



TS 03984:1.0
T HR RS 00117 ST
Standard

Electric Circuits and Equipment for Passenger Rolling Stock

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1.0	27/06/2014	First issue as T HR RS 00117 ST.
2.0	09/12/2014	Second issue. Changes from previous issue: removal of prescriptive requirements for the numbering of three-phase cables and the types of miniature circuit breakers to be used.
3.0	21/12/2016	Third issue. Changes from previous issue to align with the provisions of: T MU RS 17001 ST, T MU RS 17002 ST, T HR RS 17010 ST and T MU AM 01003 ST.
4.0	21/09/2018	Fourth issue. Changes to content in this version include amendment of Section 15 and Section 19.
1.0	27/08/2024	First issue as TS 03984. Changes from the previous version include adoption of AS/RISB 7530 and references throughout the standard have been updated.

Preface

This standard is a first issue as TS 03984:1.0 and supersedes T HR RS 00117 ST, version 4.0.

This document provides the minimum performance requirements and recommendations for the electric circuits, electric components and electro-pneumatic components for TfNSW passenger rolling stock. This document covers the mechanical, electrical, and fire performance requirements of these items.

This document has been prepared by AMB to adopt AS/RISB 7530 to provide the minimum performance requirements for the electric circuits and equipment of TfNSW passenger rolling stock. The adoption of AS/RISB 7530 is to promote standard harmonisation and asset interoperability. This is in line with the consultation results with TfNSW and other national rolling stock industry stakeholders.

This document aims to ensure the reliability, availability, maintainability and safety of the electric circuits, electric equipment and electro-pneumatic equipment used in passenger rolling stock.

Changes to content from the previous version include the adoption of AS/RISB 7530 and references throughout the standard have been updated.

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1 Scope

This standard covers the following electric circuits and electric and electro-pneumatic components for passenger rolling stock:

- traction and auxiliary power and control circuits and their components
- communication and auxiliary control circuits and their components
- electric components such as switches, push buttons, circuit breakers, and fuses
- electro-pneumatic and electro-magnetic devices such as magnetic valves and high speed circuit breakers.

2 Application

This document applies to new passenger rolling stock and the refurbishment or modifications of existing rolling stock assets.

This document should be read in conjunction with the following standards that also apply to rolling stock electrical requirements:

- TS 03999 *Electronic Equipment for Rolling Stock*
- TS 04000 *Cables for Passenger Rolling Stock*
- TS 03985 *Mounting and Installation of Electrical Equipment*.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

EN 50121-3-1 *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

EN 50121-3-2 *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

EN 50153 *Railway applications – Rolling stock – Protective provisions relating to electrical hazards*

EN 50163 *Railway applications – Supply voltages of traction systems*

IEC 60034-1 *Rotating electrical machines – Part 1: Rating and performance*

IEC 60051-1 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 1: Definitions and general requirements common to all parts*

IEC 60077-1 *Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules*

IEC 60349-2 *Electric traction – Rotating electrical machines for rail and road vehicles – Part 2: Electronic converter-fed alternating current motors*

IEC 60850 *Railway applications – Supply voltages of traction systems*

IEC 61991 *Railway applications – Rolling stock – Protective provisions against electrical hazards*

IEC 62236-3-1 *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2 *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC TS 63064 *Graphical symbols for diagrams – Guidance on design for standardization in IEC 60617*

Australian standards

AS/RISB 7530 *Electrical systems*

Transport for NSW standards

TS 01506 (all parts) *Development of Technical Maintenance Plans*

TS 03985 *Mounting and Installation of Electrical Equipment*

TS 03988 *Electric Auxiliary Power Supply and Battery System for Passenger Rolling Stock*

TS 03996 (T HR RS 17010 ST) *Passenger Rolling Stock Fire Safety*

TS 03999 *Electronic Equipment for Rolling Stock*

TS 04000 (T MU RS 00164 ST) *Cables for Passenger Rolling Stock*

TS 04002 *Environmental Conditions for Fleet Assets*

TS 04003 (T MU RS 17002 ST) *Prohibited and Restricted Materials*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ac alternating current

AMB Asset Management Branch

dc direct current

ELV extra low voltage

heavy current currents in excess of 30 A

HV high voltage

light current currents of 30 A or less

LV low voltage

RISSB Rail Industry Safety and Standards Board

TfNSW Transport for NSW.

5 Operating environment

All electrical equipment shall be suitable for use in the environmental conditions as defined in TS 04002.

6 General requirements

Electric circuits and equipment for passenger rolling stock shall comply with the requirements of AS/RISSB 7530. Where this document includes additional requirements or variations to the requirements of AS/RISSB 7530, the requirements of this document shall apply.

The requirements specified in this section take precedence if a conflict arises with the requirements shown elsewhere in the document.

All passenger rolling stock electrical circuits and equipment shall comply with the following standards:

- IEC 62236-3-1 (compliance with EN 50121-3-1 shall be deemed to comply)
- IEC 62236-3-2 (compliance with EN 50121-3-2 shall be deemed to comply)
- IEC 61991 (compliance with EN 50153 shall be deemed to comply)
- IEC 60850 (compliance with EN 50163 shall be deemed to comply)
- IEC 60034-1
- IEC 60077-1
- IEC 60349-2
- IEC TS 63064.

Voltage classification shall comply with IEC 61991 (or EN 50153) requirements set out in Table 1.

Table 1 – Voltage classification

TfNSW definition	Band	Nominal voltage (Un) V ac	Nominal voltage (Un) V dc
extra-low voltage	I	$U \leq 25$	$U \leq 60$
extra-low voltage	II	$25 < U \leq 50$	$60 < U \leq 120$
low voltage	III	$50 < U \leq 1000$	$120 < U \leq 1500$
high voltage	IV	$U > 1000$	$U > 1500$

All materials and equipment shall be suitable for use in the TfNSW rolling stock environment and remain suitable without attention for use in that environment for a minimum of six years of service, from placing in service unless otherwise specified in the contract specification. Variance to this period shall be approved in writing by a concession to this document.

The supplier shall provide adequate evidence that the materials used will not cause any environmental damage.

All materials shall comply with the requirements of TS 04003.

7 Fire protection requirements

All new equipment shall comply with TS 03996.

8 Circuit diagrams

Major electrical systems and equipment shall be accompanied by technical manuals that include functional systems diagrams, as well as point to point systems diagrams and detailed descriptions of operation for the purpose of assessment, maintenance, fault-finding and future modification activities. In such cases, a technical maintenance plan shall also be provided, which complies with TS 01506 (all parts). These documents, including all notes and symbols, shall be in English.

Circuit diagrams shall be clear and easy to interpret and comply with IEC TS 63064.

The interlocks, contacts and controlled equipment of any device shall be shown and clearly identifiable by reference to only one drawing.

A legend shall be available for all component symbols.

An electrical circuit diagrams package shall be supplied in an editable computer-aided design and searchable portable document format along with a bound hard copy.

An abbreviations table shall be available to define all abbreviations.

An index showing the drawing zone location of all numbered circuit links, wires and circuit components shall be available.

9 Circuits and earthing

9.1 General

Requirements for circuits and earthing shall comply with the relevant sections of AS/RISSB 7530 and with the additional requirements set out in Section 9.

The requirement of “All single-phase circuits shall have one pole of each device connected directly to the negative or neutral line with no switches, fuses or contacts.” in AS/RISSB 7530 shall be read as “All single-phase ac circuits shall have one pole of each device connected directly to the neutral line with no switches, fuses or contacts.”

Each circuit function shall be protected by an individual circuit breaker. The circuit breakers shall be clearly and unambiguously labelled.

Where regular switching by hand is anticipated, separate switches shall be provided.

9.2 Alternating current circuit protection

Protection and isolation of ac circuits up to and including LV shall be by magnetic circuit breakers backed up by power source circuit breakers.

Sources of ac shall have the neutral earthed and a ganged circuit breaker in each phase.

Proof of adequate protection of the power source by this circuit breaker shall be provided. That is, both the machine characteristic and circuit breaker characteristic shall be consistent.

The loading of each phase of three-phase power sources shall be within 5% of each other.

9.3 Direct current circuit protection

Protection and isolation of dc circuits up to and including LV shall be by magnetic circuit breakers backed up by power source fuses. An exception to this is motor circuits, where high rupturing capacity (also known as ‘high rupture current’) fuses shall be used for motors rated at more than 1 kW.

9.4 Earthing

Protective earthing shall comply with IEC 61991 (compliance with EN 50153 shall be deemed to comply).

Separate insulated earthing bars shall be provided for the HV, LV and ELV circuits on each car.

Each circuit shall have a separate insulated wire connecting the negative or neutral to a separate bolted terminal on the respective bars. The ac and dc circuits, or circuits of different voltages, connected to the same earthing bar, shall be arranged in groups of like circuits.

LV and ELV earthing bars shall be directly bonded to the car body.

The HV earth return circuits shall be arranged in a manner that avoids the possibility of leakage paths through wheel set bearings and stray ac signal induced currents elsewhere.

Earthing bars for HV circuits shall be connected to rail by two separate paths that are insulated from the car bodies of the train up to the earth return brushes on the wheel sets. These two separate paths shall go to wheel sets on separate bogies in the same car. The HV earth return cabling shall not have direct electrical connections with the car body or bogie frames, apart from the wheel set earth return brushes.

The car body shall be earthed directly to earth return brushes on the wheel sets by at least two separate paths. These two separate paths shall go to wheel sets on separate bogies. The paths shall be independent from the HV earthing paths. There shall not be intermediate electrical connections to bogies.

Bogie frames and bogie-mounted traction motor frames may share common electrical connections to earth return brushes on the wheel sets.

Earthing connections shall be made onto surfaces suitably prepared to provide adequate earthing continuity that are cleared of surface contaminants such as oils or paint.

Where special earthing arrangements for electronic equipment are required, these arrangements shall be submitted to the authorised TfNSW contract representative for approval.

The use of unearthed circuits shall require a concession to this document.

9.5 Colour coding and marking of cables

The colour coding and marking of cables shall comply with TS 04000.

10 Auxiliary contacts

Requirements for auxiliary contacts shall comply with the relevant section of AS/RISSB 7530.

11 Power contactors and arc control devices

Requirements for power contactors and arc control devices shall comply with the relevant section of AS/RISSB 7530.

12 Coils and windings of small inductances and transformers

Requirements for coils and windings of small inductances and transformers shall comply with the relevant section of AS/RISSEB 7530.

13 Cable connectors and plug-in components

Requirements for cable connectors and plug-in components shall comply with the relevant section of AS/RISSEB 7530.

14 Calibrated devices

Calibrated relays or electronic modules shall have their adjusting mechanism securely locked after setting.

15 Low voltage, extra low voltage switches and push buttons

Requirements for LV, ELV switches and push buttons shall comply with the relevant section of AS/RISSEB 7530 with the following additional requirement.

Tumbler switches shall have the 'off' position upwards (2 position type) or in the mid position (3 position type) except where otherwise approved.

16 Circuit breakers

Requirements for circuit breakers shall comply with the relevant section of AS/RISSEB 7530 with the following additional requirement.

All LV ac general-purpose outlets shall have residual current device protection.

17 Fuses

Requirements for fuses shall comply with the relevant section of AS/RISSEB 7530. The classes of fuses are:

- LV and ELV fuses
- HV fuses.

18 High voltage or heavy current resistors

HV or heavy current resistors shall be prevented from shorting out in overload conditions in normal service.

19 Light current resistors

Light current resistors greater than 5 W rating shall be of the wire or strip wound type, with the conductor set in vitreous enamel or silicone cement coating. In all cases the coating shall not peel off or disintegrate.

The sliders of pre-set resistors shall be adequately locked in position.

Fixed resistors of standard resistance values shall be used. Where this is not possible, the use of variable resistors shall be subject to a concession to this document.

The value, rating and tolerance shall be marked on the resistor.

20 Capacitors

Requirements for capacitors shall comply with the relevant sections of AS/RISSB 7530 and TS 03988.

21 Electrical measuring instruments

All analogue electrical measuring instruments and their accessories shall comply with IEC 60051-1. These instruments shall have a true zero and movements suitably damped for railway service.

All instruments and their parts shall be protected from tampering.

Instruments shall be suitable for mounting in any orientation and on ferro-magnetic material.

All instruments and their parts shall only be accessible for removal by maintenance staff.

All instruments shall be accurate to $\pm 0.75\%$ of full scale or better.