AS 5715:2015

Australian STANDARD

Uninterruptible power systems (UPS) for roadside devices

STANDARDS Australia

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- Australian Industry Group
- Austroads
- Brisbane City Council
- CIE Australia
- Department of Planning, Transport and Infrastructure, SA
- Department of Transport and Main Roads, Qld
- Hire and Rental Car Industry Association of Australia
- IES: The Lighting Society
- Intelligent Transport Systems Australia
- Main Roads Western Australia
- Roads and Maritime Services
- Traffic Management and Safety – Roads ACT
- VicRoads

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Australian Standard®

Uninterruptible power systems (UPS) for roadside devices

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PREFACE

This Standard was prepared by the Standards Australia Committee LG-006, Road Traffic Signals. It is one of a number of Standards which set out requirements for the equipment associated with traffic signal installations.

The objective of this Standard is to specify mechanical, electrical, functional and environmental requirements for designers and manufacturers of uninterruptible power systems (UPS) for roadside devices, in order to ensure that such systems operate safely and reliably.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard
Uninterruptible power systems (UPS) for roadside devices

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies mechanical, electrical, functional and environmental requirements, along with methods of test, for uninterruptible power systems (UPS) for use with road traffic signals or other roadside traffic devices.

The Standard specifies general requirements for the design and construction of UPS to meet the needs of users. The Standard specifies technology that has been proven in the field to provide safe and reliable operation.

The Standard also specifies the minimum documentation required for the safe and correct installation, operation and maintenance of UPS (see Appendix A).

This Standard applies to—

(a) stand-alone UPS, which are contained within a dedicated housing; and

(b) integrated UPS, which share a common housing with other equipment.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1275	Metric screw threads for fasteners
1319	Safety signs for the occupational environment
2578	Traffic signal controllers
2700	Colour standards for general purposes
3731	Stationary batteries—Nickel-cadmium
3731.2	Part 2: Valve-regulated type
4086	Secondary batteries for use with stand-alone power systems
4086.2	Part 2: Installation and maintenance
60068	Environmental testing
60068.2.6	Part 2.6: Tests—Test Fc: Vibration (sinusoidal)
60068.2.29	Part 2.29: Tests—Test Eb and guidance: Bump
60529	Degrees of protection provided by enclosures (IP Code)
60947	Low-voltage switchgear and controlgear (series)
60947.7.1	Part 7.1: Ancillary equipment—Terminal blocks for copper conductors
60947.7.2	Part 7.2: Ancillary equipment—Protective conductor terminal blocks for copper conductors
60947.7.3	Part 7.3: Ancillary equipment—Safety requirements for fuse terminal blocks
62040	Uninterruptible power systems (UPS)
62040.1.1	Part 1.1: General and safety requirements for UPS used in operator access areas
62040.2	Part 2: Electromagnetic compatibility (EMC) requirements

AS/NZS	
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
3100	Approval and test specification—General requirements for electrical equipment
3112	Approval and test specification—Plugs and socket-outlets
3190	Approval and test specification—Residual current devices (current-operated earth-leakage devices)
4029	Stationary batteries—Lead-acid
4029.2	Part 2: Valve-regulated type (IEC 60896-2:1995, MOD)
60898	Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations
60898.1	Part 1: Circuit-breakers for a.c. operation (IEC 60898-1, Ed. 1.2 (2003) MOD)
61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
61008.1	Part 1: General rules (IEC 61008-1, Ed. 3.0 (2010) MOD)
61558	Safety of power transformers, power supplies, reactors and similar products for supply voltages up to 1 100 V
61558.2.4	Part 2.4: Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers
IEC	
60269	Low-voltage fuses
60269-3	Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications)—Examples of standardized systems of fuses A to F

1.3 DEFINITIONS

1.3.1 Apparent power

Product of the r.m.s. voltage and r.m.s. current.

1.3.2 Battery

Device consisting of one or more electrochemical cells used to convert stored chemical energy into electrical energy.

1.3.3 Battery bank

Group of batteries connected in series/parallel.

1.3.4 Battery management system

Electronic system for managing a rechargeable battery by such processes as monitoring its state, charging, protecting and balancing it, and controlling its environment.

1.3.5 Bypass

Alternative power path, either internal or external, to the UPS.

1.3.6 Housing (UPS housing)

Weatherproof enclosure that provides physical protection for and houses the UPS.

1.3.7 Integrated UPS

UPS sharing a common housing with other equipment.

1.3.8 Inverter

Electrical power converter that changes direct current (d.c.) to alternating current (a.c.).

1.3.9 Maintenance bypass (path)

Alternative power path provided to maintain continuity of load power during maintenance activities.

1.3.10 Maintenance bypass switch

Switch designed to isolate a UPS, or part thereof, from the load and to maintain continuity of load power via an alternative path during maintenance activities.

1.3.11 Primary power

Power supplied by an electrical utility company or by a user's generator.

1.3.12 Rated current

Input or output current of the UPS as declared by the manufacturer.

1.3.13 Rated voltage

Input or output voltage of the UPS as declared by the manufacturer.

1.3.14 Rated voltage range

Input or output voltage range of the UPS as declared by the manufacturer, expressed by its lower and upper rated voltages.

1.3.15 Stand-alone UPS

UPS contained within a dedicated housing.

1.3.16 Static bypass (electronic bypass)

Power path (primary or stand-by) alternative to the indirect a.c. converter, where control is via an electronic power switch, for example, a transistor, thyristor, triac or other semiconductor device or devices.

1.3.17 Static bypass switch

UPS switch designed to provide static bypass function.

1.3.18 Stored energy mode

Operation of the UPS when supplied by the following conditions:

(a) Primary power is disconnected or is out of a given tolerance.

(b) Battery is being discharged.

(c) Load is within the given range.

(d) Output voltage is within the given tolerance.

1.3.19 Uninterruptible power system (UPS)

Combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure.

NOTE: Continuity of load power occurs when voltage and frequency are within rated steady-state and transient tolerance bands and with distortion and interruptions within the limits specified for the load. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or with distortion or interruptions outside the limits specified for the UPS.

1.3.20 UPS controller

Component of a UPS consisting of a battery management system, an inverter, a switching mechanism and a control/monitoring interface.

1.3.21 UPS double-conversion operation

UPS operation, where continuity of load power is maintained by a UPS inverter, with energy supplied from the d.c. link in normal mode of operation or from the energy storage system in stored energy mode of operation.

NOTE: The output voltage and frequency are independent of input voltage and frequency conditions.

1.3.22 UPS line-interactive operation

UPS operation where, in normal mode of operation, the load is supplied with conditioned a.c. input power at the input supply frequency and where, in stored energy mode of operation, the load is supplied from the output of an inverter.

1.3.23 UPS passive stand-by operation

UPS operation where the normal mode of operation consists of supplying the load from the primary power source, except when the latter is outside stated limits, in which case the load is supplied from the UPS inverter operating in stored energy mode.

SECTION 2 FUNCTIONAL REQUIREMENTS

2.1 GENERAL

The UPS shall be designed to power roadside devices under all conditions expected to be encountered at the roadside.

The UPS shall be capable of operating from any of the following supplies:

(a) Mains supply.

(b) Portable generator supply.

(c) Storage batteries.

See Figure 2.1 for a functional diagram of a UPS for supporting roadside devices.

2.2 POWER SUPPLY CONTINUITY

Where there is interruption to the primary power supply, the UPS shall ensure continuity of a.c. power for a user-specified duration without affecting operation of the load.

After a primary power supply is restored, the UPS shall revert to the primary power supply without affecting operation of the load.

2.3 POWER QUALITY MANAGEMENT

The UPS shall ensure the quality of the output power supply to the roadside devices by keeping it within specified parameters.

2.4 STATUS INDICATION

The UPS shall provide an indication of its operational status and any fault conditions.

2.5 AUXILIARY POWER CONNECTION

The UPS shall provide a connection for an auxiliary a.c. power source as an alternative to the a.c. mains supply.

2.6 USER CONTROL

The UPS shall provide user control and switching facilities to enable—

(a) the change of system parameters;

(b) the change of mode of operation; and

(c) the maintenance bypass mode.

FIGURE 2.1 UPS FUNCTIONAL DIAGRAM

SECTION 3 UPS TOPOLOGIES

3.1 GENERAL

This Section describes popular UPS topologies and shows the mode of operation of each one in the form of a block diagram. The stored energy source is commonly a battery and has been depicted as such throughout this Section.

3.2 STAND-BY TOPOLOGY

Stand-by topology comprises a battery charger, a d.c. to a.c. converter (generally a unidirectional inverter) and a UPS switch. See Figure 3.1.

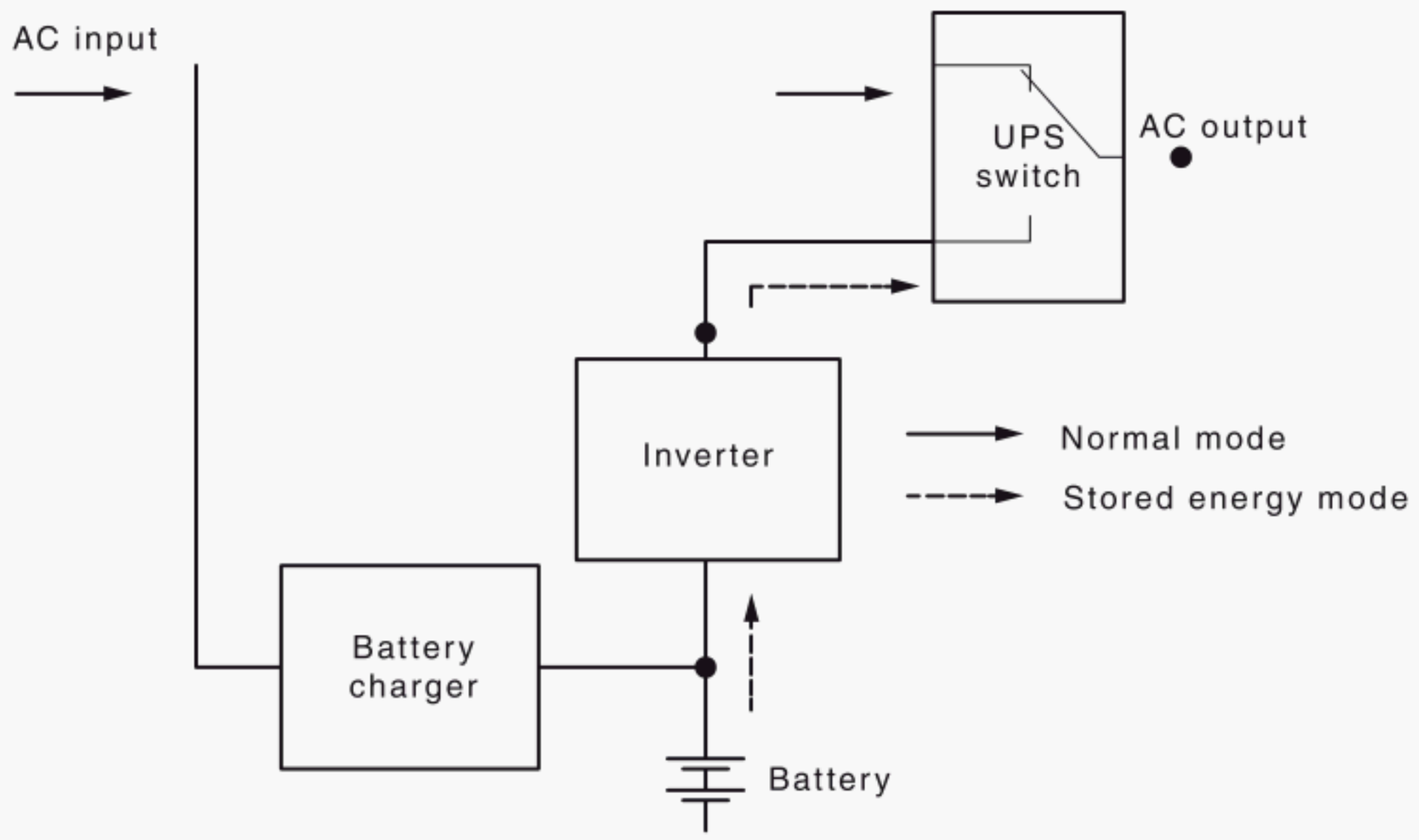

FIGURE 3.1 STAND-BY TOPOLOGY

In normal mode of operation, the load is supplied with a.c. input power via the UPS switch. When the a.c. input supply is out of UPS preset tolerances, the UPS unit enters stored energy mode of operation, and the load is transferred to the inverter directly or via the UPS switch.

The battery/inverter combination maintains continuity of load power for the duration of the stored energy time or until the a.c. input supply returns to within UPS preset tolerances and the load is transferred back, whichever is the sooner.

In active stand-by operation, the inverter is normally operating at no load.

In passive stand-by operation, the inverter is normally not operating but activated upon a.c. input failure.

3.3 LINE-INTERACTIVE TOPOLOGY

Line-interactive topology comprises an a.c. power interface and a charger/inverter. See Figure 3.2.

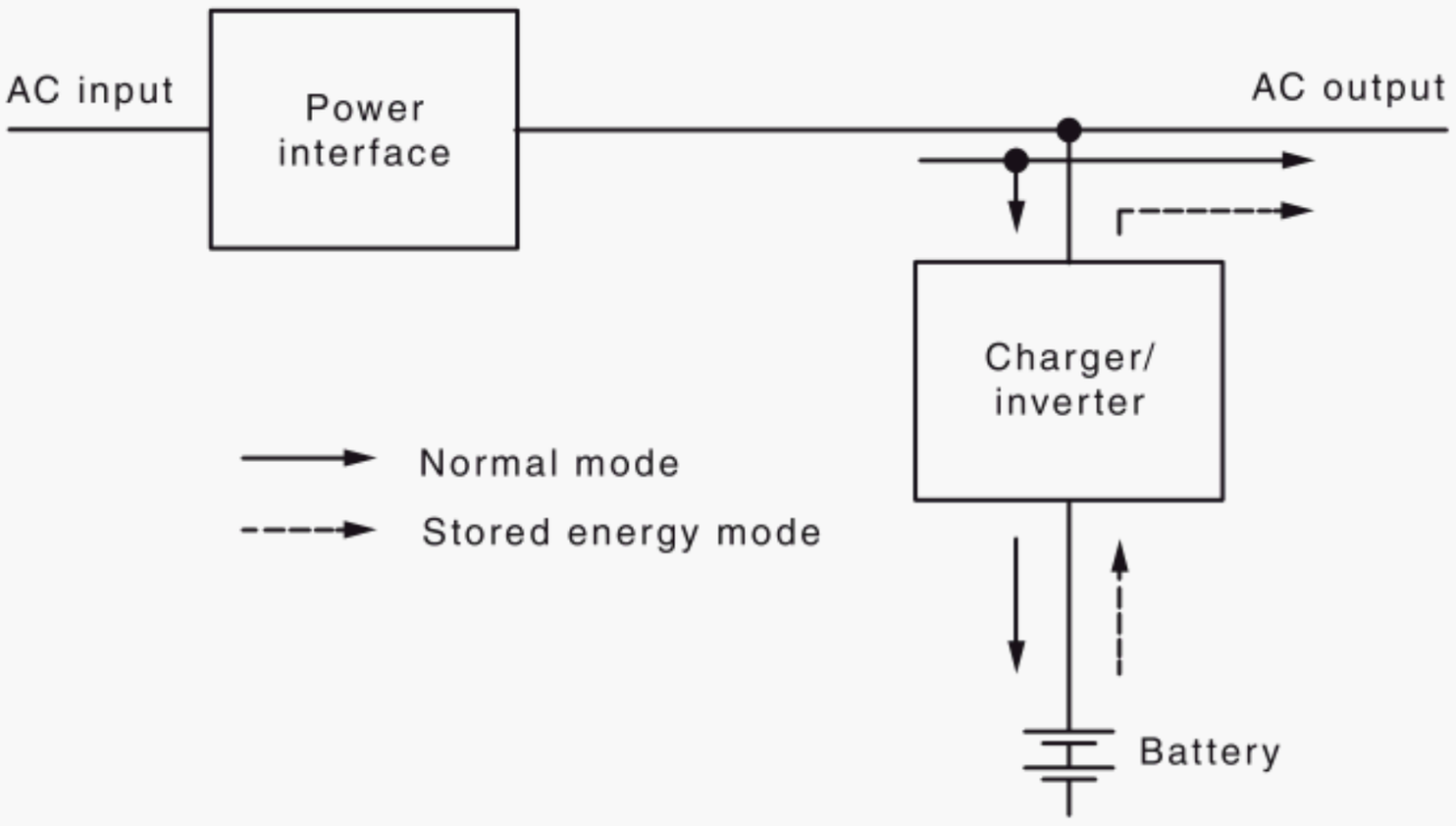

FIGURE 3.2 LINE-INTERACTIVE TOPOLOGY

In normal mode of operation, the load is supplied with conditioned power via a parallel connection of the a.c. input and the UPS inverter. The inverter or the power interface is operating to provide output voltage conditioning and/or battery charging. The output frequency is dependent upon the a.c. input frequency.

When the a.c. input supply voltage or frequency is out of UPS preset tolerances, the inverter and battery maintain continuity of load power in stored energy mode of operation.

The unit runs in stored energy mode for the duration of the stored energy time or until the a.c. input supply returns within UPS design tolerances, whichever is the sooner.

The inverter may be of bidirectional design as described above and the a.c. input power interface may consist of a passive impedance. Alternatively, the inverter may be unidirectional and the a.c. input power interface may consist of a power conditioner. In this case, a separate energy storage charger is incorporated.

3.4 DOUBLE-CONVERSION TOPOLOGY

Double-conversion topology comprises an a.c. to d.c. converter (rectifier) and a d.c. to a.c converter (inverter). See Figure 3.3.

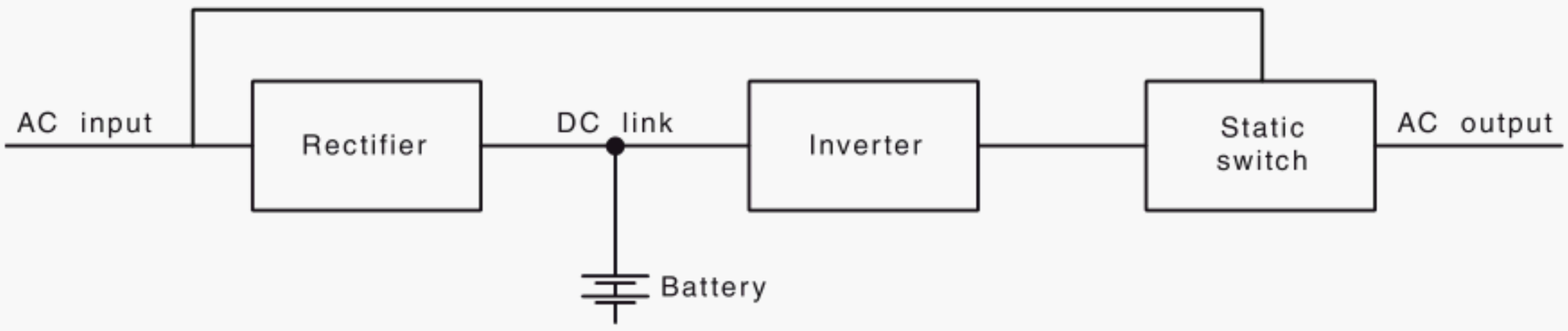

FIGURE 3.3 DOUBLE-CONVERSION TOPOLOGY

In normal mode of operation, the load is continuously supplied by the rectifier/inverter combination.

When the a.c. input supply is out of UPS preset tolerances, the UPS enters stored energy mode of operation, where the battery/inverter combination continues to support the load for the duration of the stored energy time or until the a.c. input returns to UPS design tolerances, whichever is the sooner.

SECTION 4 UPS CONTROLLER

4.1 GENERAL

The UPS controller consists of a number of functional elements:

(a) Rectifier.

(b) Battery management system.

(c) Inverter.

(d) Switching mechanism.

(e) Interfaces.

The UPS controller shall be adequately rated for the intended load specified.

NOTE: The intended load should be specified by the purchaser.

4.2 RECTIFIER

The rectifier of the UPS shall convert the input a.c. supply to a regulated d.c. output for use by the UPS battery charger (see Clause 4.3) for charging the UPS storage batteries. For UPS of the double-conversion type, this output shall also supply the UPS inverter (see Clause 4.4).

4.3 BATTERY MANAGEMENT SYSTEM

4.3.1 General

The battery management system shall comprise a battery charger, sensors and control circuitry.

Under the full range of input supply voltages and environmental factors, and the full range of load conditions, including overloads, the battery management system shall do the following:

(a) Provide optimum charging and appropriately staged charge management of the type of storage batteries and capacities required for the UPS.

(b) Provide capacity to charge the storage batteries at their maximum rate of charge.

(c) Maintain the storage batteries in optimal state of charge for all conditions and circumstances of operation and prevent overvoltage being applied to the storage batteries.

(d) Recharge, including trickle charge when appropriate, the storage batteries under temperature compensation controlled conditions with feedback provided by a skin temperature sensor on a typical storage battery.

(e) Prevent the generation of undesirable harmonic currents in the supply authority's circuits due to the charging operation.

(f) Limit ripple voltage on the d.c. rail of the storage batteries to less than 0.25% of the battery bus voltage.

(g) Prevent damage to the battery charger and its power semiconductor components by providing automatic output current limiting for all forms of output current overload. The output current limiting function shall not cause the operation of supply protective devices for the power semiconductor components. Upon removal of the overload condition, the battery charger shall automatically return to normal operation.

(h) Provide appropriate indication within the UPS status indicators when an overload condition occurs to the battery charger.

(i) Provide a power factor of not less than 0.95 when the UPS is charging the storage batteries and the load is disconnected.

(j) Provide the required data to and accept commands from the user interface.

When the UPS is supplied by a portable generator with appropriate output ratings, the battery management system shall operate with the same performance as when the UPS is connected to normal mains power supplies.

4.3.2 Battery cell balancing

Where specified by the battery manufacturer, cell balancing shall be provided by the battery management system.

4.4 INVERTER

The inverter of the UPS shall do the following:

(a) Maintain the specified UPS output voltage to the specified tolerances over the full variation of the storage battery voltage.

(b) Shut down in the event that the output voltage cannot be maintained within the required parameters specified in Table 7.1.

(c) Shut down in the event that the inverter's input d.c. voltage decreases below the minimum allowable.

(d) Synchronize the UPS output voltage and phase with the input a.c. source to within 10 V and 2°. For the purpose of this requirement, the UPS output frequency slew rate shall be limited to 1 cycle per second maximum during the synchronization process.

(e) Prevent damage to the inverter and its power semiconductor components by providing automatic output current limiting for all forms of UPS output current overload. The output current limiting function shall not cause the operation of power supply protective devices.

4.5 SWITCHING MECHANISM

4.5.1 Function

The switching mechanism shall provide for automatic switching of the load between the primary power and secondary power (UPS output).

NOTE: This operates differently for the different UPS configurations.

4.5.2 Stand-by and line-interactive configurations

For stand-by configuration, the switching mechanism shall connect the load to the primary power in normal mode. In the event of primary power failure, as defined in Clause 7.2, the load shall be connected to the inverter output.

When operating in storage mode, the switching mechanism shall connect the load to primary power under the following fault conditions:

(a) The load imposes higher current on the UPS output than the UPS overload capacity.

(b) The inverter or other module critical to UPS operation suffers a failure.

4.5.3 Double-conversion configuration

For double-conversion configuration, a static switch shall be used as the switching mechanism. It shall connect the load to the inverter output in normal mode.

The static switch shall connect the load to primary power under the following fault conditions:

(a) The load imposes higher current on the UPS output than the UPS overload capacity.

(b) In the event that the rectifier, the inverter or other module critical to UPS operation suffers a failure.

4.5.4 Recovery from fault

After overload conditions or faults have been cleared, the return to the normal mode of UPS operation shall be delayed by 15 to 30 s (user configurable) to prevent cycling of bypass operations.

4.6 INTERFACES

4.6.1 User interface

The UPS shall provide a user interface in the form of an integral control panel for the local control and monitoring of UPS operation.

All displays shall be clearly legible in the outdoor environment.

The control panel shall allow the UPS status and operational parameters to be viewed and adjusted.

The control panel shall provide the following display functions:

(a) UPS operating mode (normal, stored energy, bypass).

(b) Mains present indication, including display of the actual input voltage.

(c) Battery capacity available (as a percentage).

(d) Battery run-time remaining for connected load.

(e) UPS output voltage.

(f) UPS output current.

(g) UPS output power (real power, apparent power).

(h) Battery voltage.

(i) Battery current.

(j) Battery temperature.

(k) Alarms complete with date/time stamps in reverse chronological order.

(l) Status and event displays with date/time stamps in reverse chronological order.

(m) Set point views of UPS adjustable parameters.

The accuracy of measured values displayed shall be within ±2% of the real value.

The control panel shall provide the following control operations:

(A) Start up UPS.

(B) Shut down UPS.

(C) Select UPS mode of operation (normal, stored energy, bypass).

(D) Perform internal diagnostic checks.

(E) Setting the real-time clock, including setting the times and dates for daylight saving time changes.

(F) Adjust set point values for all adjustable parameters.

4.6.2 Logs and configuration data

The UPS shall provide non-volatile memory for the storage of all of its logs, test data, configuration settings and user accounts. User passwords shall be stored in an encrypted form.

An event and alarm log shall be provided to store a minimum of 100 individual records. Log entries shall include the following:

(a) Start up.

(b) Shut down.

(c) Mains lost.

(d) Mains recovered.

(e) Overload.

(f) Bypass operation.

(g) Operation mode changes.

(h) Battery test.

(i) Internal diagnostic checks.

(j) Over temperature (battery or UPS).

(k) Inverter failure.

(l) Charger failure.

(m) Low battery.

(n) Cooling fan failure.

4.6.3 Contact outputs

The UPS shall provide voltage-free, extra-low voltage (ELV) rated contact outputs to enable remote monitoring. The contact outputs shall be in accordance with Table 4.1.

TABLE 4.1

UPS SYSTEM STATUS VIA CONTACT OUTPUTS

System status	Condition
Mains failure	UPS is operating in stored energy mode
UPS fault	UPS is no longer operating correctly as a result of a fault(s)
Battery low threshold 1 (see Note)	One or more storage batteries is in a ‘low battery’ condition
Battery low threshold 2 (see Note)	One or more storage batteries is in a ‘low battery’ condition
Alarm 1	User defined
Alarm 2	User defined

NOTE: The ‘low battery’ condition refers to the battery capacity reaching a threshold at or below its user configured percentile level.

Each set of feedback signal contacts shall provide a common (‘C’), a normally open (‘NO’) and a normally closed (‘NC’) connection point.

Access and connection to the feedback signal contacts shall be provided via field terminals.

4.6.4 Data port and data management software

The UPS shall provide for data transmission to and from external devices (e.g. to and from a modem for remote access, notebook or laptop).

The UPS shall provide the ability for the external device to perform the following functions:

(a) Receiving, displaying, inspecting, sorting, extracting, saving, archiving and retrieving all of the UPS system status data specified in Clause 4.6.1.

(b) Receiving, displaying, inspecting, sorting, extracting, saving, archiving and retrieving the UPS system logs.

(c) Setting the real-time clock time by any of the following means:

  (i) Manual time setting by the user.

  (ii) Synchronization of time with or via the external device (e.g. with an internet time server).

(d) Setting the times and dates for daylight saving time changes for the real-time clock.

(e) Editing/modifying UPS operation set points (with user password protected access).

(f) Managing user accounts and access levels and control.

Any custom software application that is needed to operate the UPS shall be provided.

4.6.5 System reset

The UPS shall provide a hardware reset facility to allow the resetting of the system to its factory default state.

The reset facility shall be protected such that it cannot be inadvertently operated.

4.7 COOLING FANS

Fans shall only be used for the specific purpose of cooling power semiconductor assemblies and heat sinks in the rectifier and inverter modules and shall be an integral part of these units. Fans shall not be used for the general cooling of the housing.

SECTION 5 HOUSING FOR STAND-ALONE UPS

5.1 GENERAL

Where a UPS is not integrated within the same housing as other equipment, it shall be enclosed in its own weatherproof stand-alone housing.

This Section specifies provisions for this stand-alone UPS housing, and for the items of equipment that are fixtures in the housing.

NOTE: The configuration of a typical housing is shown in Appendix C.

5.2 DIMENSIONS

Where a standard UPS housing is used, the dimensions shall be as specified in Table 5.1 to be consistent with those of a traffic signal controller (see AS 2578).

TABLE 5.1

STANDARD UPS HOUSING DIMENSIONS

Dimension	Minimum mm	Maximum mm
Height	1375	1700
Depth	365	420
Width	780	800

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Where a UPS is not integrated within the same housing as other equipment, it shall be enclosed in its own weatherproof stand-alone housing.

This Section specifies provisions for this stand-alone UPS housing, and for the items of equipment that are fixtures in the housing.

NOTE: The configuration of a typical housing is shown in Appendix C.

5.2 DIMENSIONS

Where a standard UPS housing is used, the dimensions shall be as specified in Table 5.1 to be consistent with those of a traffic signal controller (see AS 2578).

TABLE 5.1

STANDARD UPS HOUSING DIMENSIONS

Dimension	Minimum mm	Maximum mm
Height	1375	1700
Depth	365	420
Width	780	800

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