

Railway Group Standard

GM/RT2111

Issue One

Date December 2014

Rolling Stock Subsystem and Interfaces to AC Energy Subsystem

Synopsis

This document defines the interface requirements to the AC energy system for all rolling stock operating over the AC electrified railway.

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Published by:

**RSSB
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Angel Square
1 Torrens Street
London
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Railway Group Standard**GM/RT2111****Issue** One**Date** December 2014**Rolling Stock Subsystem and
Interfaces to AC Energy
Subsystem****Issue record**

Issue	Date	Comments
One	December 2014	Original document This document has been developed under project 09/013a to identify existing in-scope requirements and reduce costs associated with establishing compatibility between energy and rolling stock subsystems. The document retains in scope requirements from GE/RT8025 issue one, GM/RT2181 issue three and GM/RT2304 issue three and specifies new requirements needed to establish electrical compatibility between the two subsystems.

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GE/RT8025 issue one Electrical Protective Provisions for Electrified Lines	B 4.8	03 June 2017
GM/RT2181 issue three Overhead Line Equipment (O.L.E.) Warning Line on Traction and Rolling Stock	Clauses 4 and 4.1, and parts of clauses 5.1.1 and 5.1.2	03 June 2017
GM/RT2304 issue three Equipotential Bonding of Rail Vehicles to Running Rail Potential	Parts of clauses B 4.1 and B 4.3, and clauses B 4.8 and B 5.2.1.	03 June 2017

Other parts of GE/RT8025 issue one are superseded by GL/RT1210, issue one, AC Energy Subsystem and Interfaces to Rolling Stock Subsystem.

GM/RT2181 issue three Overhead Line Equipment (O.L.E.) Warning Line on Traction and Rolling Stock, ceases to be in force and is withdrawn as of 03 June 2017.

GM/RT2304 issue three Equipotential Bonding of Rail Vehicles to Running Rail Potential, ceases to be in force as of 03 June 2017 for AC subsystems.

Supply

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Part 1 Purpose and Introduction

1.1 Purpose

- 1.1.1 This document mandates requirements for all rolling stock operating over the AC electrified railway, in order to manage interfaces with the AC energy subsystem.
- 1.1.2 This document contains an 'open point', as set out in Appendix A, to address requirements that have not yet been specified but which are within the scope of the document. It applies to both 25 kV electric rail vehicles and non-electric rail vehicles such as coaches and freight wagons.

1.2 Introduction

1.2.1 Background

- 1.2.1.1 This document mandates requirements based upon existing practice for rolling stock operating on 25 kV AC electrification, together with those requirements for new rolling stock in line with EU requirements for interoperability and a migration towards operation on electrification systems that are compliant with the uniform system for the Great Britain (GB) mainline 25 kV AC electrified railway, while continuing to give compatibility with existing infrastructure. The application of this document to rail vehicles is as set out in Part 5.
- 1.2.1.2 The rolling stock requirements in this document describe the compatibility requirements with all existing and future 25 kV electrified systems. As the existing 25 kV electrification system which predates GL/RT1210 is not TSI compliant, this has resulted in additional rolling stock requirements to fully define this interface.

1.2.2 Supporting documents

- 1.2.2.1 The following Rail Industry Guidance Note supports this Railway Group Standard:

GM/GN2611	Guidance on Rolling Stock Subsystem and Interfaces to AC Energy Subsystem
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1.3 Approval and authorisation of this document

- 1.3.1 The content of this document was approved by Rolling Stock (RST) Standards Committee on 20 June 2014.
- 1.3.2 This document was authorised by RSSB on 03 November 2014.

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Part 2 Requirements for all Rail Vehicles Required to Operate over 25 kV AC Electrified Lines

2.1 Short circuit fault protection

2.1.1 Short circuit fault protection – provision of bonding

- 2.1.1.1 Bonding shall be provided on all rail vehicles that operate over the 25 kV AC system, except as set out in 2.1.1.2. The bonding shall be provided as set out in EN 50153:2002 clause 6.4.
- 2.1.1.2 It is permissible for rail vehicles that also operate over 750 V DC electrified lines to have only a single protective bonding path between the main body structure of the rail vehicle and the running rail.
- 2.1.1.3 The running rail(s) shall not be used to return currents between loads and their supply either within a single vehicle or between vehicles of a train.

2.1.2 Short circuit fault protection – bonding capacity

- 2.1.2.1 Bonding of all rail vehicles shall be compatible with an energy subsystem having the parameters for the maximum fault current and maximum fault durations, as set out in Table 1.

Maximum rms fault current [EN50388:2012, clause 11.2]	Maximum fault duration with back-up protection	Maximum fault duration with main protection operating	Maximum number of reclosures permitted	Maximum cumulative fault duration with main protection operating and maximum number of reclosures
15 kA	1 s	200 ms	2	600 ms

Table 1 Fault current characteristics – target system

- 2.1.2.2 It is permissible for the bonding of rail vehicles that are not intended to operate on lines provided with an energy subsystem having the parameters as set out in Table 1, to be compatible with an energy subsystem having the parameters for the maximum fault current and maximum fault durations as set out in Table 2.

Maximum rms fault current	Maximum fault duration with back-up protection	Maximum fault duration with main protection operating	Maximum number of reclosures permitted	Maximum cumulative fault duration with main protection operating and maximum number of reclosures
6 kA	1 s	250 ms	2	750 ms
12 kA	1 s	250 ms	1	500 ms
15 kA	0.65 s	150 ms	1	300 ms

Table 2 Fault current characteristics for compatibility with existing rail vehicles

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2.2 Clearance to 25 kV overhead contact line (OCL)

- 2.2.1 Except where permitted under 2.2.2, the minimum electrical clearance between all rail vehicle parts not intended for connection to the 25 kV OCL, including any parts that have been disconnected from the 25 kV OCL, and any exposed live part of the 25 kV OCL shall be the maximum reasonably practicable, and no less than the 'normal' values, as set out in GL/RT1210 clause 3.1.7, taking into account the gauge for the routes over which it will operate.
- 2.2.2 Where adequate flashover withstand performance is demonstrated and with the application of appropriate safety measures, it is permissible to use lower electrical clearance values than those set out in GL/RT1210 clause 3.1.7 at particular infrastructure features where 'normal' clearances cannot be achieved.

2.3 Protection of personnel – warning line

- 2.3.1 A continuous warning line 25-30 mm wide, at least 600 mm from exposed live parts of the OCL, shall be shown on all rail vehicles, except steam locomotives and wagons, operating over the 25 kV AC electrified railway. In addition, on electric rail vehicles, the warning line shall be no closer than 600 mm to the nearest train-mounted, exposed live electrical equipment. The line shall be continuous, except where this is prevented by physical features. Appendix D sets out a method for positioning the warning line.
- 2.3.2 A 'Danger: electricity' warning sign as defined in The Health and Safety (Safety Signs and Signals) Regulations 1998 – Statutory Instruments, 1996 No. 341 (Schedule 1), with the supplementary text 'Overhead Live Wires', shall be fitted adjacent to any steps or ladders on vehicles in a position such that it is clearly visible to anyone who is about to use the steps or ladder concerned.

2.4 Shore supplies

- 2.4.1 Where AC shore supply systems are fitted to vehicles, they shall be compatible with the relevant fixed equipment provided on the network, as set out in 2.4.2 and 2.4.3. The shore supply shall incorporate a safety interlock circuit to ensure that it is not possible to:
 - a) Disconnect or connect shore supplies to and from vehicles while energised.

Or

 - b) Access live parts of jumper plugs or receptacles.

Or

 - c) Connect a fixed shore supply to the vehicle system while it is already powered from another source.
- 2.4.2 The interface parameters of the 415 V 3-phase system shall be:
 - a) Three phase with no neutral (unearthed).
 - b) 600 A per phase maximum.
 - c) 400/415 V 3-phase – 3 – pin plug / socket.

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- d) BR Catalogue number 64 / 724 or compatible for the train interface (receptacle).
 - e) BR Catalogue number 64 / 725 or compatible for the shore interface (plug).
- 2.4.3 The interface parameters of the 1000 V single phase and neutral system, normally used for electric train heating, shall be:
- a) Single phase two wire (unearthed).
 - b) 600 A maximum.
 - c) 1000 V two single pole plugs / sockets.
 - d) BR Catalogue number 64/360 or compatible for the vehicle plug interface.
 - e) BR Catalogue number 90/11401 or compatible for the vehicle receptacle interface.
 - f) BR Catalogue number 64/2419 or compatible for the shore interface plug.
 - g) BR Catalogue number 64/2418 or compatible for the shore interface (receptacle).

The train interface fitted at each end of the vehicle consists of receptacles on the right (facing the vehicle), and a lead and plug on the left (facing the vehicle).

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Part 3 Electrical Requirements for 25 kV Electric Rail Vehicles

3.1 System frequency

- 3.1.1 25 kV electric rail vehicle(s) shall be able to operate continuously over the frequency range 47 Hz to 52 Hz, as set out in EN 50163:2004+A1:2007 clause 4.2.

3.2 System voltage

- 3.2.1 25 kV electric rail vehicle(s) shall be able to operate over the voltage range, as specified in EN 50163:2004+A1:2007 clause 4.1, including the special national condition for UK low voltage as specified in Annex B of EN 50163:2004+A1:2007.
- 3.2.2 It is permissible to omit compliance with the special national condition for UK low voltage, as set out in Annex B of EN 50163:2004+A1:2007, if the overhead line voltage at the pantograph is compliant with EN 50163:2004+A1:2007 clause 4.1, for all the routes over which the 25 kV electric rail vehicle operates.
- 3.2.3 Electric rail vehicle(s) shall not be damaged if the supply voltage falls to any value below U_{min2} .

3.3 Power factor

- 3.3.1 25 kV electric rail vehicle(s) shall meet the requirements for power factor, as set out in EN 50388:2012 clauses 6.2 and 6.3.

3.4 Maximum allowable train current and limitation

- 3.4.1 The maximum allowable train current (ID_{max}) shall not exceed 300 A, except where a higher value is compatible with the OCL supply provided on the routes over which a 25 kV electric rail vehicle operates.
- 3.4.2 25 kV electric multiple units, fixed formation units and locomotives, with power higher than 2 MW, including the declared fixed and predefined formations, shall be equipped with power or current limitation function.

3.5 Current regulation

- 3.5.1 25 kV electric vehicle(s) that operate over lines that do not conform to the Energy subsystem Technical Specification for Interoperability (ENE TSI) shall regulate current demand so that:
- At supply voltages at or above 20 kV, current regulation is not required.
- And
- At supply voltages below 20 kV and above 12.5 kV, regulation is required. The regulation shall be implemented so that the maximum allowable train current (ID_{max}) is reduced by the ratio of the line voltage divided by 20 kV, that is, $ID_{max} = (I_{max} \times V_{line} (kV))/20 \text{ kV}$.
- 3.5.2 For 25 kV electric rail vehicle(s) that operate exclusively over lines that comply with the ENE TSI, automatic regulation, as set out in EN 50388:2012 clause 7.2, shall be provided.

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3.6 Regenerative braking requirements

- 3.6.1 25 kV electric rail vehicle(s) equipped with regenerative braking shall meet the following requirements:
- a) Regenerative braking shall not be initiated if the OCL voltage at the pantograph is less than 17.5 kV.
 - b) Regeneration shall cease when the OCL voltage at the pantograph falls below 14 kV.
 - c) Regeneration shall not be initiated or continue when the OCL voltage at the pantograph is above a predetermined value within the range of 27.5 kV to 29 kV. This setting shall be selectable in a maximum of 500 V steps.
 - d) Manual inhibition of regenerative braking in the train shall be controlled from a position on the train accessible to the train driver and shall apply to the whole train.

3.7 Control of the train in-feed circuit breaker, pantograph and associated interlocks

- 3.7.1 Each pantograph shall only be permitted to be raised when its associated train in-feed circuit breaker is in the open state.
- 3.7.2 The train in-feed circuit breaker associated with that pantograph shall not close until the associated pantograph is in contact with the live OCL.
- 3.7.3 When pantograph lowering has been initiated, the associated train in-feed circuit breaker shall open immediately.

3.8 Automatic connection and disconnection of 25 kV loads

- 3.8.1 A 25 kV voltage measurement device shall be electrically connected directly to each pantograph. This device is not considered a 25 kV load.
- 3.8.2 Each pantograph shall be able to be disconnected from all 25 kV loads that it supplies using a circuit breaker. This circuit breaker is called the train in-feed circuit breaker.
- 3.8.3 Each pantograph shall have a train in-feed circuit breaker associated with it.
- 3.8.4 The train in-feed circuit breaker associated with a pantograph shall open on the application of an automatic power control (APC) pulse from the APC system associated with that pantograph, only if that train in-feed circuit breaker is closed at the time the APC pulse is applied.
- 3.8.5 A train in-feed circuit breaker associated with a pantograph opened by an APC system as set out in clause 3.8.4, shall open within 150 ms of the associated APC receiver passing over a magnet.
- 3.8.6 The train in-feed circuit breaker associated with a pantograph shall open, within three seconds, on loss of the 25 kV OCL supply detected by the voltage measurement device electrically connected to that pantograph.

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- 3.8.7 Each train in-feed circuit breaker associated with a pantograph shall close on the application of an APC pulse from the APC system associated with that pantograph, when both the conditions in a) and b) below are met:

- a) The 25 kV OCL supply is energised.
- b) The train in-feed breaker associated with that pantograph is open.

- 3.8.8 Any train in-feed circuit breaker shall be inhibited from being automatically closed for a period of 15 minutes after detection of the 25 kV overhead line supply, excepting as set out in 3.8.7.

3.9 Prevention of bridging neutral section

- 3.9.1 Trains fitted with more than one pantograph shall not permit the pantographs to be electrically interconnected when raised for current collection.

3.10 Correct system selection

- 3.10.1 On dual voltage electric rail vehicles the 25 kV AC energy subsystem shall not be connected to the 750 V DC energy subsystem via the vehicle.

3.11 Fault current clearance requirements

- 3.11.1 25 kV electric rail vehicle(s) shall be fitted with train in-feed circuit breakers that:

- a) Disconnect all 25 kV loads on the train, except for essential voltage measurement devices.
- b) Meet all the requirements of EN 60077-4:2003, where:
 - i) The short circuit current is the maximum rms current for the route in a circuit having a maximum time constant. The maximum time constant of the infrastructure is an 'open point'.
 - ii) Capability to withstand the traction power supply reclosure strategy is as set out in GL/RT1210 clause 2.1.5.
- c) Trip immediately, without any intentional delay, except as set out in 3.11.2, on detection of a short circuit fault on the 25 kV equipment of the electric rail vehicle.

- 3.11.2 Where a holdover feature is provided, which holds the train in-feed circuit breaker closed under faults greater than the circuit breaker's rating, it is permissible to inhibit a trip of the train in-feed circuit breaker when the holdover feature is activated.

3.12 Insulation coordination

- 3.12.1 All high voltage electrical equipment on 25 kV electric rail vehicle(s) connected to the 25 kV system, except for surge suppression devices, shall have a minimum dielectric withstand rating (impulse U_{Ni} and power frequency U_a) selected in accordance with EN 50124-1:2001+A2:2005 clauses 2, 3, 4, and 6.2.

3.13 Power frequency harmonic requirements

- 3.13.1 Except for the vehicle switching frequency related harmonics set out in Table 4, the rms harmonic current generated by a train as a percentage of the rms fundamental current at any frequency shall not exceed the values set out in Table 3.