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Signalling

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Specification - Audio Frequency Jointless Track Circuits for Main Line Applications

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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.

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About This Standard

This Specification covers the manufacture, supply and delivery of Railway Track Circuit Equipment specifically designed to eliminate the use of insulated rail joints.

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Document History

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List of Amendments –

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1.3	06/05/2005	All	Document reformatted

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1. Introduction

This Specification covers the manufacture, supply and delivery of Railway Track Circuit Equipment specifically designed to eliminate the use of insulated rail joints.

From time to time the State and Federal governments lay down policies for preference for Australian manufactured equipment. These will be applied to the purchase of equipment conforming to this specification.

Where the equipment is offered in a form which has previously been granted type approval, only the Information Schedule (First part of Appendix 1) has to be completed by the supplier. Where no type approval has been received, or the equipment differs in any detail from similar type approved equipment, then all of the requirements of Appendix 1 must be complied with by the supplier.

1.1. Standards and Specifications

This equipment is required for the continuous detection of the presence of passenger and other trains moving in the track circuited area. The track circuits form the basis of the signalling system, and their integrity and reliability is fundamental to the safe operation of trains. The highest standards of design, construction, components and workmanship are imperative.

Australian Standard Specifications relating to any component, system or method of testing are deemed applicable to and form part of this Specification, or in their absence the relevant British Standard Specifications. However, where conflicts exist, this Specification shall take precedence over either.

Specific Standards applicable to this Specification are:

ARTC

Specification SPS 05, `Electronic Components'

Specification SPS 03, `Documentation and Drawings'

Specification SCP 04, ‘Surge Protection'

Specification SPS 40, `Cables for Signalling Applications'

Specification SPS 49, `High Frequency Shielded Cable'

2. Performance Requirements

The equipment shall meet the following minimum performance requirements.

2.1. Track Length

Operate effectively for a range of lengths from a minimum of 50 metres, to a maximum of at least 600 metres, under all local conditions. These lengths shall be as measured between transmitter and receiver ends of a track; centre fed arrangements shall be counted as two track circuits for this purpose.

2.2. Operating Frequencies

Operate in the mid-audio frequency range, and use a minimum number of discrete operating frequencies. Sufficient frequencies shall be used to provide effective

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isolation between successive track circuits on one road, and between adjacent roads.

The frequencies currently used and preferred by ARTC are 1700, 2000, 2300 and 2600 Hz (nominal frequencies).

The arrangements and equipment layout used must be such that similar frequency interference at any receiver is no more than 10% of the input level sufficient to produce energisation of the receiver when set at maximum gain.

Suitable modulation methods shall be applied to make the equipment immune to interference, especially from 50 Hz traction systems and chopper-controlled rolling stock under DC traction.

2.3. Shunt Sensitivity

Have a minimum train shunt sensitivity of 0.15 ohms, over the entire length of the track. Dead areas, ie sections of track where a shunt of 0.15 ohms across the rails is not detected, are not permitted. No objection is raised to slight overlapping of track circuits at separation joints. Broken rail detection is required at all times.

2.4. Fail Safety

Be completely fail-safe in design and application. If any component or connection in an operating track circuit fails in any mode, open circuit, short circuit or an intermediate condition, the track circuit itself and/or one or more of the two contiguous track circuits must immediately go to an 'occupied' state.

2.5. Pick-up Time delay

Incorporate an integral time delay, to prevent energisation of the track relay during momentary loss of shunt during the passage of a train. This delay shall be of at least 300 mS duration.

2.6. Output Protection

Provide transmitters and receivers with protection which enables them to operate for an indefinite period with the output of either one short-circuited or open-circuited, without permanent damage to the unit.

2.7. Power Supply

Operate from either 50 Hz AC mains at 120 volts with +/- 10% variation, or unregulated filtered DC supplies between 22 and 28 volts DC. No phase relationship shall need to be maintained between AC supplies at either end of a track circuit.

Require no restriction on the number and type of units sharing any one power supply unit, other than that dictated by the total load rating of the unit.

2.8. Captive Wiring Connections and Unit Coding

Provide rack-mounted units with some means of wiring termination which eliminates the possibility of incorrect connection being made when a unit is replaced under emergency conditions. Alternatively, they shall be so designed that no mis-connection can render the track circuit less shunt-sensitive than before the change.

Provide plug-in modules with coding to prevent insertion of any unit of incorrect frequency or type.

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2.9. Adjustment

Provide for simple measurement and setting of correct operating levels, and subsequent adjustments. A single voltage or current value at the receiver input must be established as the track circuit adjustment criterion.

2.10. Continuous Train Control

Are not required to make specific provision for information transfer by the track circuit to train-borne apparatus at this stage, but equipment permitting addition of this facility at a later date would be viewed favourably.

3. Operating Environment

The track circuits will be required to operate reliably in the following operating environment:

3.1. Track Characteristics

Gauge	1435 mm
Rail	53 and 60 Kg/m
Sleepers	Timber (hardwood) or concrete with steel reinforcement
Ballast	Crushed stone, may be up to head of rail
Ballast resistance	• (min) 1.5 ohm Km (0.66 mho/Km) • (max) 20 ohm Km (0.05 mho/Km) (concrete sleepers with nylon insulated chairs and resilient fasteners)
Structure Gauge and Track Maintenance Clearance	No track-side equipment, including track circuit connection units, may be located closer than 2.5 metres from the running face of the nearest rail.

3.2. Electric Traction

This equipment will be installed under any of three traction arrangements:

a) DC traction, at 1500 volts, and maximum current to 6000 amperes continuous, per train

b) AC traction, at 25 kV (25-0-25 distribution), and maximum continuous current to 2000 amperes, per train. (At a future date)

c) No electric traction Specific conditions applying to these applications are described below.

3.2.1 DC Traction Return

Traction return continuity at interfaces to other track circuits, or where insulated rail joints are required to provide a very sharply-defined cut-off point, is achieved by means of impedance bonds of the following types:

1000 amp/rail	Westinghouse MJS or similar	Westinghouse

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(unresonated)	MJ or similar
	Jeumont Schneider CIT1400 CT1
2000 amp/rail (resonated in 50 Hz use, may be resonated for audio-frequency use)	Westinghouse 2000R or similar

3.2.2 Traction tie-ins

Where there are two or more tracks in parallel, current sharing is provided between adjacent tracks by means of impedance bonds mounted in both tracks.

In DC traction areas, tie-ins are provided at intervals of between 1000 and 1600 metres (with no more than one tie-in per track circuit). Currently this is done using Westinghouse MJS or similar bonds, or with CIT1400 CT1 bonds used either unresonated or resonated, depending on the length of track circuit.

For AC traction, tie-ins are provided at 600 metre intervals, between the neutral points of aircored inductors in each tuned loop, and to a continuous 70mmsq bare copper buried earth wire.

3.2.3 Electrolysis Protection

In areas of DC electrification, connections may be provided to other buried services, to protect them against electrolysis damage from stray traction current.

These connections may be passive, or active devices injecting up to 30 amperes DC into the rail. The connection to rail is made to a track circuit neutral point, in one of the following ways:

- to the neutral point of a conveniently-located existing impedance bond;
- to the centre-tap of a conveniently-located air-cored inductor in a tuned loop, if available;
- to the centre-tap of a purpose-designed iron-cored inductor, connected across the track circuit at the required connection point.

3.2.4 Overhead Spark Gap Arrestors

In DC traction areas, overhead wiring support structures are normally of steel, not connected together but having low but finite resistance to earth by way of their footings. This has been measured to range from about 400 ohms, to less than 5 ohms, depending on local conditions. Provision is made to connect each individual structure to rail, to dissipate hazardous potentials arising due to insulation failure. This is done via a spark gap which becomes conductive at potentials in excess of 50 volts. The integrity of spark gaps cannot be guaranteed as, once broken down, they normally remain in a conducting or low-resistance state. Breakdown may be caused by electrical storms or general deterioration, connecting the rail(s) to earth via the structure footing.

Provision must be made for the existence of such rail connections, and the equipment must continue to detect trains satisfactorily.

3.2.5 Chopper-controlled Rolling Stock

Thyristor (chopper) controlled DC electric rolling stock is in use on the system. This

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uses switching frequencies of 196, 392, and 784 Hz. This stock is also fitted with static inverter equipment operating at 1200 Hz, and rated at 130 kVA per unit.

3.3. Environmental

3.3.1 Temperature

The equipment will be required to operate reliably with ambient free-air shade temperatures between 10C and 45C, and equipment housing temperatures exceeding 70C.

3.3.2 Humidity

Relative humidity ranges from 20% to 100% condensing.

3.3.3 Rainfall

Average annual rainfall ranges up to 1500 mm per annum, with peak rainfall up to 200mm per hour recorded.

3.3.4 Lightning

Much of the installation area for these tracks experiences lightning activity which is severe in both strike intensity and frequency. ARTC standards for lightning protection of signalling equipment are detailed in Specification SCP 04. The particular arrangement applicable to this type of equipment is that shown in Section 5 of that specification.

3.3.5 Insolation

Maximum solar radiation expected is 10.5 watts per sq metre of surface. It should be assumed that all of the incident heat will be absorbed, as outdoor equipment will not necessarily be kept painted or free of airborne industrial fallout.

3.4. Vandalism and Security

In common with other trackside equipment, track circuit equipment in the installation area is often subjected to physical attack by vandals.

Trackside equipment shall be provided with lockable metal housings, either integral or external to the main unit, to provide protection against vandal attack. The tuning of units shall not be subject to deterioration due to the use of such housings.

All trackside unit housings shall be suitable for securing with the standard padlock. This lock has a bow of 6 mm dia cross-section, with a maximum bow-to-body clearance of 20 mm.

4. Signalling Design Requirements

The equipment shall be able to provide the following circuit applications, which may be peculiar to ARTC. The supplier shall provide typical circuits demonstrating the recommended solution for each application.

Typical circuits, showing the application of each technique to conventional track circuits, are provided in Appendix 1.

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4.1. Track Stick

This circuit proves the normalisation of a signal by inhibiting the energisation of the replacing track circuit relay until all of the signal's control relays are proved normal.

4.2. Cut Tracks

Cut track operation may be required, with the output relay of one track circuit controlling the transmitter of the contiguous track. Direct control of one transmitter by another track's receiver output is not required.

4.3. Output Relays

The receiver output must be capable of operating directly a 24 volt or 50 volt signalling relay of the British Rail Board Specification 930 series.

5. Installation Requirements

5.1. End/centre feeds

The track circuits shall be suitable for use in both conventional end-fed arrangements, and as centre-fed tracks.

5.2. Location of indoor equipment

Indoor equipment (such as transmitters and receivers) will be located in a variety of housings, ranging from brick walk-in buildings, to small aluminium or steel trackside cupboards. The separation between indoor and trackside equipment may be required to be as much as 1500 metres; the equipment offered shall include provision for this situation.

5.3. Rack-mounting of equipment

All indoor equipment shall be modular in design, suitable for mounting on either BRB standard relay racking, or on SNCF 'NS 1' type mounting channel. Units shall be designed for convenient removal and remounting by a single person.

5.4. Tail Cables

The standard cable for connection between indoor and trackside equipment is a shielded twin cable, with 7/0.50 mm conductors having a DC loop resistance of 27 ohms per Km.

The standard arrangements for connection of trackside units to rail are shown in ARTC drawing CO7980/2, in Appendix 3. This arrangement will apply equally to all new equipment.

6. Warranty

The supplier shall provide a warranty on all items of equipment supplied, for a period not less than that specified below.

6.1. Contract Works

Where the material is supplied as part of a supply and installation contract, the warranty period shall be for 12 months from the date of practical completion of each separable part of the works.

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6.2. Supply-only Contract

Where the material is provided on a supply-only basis, the warranty period shall be for 12 months from the date of receipt, or for 6 months from the date of commissioning of the equipment, whichever is the later. Storage conditions shall in no case be less arduous than the in-service environmental conditions applying to rack-mounted field equipment.

6.3. Material in Store - Storage Life

For material purchased for placing into stock for later use, the supplier shall state a maximum 'storage life' period, beyond which the provisions of Clause 6.2, above cannot be extended.

7. Packaging and Delivery

Units of equipment provided on a supply-only basis shall be individually packaged to provide adequate protection to maintain them in as-new condition for the duration of their warranted storage-life, under basic storage conditions.

Units installed as part of contract works may be packaged in whatever way is required by the installation Contractor. Units provided as spares under an installation contract shall be supplied individually packaged, the same as supply-only items.

8. Provision of Information

8.1.1 Type-approved Equipment

The quotation shall be accompanied by a completed information schedule, together with all supporting documentation required. A copy of the Schedule is provided as Appendix 1 of this Specification.

8.1.2 New non-type-approved Equipment

In addition, the supplier shall provide complete documentation for type approval as specified in Appendix 1 , 'Type Approval Requirements'.

8.1.3 Equipment substantially of type-approved items

In addition to the Information Schedule (Clause 8.1.1), the supplier shall provide the documentation required for type approval of those items which are new or subject to design changes subsequent to any previous type-approval.

8.2. Test Certificates

Test certificates shall be produced by the manufacturer, documenting the testing and adjustment of all items of safety equipment provided under this specification. These records shall be retained by the manufacturer for a period not less than the nominated storage life and warranty period of the equipment. They shall be made available to the ARTC General Manager ISP or nominated Signalling representative on request, at any time during that period.

8.3. Design Changes

If design changes are effected to any item of equipment during the currency of the type approval, whether or not there exists any current quotation or order, the supplier shall provide to ARTC a brief notification of the design change, describing

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the nature of the change and the reasons for its implementation.

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9. Appendix 1 - Schedule of Information to be Provided with Quotation

Note: Where insufficient space is available for a complete response to any question, that should be provided on separate sheets, clearly identified with the number of the question concerned.

Information Schedule

1 Identification of Equipment offered

1.1 Type / Model number .....

1.2 Catalog number .....

2 Type approval status

Does the equipment offered have current type approval?

2.1 Yes, all components .....

Type approval reference .....

date .....

2.2 Yes, most components .....

Type approval reference .....

date .....

Components not yet type approved .....

2.3 No: .....

(For items requiring type approval)

2.4 List of components submitted for type approval .....

List of Documents submitted in support .....

3 Description of Equipment offered

3.1 Shunt sensitivity - in tuned loop .....

- outside tuned loop .....

3.2 Track circuit lengths -

Minimum, with infinite ballast res .....

Maximum, with 1.5 ohm.Km ballast res .....

3.3 Nominal frequencies used .....

3.4 Actual frequencies used .....

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Modulation - Type .....

- Rate .....

- External Mod available .....

3.6 Receiver bandwidth .....

3.7 Tuned loop - nominal length

- attenuation (min frequency) .....

- attenuation (max frequency) .....

Tuned loop max attenuation, at rails or,
at tuning unit terminals .....

3.8 Output relay - type .....

- operating voltage .....

3.9 Location equipment

mounting arrangements .....

wiring terminations .....

coding arrangements .....

3.10 Track connection units

Mounting arrangements .....

Case material .....

Suitability for installation
in vandal-resistant metal cover .....

Cabling distances - maximum permissible values, for maximum track length

Tx to trackside

(normal arrangements - specify) .....

(special arrangements - specify) .....

Rx to trackside

(normal arrangements - specify) .....

(special arrangements - specify) .....

Transmitter output

voltage .....

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current (normal output) .....

(low output) .....

Receiver input

Voltage .....

current .....

Receiver output

voltage .....

current .....

Power supply requirements

Nominal supply voltage .....

Permissible supply voltage range .....

Supply loading (current at nominal voltage) .....

Tx (normal power) .....

Tx (minimum power) .....

Rx (normal relay output) .....

4 Traction return arrangements

Maximum permissible traction unbalance

voltage (rail to rail) .....

current .....

Effect of bond on maximum track length

Maximum permissible number of bonds per track .....

Limits on positioning of bonds .....

Recommended impedance bond types
(full details if other than specified) .....

5 Packaging

Method of packing individual units for delivery

Supply Details

Delivery time from receipt of order .....

Australian manufactured content .....

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Australian content (other) .....

Percentage subject to exchange variation. .....

7 Manufacturer

Name .....

Address .....

Telephone .....

Contact name .....

8 Supplier

Name .....

Address .....

Telephone .....

Contact name .....

Signature of Supplier's authorised representative .....

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