Specification - Standalone Power System (SPS)

Standard Number: HPC-8DJ-12-0001-2022

11/07/2024

HORIZON POWER

Document Control			
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Date Created/Last Updated	10 July 2024		
Review Frequency **	3 years		
Next Review Date **	10 July 2027		

** Shall be the Process Owner and is the person assigned authority and responsibility for managing the whole process, end-to-end, which may extend across more than one division and/or functions, to deliver agreed business results.*

*** Frequency period is dependent upon circumstances– maximum is 5 years from last issue, review, or revision whichever is the latest. If left blank, the default shall be 1 year unless otherwise specified.*

Revision Control		
Revision	**Date**	**Description**
5	10/07/2024	Update references, performance specifications and terminology, Addition of Minimum function testing guide and Appendices.
4	10/05/2023	Update references and removed ambiguity regarding remote monitoring
3	22/03/2022	Update terminology to align with ESS Standard
2	1/03/2022	Standards and Performance Specification Update
1	14/09/2021	Update to remove MPS and diesel, and to reduce costs
0	16/01/2019	Original Document

STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Project Manager	Manager Asset Services
Manager Engineering and Project Services	Manager Capacity Management Support

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1 SCOPE

This Technical Specification (Specification) covers Horizon Power's technical requirements for a stand-alone power system known as a Standalone Power System (SPS).

The SPS may consist of a combination of generating units incorporating engine driven, renewable and storage energy components. SPS are generally used either:

- on the fringe of the grid areas where SPS proves viable when compared to reinvesting in the traditional poles, wires, and transformers network; or
- in remote areas to provide power to a customer's installation which is not in an area serviced by a Horizon Power's distribution network; or
- where there is no cost-effective network access.

The Specification includes the requirements for the SPS equipment. This Specification shall be read in conjunction with the Scope of Work which contains the Contractor's scope for the design, supply, factory acceptance testing (FAT), installation, site acceptance testing (SAT), commissioning and documentation requirements for the SPS.

The SPS shall provide power to the customer from:

- A ground mounted photovoltaic (PV) array and PCE.
- An Energy Storage System (ESS) with PCE; and
- An alternative generator.

2 STANDARDS, CODES, REGULATIONS & DEFINITIONS

2.1 Priority of technical standards

The order of precedence of codes and standards shall be:

- the Laws of Western Australia.
- Australian Standard statutory requirements.
- Horizon Power Standards.
- Australian informative Codes and Standards.
- IEC Codes and Standards.
- ASME/ANSI/NFPA Codes and Standards; and
- Specific UL Codes and Practices for RFI Interference.
- other International Standards and Codes of Practice.

Where conflict exists between any of the statutory regulations, standards, reference documents, and/or the requirements on drawings, data sheets and this Specification, the most stringent requirement must apply.

2.2 Statutory requirements

Relevant Government (local, state, and federal) Laws shall include but will not necessarily be limited to the latest editions of the following:

- *Electricity Act 1945* (WA) and associated regulations, including:
  - Electricity (Licensing) Licensing Regulations 1991 (WA).
  - Electricity (Network Safety) Regulations 2015 (WA); and
  - WA Electrical Requirements.
  - WA Service and Installation Requirements
- Electrical Operators (Powers) Act 1979 (WA)
- Occupational Safety and Health Act 1984 (WA) and associated regulations.
- WA Office of Energy Safety Guidelines.
- *Dangerous Goods Safety Act 2004* (WA) and associated regulations.
- Australian Dangerous Goods (ADG) Code.
- The Storage and Handling of Workplace Dangerous Goods (National Standard).

- Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007 (WA).
- *Environmental Protection Act 1986* (WA) and associated regulations.
- Environmental Protection (Noise) Regulations 1997 (WA).
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA).
- Environmental Protection (Unauthorised Discharges) Regulations 2004 (WA).
- Occupational Safety and Health Regulations 1996 (WA); and
- the *Department* of Mines, Industry Regulation and Safety approved codes of practice and the WA Work Safe Commission for Occupational Safety and Health Codes of Practice and Guidelines, including:
    - managing noise at workplaces; and
    - prevention of falls from height at workplaces.

2.3 Horizon Power standards

Refer to https://www.horizonpower.com.au/contractors-installers/manuals-standards/ for a list of Horizon Power specifications and standards.

2.4 Australian and International standards

The Contractor, in relation to the SPS design and manufacturing, shall comply with the latest revision of the relevant Australian Standards, Codes of Practise and Guidelines or, in the absence of appropriate Australian Standards, with the relevant ISO, IEC, US, British or European (DIN or similar) Standards.

Where no Australian Standard applies, another standard may be adopted with the following precedence:

- International (ISO) Standards were referenced as the basis for current mandatory Australian Standards.
- International Electro-technical Commission (IEC).
- Standards referenced in Horizon Power Engineering Standards.
- British (BS).
- European (DIN or equivalent); and
- NFPA (USA).

Refer to *Appendix B: Standards* for a non-exhaustive list of specifications and standards applicable to the Works.

2.5 Mandatory Documents

Other documents that are mandatory to this Specification include:

- WA Metering Code 2005.
- WA Electrical Requirements
- WA Service and Installation Requirements; and
- Horizon Power Technical Rules.

2.6 Definitions and Abbreviations

To this specification the following definitions apply:

2.6.1 Definitions

1) **Alternative Generator:** The equipment to generate electrical energy independent of the PV array. This includes the housing, fuel tank and controller

2) **Battery System:** The Battery System is a component of the ESS and is defined as the system within the ESS containing all cells, battery modules, battery racks, and battery management system (BMS)

3) **Energy Storage System (ESS):** An ESS is comprised of an Energy Storage Medium, a PCE, and a ESS Controller. The ESS Controller may be housed in an enclosure separate to the ESS

4) **ESS Controller:** The controller that controls the ESS, which may be comprised of one or more devices or as a part of PCE

5) **Energy Storage Medium (ESM):** The Battery System or any other medium of electrical energy storage in the ESS

6) **Power Conversion Equipment (PCE):** A device or circuitry that changes direct current (DC) to alternating current (AC) or vice versa; or transforms between voltage levels

7) **Standalone Power System:** A self-contained power generating unit or units providing the only source of electricity, independent of the Horizon Power network

8) **Nominal Battery Capacity:** The capacity of a battery in kWh when discharged from 100% to 0% state of charge

9) **Usable Battery Capacity:** The capacity of a battery in kWh when discharged from the maximum state of charge to the minimum state of charge set by the control system for operation of the battery only, excluding parasitic demand.

10) **Parasitic Demand:** Any self consumption within the SPS before the Consumer Point of Connection

11) **PV Array:** A photovoltaic array consists of PV modules and the frame

12) **Seamless Transition:** No change in power quality to support the load when energy sources are changed, i.e., Bumpless

2.6.2 Abbreviations

1) **AS:** Australian Standard
2) **AS/ CA:** Australian Standard Communications Alliance
3) **AS/NZS**: Australian Standard/New Zealand Standard
4) **CEC:** Clean Energy Council
5) **CT:** Current Transformer
6) **FAT:** Factory Acceptance Test
7) **IEC:** International Electrotechnical Commission
8) **IP:** Internet Protocol
9) **IPXX:** International Protection where 'XX' represents the level of protection
10) **kVA:** Kilovolt-ampere (apparent power)
11) **kW:** Kilowatt (active power)
12) **kWh:** Kilowatt hour (electrical energy measurement)
13) **kWp:** Kilowatt peak (peak active power)
14) **L:** Litres
15) **MEN:** Multiple Earthed Neutral
16) **PV:** Photovoltaic
17) **RCD:** Residual Current Device
18) **SAT:** Site Acceptance Test
19) **SPS:** Standalone Power System
20) **SOW**: Scope of Work
21) **STC:** Standard Test Conditions
22) **TCP:** Transmission Control Protocol

23) **THD:** Total Harmonic Distortion

24) **UPS:** Uninterruptable Power Supply

25) **WAER:** Western Australian Electrical Requirements

26) **WASIR:** Western Australian Service and Installation Requirements

3 GENERAL REQUIREMENTS

The SPS voltage and frequency output limits to the customer Installation shall comply with the requirements given in Western Australian Service and Installation Requirements (WASIR) section 10.3.

4 SPS OPERATION

This section describes the minimum functional requirements of the SPS operation.

4.1 SPS Generation Priority without Alternative Generator

With the SPS operating without the alternative generator running, the SPS shall provide power from its energy sources to the customer load in the following order of priority to meet the customer loads:

- Renewable Generation (i.e PV array); then
- The Energy Storage System

When renewable generation is available, it shall be prioritised to supply the customer loads. Where there is excess renewable generation available compared to the customer load, it shall be utilised to charge the ESS. The renewable generation should only be curtailed if it exceeds the ESS charging capability and the customer load. When the ESS is fully charged, the renewable generation should be curtailed to only supply the customer load.

Should the renewable generation not be sufficient to meet the customer demand, the ESS shall be discharged to match the customer load.

4.2 SPS Generation Priority with Alternative Generator

With the SPS operating with the alternative generator running, the SPS shall primarily provide power to the customer with the alternative generator. The alternative generator shall also be utilized to charge the ESS with its full remaining available power.

Renewable generation, if available, can continue to generate whilst being curtailed to maintain alternative generator minimum generation loading.

When renewable generation is available, it shall be priorities to supply the customer loads. Where there is excess renewable generation available than the customer load, it shall be utilised to charge the ESS. When the ESS is fully charged, the renewable generation should be curtailed to only supply the customer load. Should the renewable generation not be sufficient to meet the customer demand, the ESS shall be discharged to match the customer load.

The SPS shall provide power from the three energy sources to the customer load, in the following order:

- PV array and PCE; then

- the energy storage system; then
- the alternative generator

During the day when the customer load is less than the power output from the PV Array (see section 6.6), then the excess PV power shall charge the ESS (see section 6.4.2). When the ESS is fully charged, the PV PCE (see section 6.5) will limit power output to only the customer load.

4.3 Alternative Generator Automatic Start based on ESS SOC

When there is insufficient power from the Renewable Generation for the customer loads and for charging the ESS, and the battery state of charge has fallen to the percentage configured in the ESS Controller (see section 6.4.1), the Alternative Generator (see section 6.7) will start and provide power to charge the ESS.

4.4 Alternative Generator Automatic Start based on Overload

When there is insufficient power from the renewable generation and insufficient power from the ESS, the ESS Controller shall start the Alternative Generator to supply power to the customer load. The Alternative Generator shall be the primary power source for the customer load until the battery state of charge has risen to the percentage configured in the ESS Controller

4.5 Automatic Alternative Generator Exercise

If the generator hasn't run in the previous 14 days, the Alternative Generator will be run for thirty (30) minutes to confirm that the Alternative Generator will start when required.

Alternatively, the Alternative Generator exercise shall be conducted within the requirements as stated by the OEM manual and warranty documents.

4.6 Alternative Generator Automatic Stop

If the Alternative Generator was automatically started due to overload or low ESS SOC, the alternative generator shall stop operating when the battery state of charge has recovered to the defined set point and when customer demand has reduced below a setpoint.

4.7 Minimum Fault Contribution

The SPS shall be capable of maintaining a minimum bolted fault contribution of 630A for at least 0.4s. The fault contribution shall at least ensure the operation of a 63A C-type MCB in its instantaneous region for any fault in a customer premise.

Should the SPS reach a condition where it is incapable of meeting the design minimum fault contribution to ensure proper protection operation (i.e. partial PCE failure), the SPS shall change its operation mode to one that will satisfy this requirement. Should no such operational mode exist, the system shall failsafe by shutting down.

4.8 External Customer Inverter controls

The SPS shall be capable of charging from the customer connected Renewable Generation if available. However, should the ESS be of full SOC, the SPS shall be capable of increasing its frequency to regulate customer owned parallel generation from exporting into the SPS via frequency droop control (W/Hz) as per typical AS4777.2 set points for Australia Region C.

5 EQUIPMENT REQUIREMENTS

This section describes the equipment requirements for a SPS.

5.1 Environmental Conditions

The equipment shall be suitable for use in the location it will be situated. Conditions to consider include solar radiation, pollution (salt bearing and industrial), humidity and wind velocities.

The equipment shall be suitable for continuous operation under the relevant environmental conditions stated in HPC-9EJ-01-0001-2013 Horizon Power Environmental Conditions for the duration of its design life.

5.2 Disposable Strategy

The Contractor shall provide details of its end-of life strategy for the Equipment or in part thereof. Horizon Power has preference for a recycling scheme offered by the Contractor. The recycling scheme shall have the following as a minimum:

- Point of collection
- Transport
- Buy back value (i.e., scrap value)

5.3 Other Environmental Requirements

The maximum SPS noise emitted shall be no greater than the allowable noise level prescribed by the Environmental Protection Act 1986 (re-print May 2018) and the Environmental Protection (Noise) Regulations 1997 (Table 1).

5.4 Design Life Requirements

Equipment must meet the design life requirements described in Table **1**.

Table 1: Design Life Requirements

Component	Design Life
Battery module	10 years
Battery PCE	10 years
PV module	25 years
PV PCE	20 years
PV Array structure	25 years
Alternative Generator set and frame	30 years
Cubicles or Enclosure	30 years
Cable and wiring	20 years

5.5 Functional Requirements

Each SPS shall have the following functional requirements:

- The same or higher level of reliability as a Horizon Power network connection.
- At least 20% spare capacity for battery storage.
- No damage to SPS equipment or customer equipment and loads due to an emergency shutdown of the SPS.
- Safe, simple, and easily accessible SPS components for maintenance, replacement, and refurbishment.
- Seamless transition between energy sources.
- Ability to remotely call the Alternative Generator and power the customer in the event of the ESS Controller failure.
- All components are to function without a direct connection to the internet.
- Be able to remotely operate a Stop operation effectively switching off components such as PCE and generators.
- Energy metering capability from PV, ESS, and Alternative Generation individually; and
- Provide customer metering and protection for the Consumer Point of Connection (Consumer Mains Protection Device)
- Provide remote opening and closing of Consumer Mains Protection Device. Remote operation should not be reliant on AC bus voltage being present.

- Ability to readily connect and changeover to a plug-in mobile alternative generator of equal continuous output rating and fault rating of SPS installed without permanent Alternative generator. The changeover shall be done via a 3-way changeover switch (see section7.3).

- Have a general purpose outlet for the purposes of testing and maintenance that is readily accessible prior to the Point of Supply.

5.6 SPS Fault Performance

The SPS shall respond in the following manner to faults occurring within an SPS:

- Operate safely and fail to a safe state.

- Detect a customer fault and safely disconnecting the customer without damaging the customer's equipment and loads.

- The protection equipment for each part of the SPS (PV, ESS, and Alternative Generator) shall be coordinated/graded with each other and the customer protection circuit breakers for protection of circuits rated less than 63 A. For a customer fault on circuits rated less than 63 A, the customer protection circuit breakers should trip before the Point of Supply circuit breaker or any SPS protection equipment trips.

- The SPS Protection equipment shall include alarms for each protection device, that will be flagged and transmitted to the Horizon Power monitoring system; and

- The SPS protection equipment shall operate to ensure that the SPS is not damaged.

If there is a fault in the customer's installation or Consumer Mains and the SPS protection devices have tripped, the SPS shall not re-connect to supply to the customer installation until the fault has been cleared and an SPS restart/reset operation has been performed. This may require the attendance of Horizon Power maintenance staff.

5.7 Electrical Supply Requirements

The SPS output shall meet the supply requirements for:

- Voltage, Phases, Power factor, Nominal Frequency, and Unbalance of three phase systems as stated in the Horizon Power Technical Rules and the WASIR.

- Flicker and Voltage Transients as stated in the Horizon Power Technical Rules and AS/NZS 61000.3.11.

5.8 Harmonics

Each SPS must be capable of supporting harmonic loads with a maximum THD of 5% and be compliant to AS/NZS61000.3.6 harmonic voltage distortion.

5.9 Motor Starting

The SPS shall be able to start a motor with a capacity of 3 kW Direct Online without overloading or shutting down the SPS and without support from the Alternative Generator.

6 SPS COMPONENTS

This section describes and specifies the SPS Components.

6.1 SPS General Requirements

The safety, design, and installation of the SPS (including the PV modules and PV PCE, ESS and the Alternative Generator) shall comply with the requirements of AS/NZS 4509, Parts 1 and 2.

The finished colour of pipework, storage tanks and any fire service equipment shall comply with the colour standards given in AS 2700.

All equipment shall be compliant with AS/NZS & ISO 9001.

The SPS shall provide the required parameters as defined in Appendix C - Data Point Requirements for Technical Specifications DM: 10806403

6.2 Equipment Enclosures

The enclosure(s) shall:

- be capable of being locked with a 10mm padlock.
- have an International Protection level determined by the equipment enclosed.
- be rated for the site ambient temperature and environmental conditions to ensure that equipment will operate within their manufacturer's limits. Enclosures and equipment exposed to the environment shall be rated to a minimum of IP55.
- be designed for the site environmental conditions for temperature, humidity, rainfall, wind velocity and dust.
- enable access to the equipment.
- have barriers, shields or compartments to protect against accidental exposure to touch potentials by the installation of Acrylic Perspex Escutcheons where required.
- have an opening restraint to prevent the door being pushed open/closed by air movement. The opening restraint shall be removable if required.
- have an internal temperature sensor, monitored by the Remote Monitoring and Communication System (this only applies to enclosures housing equipment); and
- prevent any internal fire from exiting the enclosure and spreading to any external fuel; and
- have a manufacturing, defects, and materials warranty of a minimum of 1

year.

6.3 ESS

The ESS shall be comprised of:

- an Energy Storage Medium;
- a PCE; and
- a ESS Controller.

6.3.1 ESS PCE and ESS Controller

The ESS PCE and ESS Controller may be either separate devices or combined.

6.3.1.1 Required attributes

The ESS PCE and ESS Controller combined shall have:

- proven operational performance under climate conditions like Western Australian conditions.
- a listing on the CEC Approved Inverter list Approved Inverters | Clean Energy Council
- compliance with:
  - AS/NZS 5603 (operations),
  - AS/NZS 5139 (design and operation),
  - IEC 62109 (safety – design and operation),
  - IEE 1547:2020 Standard for Interconnecting Distributed Resources with Electric Power Systems,
  - UL 1741 Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources; and
  - FCC Part 15, Sub-Part B Unintentional Radiators for the Prevention of Electromagnetic interference, or radio-frequency interference, is created when an external source causes a disruption to an electrical circuit.
- a method of controlling the parallel supply of power from the PV PCE and the Alternative Generator in addition to the ESS.
- the ability to monitor the energy sources and connect/disconnect each source when necessary to maintain a reliable supply to the customer.
- protection for the Batteries against damage which includes, but is not limited to over voltage, over current and other mechanisms deemed necessary by the battery manufacture.

- have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands.
- approval by the battery manufacturer for use with the battery management system.
- the package shall be capable of providing the minimum fault current contribution for all balanced and unbalanced fault types (includes phase to earth faults), regardless of pre-load conditions.
- an efficiency ≥92% from 25% to 100% rated load; and
- have a manufacturing, defects, and materials warranty of a minimum of 10 years.

6.3.2 Energy Storage Medium

The ESM shall be comprised of:

- a Battery System; and
- a BMS.

6.3.2.1 Battery System

6.3.2.1.1 Required attributes

The battery system shall:

- be on the CEC Approved storage list or eligible to be on the list (Approved batteries | Clean Energy Council)
- be sealed and not require the addition of any medium during their lifetime.
- have maintenance or housekeeping cycle of no more than once per year.
- be recyclable.
- have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands OR provide enough information to the ESS Controller to obtain the required parameters from the ESS Controller;
- be designed such that additional Batteries can be added to provide an additional 20% spare storage capacity.
- have a performance guarantee ≥70% of nominal capacity at 10 years; and
- have a manufacturing, defects, and materials warranty of a minimum of 5 years.

- compliance with:
    - UL 1642 Standard for lithium batteries:
    - AS 62282-3-100:2021 Stationary fuel cell power systems - Safety

6.3.2.2 Battery Management System

6.3.2.2.1 Required attributes

The battery management systems shall:

- have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), with inverter and management system parameters available via the interface OR provide enough information to the ESS Controller to obtain the required parameters from the ESS Controller;
- be approved by the Battery PCE manufacturer for use with the Battery PCE.
- maintain correct balancing of battery cell voltage and cell cluster monitoring.
- provide protection to the Battery System against damage from over currents, over voltage, over temperature and any other abnormal operating conditions deemed necessary by the battery manufacturer.
- be able to detect and identify any faulty battery cells and premature battery cell degradation and transmit an alarm to the site Remote Monitoring and Communication System (Refer to section 6.8); and
- monitor and provide all key battery status parameters including, but not limited to battery voltage, battery cell state of charge, battery cells temperature.
- Be able to operate without a direct connection to the internet

6.4 PV PCE

6.4.1 Required Attributes

The PV Array PCE shall:

- Be either AC coupled inverters or DC coupled MPPT charge controllers.
- have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands.
- be listed on the CEC Approved Inverter list (Approved Inverters | Clean Energy Council).
- be compliant with:

- AS/NZS 4777.2 (if AC coupled); and
- IEC 62109 (Safety – design and operation)

- have an efficiency ≥92% of at rated output; and
- have a manufacturing, defects, and materials warranty of a minimum of 10 years.
- Be able to operate without a direct connection to the internet.

6.5 PV Modules, Arrays and Mounting Structures

6.5.1 Required attributes – PV Modules

The PV modules shall:

- be listed on the CEC approved modules list (Approved modules | Clean Energy Council.
- comply with IEC 61215 and IEC 61730.
- have a panel efficiency of ≥ 18%.
- have a performance guarantee ≥80% of nominal output at 25 years; and
- have a manufacturing, defects, and materials warranty of a minimum of 10 years.

6.5.2 Required attributes – PV Array

The PV Array shall:

- have a maximum array voltage of 1000 V_{dc}; and
- have a minimum 10 degrees of tilt to enable self-cleaning.

6.5.3 Required attributes – PV Array Mounting and Structure

The PV Array mounting, and structure shall:

- have corrosion resistance using:
  - 316 Stainless Steel to AS 1449; or
  - 6005 Aluminium to AS/NZS 1866; or
  - Hot Dipped Galvanised Structural Steel to AS/NZS 4680 and AS/NZS 1214;
- have a manufacturing, defects, and materials warranty of a minimum of 10 years; and
- be certified by a Structural Engineer.

6.6 Alternative Generator

6.6.1 Required Attributes

The Alternative Generator, controller and fuel storage system shall:

- be serviceable in Australia (preferably Western Australia).
- contain a run hour meter.
- have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands.
- be able to operate without a direct connection to the internet
- have a noise level of ≤ 80 dB(A) measured at 1 meter.
- be capable of operating in parallel or as the sole source of frequency control.
- be fitted with air filters to avoid dust ingress within the generator enclosure and into the air intake.
- comply with EPA and WorkSafe requirements for exposure to airborne contaminates.
- not permit the exhaust emissions from the Alternative Generator to fall onto or under the photovoltaic modules.
- include a spark arrestor where a combustion process occurs.
- have a pad lockable start battery isolator (i.e., ability to electrically isolate starter circuit).
- have a pad lockable fuel valve (i.e., ability to mechanical lock out the fuel source).
- have a pad lockable fuel cap (i.e., mechanism to prevent theft of fuel).
- for diesel:
    - have a fuel storage tank complaint with AS 1940, AS 1692, AS 1627.1 and AS/NZS 2312; and
- for ammonia:
    - comply with AS/NZS 2022; and
- for hydrogen:
    - be certified and independently inspected.

6.7 Remote Monitoring and Communication System

Each SPS shall be equipped with a Remote Monitoring and Communication System which will be hosted and monitored by Horizon Power. A portion of the Remote Monitoring and Communication System will be free issued by Horizon Power for installation on DIN rail(s) in the SPS cubicle or enclosure.

The Horizon Power free issued equipment comprises:

- a modem with NextG or Satellite configuration (currently a Series 2455x Cybertec Modem with the following characteristics):
    - Dimensions: H 53mm X W 103mm X D 110mm.
    - Fixing: DIN rail clip.
    - Coaxial connection: SMA Female Connector.
    - Power Input: 10-60 V (direct current).
    - Power Consumption (including antennae): 30 W.
- remote monitoring equipment (currently a Linux based device with the following characteristics):
    - Dimensions: H 31mm X W 100mm X D 125mm.
    - Weight: 310g.
    - Fixing: DIN rail clip.
    - Power Input: 12-24 V (direct current).
    - Power Consumption: 5 W.

6.7.1 Required Attributes

The Contractor shall provide the following:

- an external antenna, with requisite mountings and cabling to connect to the free issued modem. The antenna communications coaxial cable will be supplied with a lightning surge (AS/NZS 1786) suppressor Type 3 connected to the SPS main earth bar. The antenna shall support a 4G signal from Horizon Power's Telecommunication Provider and provide a minimum Signal Strength (RSCP) of -90 dBm and minimum Signal Quality (RSRQ) of -15 dB.
- un-managed Ethernet switch capable of connecting all required components including the free issued modem/router and remote monitoring equipment, DIN rail mounted with 10 – 60 V (direct current) power supply, and estimated 10W power consumption to AS/NZS 1768 and 4117.
- Cat 5e Ethernet cabling from the modem to a port on the Ethernet switch.
- Cabling for the remote monitoring system shall comply with AS/CA S008 and

AS/CA S009.

The Contractor shall:

- provide a minimum of 60 minutes of uninterruptible power in the event of a failure of the SPS, to allow for remote trouble shooting and possible restart of one or more generating sources. This power supply needs to be able to be interrogated to determine the health of the supply. Power usage of this Remote Monitoring and Communication System configuration is estimated at 45 W.

- provide an uninterrupted power source separate to the main Battery System.

- provide an uninterrupted power source that shall have a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands OR provide enough information to the ESS Controller to obtain the required parameters from the ESS Controller.

- provide full details of the addressing, tag names and protocol of the monitored parameters for each device connected to the Remote Monitoring and Communication System.

- assist Horizon Power with all information required to integrate the hardware.

The final data template/map for each device, and IP addressing requirements shall be supplied by Horizon Power.

Configuration of the Horizon Power supplied remote monitoring equipment is out-of-scope. The SPS shall monitor and transmit to the Remote Monitoring and Communication System the data specified in the Horizon Power document Appendix C - Data Point Requirements for Technical Specifications.
DM: 10806403

7 AUXILIARY EQUIPMENT

7.1 Circuit Breakers, Fuses and RCDs

All low voltage circuit breakers used in the SPS shall comply with AS/NZS IEC 60947 and AS/NZS 3190.

All low voltage fuses used in the SPS shall comply with AS/NZS 60269. The Horizon Power preference is for circuit breakers unless the circuit fault level requires the use of fuses.

All RCDs shall be Type A to allow for detection with inverter sources.

7.2 Cabling and Wiring

The Contractor shall comply with Appendix D – HPC-9DJ-23-0002-2016 – Panel Wiring and Terminals. DM: 4741129

Adequate space shall be allowed for the termination and connection of all incoming and outgoing cables as per the designer's cable circuit schedule.

All cables shall be connected directly to the associated switch / circuit breaker terminals, contactors, neutral and earth bar using screwed or bolted terminations. The following exceptions apply:

- RCDs not integrated with the associated circuit breaker shall have cables terminated on the RCDs. Internal wiring between RCD and circuit breaker shall be completed by the Contractor.
- Where circuits need to be routed via control relays, terminals shall be provided for outgoing cables with internal wiring between circuit breakers, relays and terminals being completed by the Contractor.
- Where oversized supply cables are specified, the Contractor shall install suitably sized terminals for the cable size. The Contractor shall wire between the terminals and the main isolator using adequately rated cables.

All cables and wiring shall have medium fire performance, flame retardant (self-extinguishing and shall not support combustion), low smoke, zero halogen, reduced acid gas and hazardous fume emissions sheath and insulation in accordance with AS/NZS 1660.5. The outer sheath of earth cables shall be coloured green/yellow along their entire length.

All cables ties used external to the equipment enclosures shall be stainless steel.

7.2.1 Terminals

Where necessary, rail mounted, tunnel type terminals shall be provided to terminate a minimum stranded copper conductor size of 2.5 mm². Larger terminals shall be provided where cable sizes dictate.

7.2.2 Aerial Conductors

Aerial conductors are not permitted.

7.2.3 Direct Buried Conductors

Direct buried conductors are not permitted for the SPS. The exception will be the earth grading rings.

7.2.4 Underground Wiring Systems

All underground cabling shall be installed to a minimum depth of at least 850mmand shall comply with AS/NZS 3000.

7.2.5 Conduits

Conduits shall comply with AS/NZS 2053.

7.2.6 Cable Ladder and Trunking

Cable ladder and trunking shall:

- be hot dip galvanised.
- have a lid installed to protect the cable outer sheath from UV damage.

7.2.7 Cable Glands

Non-parallel threaded glands are not permitted. Gland plates shall be made of non-ferrous material.

All gland plates shall be earthed.

7.2.8 Cable Labelling

Cables shall be labelled at each end with either strap-on imprinted stainless-steel type or UV resistant labelling ferrules. Cable labels shall be attached with stainless steel cable ties.

Individual core identification shall be with white background ferrules with engraved letters and numerals filled with non-deteriorating black text and shall correspond with the coding on approved drawings.

7.2.9 Cable Separation

Low voltage and communications cabling shall adhere to the separation requirements of Section 3.9.8.4 in AS/NZS 3000 and the requirements of AS/CA S009.

7.2.10 Cable Penetrations

All penetrations shall be as small as practicable and where going through metal shall be suitably bushed with the gap sealed with fire rated mastic.

7.2.11 Secondary and Control Wiring

Protection and control wiring shall not be less than seven stranded copper wire.

Ethernet cabling shall be Category 5e (minimum) screened cable rated to 250V minimum.

Metering and protection functions, where performed by different devices, are to be completely independent of each other. The sharing of cable wiring, test blocks, terminal strips, relays, and switches will not be permitted.

Where secondary wiring requires terminal connectors, they shall be compression type lugs. Bootlace type lugs shall be used on stranded cable cores less than $2.5mm^{2}$ for equipment having recessed screen socket type connections (i.e., terminal blocks). The width of the bootlace shall closely match the width of the terminal tunnel recess and shall have minimum blade protrusion outside of the terminal. All other equipment shall be terminated on spade lugs (except CT terminals which shall be ring lugs).

All screened cables shall have the screen earthed at the signal source end to prevent circulating currents.

7.3 Three Position Switch

The SPS shall have a three position selector switch labelled:

Hybrid – Generator Only – OFF

In the Hybrid position the Alternative Generator will start and stop by commands from the ESS Controller with power flow controlled by the ESS Controller. The selector switch Generator Only position will allow Horizon Power maintenance personnel to start the Alternative engine on site and to bypass the ESS to power the Customer. The Off position isolates the SPS from the customer. The switch position shall be monitored and be controlled by the Remote Monitoring and Communication System via a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands.

7.4 Consumer Mains Protection Device

The SPS shall have a remote controllable motorised electronic circuit breaker protecting the outgoing cable from the SPS to the Customer Main Switchboard.

The Consumer Mains Protection Device shall be monitored and be controlled by the Remote Monitoring and Communication System via a physical ethernet port and use a protocol utilising message queue principles over Ethernet (e.g., MODBUS), to communicate with the Remote Monitoring and Communication System (refer to section 6.8) to transmit and receive data and commands.

7.5 Earthing

The SPS shall have an earthing system sized and designed in accordance with AS/NZS 3000, AS/NZS 3010, AS/NZS 4509.

7.6 Signage and Labelling

All signage and labelling shall be suitable to last the 30-year life of the SPS asset

and securely fitted.

Equipment (not including external labelling outside enclosures) shall be clearly identified with black on white labels engraved in minimum height 6 mm letters on traffolyte or equivalent. Labels shall be supplied and fixed in sufficient number, size, and details to enable rapid and positive identification of all SPS power generating equipment, power, control, and signal cables. Labels shall have equipment/component numbers and names.

The SPS Contractor shall supply and install all Safety signs for the SPS in accordance with AS/NZS 1319.

Labels for dangerous goods shall comply with AS/NZS 1216.

For external labelling of equipment and enclosures, the labels shall be aligned with the SPS drawings. The Contractor shall refer to Appendix E - HPC-9AF-07-0001-2011 General Template Labelling Standard for Distribution Equipment. DM: 1805516

In addition to these requirements, the following signs shall be supplied by the Contractor and fixed to the SPS enclosures:

- one sign with the text “Equipment is the Property of Horizon Power”.
- Electrical Hazard sign to prevent access to enclosure(s) by non-service personnel; and
- combustible liquid safety warning on the fuel tank.

The Contractor’s company name or logo shall not be applied to any part of any enclosures without prior written consent from Horizon Power and any Original Equipment Manufacturer details shall be removed where possible.

8 ACCEPTANCE TESTING

Acceptance Testing shall be carried on the SPS units in the factory and on site. The testing shall cover all mandatory electrical tests and shall test every operation and functionality of the SPS. The testing shall adhere to the minimum requirements as stipulated in Appendix F - SPS Minimum Functional Testing Guide - DM 44595090

9 TECHNICAL SPECIFICATION CHANGES AND VARIATIONS

9.1 Horizon Power Initiated Changes

Horizon Power may decide at its discretion and will advise in writing either by letter or email, of any changes or variations to the Technical Specification.

9.2 Contractor Initiated Changes

Should the Contractor propose a change or variation from the Technical Specification it must be done in writing either by letter or email. The Contractor must give Horizon Power at least 10 business days to respond. No change can be made without Horizon Power approval.

10 APPENDIX A: REVISION INFORMATION

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification of errors or queries.

Each Standard makes use of its own comment sheet, which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

A comment sheet found in DM: 11353115, can be used to record any errors or queries. This comment sheet will be referred to each time the standard is updated.

Rev No.	Date	Notes
5	10/07/2024	Update references, performance specifications and terminology, Addition of minimum functional testing guide.
4	10/05/2023	Update references and removed ambiguity regarding remote monitoring
3	22/03/2022	Update terminology to align with ESS Standard
2	1/03/2022	Standards and Performance Specification Update
1	14/09/2021	Update to remove MPS and diesel, and to reduce costs
0	16/01/2019	Initial Document Creation

As part of document quality control, revision information for initial document creation and subsequent revisions must be kept. Also, a comment sheet must be maintained in DM to document all comments and how those comments were addressed must also be documented.

11 APPENDIX B: STANDARDS

The Contractor shall comply with the following standards as a minimum:

STANDARD	TITLE
AS 1216	Class labels for dangerous goods
AS 1319	Safety signs for the occupational environment
AS 1449	Wrought alloy steels - Stainless and heat-resisting steel plate, sheet, and strip
AS 1627.1	Metal finishing - Preparation and pre-treatment of surfaces - Removal of oil, grease, and related contamination
AS 1692	Steel tanks for flammable and combustible liquids
AS 1768	Lightning Protection
AS 1940	The storage and handling of flammable and combustible liquids
AS 2700	Colour standards for general purposes
AS 4086	Secondary batteries for use with Stand-alone power systems
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS 62282-3-100:2021	Stationary fuel cell power systems - Safety
AS/CA S008	Requirements for customer cabling products (Telecommunications)
AS/CA S009	Installation requirements for customer cabling (Wiring Rules) (Telecommunications)
AS IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes – safety requirements for secondary lithium cells and batteries, for use in industrial applications
AS/NZS 1170.2	Structural design actions - Wind actions
AS/NZS 1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)

STANDARD	TITLE
AS/NZS 1866	Aluminium and aluminium alloys - Extruded rod, bar, solid and hollow shapes
AS/NZS 2053	Conduits and fittings for electrical installations
AS/NZS 2312	Guide for protection of structural steel against atmospheric corrosion using protective coatings.
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008.1	Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV
AS/NZS 3010	Electrical installations - Generating sets and associated standards
AS/NZS 3017	Electrical installations – Verification Guidelines
AS/NZS 3100	Approval and Test Specification – General Requirements for Electrical Equipment
AS/NZS 4509	Stand-alone power systems
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4755	Demand Response capabilities and supporting technologies for electrical products.
AS/NZS 4777:2020	Grid connection of energy systems via inverters, with the default regional setting selection set to “Australia C”. For all other modes and operation that are not covered by a regional setting then default settings of AS/NZS 4777.2 2020 apply.
AS/NZS 5033	Installation and Safety Requirements for Photovoltaic (PV) Arrays
AS/NZS 5139	Electrical Installations Installation and safety requirements of battery storage systems
AS/NZS 5603	Stand-alone inverters – Performance requirements
AS/NZS & ISO 9001	Quality management systems – Requirements

STANDARD	TITLE
AS/NZS 14001	Environmental Management (known as NZS/AS in NZ)
AS/NZS 60269	Low voltage fuses
AS/NZS & IEC 60947	Low-voltage switchgear and control gear
AS/NZS 61000.3.11	Electromagnetic compatibility (EMC) – Limitation of voltage changes, voltage fluctuations and flicker in public low voltage supply systems – for currents up to and including 75A per phase.
AS/NZS 61439	Low-voltage switchgear and control gear assemblies' General rules
IEE 1547:2020	Standard for Interconnecting Distributed Resources with Electric Power Systems
IEC 61215	Terrestrial photovoltaic (PV) modules
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 62109	Safety of power converters for use in photovoltaic systems
UL 1642	Standard for lithium batteries
UL 1741	Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
FCC Part 15, Sub-Part B	Unintentional Radiators for the Prevention of Electromagnetic interference, or radio-frequency interference, is created when an external source causes a disruption to an electrical circuit.

12 APPENDIX C: DATA POINT REQUIREMENTS FOR TECHNICAL SPECIFICATIONS

Insert DM link: 10806403

Note: greyed out sections are datapoints that are no longer needed to be captured (alrams, warnings, failiures – all come on a separate line now combined) Orag

Item #	Final Device Name	Final Name Field	Format	Logging Type	Modbus Map (Exemple only)								Modbus Map (Contractor to provide)							
					Slave ID	Modbus register	Register Range	Data Type	Write Type	Multiplier	Unit	Multistate Value	Slave ID	Modbus register	Register Range	Data Type	Write Type	Multiplier	Unit	Multistate Value
1	Battery Inverter	Automatic Generator Start	-	When point value changes	3	40049	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	305 OFF 308 ON 1129 YES 1130 NO 16777213 Information							-	
2	Battery Inverter	Average Time For Generator Request Via Power	0	When point value changes	3	40561	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	s								s	
3	Battery Inverter	Battery Charge	0.000	Interval 1 minute	3	31197	HOLDING_REGISTER	EIGHT_BYTE_INT_UNSIGN	NOT_SETTABLE	1	MWh	-							MWh	
4	Battery Inverter	Battery Charge Throughputs	0	Interval 1 minute	3	30967	HOLDING_REGISTER	EIGHT_BYTE_INT_UNSIGN	NOT_SETTABLE	1	-	-							-	
5	Battery Inverter	Battery Current	0.000	Interval and point value changes 1 minute Tolerance 1	3	30843	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
6	Battery Inverter	Battery Discharge	0.000	Interval 1 minute	3	31401	HOLDING_REGISTER	EIGHT_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	MWh	-							MWh	
7	Battery Inverter	Battery SoC for Protection Mode	0	When point value changes	3	40971	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	0.1	%	-							%	
8	Battery Inverter	Battery SoC Limit Generator Shutdown	0	When point value changes	3	40539	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
9	Battery Inverter	Battery SoC Limit Generator Shutdown In Additional Time Range	0	When point value changes	3	40547	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
10	Battery Inverter	Battery SoC Limit Generator Start	0	When point value changes	3	40537	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
11	Battery Inverter	Battery SoC Limit Generator Start In Additional Time Range	0	When point value changes	3	40545	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
12	Battery Inverter	Battery Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	3	30851	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	V	-							V	
13	Battery Inverter	Condition	-	When point value changes	3	30201	INPUT_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	35 ERROR 303 OFF 307 OK 455 WARNING 16777213 Information							-	
14	Battery Inverter	Consumed Energy	0	Interval 1 minute	3	30695	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	Wh	-							Wh	
15	Battery Inverter	Current Master	0.000	Interval and point value changes 1 minute Tolerance 1	3	30997	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
16	Battery Inverter	Current Slave	0.000	Interval and point value changes 1 minute Tolerance 1	3	30979	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
17	Battery Inverter	Frequency	0.00	Interval and point value changes 1 minute Tolerance 0.1	3	30803	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	Hz	-							Hz	
18	Battery Inverter	Generator Request	-	When point value changes	3	40535	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	10908 Automatic Generator Start 10911 Manual Generator Control 16777213 Information							-	
19	Battery Inverter	Generator Request Via Power On	-	When point value changes	3	40057	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	1129 YES 1130 NO 16777213 Information							-	
20	Battery Inverter	Generator Shutdown Load Limit	0	When point value changes	3	40059	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	W	-							W	
21	Battery Inverter	Generator Startup Load Limit	0	When point value changes	3	40061	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	W	-							W	
22	Battery Inverter	Generator Status	-	When point value changes	3	30917	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	303 OFF 1392 Error 1787 Initialization 1788 Ready 1789 Warm Up 1790 Synchronize 1791 Activated 1792 Re-synchronize 1793 Generator Separation 1794 Shut-off Delay 1795 Blocked							-	
23	Battery Inverter	Highest Measured Battery Temperature	0.0	Interval and point value changes 1 minute Tolerance 1	3	30999	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.1	C	-							C	
24	Battery Inverter	Initiate Device Restart	-	When point value changes	3	40077	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	1240 Execute 16777213 Information							-	
25	Battery Inverter	Lower Limit Peak Discharge	0	When point value changes	3	40715	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
26	Battery Inverter	Lowest Measured Battery Temperature	0.0	Interval and point value changes 1 minute Tolerance 1	3	30997	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.1	C	-							C	
27	Battery Inverter	Manual Generator Control	-	When point value changes	3	40055	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	181 Stop 1467 Start 1776 Manual One Hour 10908 Automatic Generator Start 16777213 Information							-	
28	Battery Inverter	Maximum Battery Current In Charge Direction	0.000	Interval and point value changes 1 minute Tolerance 1	3	30989	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	A	-							A	
29	Battery Inverter	Maximum Battery Current In Discharge Direction	0.000	Interval and point value changes 1 minute Tolerance 1	3	30991	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	A	-							A	
30	Battery Inverter	Maximum Charge Power of Battery	0.000	When point value changes	3	40969	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	0.001	A	-							A	
31	Battery Inverter	Maximum Discharge Current Of Battery	0.000	When point value changes	3	40965	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	0.001	A	-							A	
32	Battery Inverter	Minimum Width Of Deep Discharge Protection Area	0	When point value changes	3	40973	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	%	-							%	
33	Battery Inverter	Operating Status Battery	-	When point value changes	3	30955	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	2292 Charge battery 2293 Discharge battery 16777213 Information							-	
34	Battery Inverter	Operating Status Master	-	When point value changes	3	31015	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	35 FAULT 303 OFF 307 OK 455 WARNING 16777213 Information							-	
35	Battery Inverter	Operating Status Slave	-	When point value changes	3	31053	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	35 FAULT 303 OFF 307 OK 455 WARNING 16777213 Information							-	
36	Battery Inverter	Power	0	Interval and point value changes 1 minute Tolerance 100	3	30775	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
37	Battery Inverter	Power Master	0	Interval and point value changes 1 minute Tolerance 100	3	30777	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
38	Battery Inverter	Power Slave	0	Interval and point value changes 1 minute Tolerance 100	3	30779	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
39	Battery Inverter	Reaction To Digital Input Of Generator Request	-	When point value changes	3	40559	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	303 OFF 308 ON 16777213 Information							-	
40	Battery Inverter	Reactive Power	0	Interval and point value changes 1 minute Tolerance 100	3	30805	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	VAR	-							VAR	
41	Battery Inverter	Reactive Power Master	0	Interval and point value changes 1 minute Tolerance 100	3	30807	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	VAR	-							VAR	
42	Battery Inverter	Reactive Power Slave	0	Interval and point value changes 1 minute Tolerance 100	3	30809	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	VAR	-							VAR	
43	Battery Inverter	Reason For Generator Request	-	When point value changes	3	30879	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	46 Battery 1773 No Request 1774 Load Delete 1775 Time Control 1776 Manual One Hour 1777 Manual Start 1778 External Source 16777213 Information							-	
44	Battery Inverter	Repetition Cycle Of Time Controlled Generator Operation	-	When point value changes	3	40555	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	1389 Daily 2622 Once 2623 Weekly 16777213 Information							-	
45	Battery Inverter	Runtime For Time Controlled Generator Operation	0	When point value changes	3	40553	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	min	-							min	
46	Battery Inverter	Start Time Additional Time Range Generator Request	Time HH:mm:ss Conversion exponent: 1	When point value changes	3	40541	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	-							-	
47	Battery Inverter	Start Time For Time Controlled Generator Operation	Time MMM dd, yyyy HH:mm:ss.z Conversion exponent: 1	When point value changes	3	40551	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	-							-	
48	Battery Inverter	Time Controlled Generator Operation	-	When point value changes	3	40549	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	1129 YES 1130 NO 16777213 Information							-	
50	Battery Inverter	Voltage Master	0.00	Interval and point value changes 1 minute Tolerance 1	3	30783	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	V	-							V	
51	Battery Inverter	Voltage Slave	0.00	Interval and point value changes 1 minute Tolerance 1	3	30785	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	V	-							V	
52	BMU	Battery Alarm	-	When point value changes	1	49/2	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Inactive Active							-	
78	BMU	Average Current	0.000	Interval and point value changes 1 minute Tolerance 1	1	59	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
79	BMU	Battery Failure	-	When point value changes	1	85/2	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Inactive Active							-	
99	BMU	Maximum Cell Temperature	0.0	Interval and point value changes 1 minute Tolerance 1	1	73	INPUT_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	C	-							C	
100	BMU	Maximum Cell Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	1	71	INPUT_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	V	-							V	
101	BMU	Maximum Module Current	0.000	Interval and point value changes 1 minute Tolerance 1	1	63	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	A	-							A	
102	BMU	Maximum Module DC Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	1	67	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	V	-							V	
103	BMU	Minimum Cell Temperature	0.0	Interval and point value changes 1 minute Tolerance 1	1	74	INPUT_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	C	-							C	
104	BMU	Minimum Cell Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	1	72	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	V	-							V	
105	BMU	Minimum Module Current	0.000	Interval and point value changes 1 minute Tolerance 1	1	63	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	A	-							A	
106	BMU	Minimum Module DC Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	1	69	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	V	-							V	
107	BMU	Relative SoC	0	Interval and point value changes 1 minute Tolerance 1	1	75	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.1	%	-							%	
108	BMU	Remaining Capacity	0	Interval and point value changes 1 minute Tolerance 1	1	76	INPUT_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	Ah	-							Ah	
109	BMU	State Of Health	0	Interval 1 minute	1	80	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.1	%	-							%	
110	BMU	Warning	-	When point value changes	1	50/15	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Inactive Active							-	
140	Generator	Active Power	0	Interval and point value changes 1 minute Tolerance 0.1	1	1020	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
141	Generator	Alarm	-	When point value changes	1	1069/6	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Inactive Active							-	
169	Generator	Capacity	0.0	When point value changes	1	1228	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	1	kW	-							kW	
170	Generator	Command Response Generator On Off	-	When point value changes	1	4207	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	510 ON 300 OFF							-	
171	Generator	Command Set Controller Code	-	When point value changes	1	4209	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	SETTABLE	1	-	1 Set							-	
172	Generator	Command Set Generator Mode	-	When point value changes	1	3021	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	SETTABLE	1	-	0 OFF 1 MANUAL 2 AUTO 3 TEST							-	
173	Generator	Command Set Generator On Off	-	When point value changes	1	4207	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	SETTABLE	1	-	510 ON 300 OFF							-	
174	Generator	Communication Status	-	When point value changes	1	1203	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	0 Unknown 1 Disconnected 2 Connecting 3 Connected							-	
177	Generator	Current	0.000	Interval and point value changes 1 minute Tolerance 1	1	1045	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	-	A	-							A	
178	Generator	Emergency Stop	-	When point value changes	1	1068/0	INPUT_REGISTER	Binary	NOT_SETTABLE	1	-	Closed Open							-	
179	Generator	E-Stops	0	Interval 1 minute	1	1281	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	-							-	
180	Generator	Frequency	0.00	Interval and point value changes 1 minute Tolerance 0.1	1	1038	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.1	Hz	-							Hz	
181	Generator	Fuel Level	0	Interval and point value changes 1 minute Tolerance 1	1	1055	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	1	%	-							%	
184	Generator	Reset to Manual	-	When point value changes	1	3024	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	SETTABLE	1	-	0 Disabled 1 Enabled							-	
185	Generator	RPM	0	Interval and point value changes 1 minute Tolerance 100	1	1001	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	Rev/min	-							Rev/min	
186	Generator	Run Hours	0.0	Interval 5 minute	1	1771	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGN	NOT_SETTABLE	0.1	h	-							h	
187	Generator	Starter Battery Voltage	0.00	Interval and point value changes 1 minute Tolerance 0.1	1	1053	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	0.1	V	-							V	
188	Generator	Starts	0	When point value changes	1	1271	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	SETTABLE	1	-	-							-	

189	Generator	State	-	When point value changes	1	1298	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	0 Init 1 Ready 2 NotReady 3 Prestart 4 Cranking 5 Pause 6 Starting 7 Running 8 Loaded 9 Soft unld 10 Cooling 11 Stop 12 Shutdown 13 Ventil 14 EmergMan 15 Soft load 16 WaitStop							-	
190	Generator	Voltage	0.00	Interval and point value changes 1 minute Tolerance 1	1	1037	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	V	-							V	
191	Main Switch	CB Alarm Status	-	When point value changes	247	40/10	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal Alarm Error							-	
192	Main Switch	CB Local Remote Status	-	When point value changes	247	40/8	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Local Remote							-	
193	Main Switch	CB Open Close Status	-	When point value changes	247	40/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Open Closed							-	
194	Main Switch	CB Operating Status	-	When point value changes	247	40/3	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal CB Tripped							-	
195	Main Switch	CB Timing Status	-	When point value changes	247	40/11	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal Timing Error							-	
196	Main Switch	CB Trip Command Failed Status	-	When point value changes	247	40/7	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal Command Failed							-	
197	Main Switch	CB Trip Status	-	When point value changes	247	40/12	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal Trip Error							-	
198	Main Switch	CB Warning Status	-	When point value changes	247	40/9	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	Normal Warning Error							-	
199	Main Switch	Command Set CB Open Close	-	When point value changes	247	0	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED_SWAPPED	SETTABLE	1	-	7 OPEN 8 CLOSE							-	
200	Main Switch	Electronic I Protection Configuration	-	When point value changes	247	670/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
201	Main Switch	Electronic I Protection Threshold	0.0	When point value changes	247	671	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01		-								
202	Main Switch	Electronic L Protection Threshold	-	When point value changes	247	651	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
203	Main Switch	Electronic L Protection Time	0	When point value changes	247	652	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	s	-							s	
204	Main Switch	Electronic LC Protection Configuration Iw Threshold Status	-	When point value changes	247	810/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
205	Main Switch	Electronic LC Protection LC1 Threshold	0.0	When point value changes	247	812	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
206	Main Switch	Electronic LC Protection LC1 Threshold Status	-	When point value changes	247	810/1	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
207	Main Switch	Electronic LC Protection LC2 Threshold	-	When point value changes	247	813	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
208	Main Switch	Electronic LC Protection LC2 Threshold	-	When point value changes	247	810/2	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
209	Main Switch	Electronic LC Protection Iw Threshold	-	When point value changes	247	811	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
210	Main Switch	Electronic OV Protection Configuration Status	-	When point value changes	247	740/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
211	Main Switch	Electronic OV Protection Threshold	-	When point value changes	247	741	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
212	Main Switch	Electronic OV Protection Time	0	When point value changes	247	742	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	s	-							s	
213	Main Switch	Electronic S Protection Configuration Status	-	When point value changes	247	660/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
214	Main Switch	Electronic S Protection Threshold I2t=k	-	When point value changes	247	661	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
215	Main Switch	Electronic S Protection Threshold t=k	-	When point value changes	247	663	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
216	Main Switch	Electronic S Protection Time I2t=k	0	When point value changes	247	662	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	s	-							s	
217	Main Switch	Electronic S Protection Time t=k	0	When point value changes	247	664	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	s	-							s	
218	Main Switch	Electronic UV Protection Configuration Status	-	When point value changes	247	730/0	INPUT_REGISTER	Binary	NOT_SETTABLE	-	-	0 Disabled 1 Enabled							-	
219	Main Switch	Electronic UV Protection Threshold	-	When point value changes	247	731	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	-	-							-	
220	Main Switch	Electronic UV Protection Time	0	When point value changes	247	732	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.01	s	-							s	
221	Main Switch	Programming Fail Error Code	-	When point value changes	247	30	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	(multiple values)							-	
222	Main Switch	Slave Address	0	When point value changes	247	625	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	-							-	
223	Main Switch	Trip Number	0	When point value changes	247	1700	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	-							-	
224	Main Switch	Trip Type	-	When point value changes	247	1701	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	1 L 2 S 3 I 4 G 5 Iinst 12 UV							-	
225	Main Switch	Voltage	0.00	Interval and point value changes 30 seconds Tolerance 1	247	154	INPUT_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	V	-							V	
226	Power Meter	Active Energy Total	0.0	Interval and point value changes 30 seconds Tolerance 0.1	247	4124	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.1	kWh	-							kWh	
227	Power Meter	Active Power	0	Interval and point value changes 30 seconds Tolerance 100	247	4140	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	W	-							W	
228	Power Meter	Apparent Power	0	Interval and point value changes 30 seconds Tolerance 100	247	4158	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	VA	-							VA	
229	Power Meter	Current	0.000	Interval and point value changes 30 seconds Tolerance 1	247	4102	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	A	-							A	
230	Power Meter	Frequency	0.00	Interval and point value changes 30 seconds Tolerance 0.1	247	4134	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	Hz	-							Hz	
231	Power Meter	Power Factor	0.000	Interval and point value changes 30 seconds Tolerance 0.01	247	4164	HOLDING_REGISTER	TWO_BYTE_INT_SIGNED	NOT_SETTABLE	-0.01	-	-							-	
232	Power Meter	Voltage	0.00	Interval and point value changes 30 seconds Tolerance 1	247	4096	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	0.001	V	-							V	
233	Changeover Switch	Command Set Position Generator	-	When point value changes	1	4	COIL_STATUS	Binary	SETTABLE	1	-	0 - False 1 - True							-	
234	Changeover Switch	Command Set Position Normal	-	When point value changes	1	3	COIL_STATUS	Binary	SETTABLE	1	-	0 - False 1 - True							-	
235	Changeover Switch	Command Set Position Off	-	When point value changes	1	5	COIL_STATUS	Binary	SETTABLE	1	-	0 - False 1 - True							-	
236	Changeover Switch	Status Operating Mode Generator	-	When point value changes	1	6	COIL_STATUS	Binary	SETTABLE	1	-	N/A Generator							-	
237	Changeover Switch	Status Operating Mode Normal	-	When point value changes	1	7	COIL_STATUS	Binary	SETTABLE	1	-	N/A Normal							-	
238	Changeover Switch	Status Operating Mode Off	-	When point value changes	1	8	COIL_STATUS	Binary	SETTABLE	1	-	N/A Off							-	
239	Changeover Switch	UPS Bank Voltage	0.00	Interval and point value changes 1 minute Tolerance 0.1	1	2	HOLDING_REGISTER	FOUR_BYTE_FLOAT_SWAPPED	NOT_SETTABLE	1	V	-							V	
240	Sensor	Ambient Temperature Battery Enclosure	0.0	Interval and point value changes 1 minute Tolerance 1		1	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	C	-							C	
241	Sensor	Ambient Temperature Comms Enclosure	0.0	Interval and point value changes 1 minute Tolerance 1		0	HOLDING_REGISTER	TWO_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	C	-							C	
242	PV Inverter 1	Condition	-	When point value changes		30201	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	35 FAULT 303 OFF 307 OK 455 WARNING 16777213 Information Not Available							-	
244	PV Inverter 1	DC Current Input String A1	0.000	Interval and point value changes 1 minute Tolerance 1		30769	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
245	PV Inverter 1	DC Current Input String B1	0.000	Interval and point value changes 1 minute Tolerance 1		30957	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
246	PV Inverter 1	DC Power Input String A1	0	Interval and point value changes 1 minute Tolerance 100		30773	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
247	PV Inverter 1	DC Power Input String B1	0	Interval and point value changes 1 minute Tolerance 100		30961	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
248	PV Inverter 1	DC Voltage Input String A1	0.00	Interval and point value changes 1 minute Tolerance 1		30771	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	V	-							V	
249	PV Inverter 1	DC Voltage Input String B1	0.00	Interval and point value changes 1 minute Tolerance 1		30959	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	V	-							V	
250	PV Inverter 1	Operating State RW	-	when point value changes		40009	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	295 MPP 381 Stop 443 Constant voltage 16777213 Information Not Available							-	
251	PV Inverter 1	Power	0	Interval and point value changes 1 minute Tolerance 100		30775	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
253	PV Inverter 2	Condition	-	When point value changes		30201	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	35 FAULT 303 OFF 307 OK 455 WARNING 16777213 Information Not Available							-	
255	PV Inverter 2	DC Current Input String A1	0.000	Interval and point value changes 1 minute Tolerance 1		30769	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
256	PV Inverter 2	DC Current Input String B1	0.000	Interval and point value changes 1 minute Tolerance 1		30957	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.001	A	-							A	
257	PV Inverter 2	DC Power Input String A1	0	Interval and point value changes 1 minute Tolerance 100		30773	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
258	PV Inverter 2	DC Power Input String B1	0	Interval and point value changes 1 minute Tolerance 100		30961	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	
259	PV Inverter 2	DC Voltage Input String A1	0.00	Interval and point value changes 1 minute Tolerance 1		30771	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	V	-							V	
260	PV Inverter 2	DC Voltage Input String B1	0.00	Interval and point value changes 1 minute Tolerance 1		30959	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	0.01	V	-							V	
261	PV Inverter 2	Operating State RW	-	when point value changes		40009	HOLDING_REGISTER	FOUR_BYTE_INT_UNSIGNED	NOT_SETTABLE	1	-	295 MPP 381 Stop 443 Constant voltage 16777213 Information Not Available							-	
262	PV Inverter 2	Power	0	Interval and point value changes 1 minute Tolerance 100		30775	HOLDING_REGISTER	FOUR_BYTE_INT_SIGNED	NOT_SETTABLE	1	W	-							W	

13 APPENDIX D: HPC-9DJ-23-0002-2016 – PANEL WIRING AND TERMINALS

Insert DM link: 4741129

Standard - Panel Wiring and Terminals

Standard Number: HPC-9DJ-23-0002-2016

Document Control			
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Date Created/Last Updated	1 February 2023		
Review Frequency **	5 years		
Next Review Date **	1 February 2028		

** This person will have the power to grant the process owner the authority and responsibility to manage the process from end to end.*

*** Frequency period is dependent upon circumstances– maximum is 5 years from last issue, review, or revision whichever is the latest. If left blank, the default shall be 1 year unless otherwise specified.*

Revision Control		
Revision	**Date**	**Description**
1	1/02/2023	Document format and updating
0	11/11/2016	Initial Document Creation – Based on an existing specification

STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Manager Engineering & Project Services	Asset Managers
Manager Systems & Network Planning	Manager Assets Services
Senior Manager Safety, Health and Wellbeing	

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1 PURPOSE

This standard outlines the requirements for internal small wiring, terminations and multicore cables in substations.

2 APPLICATION

All persons, including Horizon Power staff and contractors involved in the installation of substations for connection to Horizon Power's distribution network shall comply with these requirements, except as otherwise approved.

3 NORMATIVE REFERENCES

3.1 Standards

3.1.1 Australian Standards

The following standards are available at http://www.saiglobal.com.

[1] *AS 2067, Substations and high voltage installations exceeding 1 kV a.c.* Standards Australia, 2016

3.1.2 International Standards

The following standards are available at http://www.saiglobal.com.

[2] *IEC 60947.7.1, Low voltage switchgear – Part 7.1 Ancillary equipment - Terminal blocks for copper conductors*, International Electrotechnical Commission, 2009

3.2 Definitions and Abbreviations

For the purposes of this standard, definitions shall apply as in the relevant Australian Standards (AS 2067 [1]) with the addition of a few general definitions listed below in alphabetical order.

CT: Current Transformer

EF: Earth Fault

OC: Over Current

PVC: Polyvinyl Chloride

SCADA: Supervisory Control and Data Acquisition

VT: Voltage Transformer

4 WIRING

4.1 General

All wiring that originates and terminates within the one panel must be single core, unsheathed multi-stranded, PVC flexible insulated copper conductor. The only exception is for transducer outputs which must use paired screened cable.

New installation wiring must be:

- neatly enclosed in ducting with removable covers and must not exceed 50% of the duct volume
- run in the most efficient manner from point to point
- left sufficiently long and neatly looped to allow a minimum of two fresh terminations to be made, with the loop length approximately 200 mm
- be flexible cable installed in a cable loom where wiring crosses between a side sheet and a hinged panel

4.2 Wiring identification

4.2.1 Ferrules

All wiring must be ferruled at both ends.

Ferrules must be white insulating material with black character marking and have a glossy finish to prevent adhesion of dirt. They must not be affected by damp or oil.

Critchley ® type Z or Grafoplast ® ferrules must be used.

'C' type or saddle type clip on ferrules must not be used.

4.2.2 Prefix lettering

Wire identification must utilise a prefix letter, a number and then an optional suffix letter. Case earths (e.g. for relays) do not require identification.

Prefix letters must be as per Table 1. This scheme is derived from AS 2067 [1].

Each branch of any connection must have the same identification. Where it is necessary to separately identify branches that are connected at a common point (e.g. CT leads), they must be connected via a link or terminals joined with a removable connection.

Where more than one function is covered by common wiring (i.e. parallel circuits), the first appropriate prefix letter will be used.

Where the circuits split at a separable contact e.g. fuse, link, switch, relay contact, the prefix letter should change from the splitting point as required.

Where interposing, auxiliary and isolating transformers are used, the prefix letters must follow through the transformer, provided they do not couple/connect circuits that have different functions (e.g. interposing CT for metering branching off from protection circuits).

Table 1: Wiring Identification

Prefix Letter	Circuit Function	Wire Numbers
A	Current transformers for protection (excluding over current and bus-zone protection).	Protection Number 1[1] (10-29) Red Phase (30-49) White Phase (50-69) Blue Phase (70-89) Residual circuits and neutral current transformers (90) Earth wires connected directly to the earth bar Protection Number 2 (310-329) Red Phase (330-349) White Phase (350-369) Blue Phase (370-389) Residual circuits and neutral current transformers (390) Earth wires connected directly to the earth bar
B	Current transformers for bus-zone protection.	
C	Current transformers for over current protection (including combined protection devices such as OC/EF relays and protection/SCADA devices e.g. SEL351).	
D	Current transformers for instruments, metering and voltage control.	
E	Reference voltage for instruments, metering and protection.	
F	Reference voltage for voltage control. This includes Automatic Voltage Control.	
G	Reference voltage for synchronising.	
DD	Output side of current metering transducers.	Any number from 1 upward
DE	Output side of voltage metering transducers.	
DF	Output side of frequency transducers.	
DP	Output side of power factor transducers.	
DR	Output side of reactive power (MVAr) metering transducers.	
DT	Output side of temperature and condition monitoring metering transducers.	
DW	Output side of power (MW) metering transducers.	

[1] If additional numbers are required, multiples of 100 may be added to the above ranges, provided the 'Protection 1' numbering does not intrude on those of 'Protection 2'. E.g. Protection 1 Red Phase may also use 110-129 and 210-229

Prefix Letter	Circuit Function	Wire Numbers
H	AC Supplies	240 V and 415 V AC[2] (410-429) Red Phase (430-449) White Phase (450-469) Blue Phase (470-489) Neutrals (800-999) Other
J	DC Supplies	(3,4) 50 V DC Supplies (1,2) DC Battery Number 1 (32 V, 110 V or 230 V)[3] (301, 302) DC Battery Number 2 (32 V, 110 V or 230 V) [4] (800-999) Other
K	Closing and tripping circuits excluding those for SCADA control connections covered under W.	(1-300) Circuits supplied from DC Battery Number 1 (301-600) Circuits supplied from DC Battery Number 2 (800-900) Other
L	Alarm and indication circuits initiated by auxiliary switches and relay contacts, excluding those for SCADA light current indication and alarms covered under X.	As for K
M	Motor control circuits e.g. spring charge, transformer cooler and disconnector motors.	Any number from 1 upward
N	Tap-changer control, including automatic voltage control, tap position and progress indications.	Any number from 1 upward
O	An indication that the ferruling is not in accordance with this general scheme and that if it is not altered; double ferruling will be required for coordination with the remaining equipment in the substation.[5]	Any number from 1 upward

[2] If additional numbers are required, multiples of 100 may be added to the above ranges. E.g. Red Phase may also use 510-529, 610-629 and 710-729
[3] Depends on which is installed
[4] Depends on which is installed
[5] This is only to be used by manufacturers where the wire numbering required has not been supplied by Western Power.

Prefix Letter	Circuit Function	Wire Numbers
P	DC tripping circuits used solely for busbar protection.	As for K
R	Interlock circuits not covered above.	As for K
S	DC instruments and relays (with the exception of outputs from transducers covered above).	As for K
T	Pilot conductors and their connections to associated protection equipment.	As for K
U	Spare cores and connections to spare contacts.	Any number from 1 upward
V	Automatic switching circuits not integral to circuit breaker control schemes i.e. separately supplied or isolable from the circuit breaker control scheme.	As for K
W	SCADA control connections.	Any number from 1 upward
Y	Telephones.	Any number from 1 upward

4.3 Wire numbering

4.3.1.1 General

All replacement wires must be numbered to match the wire being replaced and must read left to right or bottom to top. All new wires must be numbered to match the termination drawings and must read left to right or bottom to top.

4.3.1.2 Line referencing

Line referencing must be used on protection schematics for all new circuits. When working on existing circuits that do not have line referencing, the existing drawing style may be used. An example of this would be adding a line to an AC drawing for an existing partially completed bay.

4.3.1.3 AC circuits

AC circuits wire numbering is as per the 'Wire Numbers' column of Table 1. The only exception to this is for the power transformer bund valve circuitry, for which the wire number is derived from the drawing line numbers on all new circuits.

4.3.1.4 Old DC circuits

The wire number may consist of one or more digits as required and as detailed in the 'Wire Numbers' column of Table 1. DC supply wiring normally at positive potential must have odd numbers and those from a negative source must have even numbers. The change from odd to even numbers must occur at the load (coil, resistor, lamp, relay etc.) that is closest to the negative supply.

4.3.1.5 New DC circuits

The wire number consists of three digits corresponding to the line from which the wire appears on, and a final sequential digit to make it odd or even. The final sequential digit is a 1, 3, 5, 7 or 9 for the positive supply and a 2, 4, 6 or 8 for the negative supply. The change from odd to even numbers must occur at the load (coil, resistor, lamp, relay etc.) that is closest to the negative supply. Refer to Figure 1 for an example.

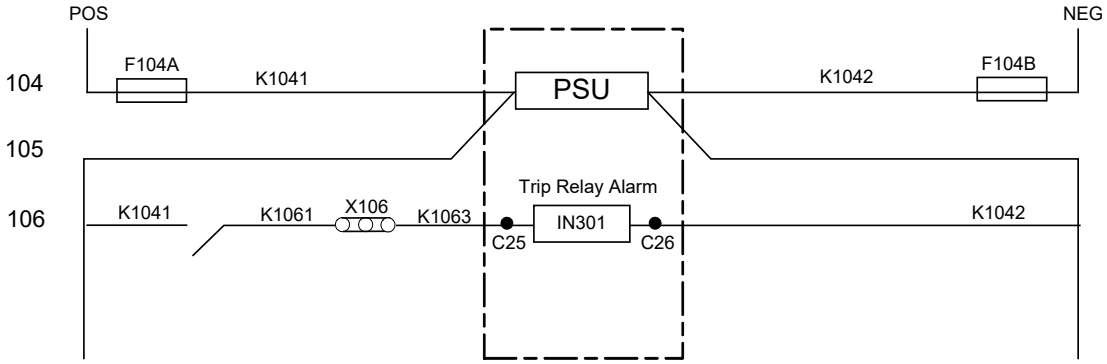

Figure 1: DC Circuit example

4.3.2 Suffixing

4.3.2.1 General

Suffix letters A, B, C etc. must be used when similar numbered wires are taken from separate units to a common panel e.g. as part of bus-zone protection. Suffix allocation is determined by the location of the asset within the substation. Refer to the substation single line diagram for suffix letter allocations.

4.4 Wiring sizes, colour and voltage grade

All wiring is to be PVC Flex V105 with a voltage grade of 0.6/1 kV. Paired screen cable used for instruments do not require the 0.6/1 kV voltage grade.

The wire sizes in Table 2 are the minimum requirements. Some installations may require larger cable due to load current and voltage drop limitations. This must be taken into account during design and shown on the appropriate drawings.

Table 2: Panel Wiring Sizes and Voltage Grades

Application	Wiring Size	Wiring Colouring
CT and VT Secondary	2.5 mm^2 (50/0.25)	Phase: Red, White and Blue; Neutral: Black
250 V AC Power (5 A)	1.5 mm^2 (30/0.25)	Phase: Red, White and Blue; Neutral: Black
440 V AC Power	2.5 mm^2 (50/0.25)	Phase: Red, White and Blue; Neutral: Black
Earthing	2.5 mm^2 (50/0.25)	Green/Yellow
110 V, 230 V and 250 V DC Control	1.5 mm^2 (30/0.25)	Grey
32 V DC Control	2.5 mm^2 (50/0.25)	Grey
DC Battery Supply	2.5 mm^2 (50/0.25)	Positive: Red; Negative: Blue
50 V DC Alarm and Indication	0.5 mm^2 (16/0.2)	Brown

Application	Wiring Size	Wiring Colouring
Metering and Transducers	1.5 mm^2 (30/0.25)	Violet
Pilot Equipment	1.5 mm^2 (30/0.25)	Pink
DC Battery Boards	4 mm^2 Triangle 6 mm^2 Triangle 16 mm^2 Triangle 35 mm^2 Triangle	Phase: Red, White and Blue; Neutral: Black

Refer to Table 3 for the wire colour abbreviations.

Table 3: Drawing colour abbreviations

Abbreviation	Colour
Bk	Black
Bn	Brown
Rd	Red
Og	Orange
Ye	Yellow
Gn	Green
Bu	Blue (including Light Blue)
Vt	Violet (purple)
Gy	Grey (slate)
Wh	White
Pk	Pink
Gd	Gold
Tq	Turquoise
Sr	Silver
GnYe	Green and Yellow

4.5 Current transformer wiring

Current transformer wiring must be continuous between the CT secondaries and the marshalling box. It must also be continuous from the marshalling box to the first terminal strip in the relay protection panel or metering panel. Here ‘continuous’ means no intermediate connections, for example inline crimps.

5 TERMINATION AND CONNECTORS

5.1 General

The terminations outline in Table 4 are all approved for use. Equivalent alternatives that are functionally the same may be considered if approved by the substation design engineer for that project.

Determining the correct type of termination for a wire into a terminal block or accessory must consider the following however the best fit practice on each installation will be followed.

5.1.1 Clamp type

Wires no less than 1.5 mm² and of 30 strands or less, may be terminated bare in clamp type terminal blocks or accessory terminations (excluding screw type clamp). It is permissible to terminate two wires into a clamp terminal provided they are specifically designed for this purpose. If the clamp is a screw type the wire strands must be protected by using a crimp lug.

5.1.2 Crimp type

Crimp type lugs must be used for all flexible type wire of 30 strands or more, or if the cross sectional area of the cable is less than 1.5 mm².

Wire connectors must be crimp type. Uninsulated is acceptable provided electrical clearance is maintained. Where insulated lugs are used, they must be “UTILE super grip” style. These lugs require a double crimp rather than a single crimp.

5.1.3 Linked terminals

Only one wire may be terminated in each terminal. If the terminal rail space prevents additional terminals from being added, the preferred method of connecting two or more leads is to use a group of bridged, “double bootlace”, or linked terminals. Where two wires are required to be terminated in one terminal then flat blade lugs must be used back to back. Note that lip blade lugs should only be used on vibration terminals.

5.1.4 Stud type terminals

For stud type terminals, eyelet type lugs must be used. Locknuts must be fitted to the stud on the rear face behind where the lug is be fitted. A flat washer must be fitted either side of the lug followed by a spring washer and a full thread nut. Washers must be made of non-corrosive or of equivalent material as that of the stud. Flat washers that form part of the conductive path must be of a high conductive material.

For stud type terminals, multiple wires (using eyelet lugs), up to maximum three, may be connected to the one terminal. Any more than this will compromise the clamping pressure across multiple contact surfaces.

Wherever a relay or equipment terminal is designed to accept an eyelet type crimp lug these should be used. Forked/open eyelet type lugs (except for CT circuits) may be accepted where ease of connection is a factor, and where circuit integrity can be maintained.

5.1.5 Krone terminals

Only one wire must be terminated at each Krone terminal point.

5.1.6 Bootlace lugs

Bootlace lugs are commonly supplied on manufacturer's equipment. It is acceptable to use bootlace lugs for the termination of field data type cables typically of 0.5 mm² or less. The use of bootlace lugs for other termination applications will be considered on merit or where the crimp lug is considered unsuitable for the particular application.

5.2 Approved terminals

Table 4 summarises the terminals that are approved for use within Horizon Power substations.

Table 4: Approval Terminals

Application	Approved Terminals
CT Secondary	WTD 6/1 EN (6 mm^2 41 A Feed-through) WTL 6/1 EN (6 mm^2 41 A Earth link)
VT Secondary	WTL 4 (4 mm^2 32 A Slide)
DC Control	WDU 4 (4 mm^2 32 A Feed-through) WTL 4 (4 mm^2 32 A Slide)
AC and DC Power	WDU 4 (4 mm^2 32 A Feed-through) WTL 4 (4 mm^2 32 A Slide)
Light Current (control, indication, alarm, metering, telephone, fault recorder)	WDU 4 (4 mm^2 32 A Feed-through) WTL 4 (4 mm^2 32 A Slide) WTR 2.5 STB (2.5 mm^2 24 A Blade)
Power: 6 mm^2 32A	WTD 6/1 EN (6 mm^2 41 A Feed-through)

Notes:

- Weidmuller are the manufacturers of all products in Table 4.
- Terminal ratings as per IEC 60947.7.1 [2].
- Terminals must be specified on drawings

5.3 Vibration proof terminals

All CT, VT and 50/110 V DC wiring on all power transformers and previously identified vibration areas must use vibration proof terminals (spring loaded) as per Table 4. CT circuits must use lip blade lugs.

5.4 Shrouding of terminals

All exposed terminals where access may be gained whilst the equipment is live must be shrouded. This also includes fuse holder connectors and relay terminals. Shrouding of terminals is to be shown on all appropriate drawings.

5.5 Orientation of disconnect terminals

Table 5 summarises the terminal orientation for vertical arrangements.

Table 5: Terminal Orientation

Application	Orientation
CT earth link terminal	Slide up to open
All other slide terminals	Slide down to open
SCADA blade terminals	Blade flicks up to open (to allow installation of shorting links to be installed on the field side of the terminals
All blade terminals	Blade flicks down to open

APPENDIX A REVISION INFORMATION

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification of errors or queries.

Each Standard makes use of its own comment sheet which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

A comment sheet found in **DM# 4739275** can be used to record any errors or queries found in or pertaining to this standard. This comment sheet will be referred to each time the standard is updated.

Date	Rev No.	Notes
11/11/2016	0	Initial Document Creation – Based on an existing specification
1/02/2023	1	Document format and updating

14 APPENDIX E: HPC-9AF-07-0001-2011 GENERAL TEMPLATE LABELLING STANDARD FOR DISTRIBUTION EQUIPMENT

Insert DM link 1805516

Standard: General Template Labelling Standard for Distribution Equipment

Standard Number: HPC-9AF-07-0001-2011

Original Issue Date: 15th April 2011
Document Number: 1805516

Print Date: 28/09/2023

Document Control		
Author	**Name:** Andrew Nguyen **Position:** Standards and Plant Engineer	
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Date Created/Last Updated	28 September 2023	
Review Frequency **	3 years	
Next Review Date **	September 2026	

** Frequency period is dependent upon circumstances– maximum is 5 years from last issue, review, or revision whichever is the latest. If left blank, the default must be 1 year unless otherwise specified*

Revision Control		
Revision	**Date**	**Description**
3	28/09/2023	Document updated with the relevant and current Australian Standards, includes standards label of GMK, update the Appendix B- Schedule of Label Requirements
2	1/11/2019	Document updated based on regional improvement suggestions, mini pillar labelling added and introduction of Standalone Power System labelling. Fusesaver Information added.

STAKEHOLDERS The following positions shall be consulted if an update or review is required:	
Asset Managers	Works Delivery Managers
	Asset Services Delivery Manager

TABLE OF CONTENTS

1 PURPOSE

The purpose of this document is to provide a standard general template for consistency in labelling of distribution primary equipment.

2 APPLICATION

This Standard covers all labelling to be secured to distribution primary equipment on Horizon Power's distribution network and represents the minimum requirements applicable to all labels applied to the distribution primary equipment.

3 NORMATIVE REFERENCES

3.1 Standards

3.1.1 Australian Standards

The following standards are available at http://www.saiglobal.com.

[1]. *AS 1319, Safety signs for the occupational environment,* Standards Australia, 2005

[2]. *AS 2067, Substations and high voltage installations exceeding 1 kV a.c.,* Standards Australia, 2016

[3]. *AS/NZS 3000, Electrical Installations (known as Australian/New Zealand Wiring Rules)*, Standards Australia, 2018 (Amdt 2:2021)

[4]. *AS/NZS 4777.2, Grid connection of energy systems via inverters*, Standards Australia, 2022

[5]. *AS/NZS 5033, Installation and safety requirements for photovoltaic (PV) arrays*, Standards Australia, 2021

[6]. *AS/NZS 61439, Low voltage switchgear and controlgear assemblies – General rules*, Standards Australia, 2016

3.1.2 Other References

[7]. *WAER, Western Australian Electricity Requirements*, WA Electrical Requirements (WAER) | Department of Mines, Industry Regulation and Safety (commerce.wa.gov.au)

[8]. *WASIR, Western Australian Service and Installation Requirements*, https://www.westernpower.com.au

3.2 Abbreviations

1) CAPT: Capacitor
2) CBOX: Control Box
3) CBHV: MV Circuit Breaker
4) CBLV: LV Circuit Breaker
5) DDOF: Drop Out Fuse

6) DPTS: Pole Top Switch
7) DRMU: Ring Main Unit
8) DSUB: Distribution Substation
9) DTTX: Distribution Transformer
10) EASW: Earth Switch
11) NMTR: Medium Voltage Customer Metering Unit
12) FDIS: Fuse Disconnector LV
13) FLIN: Fault Indicator
14) FUSV: Fusesaver
15) FUSW: Fuse Switch
16) GMK: Ground Mounted Kiosk
17) GIS: Horizon Power's Geographic Information System
18) HVDI: MV Disconnector
19) ISTX: Isolating Transformer
20) LUMI: Luminaire
21) LV: Low Voltage <1000 volts ac
22) LVDI: Low Voltage Disconnector
23) LVFM: Low Voltage Distribution Frame
24) SPS: Standalone Power System
25) MV: Medium Voltage >1000 volts ac; <36 000 volts ac
26) PILL: Pillar (used for mini and universal pillars and wall-mounted boxes)
27) POLE: Pole
28) REAC: Reactor
29) RECL: Recloser
30) RETX: Voltage Regulator
31) SURD: Surge Diverter
32) SECT: Sectionaliser
33) SLCB: Street Light Control Box
34) SWTC: Switch Disconnector
35) WAER: Western Australian Electrical Requirements

3.3 Definitions

1) **Critical Information**: Information that needs to be prominently displayed in comparison to other information on a Label.
2) **Equipment Number**: A unique identification number assigned to each item in GIS/Ellipse and 'PowerOn Fusion'.

3) **Label:** An inscribed board, plaque or other delineated space on which a combination of words and/or symbols is used to identify a piece of equipment.

4) **SPS:** Standalone Power System.

5) **PowerOn Fusion:** Human Machine Interface System for SCADA.

6) **RMU:** Ring Main Unit.

7) **SCADA:** Supervisory Control and Data Acquisition.

8) **Sign:** An inscribed board, plaque or other delineated space on which a combination of legend and/or symbolic shape is used to convey a message.

4 RESPONSIBILITIES

The fixing of permanent labels is the responsibility of the equipment installer. However, the commissioning officer must identify and confirm the presence and correctness of all labels fitted to distribution equipment. No equipment as specified in this standard shall be commissioned and placed into service without permanent labels installed.

The maintenance of labels is the responsibility of the relevant regional maintenance power systems officers; however the switching operator must identify and confirm the presence and correctness of all labels fitted to distribution primary equipment at the time of switch operation.

The installer has the responsibility of ensuring that information included in a label can be interpreted by others, particularly for operators that do not have local knowledge of the area. If the installer deems that the information provided by the standard format is insufficient for a particular asset, it is the installer's responsibility to seek advice.

5 GENERAL REQUIREMENTS

Equipment labels are used to identify plant and also to assist operators in the field during switching and incident responses.

Distribution primary equipment shall be legibly and indelibly labelled to clearly identify the equipment, what it is connected to, and where applicable indicate the portion of the electrical installation that it controls.

Labelling shall be located on or adjacent to the equipment, in a position adjacent to the means of operation. Where access is provided to equipment at the side or rear, such labelling shall also be located on a fixed portion at the alternate location.

The following represents the minimum requirements for material to be used for distribution primary equipment labels.

5.1 Material

The labels shall be capable of being adhered or fastened to any smooth, clean surface inclusive of wood, metalwork, and concrete. Details are:

1) Yellow vinyl adhesive-backed tape with a minimum of 10 years' adhesiveness.

2) Minimum outdoor life (UV tolerant) of 10 years and remain legible.
3) Must provide for the text to have a viewing distance of 6 metres as per AS 1319 [1].
4) Up to four lines of text, arial bold type.
5) Length is dependent on entered text.

5.2 Graffiti Resistance

Labels shall have a graffiti resistant laminate or coating applied for environments where graffiti may be applied.

5.3 Housekeeping Rules

1) Where a location is provided for a referenced asset, the 'at' @ symbol can be used to improve readability as often the address is provided with other details.
2) Where a referenced asset shares the same site as the asset being labelled, the referenced asset's location can simply be 'local'.
3) If there is space in a label, the installer can include an upstream isolation point with the use of the word 'VIA' if preferred.
4) Do not use business names for locations as business names are likely to change over the life of the asset.
5) If a lot or street number is not signed or available at the site, the label must include further information that will enable operators to locate the referenced asset e.g. Brockman Park, High School, Hospital.
6) Addresses in locations shall have the lot number shown by including an 'L' in front of the number with no space between, and then the house number and street name following a comma (e.g. *L100, 2 Smith St.).*
7) If a pole rural number is large and does not fit in one line using 13 mm text, multiple lines may be used with the final line having the largest text.
8) If a label contains all adequate information and there is room to spare using the specified text sizes, the text sizes may be increased to fill the label so long as the text sizes remain in proportion to the sizes specified.

5.3.1 Label Size, Formatting & Colour

All labels shall have black text on a yellow background and must also have a thin frame border.

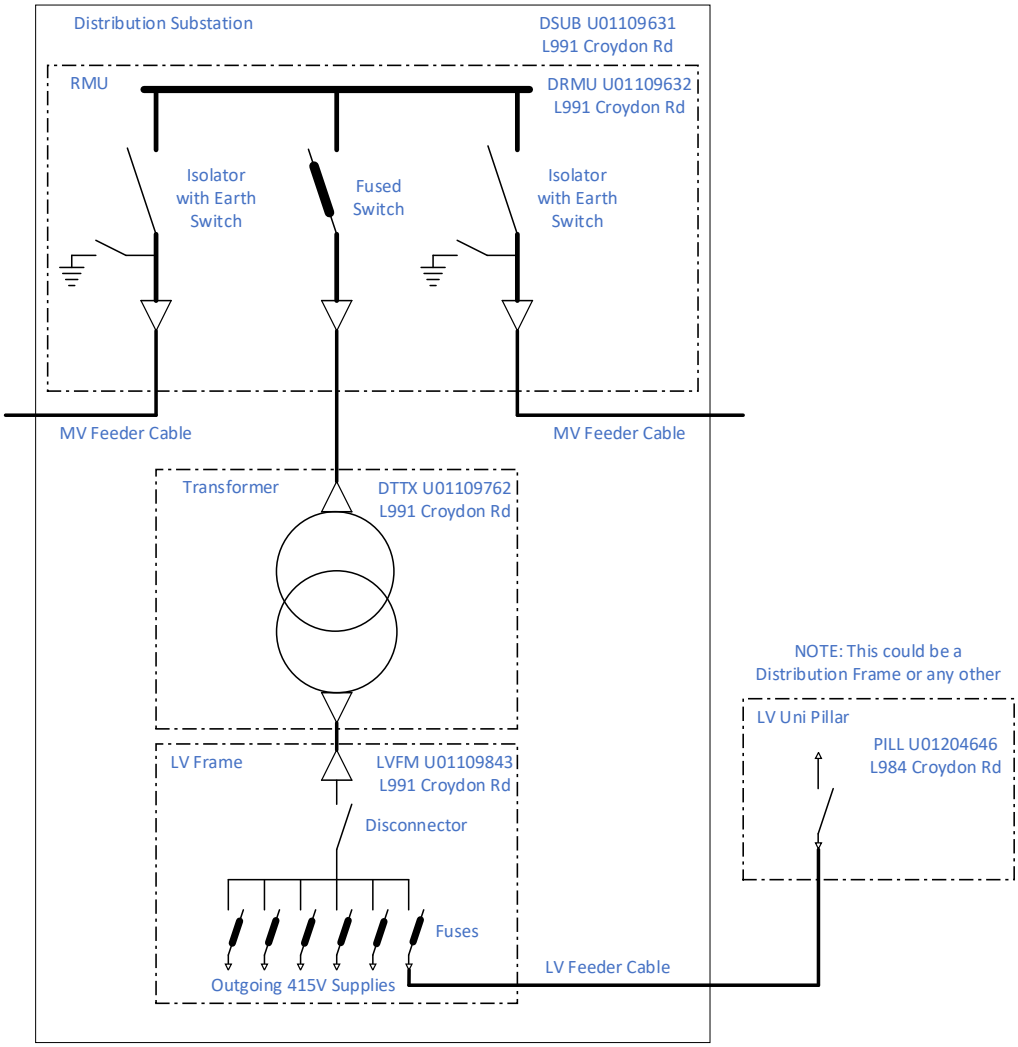
Standard labels size shall be with minimum:

- 50 mm roll width
- 13 mm font size for lines with critical information
- 7 mm font size for other lines.

6 GROUND-MOUNTED SYSTEM EQUIPMENT

All labelling shall be affixed directly to the equipment.

Figure 1 – Schematic Diagram of a typical underground network.



The schematic diagram of a typical underground network has been used to derive the ground-mounted equipment labels including the following:

1) Distribution Substations
2) Distribution Transformers
3) Metering Transformers
4) Voltage Regulators
5) Fault Indicators
6) Ring Main Units (RMU's)
7) HV Switch Disconnector

8) HV Fuse Switch Disconnectors
9) HV Distribution Recloser in Kiosks
10) LV Distribution Frames
11) LV Disconnectors
12) LV Fuse Disconnectors
13) Universal Pillars
14) Mini Pillars
15) Streetlights
16) Wall Mounted Boxes

Labels shall be attached to the equipment as indicated in the following sections.

6.1 Distribution Substations – Ground Mounted

Distribution substations are representative of a group of assets inclusive of a distribution transformer or high voltage switchgear. A substation label shall be used where there is a physical enclosure to which it can be attached. If a non-enclosed distribution substation consists of only ground-mounted assets which are individually identified with a label, then a substation label is not required.

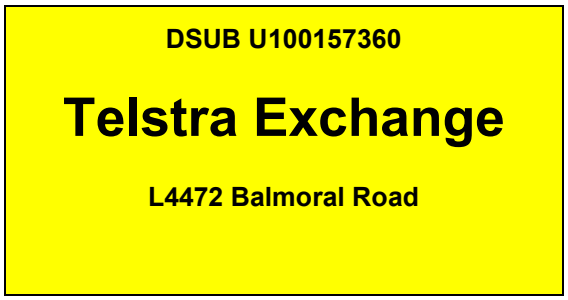
A substation shall be primarily identified with the abbreviation DSUB followed by a system-generated number. In addition, the name of the distribution substation and the location address shall also be included.

Labels for distribution substations shall have a roll width of 50 mm and be of the following format:

Table 1 - Ground mounted substation label format.

Line 1	**[DSUB]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Substation name]**	Text: 13 mm
Line 3	**[Location]**	Text: 7 mm
Line 4	Space	Text: 7 mm

Figure 2 – Distribution Substation label example.



6.1.1 Label Location - Brick Enclosures

Where the substation enclosure has a door, the label shall be fitted at a height of approximately 1.8 m above the finished floor level, on the inside of the door. An additional label may be fitted at a height of approximately 1.8 m above the finished floor level, on the outside of the door.

Where the doors are removable, the label shall be fitted inside the substation, adjacent to the doors and on the same face of the substation as the doors. Alternatively the label may be placed inside the substation at a conspicuous location in full view of the operator.

Figure 3 – Brick enclosure Substation.

6.1.2 Label Location - Non-brick enclosures

This may include cyclone or sheeted perimeter fencing. Where the substation enclosure has a door, the label shall be fitted at a height of approximately 1.8 m above the finished floor level on the outside of the door, otherwise on the outside of the fence. An additional label shall be fitted inside the substation at a conspicuous location in full view of the operator.

6.2 Distribution Transformers – Ground Mounted

A ground-mounted transformer shall be primarily identified with the abbreviation DTTX, followed by a system-generated number. The substation name is displayed in the second line with the location of the transformer in the third line. Details of the supplying asset and location are included in the fourth line.

Labels for ground-mounted distribution transformers shall have a roll width of 50 mm and be of the following format:

Table 2 - Ground mounted distribution transformer label format.

Line 1	**[DTTX]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Substation name]**	Text: 13 mm
Line 3	**[Location]**	Text: 7 mm
Line 4	**[From]** and **[Switch name and Asset name]** for a RMU switch or **[Pole number]** and **[Location]**	Text: 7 mm

Figure 4 – Distribution Transformer label examples.

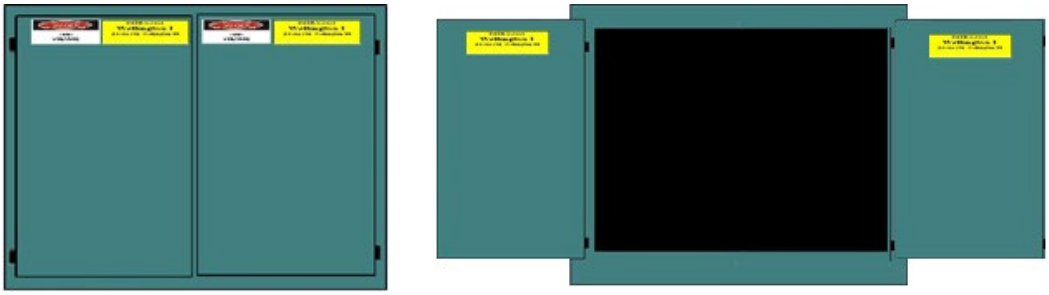
6.2.1 Label Location - Brick buildings, Brick compounds, or Non-brick enclosures

Distribution transformers located in brick buildings, brick compounds, or non-brick enclosures are free standing. There may be more than one transformer in any one substation. As such, the transformer label shall be fitted to the transformer tank, adjacent to the transformer nameplate.

6.2.2 Label Location - Ground Mounted Transformers (standalone)

Access to the nameplate of ground-mounted transformers located inside kiosks is not readily available. Therefore, labels shall be fitted to the inside and outside of the doors to the LV and HV compartments. The label sizes in the figure below are only informative; the proper label sizes shall be used.

Figure 5 – Ground-mounted Transformer label positions.



6.3 Metering Transformer – Ground Mounted

A ground-mounted metering transformer shall be primarily identified with the abbreviation NMTR, followed by the system-generated number. Its name and physical address is also included. In addition to this, the equipment number and location address from which the metering transformer is supplied is also included.

Labels for ground-mounted metering transformers shall have a roll width of 50 mm and be of the following format:

Table 3 - Ground mounted metering transformer label format.

Line 1	**[NMTR]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Substation name]**	Text: 13 mm
Line 3	**[Location]**	Text: 7 mm
Line 4	**[From]** and **[Switch name and Asset name]** for a RMU switch or **[Pole number]** and **[Location]**	Text: 7 mm

Figure 6 – Metering Transformer label example.

The label shall be placed on the front panel of the metering unit, in full view of the operator.

6.4 Voltage Regulator – Ground Mounted

A voltage regulator shall be primarily identified with the abbreviation RETX, followed by the system-generated number. The name is included in the second line and the location of the regulator is included in the third. In addition to this, the details and location from which the regulator is supplied is also included.

Labels for voltage regulators shall have a roll width of 50 mm and be of the following format:

Table 4 - Ground mounted voltage regulator label format.

Line 1	**[RETX]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Name]**	Text: 13 mm
Line 3	**[Location]**	Text: 7 mm
Line 4	**[From:]** and **[Switch name and Asset name]** for a RMU switch or **[Pole number]** and **[Location]**	Text: 7 mm

Figure 7 – Voltage Regulator label example.

The labels shall be placed on the exterior surface of the control panel door and the body of the tank (opposite the control panel but not on the cooling fins).

6.5 Fault Indicator (Relay & Flag Type) – Ground Mounted

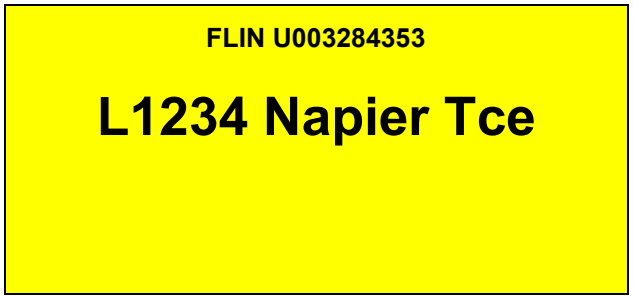
A fault indicator shall be primarily identified with the abbreviation FLIN, followed by a system-generated number. Its physical address is also included.

Labels for fault indicators shall have a roll width of 50 mm and be of the following format:

Table 5 – Ground mounted fault indicator label format.

Line 1	**[FLIN]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	Spare	Text: 7 mm
Line 4	Spare	Text: 7 mm

Figure 8 – Fault Indicator label example.



The label shall be fixed to the fault indicator or placed adjacent to the fault indicator, on the switchgear panel. The following examples in Figures 9.1 & 9.2 illustrate the placement of labels for fault indicators.

Figure 9.1 – 'Relay and Flag' Fault Indicator label example.

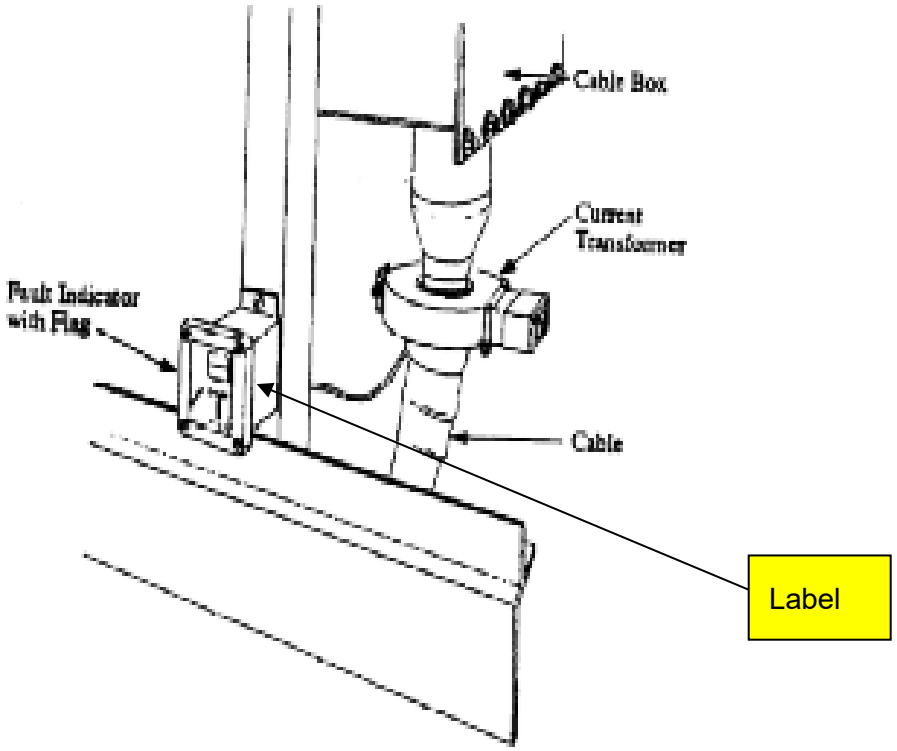
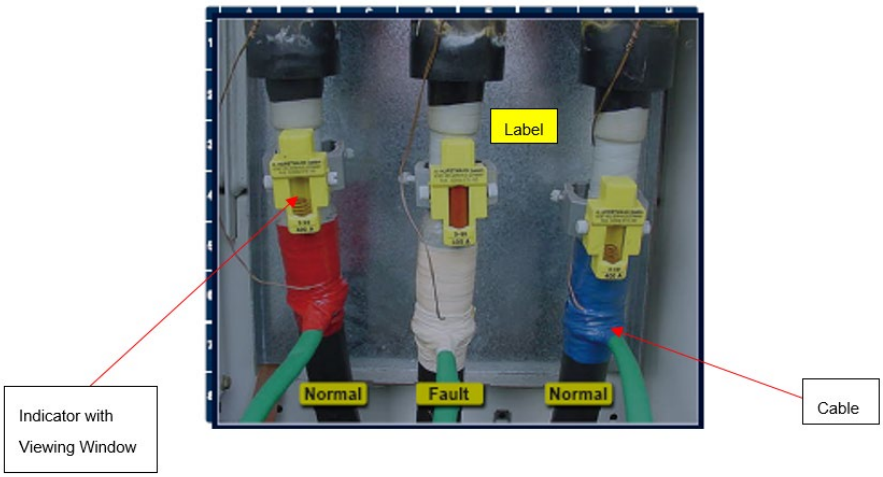


Figure 9.2 – 'Horstmann Fluid type' Fault Indicator label example.



6.6 Ring Main Unit (RMU) – Ground Mounted

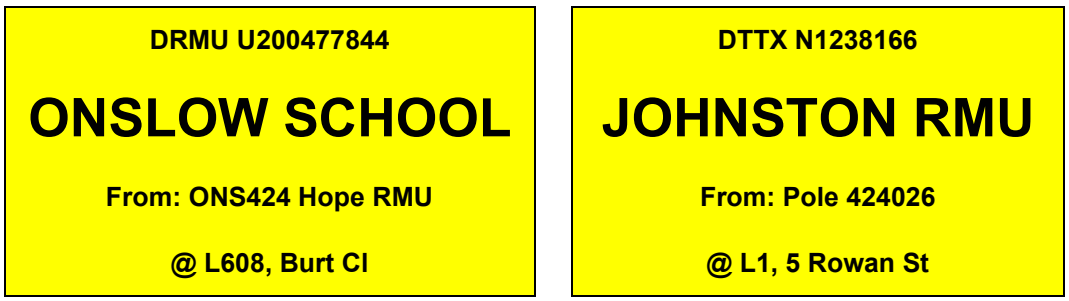
A ring main unit shall contain the abbreviation DRMU followed by a system-generated number for identification with the system. The substation name is shown in the second line and details as well as the location of where the RMU is supplied from shall be included in the third and fourth line to assist operators.

Labels for RMUs shall have a roll width of 50 mm and be of the following format:

Table 6 – Ground mounted RMU label format.

Line 1	**[DRMU]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Substation Name]** (This should not include the equipment abbreviation, but should include the town code if this is used in PoA)	Text: 13 mm
Line 3	**[From:]** and **[Feeder number + Substation name]** for a zone substation or power station, or **[Switch name and Substation name]** for a RMU switch, or **[Pole number]** for a HV cable termination	Text: 7 mm
Line 4	**[Location]**	Text: 7 mm

Figure 10 – RMU label examples.



Labels shall be fixed to the inside and outside of both doors and also on the RMU front panel.

6.7 HV Switch Disconnector – Ground Mounted

A switch disconnector shall contain the abbreviation SWTC followed by a system-generated number for identification with the system. Its name and details of where the switch's cable is connected to shall also be included in order assist operators.

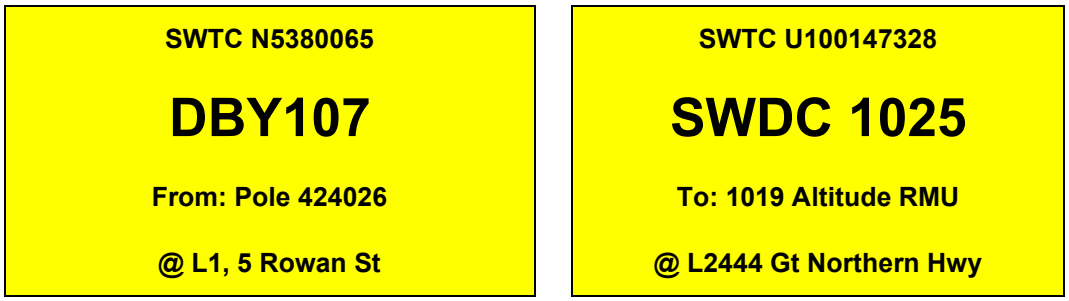
The location of the switch itself is not necessary as this is included in the label for the RMU.

Labels for HV switch disconnectors shall have a roll width of 50 mm and be of the following format:

Table 7 - Ground mounted HV switch disconnector label format.

Line 1	**[SWTC]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Switch name]** Do not include any earth switch details if included in the name, for example *289/ES66* is to be labelled with its name as *SWDC 289*.	Text: 13 mm
Line 3	**[From/To:]** and **[Feeder number + Substation name]** for a zone substation or power station, or **[Switch name and Substation name]** for a RMU switch or **[Pole number]** for a HV cable termination.	Text: 7 mm
Line 4	**[Location]**	Text: 7 mm

Figure 11 – HV Switch Disconnector label examples.



In most cases the label shall be placed on the label placard, or front panel, of the RMU. The examples later in this section illustrate the placement of labels for switch disconnectors.

6.7.1.1 Alstom RMU Label Locations

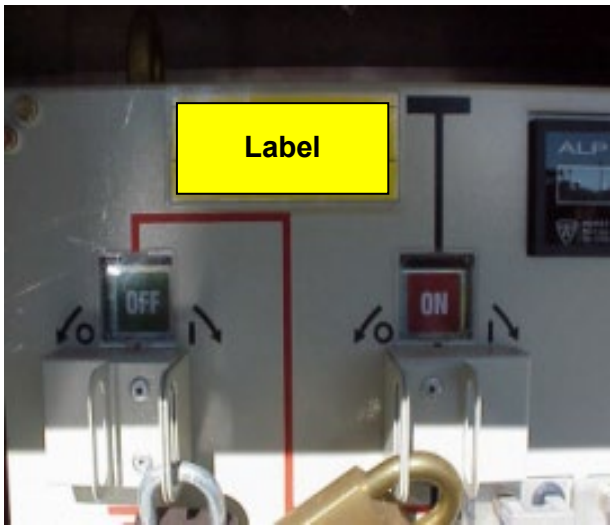
The label shall be placed on the label placard on the front panel of the RMU.

Figure 12 – 'Alstom' RMU label location.

6.7.1.2 F&G RMU Label Locations

The label shall be placed on the label placard of the RMU.

Figure 13 – 'F&G' RMU label location.



6.7.1.3 Merlin Gerin RMU Label Locations

The label shall be placed on the front panel of the RMU, adjacent to the operating mechanism.

Figure 14 – 'Merlin Gerin' RMU label location.

6.7.1.4 Long & Crawford RMU Label Locations

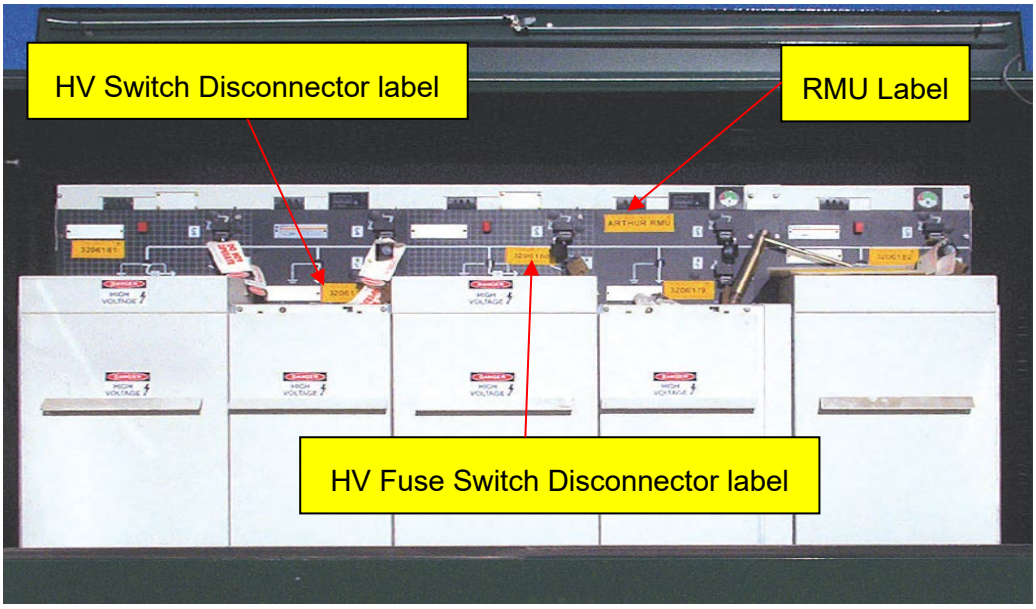
The label shall be placed on the front panel of the RMU, adjacent to the operating mechanism.

Figure 15 – 'Long & Crawford' RMU label location.

6.7.1.5 Schneider RMU Label Locations

The label shall be placed on the front panel of the RMU, in the designated area.

Figure 16 – 'Schneider RM6' RMU label location.



6.8 HV Fuse Switch Disconnector – Ground Mounted

A fuse switch disconnector shall contain the abbreviation FUSW followed by a system-generated number for identification with the system. Its name and details of where the fuse switch's cable is connected to is also included in order assist operators. The location of the fuse switch itself is not necessary as this is included in the label for the RMU.

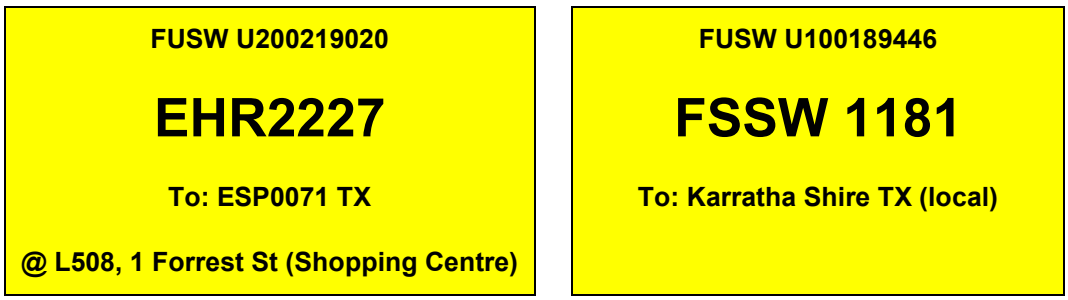
In most cases the label shall be placed on the label placard, or front panel, of the RMU.

Labels for HV fuse switch disconnectors shall have a roll width of the 50 mm and format shall be as follows:

Table 8 - Ground mounted HV switch disconnector label format.

Line 1	**[FUSW]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Fuse switch name]** Do not include any earth switch details if included in the name, for example 290/ES67 is to be labelled with its name as *FSSW 290*.	Text: 13 mm
Line 3	**[To:]** and **[Substation name]** for a transformer or **[Pole number]** for a HV cable termination.	Text: 7 mm
Line 4	**[Location:]**	Text: 7 mm

Figure 17 – HV Fuse Switch Disconnector label examples.



6.9 HV Distribution Recloser in Kiosk – Ground Mounted

A Ground Mounted Recloser Kiosk shall contain the acronym RECL followed by a system-generated number for identification with the system. The name or number of the GMK shall be contained in the second line. In addition, GMK's physical address is included in the third line.

The label shall be placed on the front panel of the GMK.

Labels for Ground Mounted Recloser Kiosk shall have a roll width of the 50 mm and format shall be as follows:

Table 9 – Ground mounted HV Distribution Recloser in a kiosk.

Line 1	**[RECL]** and **[System-generated number]**	Text 7 mm
Line 2	**[GMK RECLOSER]** and **[Number]**	Text 13 mm
Line 3	**[Location]**	Text 7 mm
Line 4	Spare	Text 7 mm

Figure 18 – HV Distribution Recloser label example.

Figure 19 – HV Distribution Recloser label location.

6.10 LV Distribution Frame – Ground Mounted

A low voltage distribution frame, shall be identified with the abbreviation LVFM, followed by a system-generated number. Its physical address is also included.

In most cases, labels shall be placed on the centre of both sides of each door.

Labels for LV distribution frames shall have a roll width of 50 mm and be of the following format:

Table 1 – Ground mounted LV distribution frame label format.

Line 1	**[LVFM]** and **[System-generated number]** and **[Substation Name]** if applicable	Text: 13 mm
Line 2	**[Location]** (Location to be included only if the LV kiosk is not located within a substation site.)	Text: 7 mm
Line 3	**[From:]** and **[Circuit Number + Substation name]** for a distribution substation or **[Abbreviation + system-generated number]** for universal pillars standalone frames or **[Pole number]** for a LV cable termination.	Text: 7 mm
Line 4	**[Location:]**	Text: 7 mm

Figure 20 – LV Distribution Frame label examples.

6.10.1.1 LV Distribution Frames in Kiosks, Label Locations

Where a distribution frame is located within a kiosk, labels shall be placed on the inside and outside of the kiosk door. The labels shall be placed on the centre of the door.

6.10.1.2 LV Distribution Frames in Wall Mounted Feeder Pillars, Label Locations

Where a distribution frame is located in wall-mounted boxes, labels shall be placed on the inside and outside of the kiosk door. The labels shall be placed in the centre of the door.

6.10.1.3 Freestanding LV Distribution Frames in Substations, Label Locations

Where a distribution frame is located in a substation and is freestanding, the label shall be fixed to the distribution frame and also placed on the inside of the substation door, at a height of approximately 1.5 m above the finished floor level and located just below the substation label. If more than one LV Frame exists in the substation, then each label must be fixed to the appropriate distribution frame.

6.11 LV Disconnector – Ground Mounted

A LV disconnector shall be primarily identified with the abbreviation LVDI, followed by a system-generated number for identification with the system. Its physical address is not necessary as this shall be included in the label for the LV frame or Modular Package Substation transformer kiosk. The circuit number as well as details of the connected asset of the outgoing cable shall be included to assist operators.

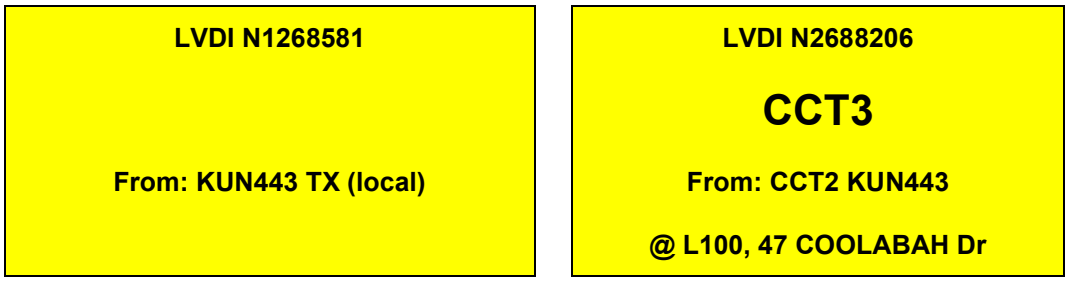
In most cases the label shall be placed on the transformer disconnector label placard or on the disconnector panel. More specific details for label placements are given later in this section.

Labels for LV disconnectors in ground-mounted equipment shall have a roll width of 50 mm and be of the following format:

Table 11 - Ground mounted LV disconnector label format.

Line 1	**[LVDI]** and **[System-generated number]**	Text: 4 mm
Line 2	**[Circuit number]** (This line is not required for LV disconnectors used as a transformer isolator)	Text: 6 mm
Line 3	**[From/To:]** and **[Circuit Number + Substation Name]** for substations or **[Abbreviation + system-generated number]** for pillars or standalone frames, or **[Customer Switchboard Name]** for consumer mains.	Text: 4 mm
Line 4	**[Location:]**	Text: 4 mm

Figure 21 – LV Disconnector label examples.



6.11.1.1 Pronutec Disconnector

The label shall be placed on the disconnector top space, as shown:

Figure 22 – 'Pronutec' LV Disconnector label location.

6.11.1.2 ABB Isolator (Disconnector) Label Location

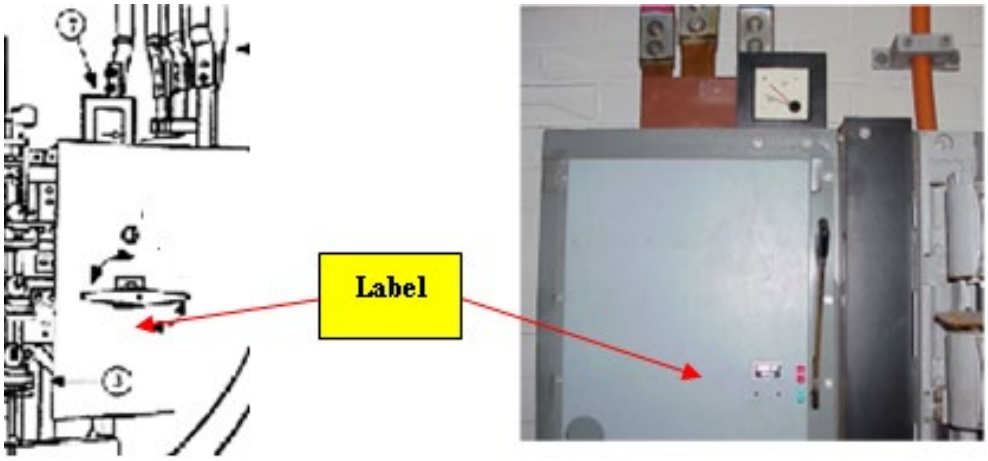
The label shall be placed on the transformer disconnector label placard, as shown:

Figure 23 – 'ABB' LV Disconnector label location.

6.11.1.3 Lever Operated Isolator (Disconnectors) Label Location

The label shall be placed on the transformer disconnector panel, as shown:

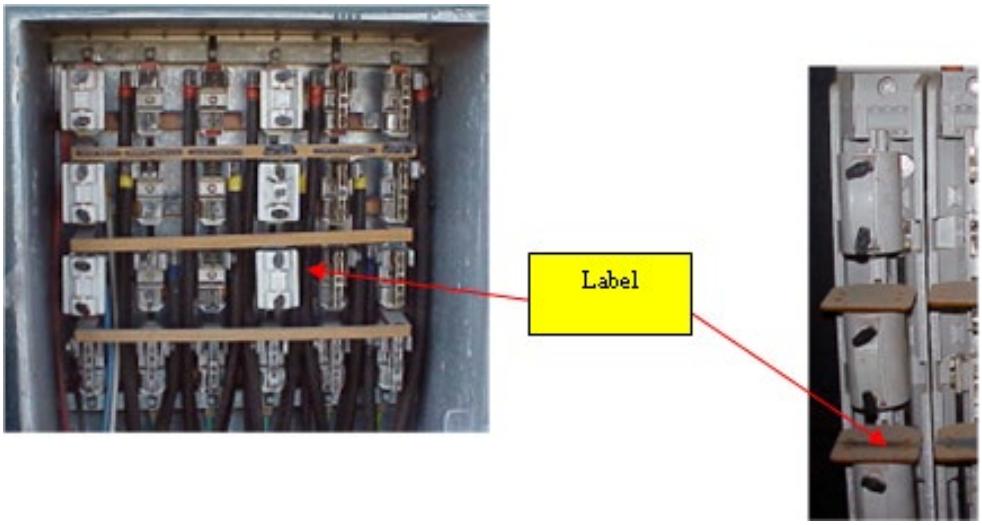
Figure 24 – 'Level Operated' LV Isolator label location.



6.11.1.4 Extractable Links Label Location

The label shall be placed on the middle transformer disconnector label placard, as shown.

Figure 25 – 'Extractable' Links label location.



6.12 LV Fuse Disconnector – Ground Mounted

A low voltage fuse disconnector shall be primarily identified with the abbreviation FDIS, followed by a system-generated number for identification with the system. The circuit number (fuse ways numbered from left to right) and also the 'to/from' information for the terminated cable is included to assist operators.

In most cases the label shall be placed on the label placard provided with the LV fuse disconnector. Examples of label locations are provided later in this section.

The format of the label shall be of the table below:

Table 12 - Ground mounted LV fuse disconnector label format.

Line 1	**[FDIS]** and **[System-generated number]**	Text: 4 mm
Line 2	**[Circuit number]**	Text: 6 mm
Line 3	**[To:]** and **[Abbreviation + system-generated number]** for pillars or stand-alone frames, or **[Customer Switchboard]** for consumer mains.	Text: 4 mm
Line 4	**[Location:]**	Text: 4 mm

Figure 26 – LV Fuse Disconnector label examples.

FDIS N1268584 **CCT2** **To: POST OFFICE** **@ L2227, 89 COOLABAH Dr**	**FDIS N1268613** **CCT1** **To: PILL S455055** **@ L560, 106 COOLABAH Dr**

6.12.1.1 Pronutec Fuse Switch Label Location

The label shall be placed on the fuseswitch disconnector label placard, as shown.

Figure 27 – 'Pronutec' Fuse Switch label location.

6.12.1.2 ABB Fuse Switch Label Location

The label shall be placed on the fuse switch disconnector label placard, as shown.

Figure 28 – 'ABB' Fuse Switch label location.

6.13 Universal Pillar – Ground Mounted

A universal pillar shall be primarily identified with the abbreviation PILL, followed by a system-generated number for identification with the system. Its physical address shall be given in the second line. The physical addresses of the equipment in which any LV mains cable is connected to are also included to assist operators.

The lid of the universal pillar displays the words 'HORIZON POWER - DANGER ELECTRICAL CABLES' as per specification - 'Low Voltage Underground Distribution Pillars'.

Labels for universal pillars shall have a roll width of 50 mm and be of the format below:

Table 13 – Ground mounted universal pillar label format.

Line 1	**[PILL]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[Top:]** and **[Abbreviation + system-generated number]** for pillars or stand-alone frames, or **[Circuit Number + Substation name]** for a distribution substation or **[Pole Number]** and **[Location]**	Text: 7 mm
Line 4	**[Bottom]** and **[Abbreviation + system-generated number]** for pillars or stand-alone frames, or **[Circuit Number + Substation name]** for a distribution substation or **[Pole Number]** and **[Location]** for both left and right bars if applicable.	Text: 7 mm

Figure 29 – Universal Pillar label examples.

PILL U100181045

L164, 19 Withnell Wy

Top: L170, 33 Richardson Wy

Bottom L: Withnell TX – R: L163, @ 17 Withnell Wy

PILL S2241244

L18, 20 William St

Top: Pole 581047 @ William St

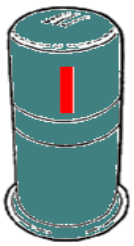
Bottom L: Local pillar - R: Pole 581930 @ Windich St

Figure 30 – Universal Pillar label locations.

The label shall be placed on the top of the orange plastic covering, located inside the universal pillar. If preferred an additional label can be placed on the exterior of the universal pillar facing an area where it will be best visible, preferably on the road side of the pillar.

In addition, universal pillars functioning as normally-open points shall have a reflective red 'I' marking on the outer case of the pillar lid, to indicate the open point status. As open points are changed, the lid with the 'I' marking may move with the open point. The marking shall be placed on the roadside of the pillar. This marking is shown in the following diagram:

Figure 31 – Universal Pillar with Normally-Open point marked with 'I'.



Where required, and where the universal pillar has a LV disconnector or LV fuse disconnector fitted, a label may be fitted for these items as per Clause 6.13 and 6.14.

6.14 Mini Pillar – Ground Mounted

The lid of the mini pillar displays the words 'HORIZON POWER - DANGER ELECTRICAL CABLES'.

A mini pillar shall be primarily identified with the abbreviation PILL, followed by a system-generated number for identification with the system. The pillar's physical address is included in the second line.

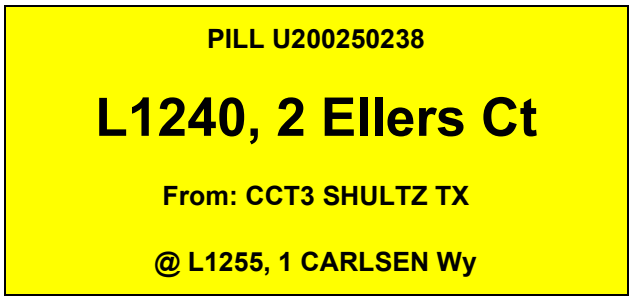
For pillars of an LV circuit supplied by an underground transformer, the supplying transformer name, circuit number and address shall be displayed on the third and fourth lines to assist operators.

Labels for mini pillars shall have a roll width of 50 mm and where the pillar is supplied by a ground-mounted transformer, the format of the label shall be that of the table below:

Table 14 – Ground mounted mini pillar label format for underground systems.

Line 1	**[PILL]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[From:]** and **[Circuit Number + Substation name]** for the distribution substation.	Text: 7 mm
Line 4	**[Location:]**	Text: 7 mm

Figure 32 – Mini Pillar label for LV circuit with ground-mounted transformer example.



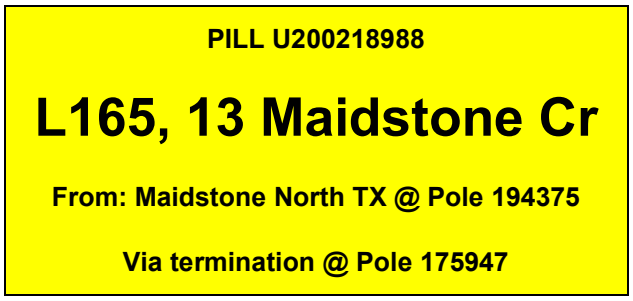
For mini pillars of an LV circuit supplied by a pole-mounted transformer, the transformer name and pole number shall be displayed in the third line to assist operators. The final line shall contain the pole number at which the LV section connects to the overhead network.

Where the pillar is supplied by a pole-mounted transformer, the format of the label shall be that of the table below:

Table 15 – Ground mounted mini pillar label format for overhead systems.

Line 1	**[PILL]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[From:]** supplying transformer **[Name]** and **[Pole Number]**	Text: 7 mm
Line 4	**[VIA]** cable termination **[Pole number]**	Text: 7 mm

Figure 33 – Mini Pillar label for LV network with pole-mounted transformer example.



The label shall be placed on the exterior of the pillar facing an area where it will be best visible, preferably on the road side of the pillar.

6.15 Streetlight Poles & Luminaires – Ground Mounted

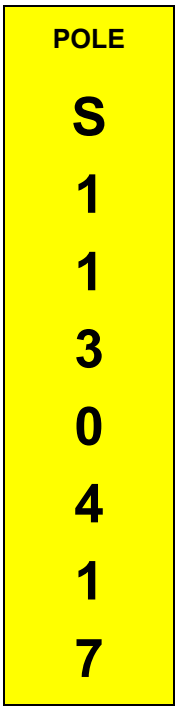
A streetlight standard pole is to be primarily identified with the abbreviation POLE, followed by a system-generated number shown vertically. The label shall be affixed to the pole at a height of 1.8 metres.

Labels for streetlight poles and shall have a roll width of 50 mm and be that of the format below:

Table 16 – Ground mounted streetlight pole label format.

Line 1	**[POLE]**	Text: 7 mm
Line 2	**[System-generated number]** (shown vertically)	Text: 13 mm

Figure 34 – Streetlight Pole label example.



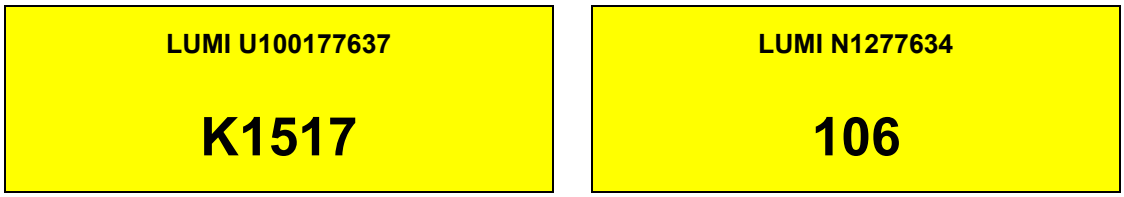
Luminaire numbers on the streetlight pole may also be included as a separate label, these are to include the abbreviation LUMI followed by a system-generated number in the first line. The second line shall contain the streetlight number if available. Luminaire labels shall be affixed to the pole beneath the pole label.

The label format for a streetlight pole label shall be that of the table below:

Table 17 – Ground mounted streetlight luminaire label format.

Line 1	**[LUMI]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Luminaire number]**	Text: 13 mm

Figure 35 – Streetlight Luminaire label examples.



6.16 Wall Mounted Box – Ground Mounted

A wall-mounted box shall be primarily identified with the abbreviation PILL, followed by a system-generated number for identification with the system. The pillar's physical address is included in the second line.

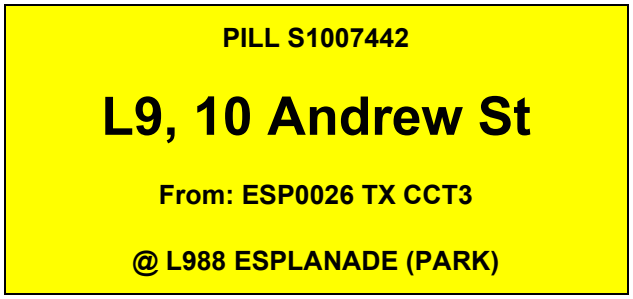
For wall-mounted boxes of an LV circuit supplied by an underground transformer, the supplying transformer name, circuit number and address shall be displayed on the third line to assist operators. The fourth line may be used for additional information such as upstream isolation point details etc. if preferred.

Where the wall-mounted box is supplied by a ground-mounted transformer, the format of the label shall be that of the table below:

Table 18 – Ground mounted wall mounted box label format for underground systems.

Line 1	**[PILL]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[From:]** supplying transformer **[Substation name]** and **[Circuit Number]**	Text: 7 mm
Line 4	**[Location:]**	Text: 7 mm

Figure 36 – Wall-mounted box label for LV circuit with ground-mounted transformer example.



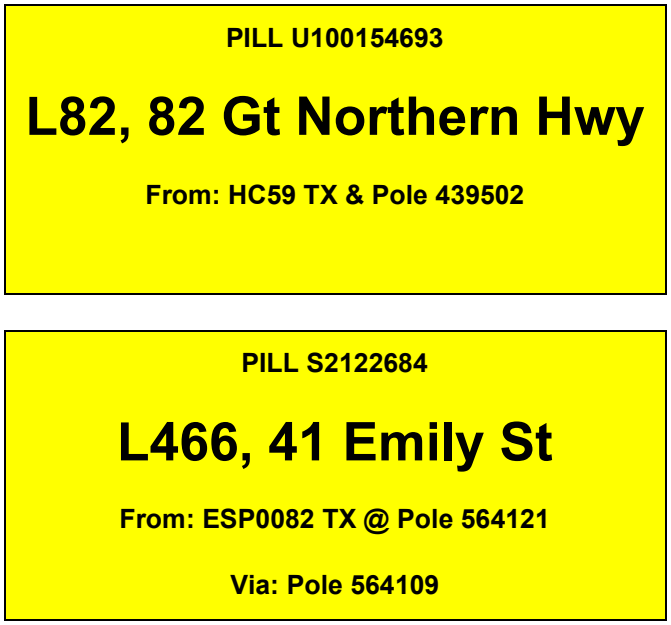
For wall-mounted boxes of an LV circuit supplied by an overhead transformer, the transformer name, pole number and pole location shall be displayed in the third line to assist operators. If the LV underground section terminates to a pole that is not shared by the supplying transformer, then this pole may be labelled in the fourth line. The pole number shall be the rural or short plant ID whichever is considered easiest to locate and identify for the pole.

Where the wall-mounted box is supplied by an overhead transformer, the format of the label shall be that of the table below:

Table 19 – Ground mounted wall mounted box label format for overhead systems.

Line 1	**[PILL]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[From:]** supplying **[Substation name]** and **[Pole Number]**	Text: 7 mm
Line 4	**[VIA]** cable termination @ **[Pole number]**	Text: 7 mm

Figure 37 – Wall-mounted box label for LV circuit with pole-mounted transformer examples.



7 UNDERGROUND EQUIPMENT

Underground equipment generally does not have visibility of individual items from above ground.

Labelling shall have two components, one of the individual components within the underground portion and one allowing easy identification from above the ground.

This covers the following equipment:

1) Un-metered supply pit
2) Underground cables
3) Underground supply pit

7.1 Un-metered Supplies

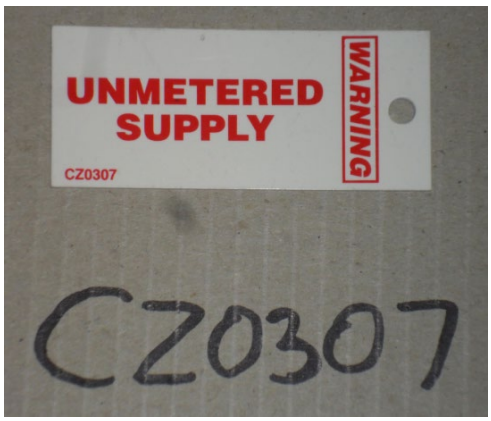
7.1.1 Pits

The concrete lid of the un-metered supply pit indicates the Horizon Power and customer cables as per standard – 'Un-Metered Supply Standard'. Main power fuse inside the pit shall be tagged with a label "Unmetered Supply" – Stock Item No: CZ0307. No other labels are fixed to LV un-metered supply pits.

7.1.2 Pillars

The un-metered supply cable from a mini pillar shall be tagged with a label "Unmetered Supply" – Stock Item No: CZ0307.

Figure 38 – Unmetered Supply label example.



7.2 Underground Cables

In some cases a label displaying the words 'Horizon Power – DANGER – Underground Electrical Cables in the Vicinity' may be required (ref Horizon Power manuals 'Underground Distribution Schemes', 'Single Phase Underground Rural Supply', and 'Single Phase Underground Distribution System'. This label is commonly placed on a marker post, in close proximity to the cable.

No other labelling shall be fixed to underground cables.

7.3 Underground Supply Pit

The concrete lid of the underground supply pit displays the words 'HORIZON POWER - DANGER ELECTRICAL CABLES'.

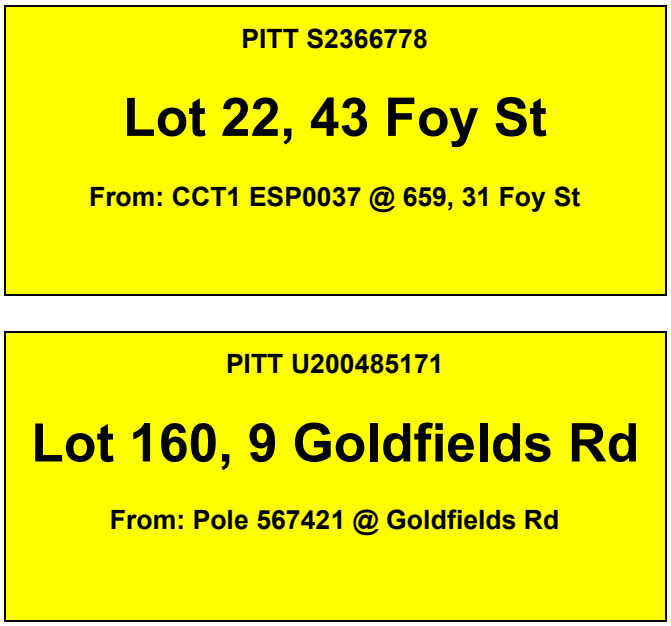
An underground supply pit shall be primarily identified with the abbreviation PITT followed by a system-generated number.

For an underground supply pit, the format of the label shall be that of the table below:

Table 20 - Underground supply pit label format.

Line 1	**[PITT]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Location]**	Text: 13 mm
Line 3	**[From:]** and **[Abbreviation + system-generated number]** for pillars or stand-alone frames, o**r** **[Circuit Number + Substation name]** for a distribution substation, or **[Pole Number]** and **[Location]**	Text: 7 mm
Line 4	**[To:]** and **[Abbreviation + system-generated number]** for pillars or stand-alone frames, or **[Circuit Number + Substation name]** for a distribution substation or **[Pole Number]** and **[Location]**	Text: 7 mm

Figure 39 – Underground Supply Pit label examples.



The label shall be tagged on to the neutral of the incoming cable, or neutral connector.

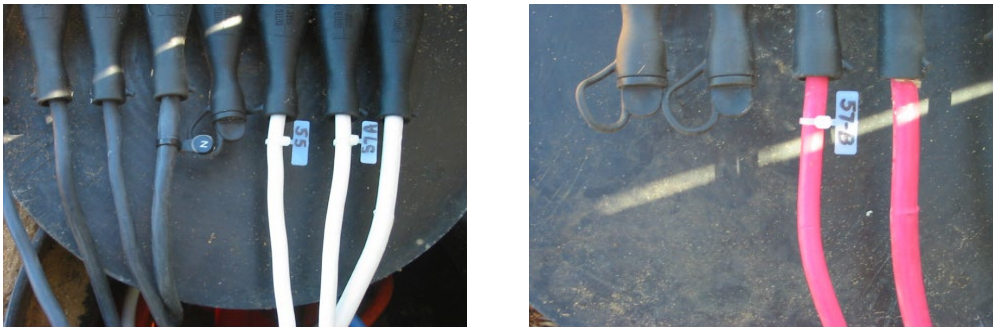
7.3.1 Consumer Service Cable ID Tag

The tag shall be used to identify consumer services within underground pits and pillars.

Single phase services are tagged on the phase of the service cable with the corresponding house number clearly marked on the tag using a permanent marker pen.

Three phase services are tagged on the red phase of the service cable and similarly the house number is included on the tag.

Figure 40 – Consumer Service Cable ID Tag label examples.



8 OVERHEAD SYSTEM EQUIPMENT

This section covers the following equipment:

1) Poles
2) Pole Top Switches
3) Drop Out Fuses
4) Fusesavers
5) Distribution Transformers
6) Load Break Switches
7) Reclosers
8) HV Disconnectors
9) LV Disconnectors
10) LV Fuse Disconnectors
11) Sectionalisers
12) Metering Transformers
13) Fault Indicators
14) Voltage Regulators
15) Capacitor Banks
16) Reactors
17) Streetlights

8.1 Poles

8.1.1 Warning sign for poles with high voltage

High Voltage poles require the fitting of a ‘HORIZON POWER DANGER HIGH VOLTAGE’ warning sign (stock number CZ0230).

The sign shall be positioned directly on the pole surface. The label shall be positioned approximately to 1.8 m above ground level and located for viewing on the best approachable side of the pole.

Figure 41 – Warning label for poles with high voltage.

8.1.2 Pole Labelling

Where the surface of the pole is not appropriate to fix a sign or label, the label may be affixed to a plate (stock item no: CZ5005) and the plate shall be fixed to the pole surface using silicon sealant, Sikaflex sealant or liquid nails.

Figure 42 – Label plate CZ5055.

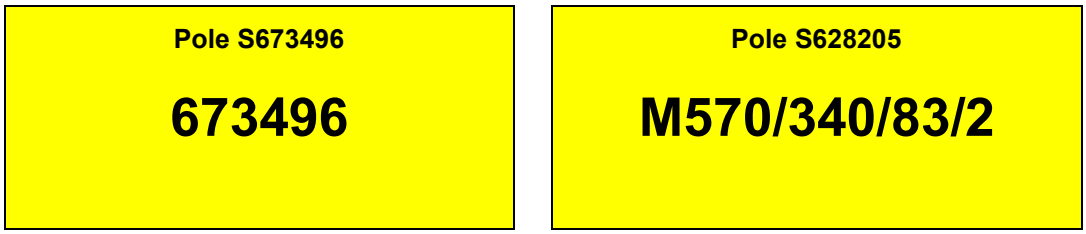
A pole is to be primarily identified with the abbreviation POLE, followed by a system-generated number. The pole number shall be placed either in a vertical or horizontal position appropriate for the type of pole and the surface area. If the rural number of a pole is large and does not fit it one line, multiple lines may be used with the final line having 13 mm font.

Labels for poles shall have a roll width of 50 mm and when labelled horizontally, the format shall be of that the table below:

Table 21 - Pole label horizontal format.

Line 1	**[POLE]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Pole Number]**	Text: 13 mm

Figure 43 – Distribution pole horizontal label examples.

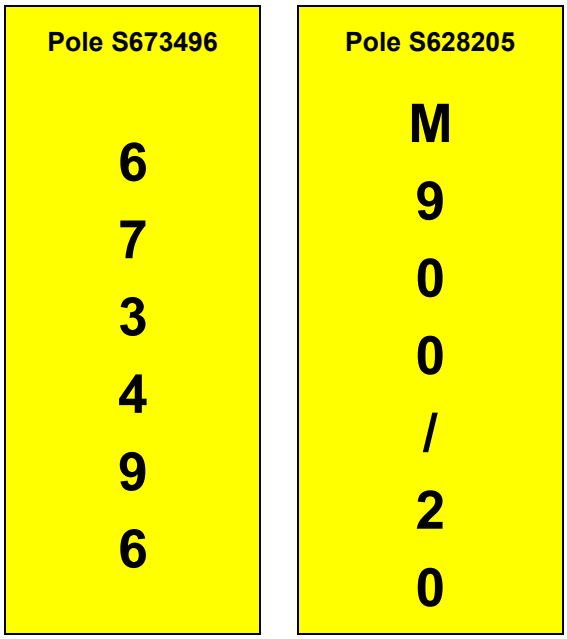


When labelled vertically, the format shall be of the table below:

Table 22 - Pole label vertical format.

Line 1	**[POLE]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Pole Number]** (displayed vertically)	Text: 13 mm

Figure 44 – Distribution pole horizontal label examples.



8.1.3 Pole Equipment Label Positioning

Pole equipment labels shall be attached to the danger plate below the pole label or to the pole below the danger plate.

8.2 Pole Top Switch

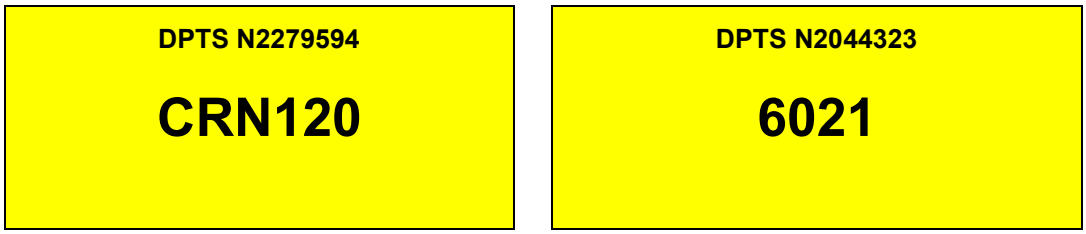
Pole top switches shall be labelled with the acronym DPTS followed by a system-generated number for identification with the system. The name or number of the switch shall be contained in the second line.

Labels for pole top switches shall have a roll width of 50 mm and the format shall be that of the table below:

Table 23 - Pole top switch label format.

Line 1	**[DPTS]** and **[System-generated number]**	Text: 7 mm
Line 2	Switch **[Name]** or **[Number]**	Text: 13 mm

Figure 45 – Pole Top Switch label examples.



8.3 Drop Out Fuse

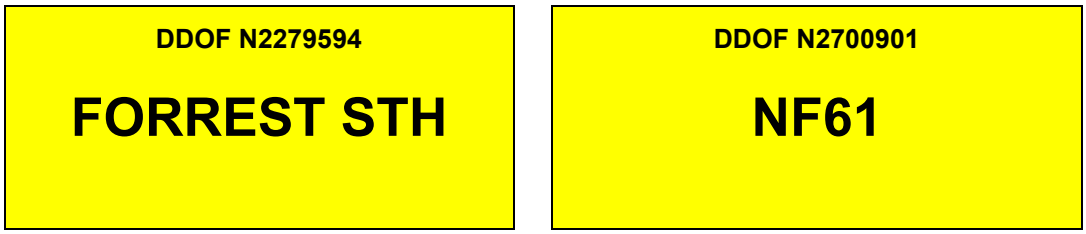
Drop-out fuses may be labelled with the acronym DDOF followed by a system-generated number for identification with the system. The name or number of the drop out fuse/s shall be contained in the second line.

Labels for drop out fuses shall have a roll width of 50 mm and the format shall be that of the table below:

Table 24 - Drop out fuse label format.

Line 1	**[DDOF]** and **[System-generated number]**	Text: 7 mm
Line 2	Drop out fuse **[Name]** or **[Number]**	Text: 13 mm

Figure 46 – Drop Out Fuse label examples.



8.4 Fusesaver

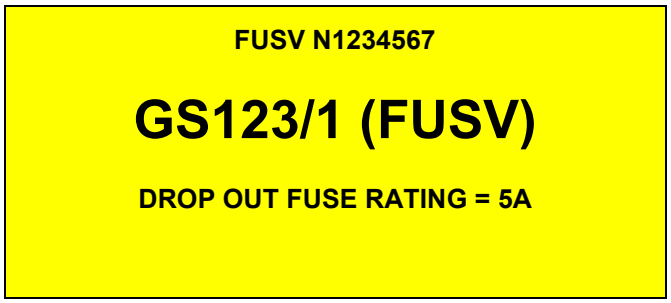
Fusesavers may be labelled with the acronym FUSV followed by a system-generated number for identification with the system. The name of the fusesaver associated with the area spur name and pole number shall be contained in the second line. The third line shall contain the drop out fuse rating.

Labels for fusesavers shall have a roll width of 50 mm and the format shall be that of the table below:

Table 25 - Fusesaver label format.

Line 1	**[FUSV]** and **[System-generated number]**	Text: 7 mm
Line 2	Fusesaver **[Name]**	Text: 13 mm
Line 3	**[DROP OUT FUSE RATING =]** insert DOF rating **[A]**	Text: 7 mm

Figure 47 – Fusesaver label example.



8.5 Distribution Transformer – Pole Mounted

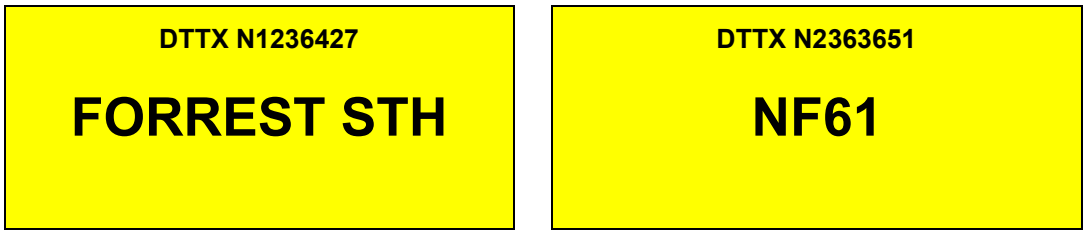
Distribution transformers shall be labelled with the acronym DTTX followed by a system-generated number for identification with the system. The name of the distribution transformer shall be contained in the second line. If the rural number of a pole is used for the transformer name and this number is large, multiple lines may be used with the final line having 13 mm font.

Labels for pole mounted distribution transformer shall have a roll width of 50 mm and the format shall be that of the table below:

Table 26 - Pole mounted distribution transformer label format.

Line 1	**[DTTX]** and **[System-generated number]**	Text: 7 mm
Line 2	Transformer **[Name]**	Text: 13 mm

Figure 48 – Pole-mounted Distribution Transformer label examples.



8.6 Load Break Switch

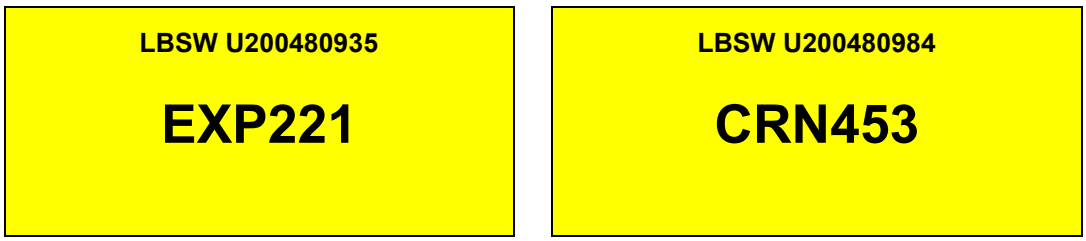
Load break switches shall be labelled with the acronym LBSW followed by a system-generated number for identification with the system. The name or number of the load-break switch shall be contained in the second line.

Labels for load break switches shall have a roll width of 50 mm and the format shall be that of the table below:

Table 27 - Load break switch label format.

Line 1	**[LBSW]** and **[System-generated number]**	Text: 7 mm
Line 2	Load Break Switch **[Number]**	Text: 13 mm

Figure 49 – Load Break Switch label examples.



8.7 Recloser

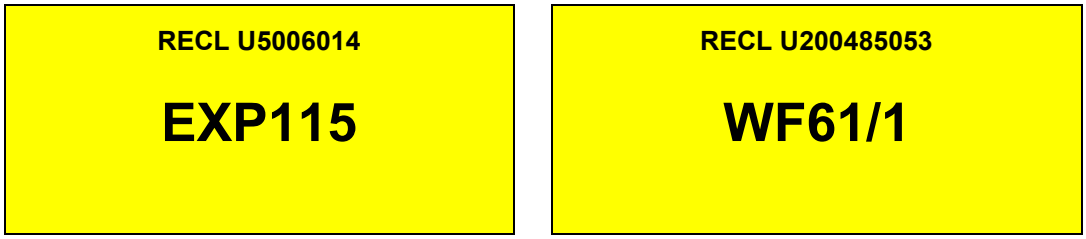
Reclosers shall be labelled with the acronym RECL followed by a system-generated number for identification with the system. The name or number of the recloser shall be contained in the second line.

Labels for reclosers shall have a roll width of 50 mm and the format shall be that of the table below:

Table 28 - Recloser label format.

Line 1	**[RECL]** and **[System-generated number]**	Text: 7 mm
Line 2	Recloser **[Number]**	Text: 13 mm

Figure 50 – Recloser label examples.



8.8 HV Disconnector – Pole Mounted

HV disconnector may be labelled with the acronym HVDI followed by a system-generated number for identification with the system. The name or number of the HV disconnector shall be contained in the second line.

Labels for pole-mounted HV disconnector shall have a roll width of 50 mm and the format shall be that of the table below:

Table 29 - Pole mounted HV disconnector label format.

Line 1	**[HVDI]** and **[System-generated number]**	7 mm
Line 2	HV disconnector switch **[Number]**	13 mm

Figure 51 – HV Disconnector label example.

8.9 LV Disconnector – Pole Mounted

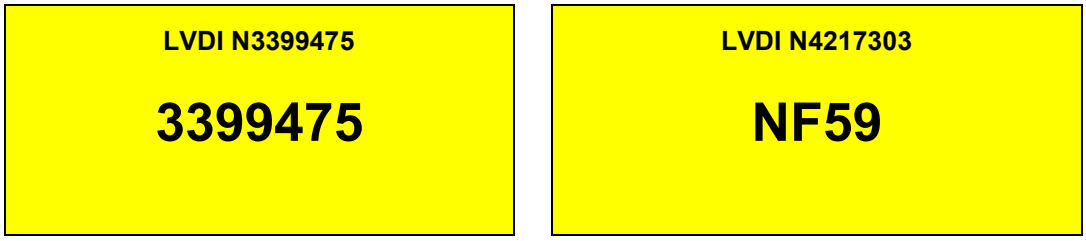
LV disconnectors may be labelled with the acronym LVDI followed by a system-generated number for identification with the system. The name of the LV disconnector shall be contained in the second line.

Labels for pole-mounted LV disconnectors shall have a roll width of 50 mm and the format shall be that of the table below:

Table 30 - Pole mounted LV disconnector label format.

Line 1	**[LVDI]** and **[System-generated number]**	Text: 7 mm
Line 2	**[Name]**	Text: 13 mm

Figure 52 – LV Disconnector label examples.



8.10 LV Fuse Disconnector – Pole Mounted

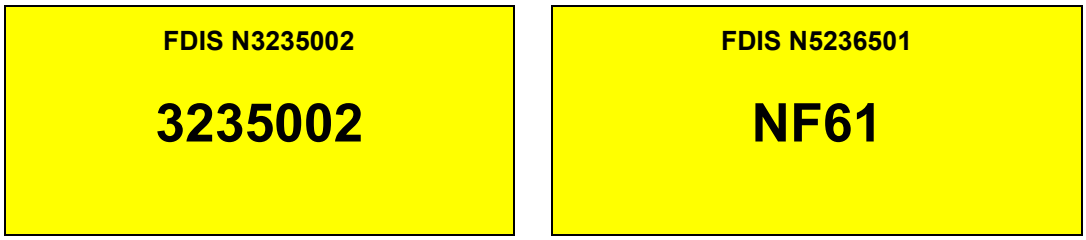
LV fuse disconnectors may be labelled with the acronym FDIS followed by a system-generated number for identification with the system. The name or number of the LV fuse disconnector shall be contained in the second line.

Labels for pole-mounted LV fuse disconnectors shall have a roll width of 50 mm and the format shall be that of the table below:

Table 31 - Pole mounted LV fuse disconnector label format.

Line 1	**[FDIS]** and **[System-generated number]**	Text: 7 mm
Line 2	LV fuse disconnector **[Name]** or **[Number]**	Text: 13 mm

Figure 53 – LV Fuse Disconnector label examples.



8.11 Sectionaliser

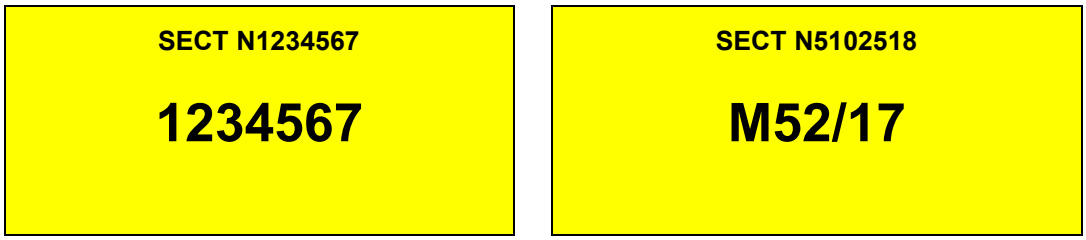
Sectionalisers may be labelled with the acronym SECT followed by a system-generated number for identification with the system. The name or number of the HV disconnector shall be contained in the second line followed by the location or pole rural number if available in the third line.

Labels for pole-mounted sectionalisers shall have a roll width of 50 mm and the format shall be that of the table below:

Table 32 - Sectionaliser label format.

Line 1	**[SECT]** and **[System-generated number]**	Text: 7 mm
Line 2	Sectionaliser **[Name]** or **[Number]**	Text: 13 mm

Figure 54 – Sectionaliser label examples.



8.12 Metering Transformer – Pole Mounted

Metering transformers shall be labelled with the acronym NMTR followed by a system-generated number for identification with the system. The name of the metering transformer shall be contained in the second line, and the location in the third.

Labels for pole-mounted metering transformers shall have a roll width of 50 mm and the format shall be that of the table below:

Table 33 - Pole mounted metering transformer label.

Line 1	**[NMTR]** and **[System-generated number]**	Text: 7 mm
Line 2	Metering Transformer **[Name]** or **[Number]**	Text: 13 mm
Line 3	**[Location]**	Text: 7 mm

Figure 55 – Metering Transformer label example.

8.13 Fault Indicator – Pole Mounted

Fault indicators may be labelled with the acronym FLIN followed by a system-generated number for identification with the system. The name or number of the fault indicator shall be contained in the second line.

Labels for pole-mounted fault indicators shall have a roll width of 50 mm and the format shall be that of the table below:

Table 34 - Pole mounted fault indicator label format.

Line 1	**[FLIN]** and **[System-generated number]**	Text: 7 mm
Line 2	Fault indicator **[Name]** or **[Number]**	Text: 13 mm
Line 3	**[Location]** or **[Rural number]** if available	Text: 7 mm

Figure 56 – Fault Indicator label example.

8.14 Voltage Regulator – Pole Mounted

Voltage regulators shall be labelled with the acronym RETX followed by a system-generated number for identification with the system. The name of the fault indicator shall be contained in the second line.

Labels for pole-mounted voltage regulators shall have a roll width of 50 mm and the format shall be that of the table below:

Table 35 - Pole mounted voltage regulator.

Line 1	**[RETX]** and **[System-generated number]**	Text: 7 mm
Line 2	Voltage regulator **[Name]**	Text: 13 mm

Figure 57 – Voltage Regulator label example.

8.15 Capacitor Bank

Capacitor banks shall be labelled with the acronym CAPT followed by a system-generated number for identification with the system. The name of the capacitor bank shall be contained in the second line.

Labels for capacitor banks shall have a roll width of 50 mm and the format shall be that of the table below:

Table 36 - Capacitor bank label format.

Line 1	**[CAPT]** and **[System-generated number]**	Text: 7 mm
Line 2	Capacitor bank **[Name]**	Text: 13 mm

Figure 58 – Capacitor Bank label example.

8.16 Reactor – Pole Mounted

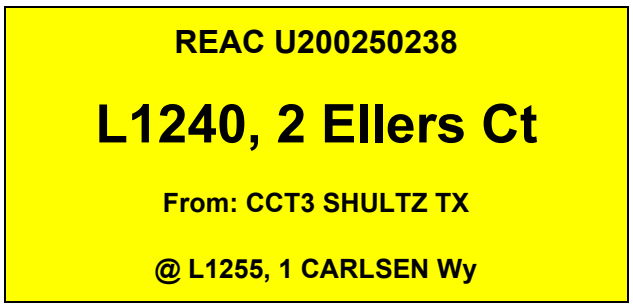
Reactors shall be labelled with the acronym REAC followed by a system-generated number for identification with the system. The name or number of the reactor shall be contained in the second line.

Labels for pole-mounted reactors shall have a roll width of 50 mm and the format shall be that of the table below:

Table 37 - Pole mounted reactor label format.

Line 1	**[REAC]** and **[System-generated number]**	Text: 7 mm
Line 2	Capacitor bank **[Name]** or **[Number]**	Text: 13 mm

Figure 59 – Reactor label example.



8.17 Luminaries – Pole Mounted

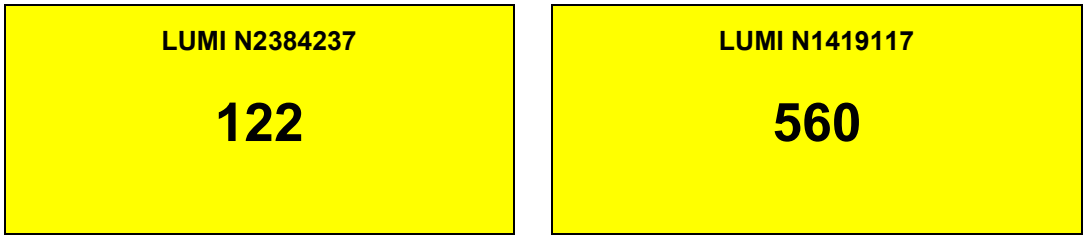
Pole-mounted luminaires shall be labelled with the abbreviation LUMI, followed by a system-generated number. The streetlight number shall be contained in the second line.

Labels for pole-mounted luminaires shall have a roll width of 50 mm and the format shall be that of the table below:

Table 38 - Pole mounted luminaire label format.

Line 1	**[LUMI + System-generated number]**	Text: 7 mm
Line 2	**[Luminaire number]**	Text: 13 mm

Figure 60 – Luminaire label examples.



9 STANDALONE POWER SYSTEM

Standalone Power System (SPS) is a distribution plant equipment comprises of a Diesel generator, PV Solar array, Battery and Battery cabinet, Battery inverters, PV inverters and an electrical switchboard, the electrical equipment installed within an enclosed fencing with a lockable access gate.

Figure 61 – Typical Standalone Power System (SPS) site label location.

Standalone Power System (SPS) shall be labelled with a sign of a system-generated number for identification of the system, the location shall be contained in the second line.

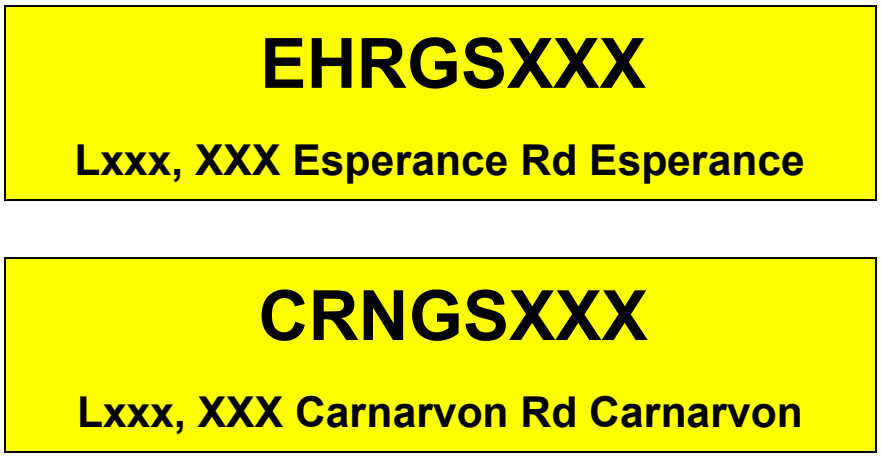
Location of the labels shall be installed on the access gate, labels for Standalone Power System shall have a roll width of 50 mm and the format shall be that of the table below:

Note: Labels of individual equipment within the SPS compound such as Generator, Batteries, and Inverters etc. shall be supplied and installed by others.

Table 39 – Standalone power system label format.

Line 1	**[System-generated number]**	Text: 19.5 mm
Line 2	**[Location]**	Text: 13 mm

Figure 62 – Standalone Power System label examples.



APPENDIX A - REVISION INFORMATION

(Informative) Horizon Power has endeavoured to provide standards of the highest quality and would appreciate notification if any errors are found or even queries raised.

Each Standard makes use of its own comment sheet which is maintained throughout the life of the standard, which lists all comments made by stakeholders regarding the standard.

A comment sheet found in **DM# 1565365**, can be used to record any errors or queries found in or pertaining to this standard, which can then be addressed whenever the standard gets reviewed.

Date	Rev No.	Notes
15/04/2013	0	Original Issue
19/07/2016	1	Revised to incorporate new equipment numbering and label format
1/11/2019	2	Revised to include more information, mini pillar, fusesaver and Standalone Power System labelling added.
28/09/2023	3	Document updated with the relevant and current Australian Standards, includes standards label of GMK, update the Appendix B- Schedule of Label Requirements

APPENDIX B - SCHEDULE OF LABEL REQUIREMENTS

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Capacitor Bank – Pole Mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• CAPT and system-generated number • Capacitor bank name or number	**CAPT**	
Concrete Pole	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• POLE and system-generated number. • Pole/rural number.	**POLE**	High Voltage poles require the fitting of a 'HORIZON POWER DANGER HIGH VOLTAGE' warning sign (stock number **CZ0230**) at a height of approximately 1.8 m above ground.
Ring main Unit	✓	**50 mm**	**Yellow vinyl**	The labels shall be fixed to the inside and outside of both doors and also on the RMU front panel.	• DRMU and system-generated number. • Substation name • Feeder number and substation name or Switch name and Substation name or Pole number • Location	**DRMU**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000** **'AUTHORISED PERSONS ONLY sign in accordance with AS/NZS 3000**
Distribution Substation – Brick Building	✓	**50 mm**	**Yellow vinyl**	The label shall be fitted at a height of approximately 1.8 m above the finished floor level, on the inside of the door.	• DSUB and system-generated number. • Substation name • Location	**DSUB**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000** **'AUTHORISED PERSONS ONLY sign in accordance with AS/NZS 3000**

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Distribution Substation – Brick Compound	✓	**50 mm**	**Yellow vinyl**	The label shall be fitted at a height of approximately 1.8 m above the finished floor level, on the inside of the door.	• DSUB and system-generated number. • Substation name • Location.	**DSUB**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.** **'AUTHORISED PERSONS ONLY sign in accordance with AS/NZS 3000.**
Distribution Substation – Fenced Compound	✓	**50 mm**	**Yellow vinyl**	The label shall be fitted at a height of approximately 1.8 m above the finished floor level, on the door, using the metal plate.	• DSUB and system-generated number. • Substation name. • Location.	**DSUB**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.** **'AUTHORISED PERSONS ONLY sign in accordance with AS/NZS 3000.**
Distribution Substation – Modular Package Substation/Non-Modular Package Substation	✘	**50 mm**	**Yellow vinyl**	Labels shall be fitted on the inside of the door to the LV switchgear only where applicable.	• DSUB and system-generated number. • Substation name. • Location.	**DSUB**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.** **'AUTHORISED PERSONS ONLY sign in accordance with AS/NZS 3000.**
Distribution Transformer – Modular Package Substation & Non-Modular Package Substation	✓	**50 mm**	**Yellow vinyl**	The label shall be fitted to the inside and outside of the transformer doors.	• DTTX and system-generated number. • Substation name. • Information for where and what the transformer is supplied from. See relevant section.	**DTTX**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.**
Distribution Transformer – Pole-mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• DTTX and system-generated number. • Substation name.	**DTTX**	

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Drop Out Fuse	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• DDOF and system-generated number • Name or number of drop-out fuse.	**DDOF**	
Fault Indicator – Pole Top	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• FLIN and system-generated number. • Name or number of fault indicator.	**FLIN**	
Fault Indicator – Relay & Flag	✓	**25 mm**	**Yellow vinyl**	The label shall be placed on the side of the relay unit, or directly underneath the relay on the relay panel.	• Fault Indicator Number. • Location.	**FLIN**	
Fusesaver	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• FUSV and system-generated number. • Name of fusesaver associated with the area spur name and pole. • Drop Out Fuse Rating.	**FUSV**	
HV Fuse Switch Disconnector – Inside RMU	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the label placard, or front panel, of the ring main switchgear unit.	• FUSW and system-generated number • Fuse switch name • Information for where and what the remote end of the terminated cable is connected to. See relevant section. • Location.	**FUSW**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.**

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
HV Distribution Recloser in Kiosk – Ground Mounted Equipment	✓	**50 mm**	**Yellow vinyl**	The label shell be placed on the label placard, or front panel of the Ground Mounted kiosk	• RECL and system-generated number. • GMK number. • Location.	**RECL**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000. Warning: Arc Flash and Shock Hazard sign**
HV Switch Disconnector – Inside RMU	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the label placard, or front panel, of the ring main switchgear unit.	• SWTC and system-generated number. • Switch name or number. • Information for where and what the remote end of the terminated cable is connected to. See relevant section. • Location.	**SWTC**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.**
HV Isolator – Pole Mounted	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• HVDI and system-generated number. • HV isolator name or number.	**HVDI**	
Joints, Terminations, Line Hardware	✘	**-**	**-**	-	-	**-**	**-**
Load Break Switch	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• LBSW and system-generated number. • Load break switch number.	**LBSW**	

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Luminaire – Pole Mounted	✖	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• LUMI and system-generated number. • Streetlight number.	**LUMI**	
LV Disconnector – Ground Mounted Asset	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the LV disconnector label placard.	• LVDI and system-generated number. • Circuit number • Information for where and what the remote end of the terminated cable is connected to. See relevant section.	**LVDI**	
LV Disconnector – Pole Mounted	✖	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• LVDI and system-generated number. • Switch disconnector name.	**LVDI**	
LV Distribution Frame	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the inside and outside of the kiosk door. The label shall be placed in the centre of the door. For freestanding frames in substations the label shall be attached to the frame.	• LVFM and system-generated number. • Location. • Information for where and what the frame is supplied from. See relevant section.	**LVFM**	

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
LV Fuse Disconnector – Pole-mounted	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• FDIS and system-generated number. • Fuse switch disconnector name.	**FDIS**	
LV Fuse Disconnector – Ground-mounted Asset	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the fuse disconnector label placard.	• FDIS and system-generated number. • Circuit number. • Information for where and what the remote end of the terminated cable is connected to. See relevant section. • Location.	**FDIS**	
Metal Pole	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• POLE and system-generated number. • Pole/rural number.	**POLE**	High Voltage poles require the fitting of a 'HORIZON POWER DANGER HIGH VOLTAGE' warning sign (stock number **CZ0230**) at a height of approximately 1.8 m above ground.
Metering Unit – Ground-mounted Asset	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the front panel of the metering transformer unit.	• NMTR and system-generated number. • Substation name. • Location. • Information for where and what the metering transformer is supplied from. See relevant section.	**NMTR**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.**

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Metering Unit – Pole-mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• NMTR and system-generated number. • Substation name. • Location or pole rural number.	**NMTR**	
Mini Pillar	✓	**50 mm**	**Yellow vinyl**	Label shall be placed on the exterior of the mini pillar on a side most easily visible to operators.	• PILL and system-generated number. • Location. • Transformer name and relevant circuit number if underground transformer. Transformer name and pole number if overhead transformer. • LV cable termination pole and location for LV cable termination to pole if applicable. See relevant section.	**PILL**	
Overhead Conductor	✘	**-**	**-**	-	• -	**-**	**-**
Pole Top Switch	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• DPTS and system-generated number. • Switch Name.	**DPTS**	
Reactor – Pole-mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• CAPT and system-generated number. • Substation name or number.	**REAC**	

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Recloser	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• RECL and system-generated number. • Recloser number.	**RECL**	
Ring Main Unit	✓	**50 mm**	**Yellow vinyl**	Labels shall be affixed to both sides of each door and to the front panel of the RMU.	• DRMU and system-generated number. • Substation name. • Information for where and what the RMU is supplied from. See relevant section.		
Sectionaliser	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• SECT and system-generated number. • Sectionaliser name or number.	**SECT**	
Stays & Anchors	✘	**-**	**-**	-	• -	**-**	**-**
Streetlight Pole	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole at approximately 1.8 m above ground.	• POLE and system-generated number.	**POLE**	
Streetlight Pole Luminaires	✘	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole at approximately 1.8 m above ground, below the pole label.	• LUMI and system-generated. • Luminaire number.	**LUMI**	
Surge Diverter	✘	**-**	**-**	-	• -	**SURD**	**-**

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Transformer – Ground-mounted in Brick or Non-Brick Enclosures	✓	**50 mm**	**Yellow vinyl**	The label shall be fitted adjacent to the transformer nameplate.	• DTTX and system-generated number. • Substation name. • Information for where and what the transformer is supplied from. See relevant section.	**DTTX**	
Underground Cable	✘	**-**	**-**	-	• -	**-**	**-**
Underground Supply Pit	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the neutral incoming cable, or neutral connector.	• PITT and system-generated number. • Location. • Information for where and what the pit is supplied from and also where and what the pit supplies if the pit supplies a Horizon Power asset. See relevant section.	**PITT**	
Universal Pillar	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the top of the orange plastic covering, located inside the universal pillar. An additional label can also be placed on the exterior of the pillar if preferred.	• PILL and system-generated number. • Location. • Information for where and what the pit is supplied from and also where and what the pit supplies if the pit supplies a Horizon Power asset. See relevant section.	**PILL**	Universal pillars functioning as normally open points shall have a reflective red or white 'I' marking on the outer case of the pillar lid.
Un-Metered Supply Pit	✘	**-**	**-**	-	• -	**-**	**-**

Equipment Type	Label Mandatory?	Label Tape Size	Label Type	Label Placement	Label Contents (L1, L2, L3, L4)	Handimark Filename	Other Requirements
Voltage Regulator – Ground-mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the exterior surface of the control panel door.	• RETX and system-generated number. • Locations. • Information for where and what the voltage regulator is supplied from, see relevant section.	**RETX**	**'DANGER – HIGH VOLTAGE' sign in accordance with AS/NZS 3000.**
Voltage Regulator – Pole-mounted	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• RETX and system-generated number. • Regulator name.	**RETX**	
Wall Mounted Box	✓	**50 mm**	**Yellow vinyl**	The label shall be placed on the exterior surface of the Wall Mounted Box.	• PILL and system-generated number. • Location. • Information for where and what the Wall Mounted Box is supplied from, see relevant section.	**PILL**	
Wood Pole	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed to the road side of the pole on the bottom of the danger plate or separately.	• POLE Number • Voltage/Substation/ Feeder name/Tee-Off-Number/Name (optional).	**POLE**	High Voltage poles require the fitting of a 'HORIZON POWER DANGER HIGH VOLTAGE' warning sign (stock number **CZ0230**) at a height of approximately 1.8 m above ground.
Standalone Power System	✓	**50 mm**	**Yellow vinyl**	The label shall be affixed on the access gate of the site.	• SPS and system generated number. • Location.	**SPS**	**'AUTHORISED PERSONS ONLY' sign in accordance with AS/NZS 3000.**

15 APPENDIX F: SPS MINIMUM FUNCTIONAL TESTING GUIDE

Insert DM link: 44595090

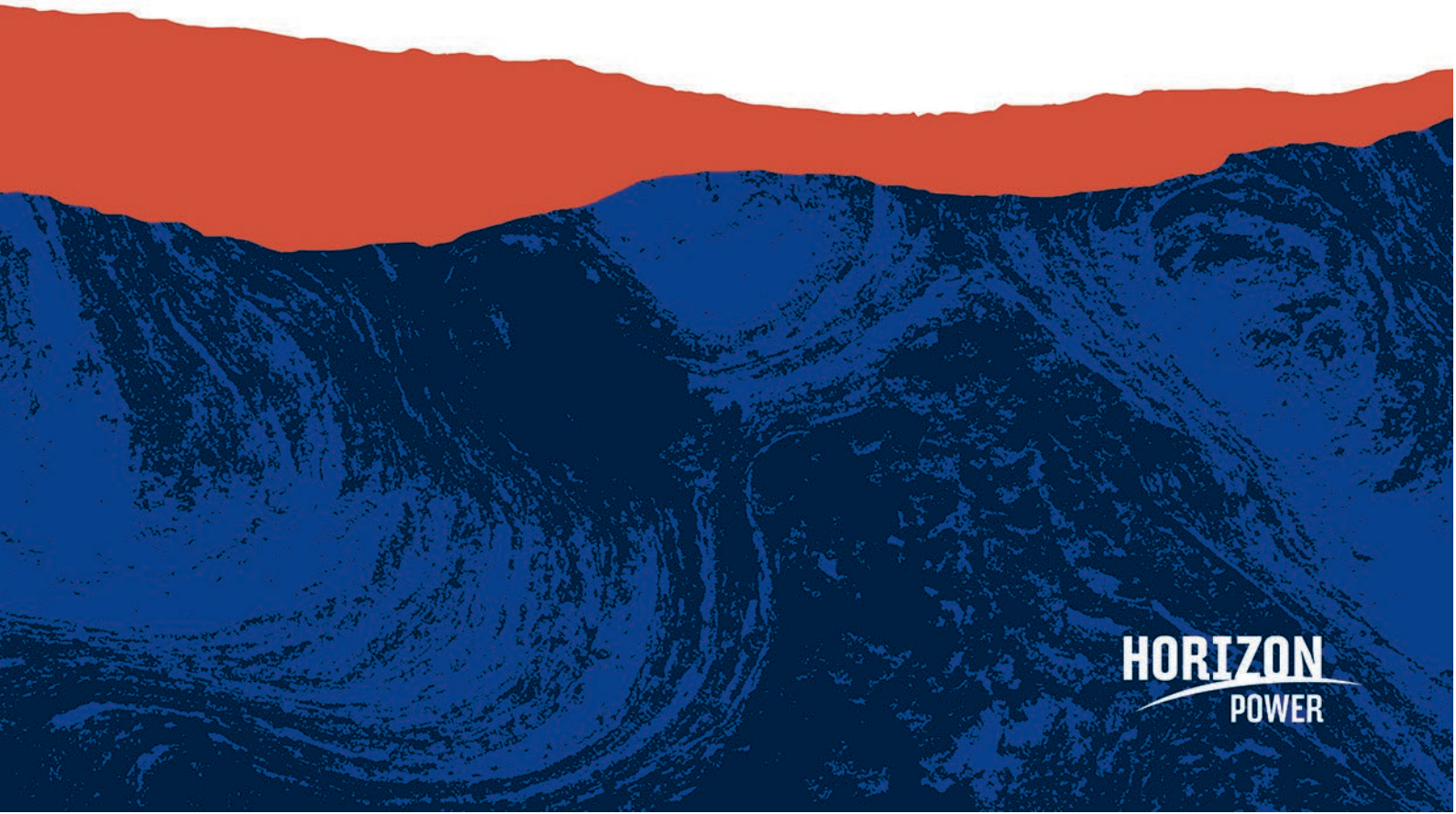
SPS Minimum Functional Testing Guide

For LV network SPS Type-testing, FAT and SAT

Version: 0

Date of issue: 20/05/2024

DM#: 44595090



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1. Purpose

This document summarises the minimum testing requirements for the acceptance of the SPS at its various stages of testing. This guide shall be utilised by the SPS supplier as a base reference to develop and conduct their own suite of testing and documentation.

Testing is expected to be carried out in 3 stages:

1. Factory Type Testing (FTT)
2. Factory Acceptance Testing (FAT)
3. Site Acceptance Testing (SAT)

1.1 Abbreviations

Table 1 below summarises the abbreviations utilised in this document.

Table 1 | Abbreviations

Term	Description
AS	Australian Standard
BMS	Battery Management System
ESS	Energy Storage System
FAT	Factory Acceptance Testing
FTT	Factory Type Testing
GEN	Alternative Generator
HP	Horizon Power
HVAC	Heating, Ventilation, and Air Conditioning
ITP	Inspection Test Plan/Procedure
ITR	Inspection Test Record
MCCB	Moulded Case Circuit Breaker
MPPT	Maximum Power Point Tracking
PCS	Power Conversion System
PF	Power Factor
PQ	Power Quality
PQM	Power Quality Meter
PV	Photovoltaic
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition
SPS	Standalone Power System
UPS	Uninterrupted Power Supply

2. Minimum Test Requirements

2.1 Minimum Measured Signal List

The following data shall be logged at 1 second intervals (max 1 minute interval, should 1s not be available) and overlayed in testing results. Data points with an "*" may be omitted with approval from HP.

- Generator
  - Current (A)
  - Active Power (kW)
  - Reactive Power (kVAr)
  - Power Factor (p.f)*
- ESS inverter
  - AC Output
    - Current (A)
    - Active Power (kW)
    - Reactive Power (kVAr)
    - Power Factor (p.f)*
  - DC Input
    - Voltage (V)*
    - Current (A)*
    - Active Power (kW)*
    - State of Charge (SOC)
- PV inverter
  - AC Output
    - Current (A)
    - Active Power (kW)
    - Reactive Power (kVAr)
    - Power Factor (p.f)*
  - DC Input
    - Voltage (V)*
    - Current (A)*
    - Active Power (kW)*

Outgoing customer connection/load values shall be logged by means of an IEC 61000-4-30 class A Power Quality meter/data logger with the following data points recorded at 1s interval:

1. Voltage (V)
2. Current (A)
3. Frequency (Hz)
4. Active Power (kW)
5. Reactive Power (kVAr)
6. PF
7. Voltage unbalance (%)*

8. Flicker
    a. Pst*
    b. Plt*
9. Current harmonics up to the 50th order and THDi*
10. Voltage harmonics up to the 50th order and THDv*

All logging equipment shall be time synchronised.

2.2 Minimum Test Equipment

All test equipment make, model, serial number, calibration date and calibration due date shall be recorded in the respective ITP/ITR.

1. Resistive load bank
    a. Minimum rating of 150% of system maximum output or contract maximum design load.
    b. Minimum load step size of, at most, 5kW
    c. Capable of instantaneous step change
2. PV array
    a. Should be a test array or PV emulator of rated power of at least 20kW or 50% of design array.
3. Generator
    a. The actual generator should be used.
4. Power Quality meter
    a. Shall be IEC 61000-4-30 class A Power Quality meter with capability to measure the required data points.
5. Other test equipment as required for AS3000, AS5033 etc. mandatory test.

2.3 Minimum Test Documentation

ITP/ITR documentation shall be provided to HP for review prior to testing. At the completion of the testing, signed ITP/ITR shall be supplied to HP for approval along with the following:

- All equipment settings/configuration files
    - A pdf version shall be provided with the dedicated file.
    - Where settings cannot be extracted as a dedicated file, settings shall be recorded in a table (i.e. spreadsheet)
- Logged data consolidated to each test (raw and processed)
- Punchlist, with evidence if item is addressed to be closed.

Signed ITP/ITR shall be submitted to HP within 2 weeks from the date of test completion.

3. List of all Minimum Required Functional Tests

The list below details the required functional tests for each category of components and procedures. The order of testing need not follow the list order and list does not include AS3000, AS5033, and other mandatory electrical compliance and pre-energisation testing. For the purposes of this list the SPS is assumed to have primary components as listed in Appendix II.

Table 2 | Minimum Functional Test Matrix and Stages

Test Category	Test No.	Functional Test Title	FTT	FAT	SAT**
SPS Rating	R1	Complete depth of discharge Test	✓*	✓	
SPS Rating	R2	Complete depth of charge Test	✓*	✓	
SPS Rating	R3	Load stability Test without GEN	✓	✓	✓
SPS Rating	R4	Load stability Test with GEN only	✓	✓	✓
SPS Rating	R5	Load rejection and Acceptance	✓	✓	
SPS Rating	R6	Dynamic PV & ESS Response (cloud event)	✓	✓	✓
SPS Rating	R7	Dynamic GEN & ESS Response	✓	✓	
SPS Rating	R8	Solar Curtailment on High SOC	✓	✓	
SPS Rating	R9	GEN only solar curtailment	✓	✓	
SPS Rating	R10	Very low SOC BESS shutdown	✓	✓	
GEN Control	G1	GEN automatic startup on low SOC and shutdown on high SOC	✓	✓	✓
GEN Control	G2	GEN automatic startup on overload and shutdown on underload	✓	✓	✓
GEN Control	G3	GEN Exercise call and minimum runtime	✓	✓	✓
GEN Control	G4	GEN Startup on inverter failure	✓	✓	
Control System	C1	HVAC nominal operation based on temperature sensors	✓	✓	
Control System	C2	HVAC nominal operation based on GEN Operation	✓	✓	
Control System	C3	UPS discharge test	✓*	✓	
Control System	C4	SCADA Point-to-point	✓	✓	✓***
Control System	C5	Remote SCADA controls	✓	✓	✓
Control System	C6	Remote Access	✓	✓	✓
Short-Circuit	S1	Bolted Short-circuit test	✓		
Short-Circuit	S2	High Impedance Short-circuit	✓		
Short-Circuit	S3	Protection Secondary injection test	✓*		

Note:
* Tests marked with '*', may be omitted from requiring HP witness during FTT.
**functionality assessment in SAT will be mostly assessed my means of the reliability period
*** SCADA point-to-point can be spot checked as long as it covered each of the individual devices.

3.1 SPS Minimum Testing Matrix

These tests are further detailed in the testing matrix in Appendix I - SPS Minimum Testing Matrix.xlsx

DM#: 44603968

APPENDIX I. SPS MINIMUM TESTING MATRIX

Test Category	Test No.	Test Title	Purpose	Typical Test Procedure	Pass Criteria	Notes
SPS Rating	R1	Complete depth of discharge Test	To measure the full discharge capability of the ESS	Confirm if SPS is in nominal operation with maximum SOC. Set load to 100% loading and ensure GEN is offline Let ESS discharge till minimum SOC. Record discharge duration, energy and customer PQ measurements.	Total measured discharge energy shall be equal or higher than the nameplate and/or contracted value and the power quality of the customer supply shall be within the technical rules limit for the entirety of the test.	SOC based control setpoints may need to be temporarily modified to suit the test.
SPS Rating	R2	Complete depth of charge Test	To measure the full charge capability of the ESS	Confirm if SPS is in nominal operation with minimum SOC. Startup GEN and set load to 0% loading. Let ESS charge from the GEN till it reaches the maximum SOC. Record charge duration, energy and customer PQ measurements.	Total measured charged energy shall be equal or higher than the nameplate and/or contracted value and the power quality of the customer supply shall be within the technical rules limit for the entirety of the test.	SOC based control setpoints may need to be temporarily modified to suit the test.
SPS Rating	R3	Load stability Test without GEN	To measure the capability of SPS with the GEN offline at various sustained loading levels	Confirm if SPS is in nominal operation with suitable SOC and GEN offline. Set load to 0% and let system run for 5mins. Repeat the above steps for 25%, 50%, 75%, 100% and 150% loading. Record customer PQ measurements.	The SPS is capable of supporting the various load levels and the measured power quality of the customer supply is within the technical rules limit for the entirety of the test	At the 150% loading test point, it is expected that the SPS either trips on overload or the SPS handles the temporary overload.
SPS Rating	R4	Load stability Test with GEN only	To measure the capability of SPS with only the GEN online at various sustained loading levels	Confirm if SPS is in GEN only mode. Set load to 0% and let system run for 5mins. Repeat the above steps for 25%, 50%, 75%, 100% and 150% loading. Record customer PQ measurements.	The SPS with GEN only is capable of supporting the various load levels and the measured power quality of the customer supply is within the technical rules limit for the entirety of the test	At the 150% loading test point, it is expected that the SPS either trips on overload or the SPS handles the temporary overload .
SPS Rating	R5	Load rejection and Acceptance	To measure the load acceptance and rejection capability of the SPS in its various modes of operation.	Confirm if SPS is in nominal operation without GEN. Set load to 0% for 1 min. Step load up to 50% for 1 min. Step load back to 0% for 1 min. Step load up to 100% for 1 min. Step load back to 0% for 1 min. Record customer supply PQ. Repeat test for GEN only mode and Hybrid mode with GEN.	The SPS is capable of supporting the load acceptances and rejection whilst maintaining the PQ of the customer supply within technical rules limits.	-
SPS Rating	R6	Dynamic PV & ESS Response (cloud event)	To measure the prioritisation of solar supply over ESS.	Set the system to operate nominal mode. Set the loading to be ~50% of the total available solar production. Confirm if the solar is supplying the load and charging the battery. Simulate a clouding event for isolating the solar DC supply. Confirm if the ESS immediately takes on the load. Simulate the end of the clouding event by re-energising the DC supply. Confirm that solar supply ramps back up taking on the load and charging the ESS. Set the loading to be 150% of the total available solar production. Confirm if the solar is supplying the load at 100% availability with the ESS supplying the rest. Simulate a clouding event by isolating the solar DC supply. Confirm if the ESS immediately takes on the load. Simulate the end of the clouding event by re-energising the DC supply. Confirm that solar supply ramps back up taking on the load with the ESS.	The dynamic response between the ESS and solar production is consistent with intended operation.	-
SPS Rating	R7	Dynamic GEN & ESS Response	To measure the prioritisation of GEN supply of loads over ESS charging.	Set the system to operate nominal mode with GEN. Set the loading to be 50% loading. Confirm if the GEN is supplying the load and charging the battery. Increase the load to 100% loading Confirm that GEN supplies the full load and only charges the ESS with any remainder reserve. Set the loading to be 120%. Confirm that both the GEN and ESS are supplying the load with GEN being the priority. Set the loading back to 50%. Confirm if the GEN is supplying the load and charging the battery.	The dynamic response between the ESS and GEN is consistent with intended operation.	-
SPS Rating	R8	Solar Curtailment on High SOC	To measure the capability for the SPS to curtail solar locally and externally via frequency ramp control	Test procedure varies based on test setup	The SPS solar curtails as the SOC increases and the customer supply frequency is increased to 53Hz for curtailment of AU Region C PV Inverters.	-
SPS Rating	R9	GEN only solar curtailment	To measure the capability for the SPS in GEN only mode to curtail external solar via frequency ramp control	Test procedure varies based on test setup	The SPS curtails the customer solar by increasing the frequency to 53Hz for curtailment of AU Region C PV Inverters.	-
SPS Rating	R10	Very low SOC BESS shutdown	To ensure ESS fails safely when it reaches the minimum SOC without GEN start.	Run system in nominal hybrid only mode, 100% loading and with GEN isolated (offline). Continue to discharge the ESS. Confirm if SPS shuts down on the minimum SOC is reached. Isolate the load and manual startup the GEN. Confirm if ESS starts back up and recharges from the GEN.	The ESS fails safely when it reaches the minimum SOC without GEN start and starts back up automatically once the GEN is on.	-

GEN Control	G1	GEN automatic startup on low SOC and shutdown on high SOC	To test the proper startup and shutdown of the alternate generator on low and high SOC condition on the ESS	Run system in nominal hybrid only mode and 100% loading. Continue to discharge the ESS. Confirm if GEN starts-up as intended once low SOC setpoints has been reached. Confirm if load is being supported by GEN and if GEN is charging the ESS. Lower loading to 0% to maximise GEN charging. Confirm if GEN shuts down as intended once high SOC setpoints has been reached. Confirm if ESS is supporting the loads.	GEN startup and shutdown occurs within 1% of the SOC setpoint without any disruptions to the customer supply. GEN supports the load and charges the ESS when	SOC setpoints can be temporarily changed to be ~+-3% of the current SOC for the purposes of this test. Generator minimum runtime can also be adjusted to be lower so as to properly assess the stop condition. Record any changed values.
GEN Control	G2	GEN automatic startup on overload and shutdown on underload	To test the proper startup of the alternate generator on low SOC condition on the ESS	Run system in nominal hybrid only mode and 100% loading. Continue to discharge the ESS. Modify loading to be just under the overload setpoint. Confirm if GEN does not startup after setpoint time delay. Modify loading to be just over the overload setpoint. Confirm if GEN does startup after setpoint time delay. Confirm if load is being supported by GEN and if GEN is charging the ESS. Lower loading to under underload setpoint. Confirm if GEN shuts down as intended after time delay. Confirm if ESS is supporting the loads.	GEN startup and shutdown occurs at the respective setpoints and time delay without any disruptions to the customer supply.	SOC setpoints can be temporarily changed for the purposes of this test to ensure GEN control is not SOC based. Generator minimum runtime can also be adjusted to be lower so as to properly assess the stop condition. Record any changed values.
GEN Control	G3	GEN Exercise call and minimum runtime	To test the proper GEN startup and minimum runtime due to an exercise call	Run System in nominally. Confirm if GEN starts-up on exercise call. Time and record runtime of GEN. Confirm if GEN shuts down after minimum runtime duration.	GEN startup and shutdown occurs at the respective time intervals without any disruptions to the customer supply.	Exercise call setpoints may be adjusted for the purposes of completing the test within a reasonable timeframe. Other GEN start condition setpoints may need to be temporarily modified to prevent startup due to other reasons.
GEN Control	G4	GEN Startup on inverter failure	To test the failsafe changeover to GEN when an ESS inverter fails	Run system in nominal hybrid only mode and 100% loading. Simulate an ESS PCE failure. Check if GEN starts-up as intended.	GEN properly startup when there is a failure in the ESS/PV hybrid system.	-
Control System	C1	HVAC nominal operation based on temperature sensors	To test the HVAC startup and shutdown based on the temperature setpoints	Start system in cool conditions with HVAC not in operation. Heat temperature sensor and observe HVAC temperature readings. Confirm if HVAC start-up at maximum temperature setpoint. Cool temperature sensor and observe HVAC temperature readings. Confirm if HVAC shuts down at lower shutdown temperature setpoint.	HVAC startup and shutdown aligns with temperature setpoints and read from sensors.	-
Control System	C2	HVAC nominal operation based on GEN Operation	To test the HVAC startup and shutdown based the GEN operational status	Start system in cool conditions with HVAC not in operation. Startup GEN. Confirm if HVAC start-up along with GEN. Shutdown GEN Confirm if HVAC shuts down along with GEN shutdown.	HVAC startup and shutdown aligns with GEN operation status.	-
Control System	C3	UPS discharge test	To test the depth of discharge of the UPS	Ensure SPS is in nominal operation. Isolate AC supply to UPS. Confirm UPS raises alarm for backup operation. Confirm that all components supplied by UPS continue to operate as intended. Allow UPS to discharge and record time to discharge completely. Reconnect the UPS AC supply and restart the SPS. Confirm if the UPS charges back up from the AC supply.	The UPS sustains the full load longer than the contracted/specification duration and the UPS charges back up once the AC supply is restored.	-
Control System	C4	SCADA Point-to-point	To test the complete IO datapoints and alarms from the SPS to the HP SCADA system	Simulate each data point physically on the SPS and data on the HP SCADA client is reflective. For analogue values, test a range of values to ensure scaling and units are accurate.	All HP SCADA points operate as intended.	This test shall be conducted with support of HP OT for the remote access.
Control System	C5	Remote SCADA controls	To test the remote operation of the SPS main switch	Ensure SPS is in nominal operation with 50% loading. Remotely open the SPS Main Switch. Confirm that the SPS Main switch opens. Remotely close the SPS main switch. Confirm that the SPS Main switch closes. Shutdown the SPS and remove the loading. Remotely open the SPS Main Switch. Confirm that the SPS Main switch opens. Remotely close the SPS main switch. Confirm that the SPS Main switch closes.	All HP remote controls operate as intended with the AC bus either energised or deenergised.	This test shall be conducted with support of HP OT for the remote access.
Control System	C6	Remote Access	To test the remote access to the devices via port forwarding	OF the HP jumphost virtual machine, remotely access all port forwarded devices. Confirm that all devices are accessible and configurable where applicable.	All devices are accessible remotely via HP network.	This test shall be conducted with support of HP OT for the remote access.
Short-Circuit	S1	Bolted Short-circuit test	To measure the bolted fault contribution from the SPS in ESS only mode	Ensure SPS is in ESS only mode (PV and GEN offline) and loaded to 50%. Simulate a bolted L-E fault. Record fault level and clearing time. Reset test setup and simulate with similar L-N fault.	Fault contribution from SPS matches design specification and fault is cleared in the required time (<0.4s for earth faults)	-
Short-Circuit	S2	High Impedance Short-circuit	To measure the fault contribution from the SPS in ESS only mode for a simulated worst-case customer final sub-circuit	Ensure SPS is in ESS only mode (PV and GEN offline) and loaded to 50%. Simulate a High Impedance L-E fault (similar to worst-case customer final sub-circuit). Record fault level and clearing time. Reset test setup and simulate with similar L-N fault.	Fault contribution from SPS matches design specification and fault is cleared by the SPS in the required time (<0.4s for earth faults)	impedance should be ~2.5 Ohm to higher to simulate maximum earth fault loop impedance as expected in compliance with AS3000
Short-Circuit	S3	Protection Secondary injection test	To test the functionality of configure protection functions of all dedicated protection relays	Isolate and test the protection relay via secondary injection. Testing shall include all protection and logic based functions.	Secondary Injection test passes	This test is applicable to dedicated protection relays like earth leakage relays, feeder protection relays or insulation monitoring devices.

APPENDIX II. TYPICAL PRIMARY COMPONENT LISTS

A typical SPS would have the following primary components and the minimum functional test list is built upon this component list. Should there be more primary components in the SPS, these should be included into the final testing regiment.

1) Generator
   a) Alternator/Engine
   b) Controller (ComAp, DEIF, etc.)
2) PV Array
   a) Emulators, actual
3) PV inverter / MPPT
   a) AC coupled, or
   b) DC coupled
4) ESS
   a) Battery BMS
5) ESS Inverter
   a) Selectronic, SMA, Victron, etc
6) Controller
   a) DEIF/ComAP or PCE internal
7) SCADA/Mango
   a) Cybertec router
   b) Mango
8) UPS
   a) Charger
   b) Battery
9) HVAC
   a) Sensors
   b) Cooling units
10) HMI
   a) Screens
   b) Emergency stop buttons
   c) Remote SCADA
   d) Changeover switch
11) Motorised MCCB
12) Protection Relays
   a) Grid Connection Relay
   b) Earth Leakage Relay
   c) Insulation Monitoring Relay
13) CTs