**Discipline**
## Engineering Standard - NSW

**Category**
## Signalling

**Title**
# Electrical & Electronic Components (Ratings & Construction Requirements)

**Reference Number**
## SPS 05 - (RIC Standard: SC 00 26 00 00 SP)

**Document Control**

| Status | Date | Prepared | Reviewed | Endorsed | Approved |
|---|---|---|---|---|---|
| Issue 1 Revision 3 | May 05 | Standards and Systems | Standards Engineer | GM Infrastructure Strategy & Performance | Safety Committee |
| | | Refer to Reference Number | H Olsen | M Owens | Refer to minutes of meeting 12/08/04 |

## Disclaimer

Australian Rail Track Corporation has used its best endeavors to ensure that the content, layout and text of this document is accurate, complete and suitable for its stated purpose. It makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems of work or operation. Australian Rail Track Corporation will not be liable to pay compensation in respect of the content or subsequent use of this document for any other purpose than its stated purpose or for any purpose other than that for which it was prepared except where it can be shown to have acted in bad faith or there has been willful default.

## Document Approval

The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

## Document Supply and Control

The Primary Version of this document is the electronic version that is available and accessible on the Australian Rail Track Corporation Internet and Intranet website.

It is the document user's sole responsibility to ensure that copies are checked for currency against the Primary Version prior to its use.

## Copyright

## About This Standard

This Specification describes the general design, rating, and construction requirements for electrical and electronic components to be used in signalling equipment.

This Specification only applies to electrical and electronic equipment or modules that form part of the signalling system or directly interface to the signalling system.

Note: For the purposes of this Specification, signalling equipment and the signalling system only include those parts of the signalling infrastructure that directly relate to safety.

## Document History

**Primary Source –** RIC Standard SC 00 26 00 00 SP Version 2.0

**List of Amendments –**

| ISSUE | DATE | CLAUSE | DESCRIPTION |
|---|---|---|---|
| 1.1 | 01/09/2004 | | Reformatting to ARTC Standard |
| 1.2 | 14/03/2005 | Disclaimer | Minor editorial change |
| 1.3 | 06/05/2005 | All | Document reformatted |
| | | | |
| | | | |
| | | | |

## Contents

## 1. Introduction

This Specification describes the general design, rating, and construction requirements for electrical and electronic components to be used in signalling equipment.

This Specification only applies to electrical and electronic equipment or modules that form part of the signalling system or directly interface to the signalling system.

**Note:** For the purposes of this Specification, signalling equipment and the signalling system only include those parts of the signalling infrastructure that directly relate to safety.

The intent of this Specification and its requirements is to ensure that the item of equipment produced shall have a service life of greater than 20 years and a Mean Time Between Failures of greater than 100,000 hours in the environment that the equipment is to be installed. Where there is any conflict or details are not specified, the onus is on the designer or supplier of the equipment to design or select components that meet the intent of this Specification.

If the supplier or designer is in doubt concerning component selection then the

US MIL-HDBK-217E or later provides the means to predict the reliability of electronic equipment. US MIL-HDBK-217E may be used in reverse as an aid in determining the quality and rating requirements for the components to be used in the equipment.

## 2. Referenced Standards

The following Australian Standards are referenced in this specification:

| | |
|---|---|
| AS 1243 | Voltage transformers for measurement and protection |
| AS 1352 | Fixed resistors for use in electronic equipment |
| AS 1541 | Fixed capacitors for use in electronic equipment |
| AS 1675 | Current transformers - Measurement and protection |
| AS 2065 | Preferred number series for Resistors and Capacitors |
| AS 2066 | Marking codes Resistors and Capacitors |
| AS 2374 | Power transformers |
| AS 2546 | Printed Boards |
| AS 2547 | Semiconductor devices. |
| AS 2735 | Dry-type power transformers |
| AS 3108 | Approval and test specification-Particular requirements for isolating transformers and safety isolating transformers |

AS 3147 Approval and test specification - Electric cables - Thermoplastic insulated for working voltages up to and including 0.6/1kV

AS 3260 Approval and test specification - Safety of information technology equipment including electrical business equipment

AS 3508 Printed Board Assemblies

AS 3953 Loading guide for dry-type power transformers

The following International standards or documents are referred to in this specification:

US MIL-HDBK-217E *Reliability prediction of electronic equipment*

VDE 110 *Specification for clearances and creepage distances in electrical equipment*

The following ARTC specifications are referenced by this specification:

Specification SC 05 15 00 00 SP - Non-Vital Relays for Signalling Applications

Specification SCP 04 - Lightning/Surge Protection Requirements

Specification SPS 06 - Connectors for Signalling Interface

Specification SPS 10 - Relays, Plug-in Vital

Specification SPS 51 - Solderless Terminals - Terminal Blocks

Specification SPS 33 - Solderless Terminals - Cable Lugs for Railway Signalling Applications

# 3. Operating Environment

## 3.1. Electrical

### 3.1.1 Power Supplies

Power supplies for signalling purposes are not regulated. Their voltages may fluctuate either slowly or quickly between the voltages given.

The 120 volt AC signalling power supply varies from 108 to 132 volts.

The 50 volt DC signalling power supplies are full wave rectified, and are not filtered. These supplies are typically set at 55 volts but may vary from 48 to 60 volts. This results in up to 85 volts peak on the supply.

The 24 volt DC signalling power supplies vary from 20 to 32 volts DC. The 12 volt DC signalling power supplies vary from 11 to 20 volts DC.

### 3.1.2 Back EMF

The signalling system uses relays with coils of up 8 Henrys inductance. The back EMF produced when these relays are de-energised is normally dissipated by arcing across the opening contacts.

Component selection needs to take account of the back EMF produced by the signalling relays. Suitable components may not be able to be selected and the design will have to provide the means of managing the back EMF. This includes the management of voltages induced from other circuits.

## 3.2. Physical

### 3.2.1 Locations

The expected temperature range is 0 to 70 degrees.

The environment is a Pollution degree 3 for the purposes of Australian Standards and a Group C environment VDE standards.

Humidity is 0 to 95% non-condensing.

It is expected that there will occasionally be rain blown onto the equipment through an open door.

### 3.2.2 Buildings

The expected temperature range for a building is 0 to 50 degrees.

The environment is a Pollution degree 3 for the purposes of Australian Standards and a Group C environment VDE standards.

Humidity is 0 to 95% non-condensing.

# 4. Components

Components shall be capable of operating continuously at the maximum ambient temperature expected in the environment that the equipment is intended for use.

## 4.1. Resistors

Resistors shall conform to the following Australian Standards:

| | |
|---|---|
| AS 1352 | Fixed resistors for use in electronic equipment |
| AS 2065 | Preferred number series for Resistors and Capacitors |
| AS 2066 | Marking codes Resistors and Capacitors |

The minimum limiting element voltage for fixed resistors shall be 250 volts DC.

Resistors shall have a power rating selected such that:

- resistors do not exceed a surface temperature of 40 Celsius above ambient.
- they do not pose a hazard to personnel due to there operating temperature.
- they do not pose a fire hazard.

Variable resistors, Potentiometers, Pre-set resistors, and Trim pots having a power dissipation rating of less than 5 watts shall be of enclosed or sealed construction.

Wirewound variable resistors having a power rating of 5 watts or greater shall use porcelain formers and should use non soldered terminals.

### 4.2. Capacitors

Capacitors shall conform to the following Australian Standards:

AS 1541 Fixed capacitors for use in electronic equipment

AS 2065 Preferred number series for Resistors and Capacitors

AS 2066 Marking codes Resistors and Capacitors

Electrolytic capacitors shall be the long life type conforming to IEC384-4.

In general capacitors shall have their type and working voltage selected such that their life and robustness are suitable for an item of equipment that will be in continuous service for 20 years.

### 4.3. Semiconductors

Semiconductor devices shall comply with AS 2547 *Semiconductor devices.*

The semiconductor devices used should be devices that are in common usage at the time of design or manufacture and have a predicted production life of greater than 5 years.

Power and general purpose diodes shall at least be rated for 1 ampere and 1000 volt peak inverse voltage.

Power and switching semiconductors shall:

- have a breakdown voltage at least twice the working voltage of the circuit.
- be rated for twice the expected operating current.
- be protected against highly inductive loads.

### 4.4. Transformers and Inductors

Power transformers, isolating transformers, matching transformers and inductors shall comply with the requirements and recommendations of the appropriate Australian or International standards. The following Australian Standards need to be considered :

AS1243 Voltage transformers for measurement and protection

AS 1675 Current transformers - Measurement and protection

AS2374 Power transformers

AS2735 Dry-type power transformers

AS3108 Approval and test specification-Particular requirements for isolating transformers and safety isolating transformers

AS3953 Loading guide for dry-type power transformers

Transformers shall withstand a minimum of 1500 volts AC for 1 minute without breakdown. This implies the use of class H or better insulation.

Isolating transformers shall comply with AS3108 Approval and test specification-Particular requirements for isolating transformers and safety isolating transformers.

### 4.5. Relays

Relays shall have a mechanical life that exceeds their electrical life. Relays shall have an electrical life for their contacts that equals or exceeds 100,000 operations at full electrical load.

Contacts shall be suitably rated for their purpose. The isolation between contacts shall be at least 250 V RMS.

Change over contacts shall be break before make type unless specifically required as make before break.

Relays should comply with either Specification SC 05 15 00 00 SP “Non-Vital Relays for Signalling Applications” or Specification SPS 10 “Relays, Plug-in Vital”, whichever is most relevant.

### 4.6. Printed Circuit Boards

Printed Circuit Boards shall comply with AS 2546 “Printed Boards”. The designers of Printed Circuit Boards shall follow the guidance provided by “AS 2546 Printed Boards”.

Printed Circuit Board assemblies shall comply with, and follow the recommendations of AS3508 “Printed Board Assemblies”.

Either a permanent protective coating, permanent solder resist, or conforming coating shall be applied to Printed Circuit Boards. The decision as to which method of protecting the board is made based on the implications for the failure of the equipment or the level of integrity required for the equipment.

Printed Circuits Boards shall have a minimum track creepage spacing of 0.5 mm. 50 volt DC circuits shall have a minimum track creepage spacing of 1.8 mm. 120 volt AC circuits shall have a minimum track creepage spacing of 2.0 mm.

Note that this track spacing is based on AS3260 “Approval and test specification - Safety of information technology equipment including electrical business equipment” Table 6: Minimum creepage distances for Pollution degree 3. The use of Table 7: Minimum separation distances for coated printed boards, is not currently accepted.

Components that produce sufficient heat that they may damage the Printed Circuit Board with long-term continuous operation shall be mounted in such a manner as to prevent such damage.

### 4.7. Connectors/Sockets

Refer to Specification SPS 06 “Connectors for Signalling Interface” for details on connectors to be used to interface to the Signalling System.

The following requirements apply equally to connectors and sockets even though only the word connector is used. Note that the term “sockets” also refers to IC sockets:

- Connectors shall be rated for at least 100 insertions and removals.
- Connectors should have a wiping action between the electric contact points when making the connection.
- Each contact surface shall maintain electrical connection in at least 2 points.
- Connectors using machined pins are strongly preferred.
- Connectors used for circuits operating at less than 12 volts DC, or having an operating current of less than 3 mA shall have contacts with at least 0.25 micron of gold plating.

### 4.8. Terminals

Screw type or cage-clamp terminals are preferred. The Screw type or cage-clamp terminals shall comply with VDE 110 “Specification for clearances and creepage distances in electrical equipment” for 250 V RMS in a group C environment.

The screw in screw type terminals shall not press directly onto the wire that is being secured. Screw type terminals shall use a wire protector that will not foul the terminal hole or come loose when the wire is withdrawn from the terminal.

Terminals should comply with Specification SPS 51 “Solderless Terminals - Terminal Blocks”.

### 4.9. Wires and Cables

Wires and cables shall use PVC V75 or better insulation.

The minimum, maximum working voltage for wires and cables shall be 250 volts RMS.

Wire and cables shall comply with AS3147 Approval and test specification - Electric cables - Thermoplastic insulated for working voltages up to and including 0.6/1kV as appropriate.

The ends of stranded wire of cross sectional area less than 4 $mm^2$ shall be terminated using a bootlace ferrule or suitable crimp lug. Terminations should comply with Signal Standard Specification SPS 33 “Solderless Terminals - Cable Lugs for Railway Signalling Applications”.

All cable or wire shall run continuously without a joint from terminal to terminal.

The insulation of all wires shall be durable and capable of withstanding the maximum temperatures likely to be encountered in service, without deterioration of the mechanical and insulating properties. Wherever wires pass through holes in metal work or any other hard material, they shall be protected by suitable grommets securely fixed to the holes.

### 4.10. Fans

The use of fans is discouraged. However if required, fans shall have an average life expectancy of 50,000 hours or greater.

## 4.11. Lamps/Indicators

LEDs are preferred for use as indicating devices. Indicators should be clear LEDs with a viewing angle of 20 degrees or greater. LEDs with a water clear lens are preferred, as they will not give a false indication in bright light.

The maximum operating current for an LED should be less than 20 mA.

Incandescent lamps used for indicating purposes shall have an average life of 5,000 hours or greater. They may be operated at a voltage significantly lower than their nominal voltage if this will extend there operating life.

## 4.12. Switches

Switches shall be rated for at least 10,000 operations at full electrical load. Switches should at least use silver plated contacts. Switches should be rated for 250 volts operation.

## 4.13. Protection devices

Arrestors, Varistors, Divertors and earthing should be in accordance with Specification SCP 04 “Lightning/Surge Protection Requirements”.