Technical Standard - TS134

Communication Systems (inc. SCADA) for Embedded Generation

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SA Power Networks

Empowering South Australia

Revision Notice:

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1. Introduction

This technical standard specifies to designers, contractors, and consultants the technical requirements for the communication systems, including SCADA, for embedded generation (EG) systems that are connected to SA Power Networks' distribution network.

Technical Standards TS132 - *Low Voltage EG Connections above 30kVA* and TS133 – *High Voltage Embedded Generation Connection Technical Requirements* specify the type of communication system required.

2. Definitions and Abbreviations

2.1 Definitions

Connection Point	As per Electricity (General) Regulations 2012: A connection point to a transmission or distribution network. For this document, connection point also has the same meaning as point of supply as defined in AS/NZS 3000. The point of supply established between SA Power Networks and the customer.
Customer	A person who engages in the activity of purchasing electricity supplied through the distribution network to a connection point and is registered by AEMO as a customer under chapter 2 of the NER.
Consumer Energy Resources	Power generation or energy storage units that are connected directly to the distribution network.
Distribution Network	References to distribution network means the network poles, wires, underground cables, transformers, substations, etc, operated by SA Power Networks, which transports electricity to and from a customer's connection point.
Electricity Distribution Code	The Electricity Distribution Code made by ESCOSA pursuant to Section 28 of the Essential Services Commission Act 2002.
Embedded Generating Unit	A generating unit connected within a distribution network and not having direct access to a transmission network.
Embedded Generator	A generator (ie customer), who owns, operates, or controls an embedded generating unit.
Energy Storage Unit	Plant that is able to both, store electricity from, and discharge electricity to, units within the same generating system and/or distribution network (ie act as both a load and a generating unit)
Energy Storage System	A system comprising one or more energy storage units
Extra Low Voltage	Voltage not exceeding 50V ac or 120V ripple-free dc
Generating System	All embedded generating units and the associated control and protection equipment that is located on the customer's side of the connection point.
Generating Unit	The actual generator of electricity and all related equipment essential to its function as a single entity.
Generation Despatch Limit	A real power output limit value sent via a SCADA signal by the DNSP to be applied at the individual generating unit terminals.

Generator	A person/entity who engages in the activity of owning, controlling, or operating a generating system that supplies electricity to, or who otherwise supplies electricity to, a transmission or distribution network.
Grid	Portion of the electrical distribution system that is operated by an electrical distributor. Note: An alternative term for grid is electricity distribution network.
Grid Isolation Device	A device designed to safely break voltage and current such as a circuit breaker or contactor on the customer side of the connection point.
High Voltage	Voltage exceeding low voltage
Inter-trip	An anti-islanding protection scheme that is operated by the distribution network service provider to disconnect the embedded generating system when a network fault occurs.
Interface Protection	The protection relay functions that open the disconnection device of an inverter energy system, and prevent its closure, as appropriate in the case of: • A fault on the grid; • An unintentional islanding situation; or • Voltage and frequency being outside the continuous operating range
Inverter	The device that may form part of the generating system which uses semiconductor / power electronics devices to convert direct current to alternating current.
Inverter Energy System	A system consisting of one or more inverters that operate by converting direct current to alternating current. In the context of system capacity, this definition includes the capacity of ac coupled energy storage systems.
Low Voltage	Voltage exceeding 50V ac or 120V ripple free dc and not exceeding 1,000V ac or 1,500V dc
Nameplate Rating	The maximum continuous output or consumption in MW of an item of equipment as specified by the manufacturer, or as subsequently modified. Where the rating of an item of plant is specified by the manufacturer in MVA and not MW, the nameplate rating is determined by converting the manufacturer's rating in MVA to the rating in MW by applying a conversion factor of 1.
National Electricity Rules	The rules as defined in the National Electricity Law as set out in the Schedule to the National Electricity Act 1996 (SA).
Small Embedded Generation	A single phase or three phase inverter connected embedded generation system up to 30kVA.
System Capacity	Nameplate ratings of the inverter energy system or non-inverter energy systems, measured in VA
Supply	The delivery of electricity.

Total System Capacity	Sum of the nameplate ratings of the inverter energy systems or non-inverter energy systems comprising the embedded generation connection, measured in VA
Transmission Network	Network operated by ElectraNet.

2.2 Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator Limited (ACN 072 010 327)
AER	Australian Energy Regulator
AS/NZS	A jointly developed Australian and New Zealand Standard
AS	Australian Standard
BESS	Battery Energy Storage System
CBD	Central Business District
CER	Consumer Energy Resources
CSIP	Common Smart Inverter Profile
CT	Current Transformer
DERMS	Distributed Energy Resources Management System
EDC	Electricity Distribution Code
EG	Embedded Generation or Embedded Generating
ELV	Extra Low Voltage
EMTC	Electricity Metering Code (ESCOSA)
ESCOSA	Essential Services Commission of South Australia
ESS	Energy Storage System
GDL	Generation Dispatch Limit
HV	High Voltage
IEC	International Electrotechnical Commission
IES	Inverter Energy System
IPU	Interface protection Unit
LV	Low Voltage
MMOF	Multimode Optic Fibre
NEL	Net Export Limiter
NER	National Electricity Rules
NEM	National Electricity Market
NMI	National Meter Identifier
NOC	SA Power Networks' Network Operations Centre
PLC	Programmable Logic Controller

PV	Photovoltaic
RTU	Remote Telemetry Unit (Also known as 'Remote Terminal Unit' or 'Remote Telecontrol Unit')
SCADA	Supervisory Control and Data Acquisition
SIR	Service & Installation Rules
VT	Voltage Transformer

2.3 Terminology

may	Indicates a requirement that is not mandatory but can be imposed on the customer as deemed appropriate by SA Power Networks.
must	Indicates a mandatory requirement.
shall	Indicates a mandatory requirement.
should	Indicates a recommendation that will not be mandatory but can be imposed on the customer as deemed appropriate by SA Power Networks.
Suitable (or Suitably):	To the satisfaction of the relevant SA Power Networks Manager.

3. Relevant Rules, Regulations, Standards and Codes

3.1 Standards and Codes

The following listed documents are for additional information and other documentation may be required on a project specific basis. Please note: It is the responsibility of the customer to ensure you have complied with all applicable, SA Legislative Regulations (under Acts), ESCOSA/ENA/AEMC/IEC documentations, relevant AS/NZS standards, the SA Power Networks publications, and you have ensured their current publications, before implementing them.

Standards Australia Publications:

AS 2067	2016	Substations and high voltage installations exceeding 1 kV ac
AS/NZS 3000	2018	Electrical Installations (known as the wiring rules)
AS/NZS 3010	2017	Electrical Installations - Generating sets
AS/NZS 3017	2022	Electrical installations - Testing User Guides
AS/NZS 3100	2022	Approval and test specification - General requirements for electrical equipment
AS/NZS 4777.1	2024	Grid connection of energy systems via inverters - Installation requirements
AS/NZS 4777.2	2020 (Amd 2024)	Grid connection of energy systems via inverters - Inverter requirements
AS 5577	2013	Electricity network safety management
AS 60529	2004	Degrees of Protection Provided by Enclosures (IP Code)

IEC

IEC 60255-12	1980	Electrical Relays – Directional relays and power relays with two input energizing quantities
IEC 60255-26	2013	Electrical relays – Part 26: Electromagnetic compatibility requirements
IEC 60255-27	2013	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60255-127	2010	Measuring relays and protection equipment – Part 127: Functional requirements for over/under voltage protection

IEEE

IEEE 802.3	2022	IEEE Standard for Ethernet
IEEE 2030.5	2023	IEEE Standard for Smart Energy Profile Application Protocol

SA Power Networks Documents:

- Manual 14: Safety, Reliability, Maintenance & Technical Management Plan
- Manual 32: Service & Installation Rules
- Technical Standards & NICC Brochures, in particular:
  - TS085: Trenching and Installation of Underground Conduits and Cables (up to and including 33kV)
  - TS 132: Low Voltage EG Connection Technical Requirements – Capacity above 30kVA
  - TS 133: High Voltage Embedded Generation Connection Technical Requirements

3.2 Legislation and Regulations

This section provides a list of the relevant legislation and regulations which shall apply to the design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for HV EG connections to the distribution network.

In an event where there is any inconsistency between legislation and regulations and these technical requirements, the legislation and regulations shall prevail.

- Electricity Act 1996 (SA)
- Electricity (General) Regulations 2012
- National Electricity Rules (NER)
- Electricity Distribution Code (ESCOSA)
- Work Health and Safety Act 2012
- Work Health and Safety Regulations 2012
- Technical Regulator Guideline
    - Remote Communications Capabilities for Inverters
    - Declared Components of Electricity Infrastructure or an Electrical Installation Associated with an Electricity Generating Plant
    - Deemed Methodologies for Remote Disconnection and Reconnection of Electricity Generating Plants
    - Remote Updating Methods
    - Export Limiting Methods

4. General Requirements

Electricity Generating plant connected inverters must have internet capability and an on-board communication port that can be used for a physical connection to another device, as described in the Electricity (General) Regulation 2012. Remote monitoring and control will be required in cases where the combined generation capacity represents a significant portion of the total area load (typically exporting more than 200kW per parent NMI), or a credible network constraint has been identified or where deemed necessary by SA Power Networks.

The requirements will be determined during SA Power Networks' assessment of the proposed EG system's connection to the distribution network and will be provided in the Engineering Report.

Prior to final site commissioning the control system will need to be made available to SA Power Networks for user acceptance testing (UAT).

5. Remote Monitoring and Control Requirements

The nameplate rating and operational requirements of the proposed EG system in relation to the capacity of the distribution network at the proposed connection point will influence the actual interface and communications requirements**. Table 1** summarises the type of remote monitoring and control applicable to various types of generating systems. SA Power Networks defines two additional remote monitoring and control profiles, SCADA (simplified) and SCADA (Inter-trip). The requirements of these profiles are shown in clause 5.1.

For generating systems with multiple connection points, export requirements are considered for each individual NMI at the connection point.

Table 1: Remote Monitoring & Control requirements by Generation type and Capacity

Generation Type	Non-Export		Export		
	<5MVA	≥5MVA	≤200kVA	>200kVA, <5MVA	≥5MVA
IES[1]	Not Required	SCADA (Simplified)	Not Required	SCADA (Simplified) [2]	SCADA (Inter-trip)
Non-IES	SCADA (Simplified)[3]	SCADA (Simplified)	SCADA (Inter-trip)	SCADA (Inter-trip)	SCADA (Inter-trip)

Notes:

1. IES not compliant to AS/NZS 4777.2 shall comply to non-IES requirements.
2. 200kW export per NMI if in an unconstrained area. SCADA (inter-trip) may apply if there is a network constraint.
3. Only required where fault levels require management or fault ratings are at risk of exceedance (eg CBD 11kV).

5.1 Remote Monitoring and Control Arrangements

The customer shall be responsible for providing all SCADA and protection inputs (as applicable) to SA Power Networks at the designated interface points. This may include the following equipment:

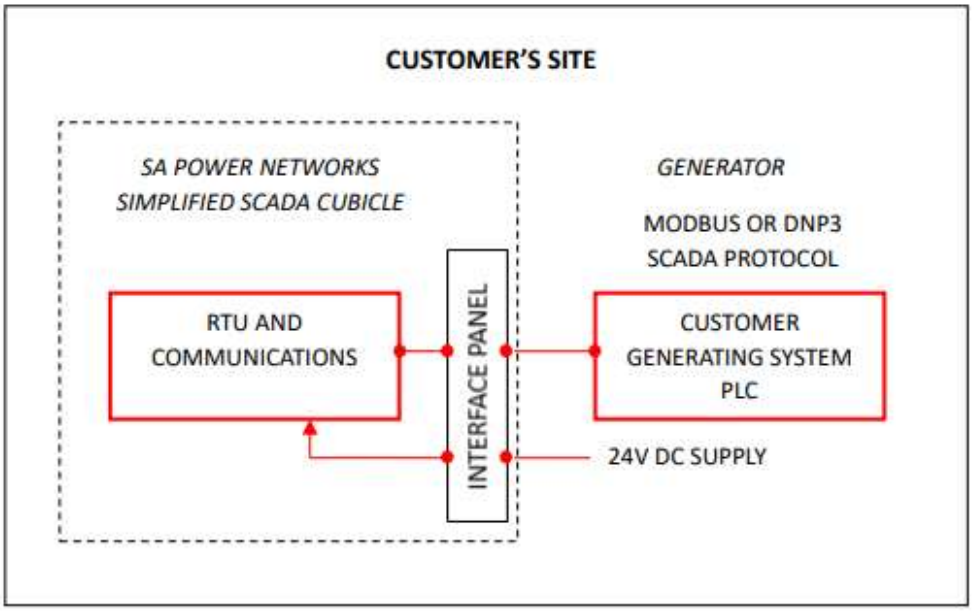
- protection relays (eg aux trip relays, directional distance relays, differential protection relays);
- current and voltage transformers;
- SCADA RTU;
- DC power system;

- discrete digital signalling fibre or radio system (eg tele-protection scheme; multiplexing or switch/router);
- private or public mobile carrier network equipment; and
- SA Power Networks' communications cubicle or cabinet.

5.1.1 SCADA (Simplified)

Table 1 outlines what generating systems require SCADA (simplified). **Figure 1** shows the typical SCADA block diagram for these systems.

Figure 1: Block diagram of SCADA/Tel solution for generating systems without inter-trip



To facilitate connection of the SCADA (simplified) equipment, the following requirements must be met by the customer.

5.1.1.1 Accommodation for SA Power Networks' Equipment

1. The customer shall provide a suitable wall space or 75mm × 75mm square steel post (typical) as close as practical to the customer's metering position, or in an easily accessible location, for the installation of a lockable SCADA enclosure with unobstructed access by SA Power Networks personnel. This location must be within normal copper serial communication cable length (15m) from the site controller if MODBUS RTU protocol is selected. Note MODBUS TCP/IP shall be considered on request.
2. SA Power Networks shall provide the lockable SCADA stainless steel enclosure (W300mm × H380mm × D210mm, weight 7kg) and the customer shall install the enclosure on the wall or post. SA Power Networks shall commission the SCADA RTU and cellular router.
3. The Customer shall be responsible for the installation of the enclosure provided by SA Power Networks. The Customer shall contact SA Power Networks Project Manager to arrange for the collection of the enclosure.
4. The customer shall provide a 32mmØ conduit to the SA Power Networks SCADA enclosure including provision of a 2.5mm² Cu cable for 24V 5W DC supply and copper data cable (Cat 5 acceptable). The Customer shall provide the appropriate matching data connector in the cubicle or clearly label the conductor functionality (ie +ve, -ve, TX, RX and GND).
5. The customer shall provide a suitability sized earth bonding for the enclosure connected to the customer's common earth bar.

5.1.1.2 Interfaces

1. Provide a serial RS-232 interface standard (compliant V24 and V28). A TCP/IP (IEEE 802.3) interface shall be considered on request.
2. Provide Modbus RTU or TCP/IP protocol for SCADA interface between customer's generating system PLC and SA Power Networks' RTU.
3. Physical layer delivery shall be via a copper RS-232 serial communication cable however this standard has a distance limitation of notionally 15m. Note the customer and SA Power Networks' equipment cubicles shall be solidly earth bonded under this arrangement.
4. For separation distances of notionally greater than 15m the delivery method shall be via a 'Multi-Mode Optic Fibre' (MMOF) via RS-232 serial communication protocol utilising optical to copper serial media converters.
5. When TCP/IP Ethernet is selected, it is required to terminate the cable with an RJ45 connector. Alternatively, in the case of RS232 connections, the cable used shall have a maximum diameter of 1.5mm and consist of three wires. These wires need to be terminated with isolation links, which will be located within the SA Power Networks cabinet.
6. SCADA interface point will be the Customer's data connector located on the SA Power Networks' RTU within the SCADA enclosure.

5.1.1.3 DC Power System

1. Provide 24V 5W DC backup power from the customer's protection and control system to supply the SA Power Networks' SCADA enclosure.
2. The DC system shall have a 24-hour survival time to allow for local electrical network outages.

5.1.1.4 Circuit Breaker(s) (Disconnecting Generator(s))

The trip circuit to be a normally closed circuit.

5.1.1.5 Communication Signal Fail-safe

The PLC must be capable of receiving a pulse for a healthy communications signal from SA Power Networks' RTU every 60s from which the customer's generating system PLC will initiate an automatic controlled shutdown of the generating system in the event of a communications failure indicated by the lack of any single pulse. Upon loss of communications between SA Power Network's RTU and the customer's control room, an automatic controlled shutdown of the generating system is to be automatically carried out by the customer following a timeout delay of 15–45mins as specified by SA Power Networks.

5.1.1.6 SCADA Input/Output

1. Customer to liaise with SA Power Networks to provide a list of SCADA inputs for the generating system.
2. SCADA data shall be via Modbus RTU or TCP/IP communication protocol (refer "interfaces"). Hard-wired I/O will not be permitted.
3. Prior to beginning SA Power Networks' SCADA works on site, the customer's generating system PLC must be brought into SA Power Networks' offices for 'User Acceptance Testing' (UAT) and confirmation that the PLC communicates correctly with SA Power Networks' equipment.

5.1.1.7 Site Access

24 hours site access to SA Power Networks' equipment for faults and maintenance (escorted or non-escorted).

5.1.2 SCADA (Inter-Trip)

Table 1outlines what generating systems require SCADA (inter-trip). **Figure 2** shows the typical SCADA block diagram for these systems.

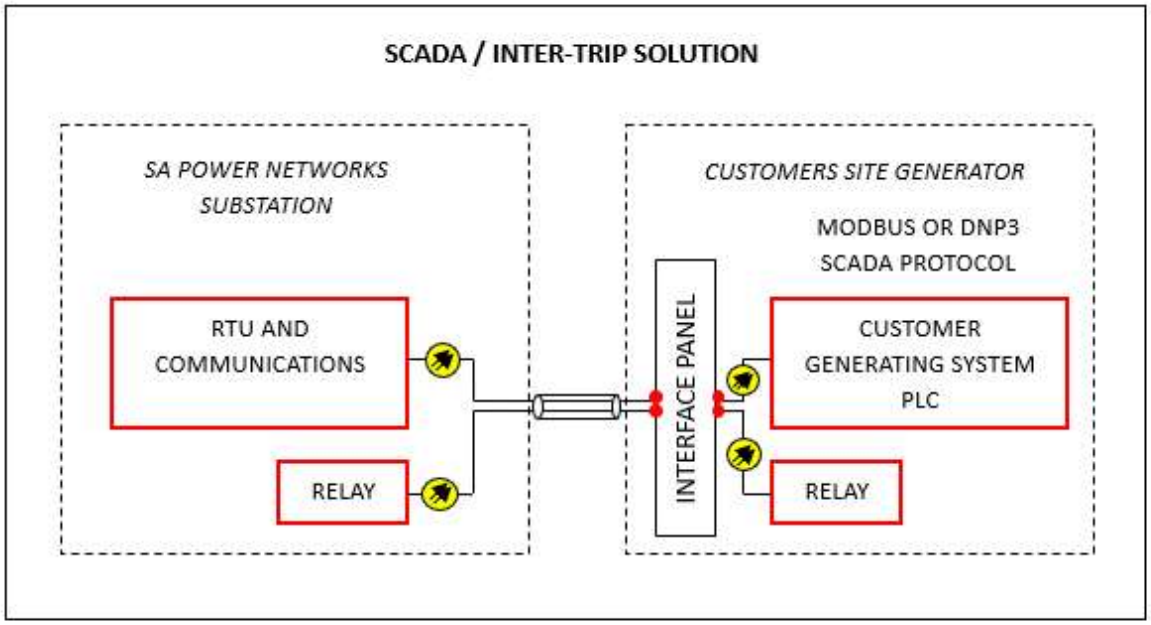


Figure 2: Block diagram of SCADA/Tel solution for generating systems with inter-trip interfaces

To facilitate connection of this size and type of generating system, the following requirements must be met by the customer:

5.1.2.1 Connection to the Customers Generation Facility

1. Simplified SCADA shall be selected for IES <5MVA however an inter-trip shall be required under substation contingency conditions, unless agreement with SA Power Networks to reduce output or for the generator to go offline.
2. Refer to Table 1 for SCADA (Inter-trip) for remote monitoring and control requirements by generator type and capacity.
3. For EG ≥5MVA connectivity between the SA Power Networks substation and the EG shall be via optical fibre however radio may be permissible under exceptional circumstances.
4. The Customer shall be responsible for the installation of a 100mm telecommunications conduit on the EG property from the boundary and into the Customers generating control room for the installation of single mode optical fibre by SA Power Networks – refer SA Power Networks Technical Standard TS085.
5. The Customer shall provide cable ladder / tray for securing optic fibre cable within the generator control room.

5.1.2.2 Accommodation and Requirements for SA Power Networks' Equipment

1. SA Power Networks shall be responsible for the installation of single mode optical fibre from the substation and within the Customer provided conduit and terminating the fibre in a wall mount fibre optic patch-panel in the Customers' control room.
2. Optical fibre patch-leads shall interface from the wall mount fibre panel to the Customers': (a) EG PLC system; and (b) protection relay.
3. The relay shall be the property and responsibility of the Customer.

5.1.2.3 Interfaces

1. The optical fibre connectors on the wall mount fibre optic patch-panel shall be the interface and demarcation point.
2. The Customer shall provide an optical interface to their PLC system based on compatibility for a 100Base-FX 1300nm single mode optic fibre compatibility.
3. Provide Modbus TCP/IP protocol for the SCADA interface between customer's generating system PLC and SA Power Networks.
4. Fail-safe contact arrangement with SA Power Networks' digital I/O to the demarcation terminal strip. Refer to "Circuit Breaker" section below.

5.1.2.4 Circuit Breaker(s) (Disconnecting Generator(s))

The trip circuit to be a normally closed circuit.

5.1.2.5 Communication Signalling Fail-safe

From SA Power Networks' RTU located in the SA Power Networks' substation (compulsory requirement), a 60s watchdog pulse arrangement will be in place. The customer's PLC will initiate an automatic controlled shutdown of the generating system in the event that this pulse is not received indicating a communications failure (either via customer's generating system PLC or SA Power Networks' RTU).

5.1.2.6 SCADA Input/Output

1. Customer to liaise with SA Power Networks to provide a list of SCADA inputs/outputs for the generating system.
2. Provide Modbus TCP/IP protocol for SCADA interface between customer's generating system PLC and SA Power Networks.
3. Prior to beginning SA Power Networks' SCADA works on site, the customer's generating system PLC must be brought into SA Power Networks' offices for 'User Acceptance Testing' (UAT) to confirm that the PLC communicates correctly with SA Power Networks' equipment.

5.1.2.7 Site Access

24-hour unrestricted site access to SA Power Networks' equipment for faults and maintenance (escorted or non-escorted – preferably the latter).

5.1.3 Cyber Security Requirement

5.1.3.1 Customer to Implement Protections

The Customer must (and must ensure its personnel) use best endeavours to ensure that no Harmful Code is coded or introduced into and of the Customers EG systems.

5.1.3.2 Directions Relating to Cyber Security

The Customer must promptly (and in five business days of a request being made by SA Power Networks) comply with all reasonable directions from SA Power Networks in relation to Cyber Security, the security of the Customers EG data and the security of any Customer EG systems.

5.1.3.3 Compliance Testing

From time to time, as required by SA Power Networks, the Customer will at its cost provide evidence of its compliance with this clause and will cooperate with and assist SA Power Networks in undertaking any reasonable tests of the Customers systems and Cyber Security procedures in order to assess whether the Customer is in compliance with this clause.

5.1.3.4 Notifiable Incident

If the Customer becomes aware that Harmful Code has been introduced into any of the Customers EG systems, or anything occurs which may corrupt or adversely affect the security of the Customer EG data (each a "Notifiable Incident"), the Customer must:

Immediately report that fact to SA Power Networks and provide all information reasonably requested by SA Power Networks in relation to the Notifiable Incident, its manner of introduction or occurrence and the effect the Notifiable Incident has had or likely to have; and

Take all necessary remedial action to eliminate the Harmful Code (if applicable) and prevent reoccurrence.

5.1.4 Permissive and Demand Availability Signaling

Permissive signaling provides a method for SA Power Networks to indicate those times when a generating system may or may not connect to and operate in parallel with the network. Permissive signaling is required for all generating systems which requires SCADA.

SA Power Networks reserves the right to request the installation of permissive signaling on generating systems if SA Power Networks deems it necessary (eg where fault current limiting methods are employed within the generating system).

The permissive signaling scheme is in addition to other SA Power Networks' EG system protection requirements.

Where a permissive signaling scheme has been deemed necessary, SA Power Networks will, at the customer's expense, install a communication link between the EG system and the relevant SA Power Networks' substation. Alternatively, the customer may provide this communication link according to SA Power Networks' specification. Under some circumstances, depending on the location and connection voltage, SA Power Networks may require diversity or duplication of these communications links.

SA Power Networks will provide the permissive signaling signal to an agreed interface panel installed at an agreed location on the customer's site. On receipt of a 'permission denied' signal it will be the responsibility of the customer to ramp down the generating units before tripping the circuit breakers of all rotating generating units. The permissive signaling signal from the interface panel to the generating unit's circuit breakers, including the communications link, must be of fail-safe design.

The permissive signaling scheme shall be installed such that the EG system performs the requirements shown in **Table 2** whenever a 'permission denied' or 'permission granted' signal is issued by SA Power Networks:

Table 2 : Permission Denied / Granted Operation Requirements

OPERATION	REQUIREMENT
Ramp down	All IES generating units shall ramp down in accordance with the principles of AS/NZS 4777.2; 0MW output must be achieved in 360 seconds. All rotating systems shall ramp down as per ramp rate specified by SA Power Networks in the engineering report, typically 1,000kW per minute.
Disconnection	All rotating generating units shall be disconnected from the Network in 360 seconds.
Permission Granted	All IES generating units shall have 'Soft Ramp Up after Connect or Reconnect Mode' in accordance with the principles of AS/NZS 4777.2

5.1.5 Interface Signals

A detailed list of interface signals will be prepared as the customer's generating system project progresses.

Inverters must be capable of (either directly or from a central controller) receiving and accepting GDL and power factor set points issued by SA Power Networks via its SCADA system. Therefore, if an inverter is certified as being AS/NZS 4777 compliant but does not have an interface enabling the MW and PF limits to be applied in real time, either directly by our SCADA or by an overarching generating system controller, it is unacceptable for connection to SA Power Networks' network.

Typical SCADA data interface requirements for multiple generating units connected via a HV connection point are shown in **Table 3** to **Table 6**.

When there are multiple connection points, the metering and control interface signals and reference signals will be required for each connection point.

The types of interface signals are described below:

5.1.5.1 Generation Dispatch Limit (GDL)

A GDL control system must be provided to control the proposed generating system's real power output. The GDL control system required by SA Power Networks will consist of a control signal that will be initiated manually via SA Power Networks' NOC and transmitted to the generating system via the SCADA Control.

The GDL will provide an analogue signal providing the set point, which will normally be set at the rated capacity of the network connection. However, subject to network conditions, the GDL set point may be altered to constrain the generating system's output between 0MW and the rated capacity of the generation system to suit the network or AEMO dispatch requirements.

5.1.5.2 Net Export Limit

The net export limit control system will be provided to enable SA Power Networks to control the export at the connection point of the proposed generating system's real power output. The next export limiter will consist of a control signal that will be initiated manually via SA Power Networks' NOC and transmitted to the generating system via the SCADA control to constrain the net site export at the connection point to suit the network requirements (eg abnormality on the Network).

5.1.5.3 Net Import Limit

The net import limit control system will be provided to enable SA Power Networks to control the import at the connection point of the proposed generating system's real power output. The next import limiter will consist of a control signal that will be initiated manually via SA Power Networks' NOC and transmitted to the generating system via the SCADA control to constrain the net site import at the connection point to suit the network requirements (eg abnormality on the Network).

5.1.5.4 Power Factor Setpoint

In order to meet network requirements, SA Power Networks may vary the generating system's power factor set point at the connection point, taking into consideration the technical and reasonable limitations of the inverter. The required power factor will be applied automatically via the power factor set point control.

5.1.5.5 Frequency Response Import / Export Limit

Generating systems intending to participate in the FCAS market may be subject to export and import limits at the connection point to prevent overload / reverse overload of distribution network limits during delivery of FCAS.

The generating system's control system must be capable of accepting net import / export limits at the connection point from SA Power Networks' NOC via SCADA and ensure the bidding algorithms take these limits into account such that the net power flow at the connection point does not violate the distribution network limits during delivery of FCAS.

5.1.5.6 DC Metering

DC coupled generating systems with multiple sources connected behind the same inverter will be required to provide DC metering for each generation source (e.g. Volts, Amps, and kW) in addition to the total AC generating system and connection point values.

5.1.5.7 Digital Inputs to SA Power Networks

SA Power Networks requires the digital inputs as shown in **Table 3**.

All available AC, DC and communication alarms are required. These signals indicate if the DC Supply bus has failed, the secondary system's battery charger station has failed, if a mains AC fail has been detected, if any SCADA or protection communication have failed, or if permission to connect/denied or inter-trip protection has been received.

Table 3: SCADA Digital Input Requirements (From Generator to SA Power Networks)

Digital Inputs for SCADA (Simplified)	Digital Inputs for SCADA (Inter-trip)	Signal Condition
Permission to Connect Received	Permission to Connect Received	Granted/ Denied
	All available AC and DC alarms[1] Mains AC Failure[1] DC Supply Battery Charger Failure[1] DC Supply Failure[1]	Normal/ Failed Normal/ Failed Normal/ Failed Normal/ Failed
	Generating System Communications Alarms	Normal/ Fault
	Generating System HV Circuit Breaker Status[2]	Open/ Closed
	Generating Unit Status (for all Generating Units)[3]	Running/ Stopped
Frequency response active (If required)		On/ Off

Notes:

1. May be required, to be stipulated in Engineering Report
2. Required for rotating systems, systems >5MVA or as stipulated in Engineering Report
3. Required for rotating systems

5.1.5.8 Digital Outputs from SA Power Networks

In addition to permission to connect/denied as shown in Table 4, SA Power Networks will send a Heartbeat which is toggled on/off by SA Power Networks' RTU to indicate active communication with the customer's control system.

Table 4: SCADA Digital Output Requirements (From SA Power Networks to Generator)

Digital Outputs for SCADA (Simplified)	Digital Outputs for SCADA (Inter-trip)	Signal Condition
Permission to Connect (permissive signalling)	Permission to Connect (permissive signalling)	Granted/ Denied
Demand Available for Energy Storage Systems to charge (if required)	Demand Available for Energy Storage Systems to charge (if required)	Available/Unavailable
Heartbeat to indicate active communication		On/Off

5.1.5.9 Analogue Outputs from SA Power Networks

SA Power Networks will issue analogue output as shown in **Table 5**. The control signals from the customer to SA Power Networks are required to feedback the real-time operation of the generating system in response to these set points.

Table 5: SCADA Analogue Output (from SA Power Networks) Requirements

Analogue Outputs for SCADA (Simplified)	Analogue Outputs for SCADA (Inter-trip)
Generating System Dispatch Limiter Set Point	Generating System Dispatch Limiter Set Point
Generating System Net Export Limiter Set Point	Generating System Net Export Limiter Set Point
Generating System Net Import Limiter Set Point	Generating System Net Import Limiter Set Point
Power Factor Set Point Control	Power Factor Set Point Control
Charge Rate Limiter for Energy Storage Systems (if required)	Charge Rate Limiter for Energy Storage Systems (if required)
Discharge Rate Limiter for Energy Storage Systems (if required)	Discharge Rate Limiter for Energy Storage Systems (if required)
Frequency response active import/export limit (if required)	Frequency response active import/export limit (if required)

5.1.5.10 Analogue Inputs to SA Power Networks

SA Power Networks expects to receive total generating system metering, including 3 phase volts (line voltage at the main bus and generating system), 3-phase Amps, kW, kVAr of the generating system (gross output) and connection point(s) (net output).

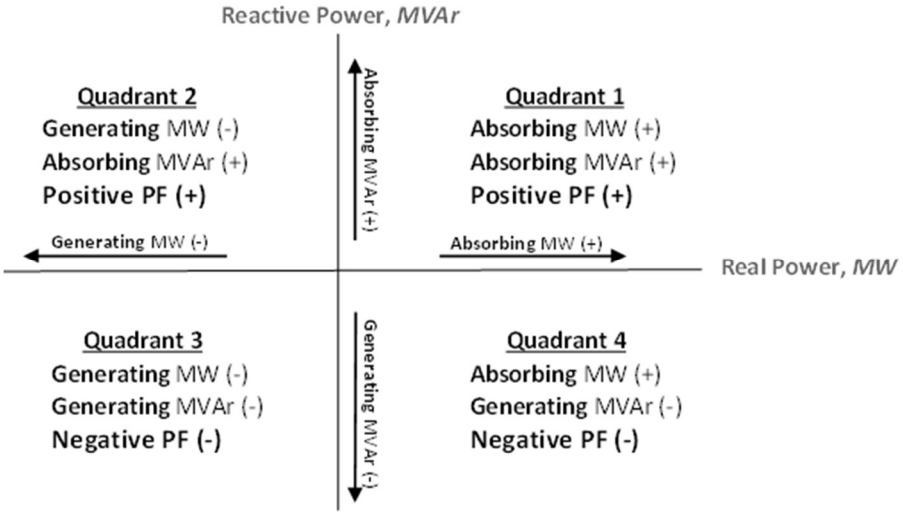


Figure 3 : Power Factor Sign Convention at the Customer Connection Point

SCADA metering of individual generating units or of the total generating system measured downstream of the connection point shall be configured as shown in with positive while generating and negative while absorbing active power. The sign of the corresponding reactive power shall be relative to the direction of active power flow such that a positive value shall indicate reactive flow in the same direction as active power flow whilst a negative value shall indicate reactive flows in the opposing direction to active power flows.

Net metering (where applicable) as seen at the connection point shall be positive for flows from the network through the connection point (ie whilst absorbing active/reactive power) and negative for flows to the network through the connection point (ie whilst exporting active/reactive power).

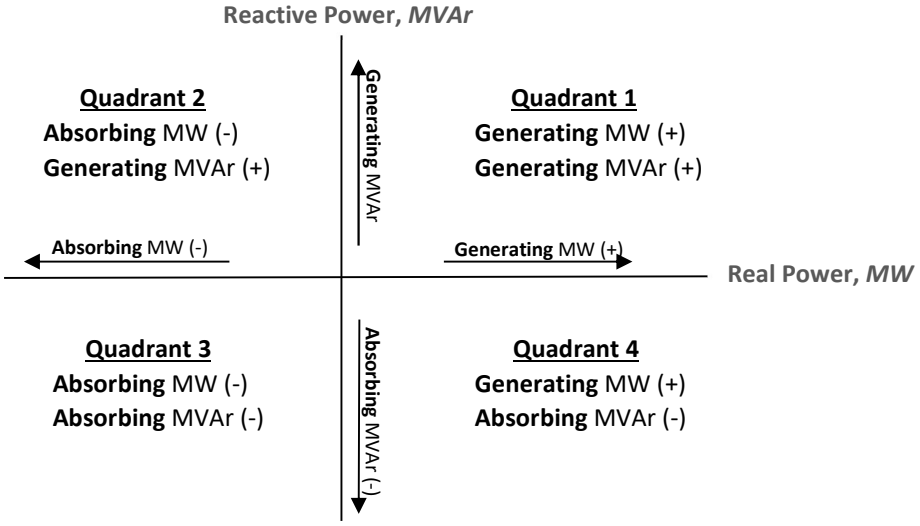


Figure 4: Power Factor Sign Convention at the Customer Generating Terminals

Where the generating system consists of more than one form of generation or technology, metering at individual generating unit level and/or at generation type summated level will be required in addition to generating system and connection point level. For example, where a site's generating system consists of multiple rotating generating units, PV generation and BESS, in addition to the total generating system and connection point values, SA Power Networks will requiring metering of:

- each individual rotating generating unit;
- the summated total output of the rotating generation;
- the total output of the PV generation;
- the total input / output to/from the BESS;
- the total generating system AC output; and
- the net export as seen at the connection point.

When the site is supplied at HV, metering class VTs and CTs are to be used.

Table 6: SCADA Analogue Input Requirements (from generator to SA Power Networks)

Analogue Inputs for SCADA (Simplified)	Analogue Inputs for SCADA (Inter-trip)
Connection Point Active Power Output	Connection Point Active Power Output
Connection Point Reactive Power Output	Connection Point Reactive Power Output
Connection Point Power Factor	Connection Point Power Factor
Connection Point Current (three-phase Amps)	Connection Point Current (three-phase Amps)
Connection Point Voltage (three-phase line Volts)	Connection Point Voltage (three-phase line Volts)
Generating System Active Power Output	Generating System Active Power Output
Generating System Reactive Power Output	Generating System Reactive Power Output
Generating System Power Factor	Generating System Power Factor
Generating System Current (three-phase Amps)	Generating System Current (three-phase Amps)
Generating System Voltage (three-phase line Volts)	Generating System Voltage (three-phase line Volts)
	Number of Generating Units Connected[1]
Generating System Dispatch Limiter Feedback	Generating System Dispatch Limiter Feedback
Power Factor Set Point Control Feedback	Power Factor Set Point Control Feedback
Charge Rate Limiter for Energy Storage Systems Acknowledged (if required)	Charge Rate Limiter for Energy Storage Systems Acknowledged (if required)
Charge Status for Energy Storage Systems (if required)	Charge Status for Energy Storage Systems (if required)
Frequency Response Import/Export Limit (if required)	Frequency Response Import/Export Limit (if required)

Notes: 1. If requested by AEMO

5.1.6 SCADA Communication Failsafe Operation

The failsafe signal will be the action when planned transfer to an abnormal feeder. When this is not specified, inverter-only generating systems will be issued a GDL 0, and generating systems with rotating generating units will be issued a 'permission denied'.

SA Power Networks proposes to have two modes of communications failsafe as shown in **Table 7**.

Table 7: Communication Failsafe Operations

	COMMUNICATIONS FAILURE	OPERATION
1	Failure of the SCADA communication link between the SA Power Networks' RTU and upstream Master Station communication link.	SA Power Networks' RTU will send a failsafe signal to the customer RTU upon waiting a pre-configured time interval (15–45 minutes) for communications to return (to prevent nuisance fail safe activation).
2	Failure of the SCADA communications link between the SAPN RTU and the customer's controller for more than 60 seconds (the Modbus communication link).	Customer's site controller must ramp to a GDL of 0kW and rotating generating units must disconnect from the Network, for which SA Power Networks will not be responsible for any losses (direct or indirect) incurred by the customer.

5.1.7 Wireless Communications

Where a generating system's protection relay (anti-islanding relay) and import/export monitoring device is remote from the EG system's isolating device, a wireless communication system contained within the customer's site may be used. The generating system's protection relay and import/export monitoring device utilising wireless communication link shall be the customer's responsibility and:

1. Have a fail-safe system disconnecting the generating system from the distribution network upon failure of any generating system protection relay's hardware/software; and
2. Disconnect the generating system from the distribution network for any loss of communications that would inhibit the correct operation of the protection system longer than 5 seconds.