Roads

Master Specification

RD-ITS-S2 Electrical Switchboard

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Document Management

Contents

RD-ITS-S2 Electrical Switchboards

1 General

1.1 This Part specifies the requirements for the supply and installation of electrical switchboards for applications other than road lighting and traffic signal controllers. This Part must be read in conjunction with RD-ITS-S1 “General Requirements for the Supply of ITS Equipment” and RD-ITS-C1 “Installation and Integration of ITS Equipment”.

1.2 Documents referenced in this Part are listed below:

a) AS/NZS 3000 Electrical Installations (also referred to as the “Wiring Rules”).

b) AS/NZS 3085.1 Telecommunications Installations – Administration of Communications Cabling Systems – Basic Requirement.

c) AS/NZS 1170 Structural design actions - General principles.

d) AS/NZS 3013 Electrical Installations – Classification of the Fire and Mechanical Performance of Wiring Systems.

e) AS/NZS 3100 Approval and Test Specification – General Requirements for Electrical Equipment.

f) AS/NZS 3111 Approval and Test Specification – Miniature Over-Current Circuit-Breakers.

g) AS/NZS 3190 Approval and Test Specification – Residual Current Devices (Current-Operated Earth-Leakage Devices).

h) AS/NZS 3947 Low-voltage Switchgear and Controlgear.

i) AS 4070 Recommended Practices for the Protection of Low Voltage Electrical Installations and Equipment in MEN Systems for Transient Over-Voltages.

j) AS/NZS 5000 Electrical Cables – Polymeric Insulated.

k) AS 61818 Application guide for low-voltage fuses.

l) AS 60529 Degrees of Protection Provided by Enclosures (IP Code).

m) AS/NZS 60947 Low-Voltage Switchgear and Controlgear.

n) AS/NZS 61439 Low-voltage Switchgear and Controlgear assemblies.

o) AS/NZS ISO 9001 Quality Management Systems – Requirements.

2 Definitions

Term	Definition
CSA	Cross-Sectional Area
DB	Distribution Board
Essential Circuit	A circuit nominated as “Essential” on the drawings and / or a circuit connected to a batter-backed power supply (such as a UPS)
LV	Low-Voltage as defined in AS/NZS 3000
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MEN	Multiple-Earthed Neutral
MSB	Main Switchboard
Switchboard Enclosure	The switchboard mounting chassis.
Switchboard	The entire functional unit, including electrical components and switchboard enclosure.
UPS	Uninterruptible Power Supply

3 Quality Requirements

3.1 All supplied equipment shall be manufactured under a quality system certified to AS/NZS 9001.

3.2 The Contractor shall prepare and implement a Quality Plan, in accordance with PC-QA1 “Quality Management Requirements” that includes or annexes the following documentation:

a) design documentation in accordance with RD-ITS-D1 "Design for Intelligent Transport System (ITS)";

b) sample(s) for acceptance in accordance with RD-ITS-S1 “General Requirements for the Supply of ITS Equipment”, Clause 3 (Equipment Requirements); and

c) drawings, manufacturer’s specifications and diagrams.

3.3 If not submitted beforehand, the documentation and samples required by this Clause must be submitted at least 20 working days prior to the commencement of site work or placing an order for Equipment.

3.4 Provision of the documentation and sample(s) listed in this Clause shall constitute a **Hold Point**.

4 Equipment Requirements

Design

4.1 The switchboard must be contained within a dedicated, sealed enclosure that prevents contact with any live LV surface. The switchboard enclosure must comply with the requirements of RD-ITS-S3 “ITS Enclosures” and RD-ITS-D1 “Design for Intelligent Transport System (ITS)”.

Electrical Requirements

4.2 All electrical design, wiring and associated Equipment must comply with the requirements of AS/NZS 3000. All electrical components must be suitable for operation on a mains 230 volt (and 240 volt) +5%/ - 10%, 50Hz ±0.1Hz system (and / or three-phase equivalent as appropriate) and rated for the respective calculated, prospective fault current. Unless otherwise noted, switchboard electrics / Equipment must be mounted on DIN rail complying with DIN 46277. DIN rail must be TH35 7.5, minimum 400 mm length and fixed securely by screws to prevent movement.

Identification and Labelling

General

4.3 Identification labels must be in accordance with AS/NZS 61439 and AS/NZS 3000. Labels must be provided for switchboards and their contents, including: instruments, controls, circuit designations and ratings, circuit protection devices, discrete devices, cabling, warning notices, and the like.

Electrical Insulation

4.4 Electrical insulation colours for wiring cores and busbars must be as shown in Table RD-ITS-S2 4-1.

Table RD-ITS-S2 4-1 Insulation Colours

Core	Multiphase Installation (Colour)	Single Phase Installations (Colour)
Active	Red, white or blue	Red
Neutral	Black	Black
Earth	Green and yellow	Green and yellow
LV Control	White with numbered ferrules	White with numbered ferrules
ELV Control	Purple with numbered ferrules	Purple with numbered ferrules

Labelling Requirements

4.5 Labels must be fixed by screws adjacent to the respective Equipment. Screws in areas accessible to the public must be of vandal-resistant design. The label must be located such that it cannot be

mistaken as referring to another device. Unless otherwise specified, labels must not be fixed on the Equipment. Labels must be laminated plastic or brushed aluminium, and coloured as follows:

a) Warning Notices: White letters on red background.

b) Essential Circuits: Red lettering on white background.

c) Other Labels: Black on white background.

4.6 Lettering height must comply with that outlined in Table RD-ITS-S2 4-2.

Table RD-ITS-S2 4-2 Label Lettering Height

Label	Lettering Height
“Main Switchboard”	25 mm
Name of other switchboards	15 mm
“Main Switch”	15 mm
DB feeder control switches	10 mm
Name of switchboard panel	6 mm
Equipment labels	4 mm
Warning notices	4 mm

Labelling of Circuit Protection Devices

4.7 Devices that protect switchboard and / or DB feeders must be labelled in a manner similar to the following examples:

a) Number of circuit protection device: Qxx [or] Fxx

b) Name of connected sub-board: DB 1 – General Light & Power

c) Setting / Rating of circuit protection device: 315A / 400A

d) Connected cable size and type: 4 x 1C 300 mm2 Cu/PVC/PVC

4.8 Devices that protect other circuits must be labelled in a manner similar to the following examples:

a) Number of circuit protection device: Qxx [or] Fxx

b) Name of final sub-circuit: L1 – S/L North 1

Schedule Cards

4.9 Circuit schedule cards must be provided to describe final sub-circuits. Cards must be at least 200 mm x 150 mm in size and contain computer-printed text showing:

a) number of circuit protection device;

b) sub-main or sub-circuit name;

c) destination area (where applicable); and

d) cable rating, type and length.

4.10 Each card must be mounted in a purpose-built holder fixed inside the door of the enclosure housing the protection devices. The card must be protected by a transparent plastic cover.

Neutral Earth

4.11 Unless otherwise specified, all new cabinets and switchboards must be bonded to earth by suitable cabling and earth conductor network as a MEN system in accordance with AS/NZS 3000. Clearly numbered terminals must be provided for all neutral and earth conductors, including the MEN link. Spare terminals must be provided for future circuits in each of the neutral and earth bars. The number of spare terminals must be the greater of: 10% of initial connected terminals; or 6 terminals. Cables with CSA of 16 mm^2 or larger must be provided with stud connections.

Switchboard Wiring

4.12 Wiring within the switchboard must:

a) have a minimum CSA or 2.5 mm^2 (7/0.67) for power supply wiring;

b) have a minimum CSA of 1.0 mm^2 (32/0.2) for control and indication wiring;

c) comply with AS/NZS 5000;

d) be sized to suit the rated current of the particular circuit; and

e) be de-rated in accordance with AS/NZS 3008 Part 1.

4.13 Only one wire must be connected to each terminal. Proprietary bonding links must be used for parallel connections between adjacent terminals. Unless otherwise specified, all wiring must use 0.6/1 V V-75 Cu/PVC cables that comply with AS/NZS 5000. Essential circuits must utilise a wiring system that complies with WS52 to AS/NZS 3013.

4.14 Where use of wiring ducts is impractical, it must be bundled and supported with PVC ties or strips so as to remain neat, functional, prevent excessive sagging, and avoid interference with maintenance activities within the enclosure. Protective insulated flashing must be provided where wiring or cables pass through cut-outs or other sharp edges.

Terminations

Terminals

4.15 Each wiring terminal must be clearly and indelibly identified. The terminal assembly must be arranged so that:

a) the connecting cables can be formed in a neat manner; and

b) all conductors can be connected or disconnected without disturbing other connections.

4.16 Stud-type terminals (minimum 5 mm diameter) must be used with wiring connections for CSA greater than 25.0 mm^2. Only 1 lug may be installed per mounting stud. Tunnel-type terminals blocks must be DIN rail mounted as follows:

a) Wire CSA 10.0 mm^2 to 25.0 mm^2 (inclusive): Compression Screws.

b) Wire CSA up to 10.0 mm^2 (exclusive): Compression Screws or Spring-Type.

4.17 Tunnel type terminals must only have one conductor connected to each end of the tunnel.

Lugs

4.18 Wiring must be terminated using compression type lugs / pins that are compatible with the terminals. Lugs / pins must be crimped in accordance with the manufacturer's instructions.

Arrangement

4.19 All internal wiring must be terminated on one side of the terminal block; wiring that exits the switchboard enclosure must be terminated on the other side. Control terminals must be grouped for each circuit with each group physically segregated. DIN rails must provide 25% spare capacity for future circuits.

5 Circuit Protection Devices

General

5.1 Mains switching, outgoing circuit switching, motor control and starters, protection and auxiliary Equipment must be provided as shown on the design documentation. Circuit protection devices must be rated for:

a) full current of connected load – continuous duty; and

b) starting currents of connected load – a duty equal to the load's rated number of starts per hour.

5.2 The protection device's make and break capacity must be equal to at least the calculated prospective short-circuit fault current of the installation. The minimum utilisation category must be AC-23 for circuits with motor or other highly inductive loads, and AC-22 for all other loads.

Switch-Isolator and Fuse-Switch Units

5.3 Switch-isolator and fuse-switch units must comply with AS/NZS 3947. Switch-isolator and fuse-switch units must allow manual operation with an integral ON-OFF indicator, and a facility to lock the device in the OFF position. The units must be totally enclosed and incorporated arc-control devices, and shrouded stationary contacts.

Fuses

5.4 Fuses must be enclosed, High Rupturing Capacity (HRC) type. Fuses must be installed in fuse-holders that allow a blown fuse to be identified while the fuse in installed in the service position. The fuse-holder must insulate all live parts when the fuse is withdrawn. A fuse insertion / extraction device must be provided to safely remove and insert fuses. The extraction device must be mounted on retention clips within the enclosure. Each switchboard must be provided with three (3) spare fuses for each size of fuse used in the switchboard. The spare fuses must be mounted in holders within the enclosure adjacent the fuse extraction device.

Moulded Case and Miniature Circuit Breakers

5.5 MCCBs and MCBs with fault capacities of 10 kA or more must be in accordance with AS/NZS 60947. MCBs with fault capacities less than 10 kA and a current rating up to 100 A must be in accordance with AS/NZS 3111. All circuit breakers must be able to be locked in the "Off" position. MCCBs need not be mounted on DIN rail.

Residual Current Devices

5.6 Residual Current Devices (RCD) must be in accordance with AS/NZS 3190 and AS/NZS 3111. Where RCD protection is provided on a circuit protected by a MCB, the RCD must be integral with the MCB. Unless otherwise specified, the tripping current for all RCDs must be 30 mA.

6 Switchboard Electrics

Protection against Electrical Transients and Over-Voltage

General

6.1 The installation must incorporate protection against electrical transients and over-voltage. Unless otherwise specified, the installation must follow the recommended practices for the MEN system, specified in AS 4070 for protection of low-voltage electrical installations and Equipment from transient over-voltages. The installation must follow the general guidelines for the protection of persons and property from hazards arising from exposure to lighting in accordance with AS 1768. The switchboard must also include the necessary devices to protect all Equipment being housed in the enclosure from electrical transients and over-voltage.

Surge Diverter

6.2 Surge diverters must be supplied and installed in the switchboard to provide protection against multiple impulses caused by lighting or other transient disturbances. Surge diverters must be connected on the load side of the installation's main switch between the following terminals:

a) phase and neutral;

b) phase and earth; and

c) phase to phase (at multi-phase installations).

6.3 Surge Diverters must:

a) be in accordance with the Australian Standard AS 4070;

b) have a minimum phase-to-neutral single shot 8/20us rating of 80kA and be suitably rated to withstand multiple impulses as defined by location category C in AS 1768;

c) be based on Metal Oxide Varistor (MOV) technology, with each MOV rated at no less than 40kA for an 8/20us pulse. MOVs must be internally fused such that they are disconnected if the unit experiences a surge that exceeds its rating;

d) have visual indication of MOV fuse operation, loss of power, and thermal overload. In the event of a thermal overload, the protection must remain in circuit;

e) have voltage free changeover contact (Alarm output). This must activate upon any MOV failure, power failure or thermal overload condition. The contact must be isolated to 4 kV to all active circuitry;

f) be rated for a nominal operating phase voltage of 230 V / 240 V, and a maximum operating voltage of at least 275 V rms; and

g) have a let through voltage (Residual Voltage) for a 6 kV 1.2/50us, 3 kA 8/20us impulse of less than 900 V when measured at the surge diverter terminals.

Surge Filters

6.4 A surge filter must be supplied and installed on the load side of the surge diverter, and on the line side of sub-circuits supplying electronic Equipment and the earth leakage protective devices of switched outlet sub-circuits. Surge filters must provide finer protection against multiple impulses caused by lightning and other transient disturbances and interferences. The surge filter must be connected between phase and neutral in accordance with AS 4070.

6.5 Surge filters must:

a) have a minimum load current rating of 10A per phase;

b) have a single shot 8/20us rating of 16 kA per mode and must be suitably rated to withstand multiple impulses as defined by location category B in AS 1768;

c) be based upon MOV technology. The line side MOVs must be internally fused such that they are disconnected if the unit experiences a surge that exceeds its rating;

d) have visual tags and LED indicating “power” and “status” for each phase. The power LED must extinguish when power to the unit is lost. The status visual tags and LEDs must extinguish when the MOV fuse operates, when power to the unit is lost, or when the unit experiences a thermal overload. In the event of a thermal overload the protection must remain in circuit;

e) have a voltage free changeover contact (Alarm output). This must activate upon any MOV failure, power failure or temperature overload condition. The contact must be isolated to 4 kV to all active circuitry;

f) be rated for a nominal operating phase voltage of 230 V / 240 V and a maximum operating voltage of at least 275 V rms; and

g) have a let through voltage (Residual Voltage) for a 6 kV 1/2/50us, 3 kA 8/20us impulse of less than 600 V when measured at the surge filter terminals.

Switches and Push Buttons

6.6 Control and test switches and push buttons must comply with AS 60947.5.1. Switches and push buttons must have a minimum rating of 6A at 240 VAC at utilisation category AC-22 in compliance with AS/NZS 3947 Part 1. Control and test switches must meet IP56. Push buttons must be colour coded according to the following functions:

a) Start / On / Close: Green.

b) Stop / Off / Open: Red.

c) Reset / Acknowledge: Black.

Control Relays

6.7 Control relays must be suitable for continuous operation for the application and comply with AS 60947.1. Only one voltage must be used on the contacts of each relay. Control relays must be plug-in type, and be held in the socket base by a captive clip that can be operated without the use of tools.

6.8 Contacts must have a minimum rating of 5A at 240 VAC. Contacts must be electrically isolated, double break, silver alloy, non-welding contacts with a duty level of IIIA as specified in AS 2481. Control relay assemblies must be provided with a minimum of four contacts, and allow expansion to eight contacts in the same assembly. Contact blocks must be readily convertible in the field to either normally open or normally closed contacts.

Time Delay Relays

6.9 Time Delay relays must be adjustable over the full timing range and be accurate within 12.5% of the nominal setting.

Phase Failure Relays

6.10 Phase failure relays must be solid-state with field adjustable trigger level. The sensing circuit must reject frequencies other than 50Hz, and be provided with surge filters.

Power Socket Outlet Panels

6.11 A minimum of two (2) proprietary, power socket outlet panels must be provided in each switchboard enclosure to supply low voltage mains power to Equipment that is mounted within the enclosure but not hard-wired. One completely spare socket outlet panel must be provided. Each power socket outlet panel must:

a) be wired to an individual sub-circuit;

b) provide a minimum of two (2) independently switched socket outlets, arranged so as to allow plug-pack type transformers to be installed in all outlets concurrently;

c) be mounted so that installed plug-pack type transformers do not interfere with Equipment and cabling management system;

d) be easily accessible from the front of the enclosure (and / or rear of the enclosure where rear access is provided);

e) be rigidly fixed to prevent it moving when inserting or withdrawing plugs; and

f) allow any Equipment installed within the enclosure to be connected via a power cord with a maximum of 1,200 mm length.

6.12 Double adaptor and power boards without switched socket outlets must not be used.

7 Minor Switchboards

7.1 All parts of the switchboard must be above the level of the access panel opening, and in any case, must be at least 300 mm above ground level. Switchboards must be limited to 5 Rack Units (RU) (approximately 220 mm) in height.

7.2 Unless otherwise specified, the switchboard must incorporate the following:

a) 1 x Single pole, DIN rail mount, miniature 250 V, 32A fused mains isolating switch;

b) 1 x Single pole, DIN rail mount, 250 V, suitably sized, miniature circuit breaker for the surge diverter;

c) surge diverter and surge filter as per Clauses 5.2 to 5.5;

d) 1 x 250 V, 10A feeding remainder of the switchboard;

e) 2 x 250 V, 6A miniature ELCB protection for separate cabinet lighting and fan circuits;

f) 2 x 250 V, 6A miniature ELCB protection for the socket outlet panels described in Clause 6.10;

g) neutral bar and cover (with a capacity suitable for the circuit requirements of the cabinet);

h) earth bar (with a capacity suitable for the circuit requirements of the cabinet); and

i) earth – Neutral link.

7.3 Where the switchboard enclosure is contained within a larger, shared enclosure, it must be mounted in the highest quarter of the enclosure. In such a case it must have a depth not greater than half that of the larger enclosure, and occupy less than 20% of the larger enclosure.

8 Design and Manufacture

General Design

8.1 Switchboards and control panels less than 100A per phase with the prospective fault current being less than 5kA must be designed and constructed to the requirements of AS/NZS 3000. Other manufactured switchgear assemblies must be in compliance with AS/NZS 61439. Unless otherwise specified, the switchboard must be of type Form 2B as specified in AS/NZS 61439.

External Design

8.2 Switchboard enclosures, panels, doors and the like must be designed and constructed in accordance with AS/NZS 61439 to provide the specified segregation and degree of protection The specified degree of protection must be in accordance with AS 60529

Supporting Structure

8.3 Supporting frames must be fabricated from rolled, cold formed or extruded metal sections with joints fully welded and ground smooth. Concealed fixings or brackets must be located to allow the assembly to be mounted and fixed in the specified location without the removal of the Equipment.

Panels

8.4 Sheet metal angles, corners and edges must be machine folded with a minimum return of 25 mm around the edges of front and rear panels, and 13 mm minimum return edge around doors. Where necessary, panels and doors must be provided with stiffening to prevent distortion or drumming.

Equipment Fixing

8.5 DIN rails and other Equipment must be mounted on Equipment mounting panel(s) that are fixed to threaded metal inserts located towards the rear of the enclosure.

Escutcheon Plates

8.6 Removable, hinged escutcheon plates with neat cut-outs for circuit breaker handles and the like, must be provided. The escutcheon plate must be fitted with lifting handles and captive fixings that can be operated without the use of tools. Sufficient clearance must be provided around equipment to allow for easy removal of escutcheon plates. Unless otherwise specified, the escutcheon plate must be transparent. A continuous support frame must be provided for the fixing of each escutcheon plate and to prevent panel distortion.

9 Installation

Switchboard Enclosure

9.1 Switchboards must be installed in accordance with AS/NZS 3000, and be fixed to comply with AS/NZS 1170. Switchboards must be plumb, level and fixed rigidly into position by at least four (4) fixing screws. Masonry anchors must be used as appropriate.

9.2 Floor mounted switchboards must be mounted on galvanized channel plinths, and fixed to a concrete floor by means of fixing screws at the front and rear, at both end and at intervals not exceeding 2 m

along the length of the enclosure. After levelling, any space under the plinths must be neatly packed with sand-cement grout.

Electrics

9.3 Fuse-holders must be arranged such that the fuse may be extracted directly towards maintenance personnel and not towards live parts. Circuit breakers must be arranged so that the breaker operation status and current rating indications are clearly visible while the switchboard panel cover or escutcheon is in positon.

9.4 Where a preformed switchboard enclosure is used, it must be capable of housing single, double, or triple width MCBs and their related preformed busbars. Proprietary pole fillers must be provided in all unused portions of the clip tray switchboard enclosure.

10 Hold Points

10.1 The following is a summary of Hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
3.4	Provision of sample(s)	10 working days
3.4	Drawings, manufacturer's specifications and diagrams	10 working days

11 Verification Requirements and Records

11.1 The Contractor must supply the following records:

Table RD-ITS-S2 11-1 Records

Document Ref.	Subject	Record to be Provided
RD-ITS-S1.11	Manuals	Operation and maintenance manual(s)
RD-ITS-S1.14	System Documentation	As-Built Documentation