AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline
Engineering Standard

Category
Rolling Stock

Signalling and Communication System

WOS 01.F

Applicability

ARTC Network wide	
New South Wales	✓
Western Jurisdiction	
Victoria	

Primary Source
(RIC Standard RSU Appendix F Version 2.0)

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1.0	07/12/2005	All	Reformatting to ARTC Standard
	13/08/2010	ALL	Superseded by ESD-32-01

Contents

This appendix is set out as follows:

F[1] Introduction

1.1 All vehicles and trains operating on the Australian Rail Track Corporation network shall satisfactorily be detected by the existing signalling system.

1.2 Vehicles that do not operate the track circuits, such as track maintenance vehicles, shall only be operated under special operating conditions. Such vehicles should be fitted with insulated wheels to avoid intermittent shunting of track circuits.

1.3 Vehicles and trains shall generate no energy capable of interfering with the Australian Rail Track Corporation signalling and communications equipment.

F[2] Types of signalling systems

F2.1 The existing signalling systems used on the Australian Rail Track Corporation network are:-

- DC track circuits, conventional and AC immune
- 'Westrak' type DC track circuits with combined feed/relay sets
- 50 Hz A.C. track circuits, double and single rail
- Audio frequency jointless track circuits operating at 1700, 2000, 2300 and 2600 Hz
- Audio frequency jointed track circuits operating at frequencies between 380 and 510 Hz
- Audio frequency overlay track circuits operating at frequencies between 800 and 5000 Hz
- High voltage impulse track circuits
- Pulse coded track circuits operating with DC or tone-burst transmission
- Level crossing motion detectors/analysers operating between 1 and 4 kHz.

Significant operating parameters of these track circuit types are shown in Table F1.1 below.

F[3] Signal shunting

F3.1 The traction return current, at any frequency, shall not exceed the limits shown on drawing S96/0301 /01.

Track Circuit Type	Frequency	Modulation	Operating Track Voltage	Receiver/Relay			Maximum Track Circuit Length		Nominal Shunt Value
				Minimum Operation	Maximum Drop-away	Normal Working Level	Double Rail	Single Rail	
DC	DC	N/A	1 to 3 V	0.4 V	0.3 V	1 V	2000 m	N/A	0.06 to 0.2 ohm
DC - AC immune	DC	N/A	3 to 5 V	0.9 V	0.6 V	3.5 V	N/A	600 m	1.5 ohm
DC - 'Westrak'	50 - 400 Hz	N/A	3 to 20 V	0.4 V	0.3 V	1 V			0.06 to 0.2 ohm
[illegible]C	50 Hz	Nil	1 to 3 V	0.5 V	0.3 V	1.3 V	1000 m	300 m	0.06 to 0.5 ohm
[illegible] jointless	1700, 2000, 2300, 2600 Hz	FSK, +/-10 to 15 Hz	3 to 5 V	200 mV	180 mV	400 mV	900 m 2000 m compensated	N/A	0.15 to 0.5 ohm
AF jointed	380 to 510 Hz (10 frequencies)	FSK, +/-10 Hz	3 to 20 V	1.7 V	1.5 V	3 to 12 V	400 m	250 m	0.5 ohm
[illegible]lay	800 to 5000 Hz (various frequencies)	N/A	0.3 to 1.3 V	-----	0.05 V	0.3 V	800 m	N/A	0.06 to 0.15 ohm
[illegible]se	Bipolar DC pulse (3 pulse/sec)	N/A	40 to 120 V	35 V	20 V	40 to 120 V	3000 m	500 m	025 to 0.5 ohm
[illegible]	2 second pulse train, DC or AF burst	N/A	+/- 1 V			+/- 0.6 V	9000 m	N/A	0.06 to 0.15 ohm
[illegible]	Steady AF, 1 in 4 kHz	N/A	3 to 5 V				1000 m	N/A	0.06 to 0.15 ohm

Table F1.1. Operating parameters for different types of track circuits

F4.1 Power cables

F4.1.1 Signalling power distribution is generally at 120 volts a.c. nominal with some 50 volts d.c. mains. Cable sizes vary from 4 mm^2 to 70 mm^2 depending on loading drop and the feeders may be open wire, or cable installed in ducting or troughing, or burried. Cable runs are generally parallel to the lines, at any convenient position between the railway boundaries.

F4.1.2 Power distribution cables are generally not screened, and where a metallic termite barrier is provided, this is not connected to earth.

F4.2 Signalling circuits

F4.2..1 Signalling circuits may be run in multicore cable installed in ducting or troughing, aerial or burried; in individual conductors installed in ducting or troughing; or in open wire line.

F4.2.2 Circuits in multicore cable operate generally at 50 volt d.c., doubled switched, not a.c. immunised. Conductors are normally 1/0.064” or 7/0.50 mm singles (not balanced pairs or quads). On the suburban lines, audio frequency track transmitters and receivers are connected to the trackside equipment by up to 1500 metres of single pair 7/0.50 mm aluminium foil screened cable, laid in trackside ducts and troughing.

F4.2.3 Circuits in individual conductors operate generally at 120 volt 50 Hz, single switched with common return, over distances up to 1000 metres. conductor size is 1/0.064’ or 1/1.70 mm.

F4.2.4 The relatively few remaining open-wire signalling circuits in electrical traction areas may operate at various voltages between 10 volts and 120 volts d.c., or 120 volt 50 Hz.

F4.2.5 Cable and linewire routes run generally parallel to the tracks, at any convenient position within the railway boundaries. signalling cables are not screened, although a metallic tape termite barrier is incorporated.

F4.3 Communication cables

F4.3.1 Frequencies in use range from D.C. to 300 kHz.

F4.3.2 **Trunk, junction and local type cables quad construction,** with screening factors of between 0.04 and 1 at 800 Hz with most cables having a system screen factor of 1. For use mainly in D.C. to VF range. Balance of cable and equipment generally 40 dB, however in older cables and plastic non-gassed cables that have been subject to the ingress of moisture, the balance may be worse.

F4.3.3 Carrier and coaxial cable.

F4.3.3.1 Carrier cable is of quad construction for use in the range 6 kHz to 150 kHz. Screening factor is similar to above.

F4.3.3.2 Coaxial cable is used with systems operating in the range 60 kHz to 150 kHz. In most cases no electromagnetic screening is applied to this cable.

F4.3.3.3 All types of cable can be located anywhere within the Australian Rail Track Corporation boundary and is often located in troughing close to the rails.

F4.3.3.4 In the Sydney metropolitan area many of the cable routes are above ground in troughing and drawings are not available. Cable route plans of buried cables are available if required. however, these are not necessarily typical. Locations of boundary fence line or between tracks, burried and elevated and at times on both sides of the railway easment.

F4.3.3.5 Cables types vary from lead sheathed tape and wire armoured to solid polythene insulated and sheathed with copper tape. A large percentage of cables have screening factor close to unity due to inadequate earthing or screening material. the critical case is related to cable installations in which a reduction of screening factor cannot be achieved due to inadequate screening materials. this type of cable exists on a number of main line routes.

F4.4 **Railway telephone and radio systems**

F4.4.1 The frequency spectrum from VF to 108 kHz. is used on all routes. There is also an increase in digital data on most routes. Train working and emergency telephones are used in some tunnels e.g. City Circle and Eastern Suburbs and the transmission circuit is single twisted pairs in trough or conduit.

F4.4.2 The present planning on new works adopts CCITT standards. The specifications for this equipment are similar to Telstra Specifications.

F4.5 **Telemetry and remote control**

F4.5.1 A variety of signalling remote control and indication systems, (SCADA, RTU, Telemetry), are in use in lines around Sydney currently electrified or proposed for electrification. These systems can be either analogue or digital with an the operating range up to 18 kHz.

Note: These systems are also in use outside the electrified area.

F4.5.2 Information is transmitted through both communications type cable and aerial lines located at various distances from and running parallel to the overhead traction wires (electrified areas) and the track.

F[5] Interference tests

5.1 **Type tests**

Type tests shall be conducted using the train set to measure vehicle generated disturbance effects in signalling track circuits, telecommunication cables and lineside telecommunications systems.

5.1.1 The tests indicated below are the minimum required for compatibility testing and may be varied at the discretion of the Australian Rail Track Corporation.

F5.2 **Tests on vehicles**

F5.2.1 Tests shall be carried out to confirm the nature of the harmonic spectrum associated with the traction unit and auxiliary power supply and other onboard systems.

F5.2.2 For electric rolling stock and locomotives the ripple current and voltage shall be recorded as a train operates in motoring and braking through typical supplied power sections. A.C. ripple measurements shall be made as the train is operated close to each type of substation used by the Australian Rail Track Corporation. The following test sites are suggested:-

- Blacktown to Emu Plains
- Hornsby to St Leonards
- Hurstville to Meeks Road
- Caringbah

F5.2.3 The results of the above tests shall be processed by an FFT analyser such that the harmonic spectrum is made available, for a complete power-brake run, for each type of substation.

F5.3 Train detection/track circuit shunting standards

F5.3.1 Rolling stock operating on the Australian Rail Track Corporation network shall meet the following requirements for compatibility with the Australian Rail Track Corporation track circuits and train detection:-

- Maximum resistance between rail contact surfaces on wheels on the same axles shall be not less than 1 milliohm
- The total rail-to-rail resistance of any one unit shall not exceed 1 milliohm, when measured on clean straight track at an open-circuit voltage not exceeding 1.0 volts
- On locomotives and multiple unit trains at least one axle per unit shall be provided with the means to keep tread surfaces clear of any contaminant build-up, especially while rolling on straight track
- This axle shall not be one providing traction current return on electric rolling stock
- Worst case wheel tread profile shall maintain effective rail wheel contact with both of the following:
  - Centre top 10 mm of new 60 kg profile rail, and
  - Inner 30 mm of top of older standard profile 53 kg rail.

F5.4 Tests on track circuits

F5.4.1 Tests shall be carried out to determine the compatibility of the rolling stock with each of the track circuits over which it will be operated. These tests shall include:

- track circuit shunting performance

- traction current harmonics causing potential failure of track circuits
- traction current harmonics causing potential false energisation of track circuits
- traction unit impedance to traction supply
- auxiliary power systems harmonic generation and impedance
- generation of interference to the signalling system by other train-borne equipment

The test programmes shall include ‘bench’ measurements of traction current interference, followed by site testing on a comprehensive range of track circuit types.