IRS
Irish Railway Standards

Irish Railway Standard IRS-203-A

EMC Co-ordination

Issue	Published by	Issue Date
A	CRR on behalf of the Irish Railway Industry	22.10.2019

1 Foreword

1.1 This Irish Railway Standard:

i. cannot replace any Technical Standard for Interoperability (TSI) or other legal requirements which may be applicable to a given project;
ii. is recommended to be chosen in accordance with RFU-STR-088 as an Alternative Solution in conjunction with a TSI Parameter to demonstrate conformity with the Essential Requirements;
iii. may be called up as a code of practice in conjunction with CSM-REA 352/2009 and 402/2013;
iv. may be called up as good industry practice in conjunction with Railway Safety Act 2005;
v. may be called up as a code of practice in conjunction with the safe integration of projects within the Railway System in the Republic of Ireland as defined under 2008/57/EC Art15 or 2016/797 (EU) Art 18;
vi. may in parts or in full be called up as a National Technical Rule (NTR) for the Republic of Ireland in conjunction with 2008/57/EC or 2016/797 (EU).

1.2 Where this document is called up as an NTR, the reason for its application shall be identified in line with EU 2016/797 Art 13(2):

i. where the TSIs do not cover, or do not fully cover, certain aspects corresponding to the essential requirements, including open points as referred to in 2016/797 Article 4(6);
ii. where non-application of one or more TSIs, or parts of them, has been notified under 2016/797 Article 7 or 2008/57/EC Art9 or Art20;
iii. where a specific case requires the application of technical rules not included in the relevant TSI;
iv. national rules used to specify existing systems, limited to the aim of assessing technical compatibility of the vehicle with the network;
v. networks and vehicles not covered by TSIs;
vi. as an urgent temporary preventive measure, in particular following an accident.

2 Scope and Application

2.1 Scope

2.1.1 This document sets out the requirements for the EMC coordination on the rail network in the Republic of Ireland.

2.2 Application – infrastructure managers

2.2.1 The requirements of this document apply to all equipment.

2.3 Application – railway undertakings

2.3.1 The requirements of this document apply to all equipment.

2.4 General Compliance Date

2.4.1 This Irish Railway Standard comes into force and is to be complied with for all new authorisations from date of issue. It is also applicable to any modifications and maintenance activities.

2.5 NTR Provisions

2.5.1 The following table identifies all proposed sections of this IRS which are proposed and notified as Irish NTRs. The rationale is identified in line with section 1.2. In each case the assessment shall be performed by an IRL recognised DeBo employing the Modules stated. The assessment Modules are defined in 2010/713/EC. The term NoBo (as used in 2010/713/EC) shall be understood to mean DeBo in this context.

Table 1 NTR Provisions

Section	Rationale (as defined in section 1.2)		Module
6	Absence of TSI requirements	i	RST&CCT: SB&(SD or SF) or SH1 CCT: SB & (SD or SF) or SG or SH1 ENE&INF: SG or SH1
	Non-application of TSIs	ii	
	Technical Compatibility between on-board and trackside equipment	iv	
	Networks/ vehicles not covered by TSIs	v	

3 Normative References

EN45502-2-1:2003	Active implantable medical devices – Part 2-1: Particular requirements for active implantable medical devices intended to treat bradyarrhythmia (cardiac pacemakers)
EN50121-1:2017	Railway applications – Electromagnetic compatibility – Part 1: General
EN50121-3-1:2017	Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle.
EN50121-4:2016	Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus.

EN50126-1:2017	Railway applications – the specification and demonstration of reliability, availability, maintainability and safety (RAMS) Part 1
EN50126-2:2017	Railway applications – the specification and demonstration of reliability, availability, maintainability and safety (RAMS) Part 2
EN50128:2011	Railway applications – communication, signalling and processing systems – software for railway control and protection systems
EN50129:2003+AC:2010	Railway applications – communication, signalling and processing systems – safety related electronic systems for signalling
EN50159:2010	Railway applications – communication, signalling and processing systems – safety related communication in transmission systems
EN50238-1:2003	Railway applications – compatibility between rolling stock and train detection systems – Part 1: general
CLC/TS50238-2:2015	Railway applications – compatibility between rolling stock and train detection systems – Part 2: compatibility with track circuits
CLC/TS50238-3:2013	Railway applications – compatibility between rolling stock and train detection systems – Part 2: compatibility with axle counters
EN50500:2008+A1:2015	Measurement procedures for magnetic field levels generated by electronic and electrical apparatus in the railway environment with respect to human exposure
CSM-RA	COMMISSION IMPLEMENTING REGULATION (EU) No 402/2013 on the common safety method for risk evaluation and assessment, as amended by 1136/2015
	For balises + air gap + coding of telegrams, see EuroBalise FFFIS
	Other IRS for CCT and CCO Class B systems in IRL
	UNISIG ERTMS/ETCS SUBSET-036:FFFIS for EuroBalise issue 3.1.0
	DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast) (even if there are no direct applicable requirements)

4 Terms and Definitions

Auxiliaries	Electrical loads in circuits separate from those providing traction power
Electrical System	The electrical and electronic equipment that directly switches, converts or controls the flow of energy in the traction and auxiliary systems, including the train current collection (overhead line equipment and neutral sections), current distribution (sub-station), and any communication transmission systems.
EMU	An EMU (electric multiple unit) is made up of passenger or non-passenger carrying coaching stock semi-permanently coupled together with motored axles or motored and trailing axles, with driver's cab at each end and accommodation in each vehicle. The sets are electrically powered and are capable of being coupled together and being driven from one cab.
Infrastructure	The IÉ railway network infrastructure, which comprises power supply system and signalling and telecommunication systems.
Signalling system	The system comprising train-borne and trackside circuits, cables, interlocking and control rooms, etc., for control of signalling.
Telecommunications system	The system comprising cables, phones, radio links, fibre communications links, and data communications, etc.
Traction and rolling stock	All moving vehicles of the railway including wagons, locomotives, coaches, electric multiple units (EMU), diesel multiple units (DMU) and vehicles used for service and maintenance duties.
Traction power supply system Train	The electrical system comprising connection to the local power grid and the conductors along the railway track, etc. The powered and non-powered vehicles that can operate as a coupled set as specified in the vehicle procurement specification, coupled together and operating on running lines, sidings and depots.
Revealed failure	An infrastructure or rolling stock failure which is immediately revealed as an equipment failure and can be expected to be rectified within a short period of time in comparison with the likelihood of extreme interference occurring.
Unrevealed failure	An infrastructure or rolling stock failure which is not revealed as an equipment failure and may lie dormant for a significant length of time.

5 Symbols and Abbreviated Terms

ATP	Iarnród Éireann ATP System (Automated Train Protection)
CAWS	Iarnród Éireann CAWS System (Continuous Automatic Warning System)
CCTV	Close Circuit Television
CSM	Common Safety Method
DMI	Driver Machine Interface

EMC	Electromagnetic compatibility
FDM	Frequency-division multiplex
FSK	Frequency shift keying
IEHS	Iarnród Éireann CAWS-ATP Hybrid System
IRL	Ireland
NTR	National Technical Rule
PCM	Pulse-code modulation
PST	Permanent Self-Test Functions
RX	Receiver
STM	Specific Transmission Module
S & T	Signalling and Telecommunications
TSI	Technical Specifications for Interoperability
T&RS	Traction and Rolling Stock
TX	Transmitter

6 Requirements

6.1.1 All parts of section 6 are an IRL NTR of types (i) and (vi) as indicated in section 1.2.

6.1.2 All products and installations shall follow that version of EN50121 family which is valid at the time when submitting the request for APIS.

6.2 Immunity

6.2.1 No tests are applied to the complete vehicle. It is expected that the assembly of the apparatus into a complete vehicle will give adequate immunity, provided that an EMC plan has been prepared and implemented, considering the requirements in EN 50121-3-2.

6.3 Emission Limits

6.3.1 Radiated electromagnetic Disturbance Limits: tests and limits are defined in EN 50121-3-1 clause 6.3.

6.4 Conducted Interference Limits

(Requirements in addition to EN 50121-3-1)

6.4.1.1 Conducted interference describes the mechanisms of interference arising from the flow of train current along the running rails and includes the following:

- The voltage drop along a signalling section that is caused by the traction return current. This applies to both single and double-rail track circuits; though in the latter a current imbalance between rails needs to exist. The return current can be distributed along paths other than the rails on which the train is standing, including adjacent and neighbouring lines;
- Longitudinal voltage resulting from axle to axle voltage drop in any foreseeable conditions (see Section 6.4.2.4).

6.4.1.2 The traction equipment must not generate an electrification fault current of peak value 44 kA for longer than 0.1 s and rate of rise of 2.82 A/µs in the vicinity of a substation.

6.4.1.3 Table 2 lists the Conducted Interference Limits at critical frequencies, which represent the maximum allowable levels of line current harmonics generated by maximum train configuration with faulty signalling infrastructure (assuming 100% imbalance in impedance bonds).

6.4.1.4 The limits in Table 2 are derived from the characteristics of AC and DC track circuits in use on IÉ infrastructure, contained in Appendix B and Appendix C.

Table 2 Conducted interference limits

Freq.	**3 dB Bandwidth**	**Circuit Type**	**Limit**
DC	0 to 0.64 Hz	DC TC in Non-Electrified Area	26mA x 0.35=9mA
0.83Hz	0.64Hz to 1.19Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area

1.25Hz	0.96Hz to 1.78Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area
2Hz	1.54 to 2.86Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area
3Hz	2.30 to 4.28Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area
4.5Hz	3.47 to 6.44Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area
7Hz	5.42 to 10.06Hz	CAWS/ATP Codes	1A x 0.35 = 350mA Non-Electrified Area 3A x 0.35 = 1.05A Electrified Area
50Hz	47.5 to 52.5Hz	CAWS/ATP Carrier Non-Electrified Area	1A x 0.35 = 350mA
83.3Hz	79.1 to 87.5Hz	AC Track Circuit	2.46A x 0.35 = 860mA for 5 sec
11.5kHz	11.38kHz to 11.62kHz	AF Track Circuit	377mA x 0.35 = 132mA for 4.5 sec
12.28kHz	11.48kHz to13.08kHz	AF Track Circuit	377mA x 0.35 = 132mA for 4.5 sec
15kHz	14.2kHz to 15.8kHz	AF Track Circuit	375mA x 0.35 = 131mA for 4.5 sec
15.2kHz	15.04kHz to 15.35kHz	AF Track Circuit	375mA x 0.35 = 131mA for 4.5 sec
18 kHz	17.94kHz to 18.06kHz	DIJD	40mA x 0.35 = 14mA
20kHz	19.2kHz to 20.8kHz	AF Track Circuit	369mA x 0.35 = 129mA for 4.5 sec
20.2kHz	19.9kHz to 20.4kHz	AF Track Circuit	369mA x 0.35 = 129mA for 4.5 sec

6.4.2 Telecommunication Interference Limits:
(Requirements in addition to EN 50121-3-1 Annex A)

6.4.2.1 As a means of measuring and controlling the impact of traction interference on telecommunications, the concept of a psophometric limit, as defined by the CCITT, is adopted. This limit applies a weighted multiplier to harmonic interference in the audio range that models the sensitivity of the human ear and thus provides a meaningful measure of the true impact of such audio systems on the user of voice-frequency telecommunication circuits.

6.4.2.2 The psophometric limit with respect to the coupling between train return current and lineside cables while the train is operating can be measured by the transverse voltage induced into the lineside cable; again, the voltage is given a psophometric weighting.

6.4.2.3 There are other issues considered by telecommunication engineers, such as the threat of induced voltages in lineside cables causing touch voltages which might be hazardous to staff. To control this hazard, a direct measurement of longitudinal voltage is made while a single maximum consist is operating.

6.4.2.4 The limits on longitudinal and transverse voltage are 60 V rms and 1 mV respectively. The limits on psophometric current are as shown in table 3 below.

Table 3 Limits on psophometric current

Average over any 20 second period	Average over any 4 second period	Instantaneous[1]
10 A	12.2 A	13 A
1 Defined as the weighted value of current over 20 ms samples treated as a repetitive waveform.		

6.4.2.5 Psophometric weighting should be to CCITT requirements and the addition of individual currents should be done using the root-sum-square method. The longitudinal and transverse levels are as set by the CCITT and detailed above.

6.4.2.6 Appendix C lists other track-based and telecommunications-based equipment which must be considered when undertaking an EMC analysis.

6.4.3 Magnetic Field Interference Limits:

6.4.3.1 The requirements of EN 50500 and EN 45502-2-1 apply with the following additions:

6.4.3.2 The train should produce a flux density of no greater than 24 mT for times greater than 10 ms or no greater than (24×10^{-6}) divided by t^2, where t is in seconds, for times shorter than 10 ms. The levels should be measured at the following locations, as shown in Figure 1:

a) above the running rails at a height that represents the position of the CAWS/ATP antenna;
b) outside the running rails at a height and location that represent the position of the CAWS/ATP antenna of a passing vehicle; and
c) outside the running rails at a height and location that represent the AWS magnets of passing vehicles.

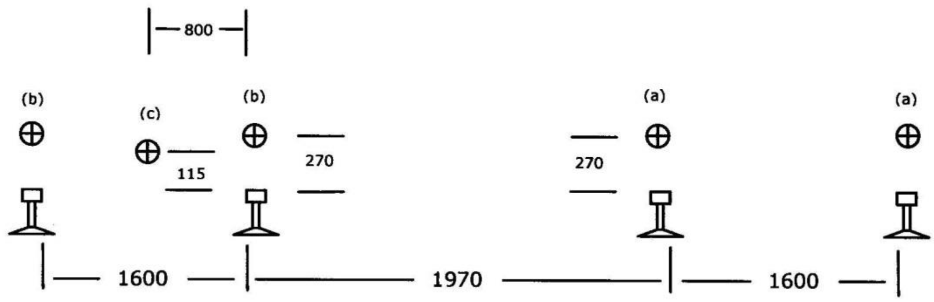

Figure 1 Location for Magnetic Flux Density measurement

6.4.3.3 The stray magnetic field emanating from any electrical system must not contain sufficient magnetic energy to cause mal-operation of, or permanent alteration of the characteristics of, train detection equipment and telecommunication circuits.

6.4.3.4 Magnetic fields in areas visited by members of the public and by railway staff in the normal course of their duties must not exceed 10 gauss. Within the train the level must not exceed 10 gauss (= 1mT) at train floor level and 5 gauss (= 0,5 mT) at height of 2 m above floor level.

6.4.4 Axle-to-Axle Voltages Limits:
(Requirements in addition to EN 50121-3-1)

6.4.4.1 Train-borne electrical systems must not be designed to use the vehicle chassis and rails as part of their return conductors unless they are derived directly from the electrification system – i.e. their current has identical characteristics to that of the main traction current.

6.4.4.2 Where train-borne electrical systems connect one pole at one location to the vehicle chassis for reasons such as system safety they must be fitted with devices such as Earth Leakage Detectors or Residual Current Detectors which detect any failure which permits current from the system to pass into the vehicle chassis.

6.4.4.3 The train-borne detectors should have two detection levels:

- The first level is set at the discretion of the rolling stock manufacturer to indicate an incipient failure which may be tolerated, and results in the incipient failure being remedied in good time before degrading to the second level;
- The second level is set to protect track circuits, and is required to de-energise the electrical system;
- The level which protects track circuits is to be determined as the current which will generate 35 % of the drop-away value of the Track Relay / Receiver when passing along the length of the train through the impedance of two rails in parallel.

6.4.4.4 In this context it is assumed that the probabilities are acceptably low of:

- multiple trains which have sustained failures between the first and second levels interacting in an additive manner; or
- a train sustaining a second level failure and the detector failing to operate.

6.4.4.5 The rolling stock manufacture is to provide evidence that reliability of the detector is adequate to fulfil the latter criterion.

6.4.5 Rail Voltage Transient Limits:
(Requirements in addition to EN 50121-3-1)

6.4.5.1 To prevent insulation breakdown of rail connected signalling equipment, the T&RS operating from the electrical system must not produce transients exceeding 1 kV peak on the rail with respect to remote earth in any credible service conditions, including pantograph up/down operations and loss of contact due to pantograph bounce.

6.5 EMC Evidence and Measurement Plan

6.5.1 The applicant shall develop an EMC Evidence and Measurement Plan. This plan shall evaluate for above mentioned individual requirements:

- how they are to be measured;
- at which single or multiple locations they shall be measured;
- at which operating status and conditions they shall be measured.

6.5.2 The plan shall include for each value which shall be measured the related pass/ fail criteria. *Note: This shall consider all those relevant functions and systems in all possible operating states which may create EMC emissions. This could be e.g. (non-exhaustive listing) traction systems at different power settings/ different speed settings, regenerative braking, auxiliary systems, any infrequently used equipment as e.g. doors, HVAC equipment, any train power lines, CCO equipment, and emissions which are controlled by software (e.g. inverters).*

6.5.3 The DeBo shall evaluate the plan before the commencement of the measurement for systematic coverage of all relevant systems and function and operating status and conditions and also the proposed pass/fail criteria.

6.5.4 Where incomplete, the plan shall be amended.

6.5.5 The applicant shall ensure the performance of the required testing according to the plan.

6.5.6 The test laboratory shall be accredited to ISO 17025 in connection with the related EMC standards. Where this is not the case, NB-Rail RFU-STR-022 may be applied by the DeBo.

6.5.7 The DeBo shall evaluate the compliance of the final test results against the requirements of this IRS.

7 Further Clarification

Further clarification on these guidelines can be sought from the CRR by phone at +353 1 206 8110 or by email info@crr.ie.

8 List of Participants

The participants for each revision of this IRS are shown in Table 4.

Table 4 List of Participants by Revision

Participant Name and Organisation		**Involved in IRS-203-A**		
Paraic O'Lochlainn	IÉ-IM	✓		
Maik Wuttke	CRR	✓		
Aidan O'Sullivan	CRR	✓		
Peter Guthoerl	CRR	✓		

APPENDIX A Track Circuits on IÉ Infrastructure

A.1 DC Track Circuits

A.1.1 D.C. track circuits are used outside the Dublin Suburban electrified area (currently Bray / Greystones to Howth / Malahide). Any track circuits that are present on route sections that are to be electrified will need to be removed and replaced with A.C. track circuits, which may include any of the types described in A.2 to A.5 below.

A.1.2 The principal D.C. track relays in use on IÉ are shown in Table A.1:

Table A.1: DC Track Relay Characteristics

Relay Type	Coil Resistance	Pick-up Current	Drop-away Current
QTA2	9 ohm	120 mA	81 mA
QTA2	20 ohm	81 mA	55 mA
NT2	9 ohm	39 mA	26 mA
PN150BH	0.5 ohm coil with series resistor	153 mA	125 mA

A.1.3 All D.C. track circuits are double-rail track circuits.

A.1.4 The minimum length of a DC track circuit is 20 m and the maximum length is 2 km.

A.1.5 The shunting sensitivity of all DC track circuits is 0.5 ohm.

A.2 83.3 Hz Union Switch & Signal Track Circuit

A.2.1 The receiver for this track circuit is a 2-phase vane relay manufactured by Union Switch & Signal. Operating parameters for this track circuit are shown in Table A.2:

Table A.2 Operating parameters for Track Circuits

Operating Parameter	Value
Pick-up	2.15 V, 0.059 A, at ideal phase relation
Full stroke	2.81 V, 0.0675 A, at ideal phase relation
Minimum drop-away	90% of pick-up
Ideal phase relation	Track current leading local voltage by 21.4^{o}
Frequency characteristic	2nd order bandpass (for use in tests)
Pick-up Delay	5 s nominal
Shunting sensitivity	0.5 ohm

A.2.2 All 83.3 Hz Union Switch & Signal track circuits are double-rail track circuits.

A.2.3 The minimum length of an 83.3 Hz Union Switch & Signal track circuit is 20 m and the maximum length is 1.2 km. Note that this maximum is limited by the maximum traction cross-bond spacing of 800 m.

A.3 83.3 Hz Sasib Solid-State Track Circuit

A.3.1 The track equipment is provided by Sasib Railway. The unit comprises a combined transmitter / receiver with the following operating parameters shown in Table A.3:

Table A.3. Operating Parameters 83.3Hz Sasib Solid State Track Circuits

Operating Parameter	**Value**
Pick-up	received voltage between 20 and 50 Vac with a frequency pass-band of +/- 0.15 Hz
Minimum drop-away	90% of pick-up
Ideal phase relation	Angle between transmit voltage and received voltage =90+/- 25 ^{o}
Frequency characteristic	2nd order bandpass (for use in tests)
Pick-up Delay	2.8 seconds. Used in conjunction with a time delay feature in the interlocking to give a total pick-up delay of 4.5 seconds.
Shunting sensitivity	0.5 ohm

A.3.2 All 83.3 Hz Sasib solid-state track circuits are double-rail track circuits.

A.3.3 The minimum length of an 83.3 Hz Union Switch & Signal track circuit is 20 m and the maximum length is 900 m. Note that this maximum is limited by the maximum traction cross-bond spacing of 800 m.

A.4 ATT20 Audio Frequency Track Circuit

A.4.1 The track circuit is supplied by Union Switch & Signal and comprises a combined transmitter/receiver unit which energises an external relay with the following operating parameters shown in Table A.4:

Table A4 Operating parameters ATT20 Audio Frequency Track Circuit

Operating Parameter	**Value**
Operating frequency	12.28 kHz, 15.00 kHz, 20.00 kHz
Modulation	Amplitude-modulated at 390 Hz
Transmitter output	1.0 V (true rms modulated) into a 5 ohm load
Output impedance	7 ohm
Pick-up	70 mV (rms) at receiver terminals
3dB Bandwidth	1.6kHz (for all 3 operating frequencies)
Drop-away time for relay	900 ms nominal
Pick-up time for relay	450 ms nominal
Pick-up Delay	5 sec. (when used in conjunction with 83.3Hz track circuit)

Shunting sensitivity	0.5 ohm

A.4.2 ATT20 audio frequency track circuits may be used in single-rail or double-rail applications.

A.4.3 The minimum length of an ATT20 audio frequency track circuit is 20 m (but may be less when used on crossovers in conjunction with 83.3 Hz track circuits) and the maximum length is 100 m.

A.5 SMTC Model 71010 Audio Frequency Track Circuit

A.5.1 The track circuit is supplied by Safetran Systems and comprises a combined transmitter/receiver unit which energises an external relay with the following operating parameters shown in Table A.5:

Table A.5. Operating parameters for SMTC Model 71010 Audio Frequency Track Circuit

Operating Parameter	**Value**
Operating frequency	11.5 kHz, 15.2 kHz, 20.2 kHz
Modulation	Frequency-shift modulation of operating frequency f between f+1% and f-1%. Modulation frequency = 0.01f
Drop-away time for relay	900 ms nominal
Pick-up time for relay	450 ms nominal
Pick-up Delay	5 sec. (when used in conjunction with 83.3Hz track circuit)
Shunting sensitivity	0.5 ohm

A.5.2 SMTC Model 71010 audio frequency track circuits may be used in single-rail or double-rail applications.

A.5.3 The minimum length of an SMTC Model 71010 audio frequency track circuit is 20 m (but may be less when used on crossovers in conjunction with 83.3 Hz track circuits) and the maximum length is 100 m.

APPENDIX B Conducted interference limits for AC Track Circuits

B.1.1 Table B.1 and Table B.2 below show the maximum permitted levels of interference current, under healthy and failed infrastructure conditions, for the different types of A.C track circuit in use on IE.

B.1.2 The limits given in these tables are absolute, i.e. the 0.35 safety factor has been applied in the calculation of the limit values.

B.1.3 The limits in these tables have been used to define the ruling limits in Table 2.

Table B.1. Maximum allowable levels of line current harmonics generated by maximum train configuration with healthy signalling infrastructure. (assuming max. 5% imbalance in impedance bonds).

Frequency	**Track Circuit Type**	**Limit**
83.3Hz	US&S T.C. with US&S Impedance Bonds	8.75A rms for 5 Sec.
83.3Hz	US&S T.C. with Westinghouse Impedance Bonds	7.65A rms for 5 Sec.
83.3Hz	SASIB T.C. with Westinghouse Impedance Bonds	9.56A rms for 4.5 Sec.
12.28kHz	US&S ATT20	132mA rms for 4.5 Sec.
15kHz	US&S ATT20	131mA rms for 4.5 Sec.
20kHz	US&S ATT20	129mA rms for 4.5 Sec.
11.5kHz	Safetran SMTC 71010	132mA rms for 4.5 Sec.
15.2kHz	Safetran SMTC 71010	131mA rms for 4.5 Sec.
20.2kHz	Safetran SMTC 71010	129mA rms for 4.5 Sec.

Table B.2. Maximum allowable levels of line current harmonics generated by maximum train configuration with faulty signalling infrastructure. (assuming 100% imbalance in impedance bonds).

Frequency	**Track Circuit Type**	**Limit**
83.3Hz	US&S T.C. with US&S Impedance Bonds	2.46A rms for 5 Sec.
83.3Hz	US&S T.C. with Westinghouse Impedance Bonds	0.86A rms for 5 Sec.
83.3Hz	SASIB T.C. with Westinghouse Impedance Bonds	1.35A rms for 4.5 Sec.
12.28kHz	US&S ATT20	132mA rms for 4.5 Sec.
15kHz	US&S ATT20	131mA rms for 4.5 Sec.

20kHz	US&S ATT20	129mA rms for 4.5 Sec.
11.5kHz	Safetran SMTC 71010	132mA rms for 4.5 Sec.
15.2kHz	Safetran SMTC 71010	131mA rms for 4.5 Sec.
20.2kHz	Safetran SMTC 71010	129mA rms for 4.5 Sec.

APPENDIX C Track-based and telecommunications-based equipment

C.1 Axle Counters

C.1.1 In many areas, train detection is by means of axle counters. The principal types are:

- Thales (Alcatel) AZLS with Zp30CA Detection Points
- Thales (Alcatel) AZLM with Zp30H Detection Points

C.2 Telecommunications-Based Equipment

C.2.1 The equipment listed in this section represents the most common telecoms systems in use on IE. The Principal Engineer, Telecommunications should be consulted to ensure that the most up-to-date information is used for any analysis.

PCM copper systems	
Ericsson Communications	2 Mbit/s digital carrier.
Platform CCTV	
Base band video.	Cameras and monitors from various manufacturers.
Platform information displays	
Data Display Ltd	RS485 Serial data link, 9600Baud, Half Duplex Communication with Handshaking.
Public address system	
Ditra Systems Ltd.	Station loudspeaker equipment fed from Telecoms Equipment Room (TER) on copper cables, audio band. System equipment in TER is connected over PDH/SDH to trackside fibre network.
SSI (Westinghouse)	
Trackside data link	20 kbit/s base band half-duplex with Hanning and Manchester II coding and synchronisation.
Long-line link	64 kbit/s via PCM copper system or via fibre-optic SDH network.
Hot Axle Box Detector	

Phoenix MB	26VDC power feeding and two RS485 data links (1x 256kbit and 1x 2Mbit/s) communications on copper cables to system equipment in TER which is connected over PDH/SDH to trackside fibre network.

PLC Code Generation System & Level Crossing Control Communications

Siemens S7 PLC Systems

Non-failsafe Communications:	Using Industrial Ethernet protocols according to IEEE 802.3 (ISO 8802.3) or Profinet protocols according to IEC 61499.
Failsafe Communications:	Using additional PROFIsafe layer according to IEC 61784-3.
Communications Speed:	10 or 100 Mbps with auto negotiating function.

Suburban level crossing indications and signalling override system

DATAC Control Systems Ltd.

Channel 1:	1.32 kHz carrier with +/- 210 Hz FSK modulation.
Channel 2:	2.76 kHz carrier with +/- 210 Hz FSK modulation.
Crossing indications:	Central office TX = Channel 1, RX = Channel 2.
Signalling override:	Central office TX = Channel 2, RX = Channel 1.

Traction control system, Central office to substations and switch houses

ABB

Base band modems:	2 kHz carrier with +/- 400 Hz FSK modulation.

OHLE Intertrip system

TFM 80

Section A:	Pilot Tone 1020 Hz
	Order Tones 1140, 1260 & 1380 Hz
Section B:	Pilot Tone 2220 Hz
	Order Tones 2340, 2460 & 2580 Hz
Transmitting Level:	390 Mv eff.

Train Radio system

EADS Communications

Lineside base stations:	300 Hz to 3.4 kHz band, audio and control tones.
Base station radio frequencies:	456.175-456.450 MHz
Train-borne station radio frequencies:	461.725-461.900 MHz

Train-borne radio equipment

Train radio mobile	EADS ZFM70, ZFM90 and ZFM21.
Driver-guard communication	*Mobiles:* Motorola GM340 and GM350
	Handportables: Motorola GP340
Shunter's communication	*Handportables:* Nabishi and Vertex VX900.

Vital Reed FDM circuits for level crossing control

8.1.1 GEC Type RR

Description:	The transmitter and receiver in the reed FDM system consist of a reed filter and an amplifier. The reed filter is a high-q band-pass filter, which passes only the frequency allocated to the particular channel and excludes all others with a nominal bandwidth of ±0.5 Hz. The selectivity of the reed filters is such that the system can be operated with frequencies as close as 4 Hz; hence a very large number of channels can be accommodated within a small range of frequencies.
Transmission:	Copper cable pairs
Reed Frequencies:	410.25, 414.75, 419.75, 425.75, 430.25, 462, 466.5, 473, 477.5, 568.75, 620.5, 624.5, 663, 765.25, 770, 817 Hz
Receiver drop-away voltage:	112mV at the reed frequency

Lineside Telephones

GAI-Tronics	Lineside telephones 300 Hz to 3.4 kHz band, audio and self-test control tones.