Setting	Relevant Agent
Remote Disconnect set with Relevant Agent	
Dynamic Export enabled (if applicable)	

Methodology to switch inverter.....

#### Table 8: Inverter Settings Checklist

Inverter Protection	Setting		Trip	Time		In	ver	ter	No	<b>) 1</b> -:	10	
Nominal Voltage	23	230V										
Over Voltage Level 1 (V)	265V	115%	1.0sec	50cyc								
Over Voltage Level 2 (V)	275V	120%	0.2sec	10cyc								
Under Voltage Level 1 (V)	180V	78%	10sec	10sec 500cyc								
Under Voltage Level 2 (V)	70V	30%	1.0sec	1.0sec 50cyc								
10min Average Sustained Voltage	258V	112%										
Over Frequency (f)	52Hz	104%	0.2sec	10cyc								
Under Frequency (f)	47Hz	94%	1.0sec	50cyc								
Active anti-islanding		layed	Functio	n Tested								
Soft Ramp Up after Reconnect	Enabled 16.6		ed 16.67%	)								
Reconnect Time	60sec											

# 4. **Power Response Setting Check**

Table 9, Table 10 and Table 11 detail the power quality response setting checks on the installed inverters to ensure compliance to AS4777.2. All of the following settings must be visually verifiable.

#### Table 9: Power Quality Response Setting Checklist

Inverter Power Quality Response	Setting	On	/Off	
Fixed Power Factor mode (if required)		On		Off
Volt-VAr response mode		On		Off
Volt-VAr reaction time		On		Off
Volt-Watt response mode		On		Off

#### Table 10: Reactive Power - Volt-VAr response mode (TS132 Table 8)

Reference	Voltage in Volts	VAr % rated VA	Inverter No 1-10									
V <sub>1</sub>												
V <sub>2</sub>												
V <sub>3</sub>												
V <sub>4</sub>												

#### Table 11: Active Power - Volt-Watt response mode (TS132 Table 9)

Reference	Voltage in Volts	Power % rated Power	Inverter No 1-10						
V <sub>1</sub>									
V <sub>2</sub>									

Customer to prove settings compliance to SA Power Networks Witnesser on multiple inverters. Ensure at least one is checked for every string of inverters.

Number of inverters

Total Inverter size \_\_\_\_\_

Number of inverters

Total Inverter size \_\_\_\_\_

#### 4.1 **Protection Settings Check**

Table 12 details the required protection setting check on the installed protection relay to ensure compliance to AS4777.1. These settings must be verifiable via visual inspection either on the protection relay panel or software on device connected to the relay.

If the protection elements are to be demonstrated via set-point manipulation on the relay, the voltage, frequency and export set-points will be adjusted to cause a trip under normal operational conditions, e.g. Under Voltage will be tested by setting the trip point to 245V.

If export controls are in place refer to Table 13 for tests.

Please see Appendix B when the NPU relay's VT is connected at HV.

#### Table 12: Protection Relay Settings Checklist for LV connected Systems

Relay Protection 1	Make/Model Se				erial No.					
Protection Relay 1 Make/Model &										
Measured Voltage	Red	v	White			v		Blue		v
Measured Frequency		Hz								
Relay Protection 1		Set	ing	Trip	o Time/	/Cvcl	es		Check	
Reference/Nominal Voltage			0	•						
Control Device										
Change - Auto Fault Reset Delay T	ïme			1						
Over Voltage Level 1										
Over Voltage Level 1 Function Tes	t Value									
Over Voltage Level 2										
Over Voltage Level 2 Function Tes	t Value									
Under Voltage Level 1										
Under Voltage Level 1 Function Te	est Value									
Under Voltage Level 2										
Under Voltage Level 2 Function Te	est Value									
Sustained Overvoltage (average 10 m	ins)									
Over Frequency										
Over Frequency Function Test Val	ue									
Under Frequency										
Under Frequency Function Test Va	alue									
Select one: ROCOF Stage 1 (preferre	d)									
or ROCOF Stage 2										
Vector Shift					•					
Voltage Unbalance										
Auto Fault Reset										
Minimum Import / Zero Export <sup>2</sup> (if applicable)					•					
Protection Relay Password										
Tamper seal serial number										

<sup>&</sup>lt;sup>1</sup> Vector Shift must remain disabled unless special SA Power Networks approval is given

<sup>&</sup>lt;sup>2</sup> Specify whether Directional Overcurrent or Reverse Power protection function will be implemented

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Relay Protection 1	Displayed Value with No Generation		Displayed Value wit Generation	h
Output achieved		kW		kW
Load observed		kW		kW

•	Ensure that all set points are returned to correct settings as listed in Table 13.	
•	SA Power Networks Witnesser confirms that the generator CB	
	opens upon protection relay failure.	
•	Check Circuit Breaker Fail operation (if applicable)	$\Box$ .

Check Circuit Breaker Fail operation (if applicable) •

#### SA Power Networks Officer Comments:

# 5. System On-Line Commissioning

This section includes control tests pertaining to export (Table 13), battery systems (Table 14) and SCADA (Table 15).

### 5.1 Export Control Tests

#### Table 13: Export Control Tests

Export / Import - Control Manager / Inverter / PLC Tests						
Step & Parameter	Setpoint	Measured Load	Measured Gen.			
1) Remove all control – record			L\\/			
total generation & load		NVV	K V V			
2) Apply 50% control of recorded		L/A/	μ\ <b>Λ</b> /			
generation		NVV	K V V			
3) Apply 20% control of recorded		L/A/	μ\ <b>Λ</b> /			
generation		NVV	K V V			
4) Apply 0% control of recorded		L/A/	<i>د</i>			
generation		NVV	K V V			
5) Disconnect communication						
cable to reference meter						
6) Protection relay status for						
above condition						
7) Control manager/PLC/Inverter						
status for above condition						
8) Reconnect Comms Cable and						
Observe Response (system ramp)						
9) Apply all control – record total		kW	kW			
generation & load						

### 5.2 Battery Control Tests – If Applicable

#### Table 14: Battery Control Tests

Battery Control Test							
Step & Parameter	Setpoint	Battery Value	Load	Generation			
1. Remove All Controls		%	kW	kW			
2. Charge Battery from Grid		%	kW	kW			
3. Discharge Battery to Grid		%	kW	kW			
4. Apply Control and Check Status		%	kW	kW			
5. Simulate Trip Scenario			kW	kW			
6. Reinstate - Confirm battery							
isolates from the network							
7.Measure Ramp Down Speed							

#### SA Power Networks Officers Comments:

### 5.3 SCADA Control Tests

Table 15: SCADA Control Tests

#### Step & Parameter

- 1. Contact NOC and <u>sign on</u> to the feeder. NOC Operator Name:
- 2. SA Power Networks to issue Permission to Connect Signal
- 3. SA Power Networks to execute the following steps and issue the following setpoint values (GDL) via SCADA and witness correct system operation

4. Record SCADA Voltage at 0% Generation	Red:		v	White:			V	Blue:		V
		Setpoint	it Measured							
GDL Limit Control Test	Exp - Limit	0	iDL	Pf		Р	owe	r	VArs	
<ol> <li>Remove all controls – record system maximum values</li> </ol>					Pf			kW		kVAr
6. Alter GDL - Export Limit Max					Pf			kW		kVAr
7. Ramp up to shown GDL setpoint of Max Value					Pf			kW		kVAr
8. Ramp up to shown GDL setpoint of Max Value					Pf			kW		kVAr
<ol> <li>Ramp down to shown GDL setpoint of Max Value</li> </ol>					Pf			kW		kVAr
10. Ramp up to shown GDL setpoint of Max Value					Pf			kW		kVAr
11. Record SCADA Voltage at 100% Generation	Red:		V	White:		V	/	Blue:		V
		· atmaint		Measured						
Net Export Limiter (If		serboiur					vieas	ureu		
Net Export Limiter (If applicable)	Exp-Lim	it (	iDL	Pf		P	owe	r	VAr	'S
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max	Exp-Lim	it (	iDL	Pf	Pf	P	owe	kW	VAr	s kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value	Exp-Lim	it (	iDL	Pf	Pf Pf	P	owe	kW kW	VAr	kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value	Exp-Lim	it (	iDL	Pf	Pf Pf Pf	P	owe	kW kW kW	VAr	s kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value	Exp-Lim	it (	;DL	Pf	Pf Pf Pf Pf Pf	P	owe	kW kW kW kW	VAr	kVAr kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value 16. Apply Permission Denied reach 0%	Exp-Lim	it (	n to	Pf	Pf Pf Pf Pf	P	owe	kW kW kW kW	Min	kVAr kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value 16. Apply Permission Denied reach 0% Power Factor Limit Control	Exp-Lim	it (	n to	Pf	Pf Pf Pf Pf	P	owe	r / / / / / / / / / / / / / / / / / / /	min	kVAr kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value 16. Apply Permission Denied reach 0% Power Factor Limit Control (If Applicable)	Exp-Lim	it (	n to tpoint	Pf	Pf Pf Pf Pf	P	owe	r / / / / / / / / / / / / / / / / / / /	VAr min rred VAr	s kVAr kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value 16. Apply Permission Denied reach 0% Power Factor Limit Control (If Applicable) 17. Set GDL Max	Exp-Lim	it (	n to tpoint iDL	Pf	Pf Pf Pf Pf	P	Powe Powe	r	VAr min red VAr	kVAr kVAr kVAr kVAr
Net Export Limiter (If applicable) 12. Alter Export limit – Keep GDL Max 13. Ramp down to shown Export Limit Value 14. Ramp down to shown Export Limit Value 15. Ramp system up to shown Export Limit Value 16. Apply Permission Denied reach 0% Power Factor Limit Control (If Applicable) 17. Set GDL Max 18. Set Export Limit to Max	Exp-Lim	it (	n to tpoint iDL	Pf	Pf Pf Pf Pf	P	Powe	r	VAr min red VAr	kVAr kVAr kVAr kVAr

20. Alter power factor setpoint <sup>3</sup>

Please note: Power Factor setpoints used must meet the following requirements

- At least 4 power factor setpoints
- At least one positive and one negative setpoint
- Down to 0.05 lower than the required power factor
- Power factor setpoint intervals not exceeding 0.05 at a time

		_			
Alter power factor					
Record SCADA Voltage					
Alter power factor					
Record SCADA Voltage					
Alter power factor					
Record SCADA Voltage					
Alter power factor					
Record SCADA Voltage					
Alter power Factor					
Record SCADA Voltage					
Alter power Factor					
Record SCADA Voltage					
22. Set required power					
factor, GDL and Export					
Limit					
System sho	ould now be i	n what will be r	normal / auto op	peration mode	

SA Power Networks Officer's Comments:

<sup>&</sup>lt;sup>3</sup> The minimum power factor to be altered down to is 0.8pf. If insufficient power factor range to fully carry out tests, apply smaller 0.02pf steps or otherwise please contact Connections Planning for proposed revised power factor alteration values.

# 6. Final Sign-Off

Details and checks must be populated in all sections (and Appendix if relevant) of this document and Section 5 On-Line Commissioning checks must be witnessed by the SA Power Networks Witnesser prior to proceeding to Final Sign-Off in Section 6.

Final Agreement	Customer	SAPN
Go ahead has been received from all parties		
Site Witness sticker placed on NPU panel		

Smarter Homes Regulations Che	eck	
Parameter	Customer (Signature)	Date
The Customer of the designated electricity generating plant confirms that they have commissioned the Remote disconnection / Reconnection technical solution as per the provider's instructions and is capable of performing the function at the time of installation.		

Custome	r Representative
Name:	
Signed:	
Date:	

SA Power	r Networks Representative
Name:	
Signed:	
Date:	

# **Appendix A - Additional NMI Tables**

#### Table A1: NMI Information

	NMI 2	NMI 3	NMI 4	NMI 5
NMI Number				
NMI Solar PV Approved				
Capacity				
NMI Battery Approved				
Capacity				
NMI Synchronous				
Approved Capacity				
NMI Power Factor				
NMI Maximum Export				
NMI Minimum Import				

If additional space is required, please provide external table in similar format.

# **Appendix B - Alternate Tables for HV Sites**

The following table is for use in place of Table 8 when inverters are connected at HV.

Inverter Anti-Islanding Protection	Setting	Trip Time		Inverter Check			
Over Voltage Level 1 (V)	115%	1.0sec	50сус				
Over Voltage Level 2 (V)	120%	0.2sec	10сус				
Under Voltage Level 1 (V)	78%	10sec	500сус				
Under Voltage Level 2 (V)	30%	1.0sec	50сус				
Sustained Overvoltage (average 10 mins)	112%	Instantaneous					
Over Frequency (f)	104%	0.2sec	10сус				
Under Frequency (f)	94%	1.0sec	50сус				
Select one: ROCOF Stage 1 (preferred)	±4 Hz/Sec	0.25sec	12.5сус				
or ROCOF Stage 2	±3 Hz/Sec	1sec	50сус				
Active anti-islanding	Enabled						
Soft Ramp Up after Reconnect	l	Enabled 16.679	abled 16.67%				
Reconnect Time	60sec						

#### Table B1: HV Inverter Settings Checklist

The following table is for use in place of Table 12 when the NPU relay's VT is connected at HV:

#### Table B2: HV Protection Relay Settings Checklist

Relay Protection	Setting	Trip Time		Check
Over Voltage Level 1	115%	2sec	100сус	
Over Voltage Level 2	120%	0.2sec	10сус	
Under Voltage Level 1	78%	11sec	550сус	
Under Voltage Level 2	30%	2sec	100сус	
Sustained Overvoltage (average 10 mins)	112%	Instantaneous		
Over Frequency	104%	2sec	100сус	
Under Frequency	94%	2sec	100сус	
Select one: ROCOF Stage 1 (preferred)	±4 Hz/Sec	0.25sec	12.5сус	
or ROCOF Stage 2	±3 Hz/Sec	1sec	50сус	
Vector Shift				
Minimum Import / Zero Export (if applicable)				
Auto Fault Reset	Enabled	60sec	3,000сус	
Relay Delay Time Change				