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Level 2

Specification for Class II Based Signalling Power Distribution Systems

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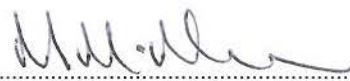


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User information

This Network Rail standard contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *No deviations, could stop the railway*

- **Red requirements shall** always be complied with and achieved.
- Red requirements shall be presented in a red box **with the word “shall” or expressed as a direct instruction**.
- Accountability for the efficacy of red requirements lies with the Professional Head/Standard Owner.
- Red requirements are monitored for compliance.
- Corrective actions shall be enforced if deviations are discovered through functional checks (e.g. engineering verification visits, audit or Operations Self-Assurance).

Amber requirements – *Controlled deviations, approved risk analysis and mitigation*

- **Amber requirements shall** be complied with unless deviation has been approved in advance.
- Amber requirements shall be presented with an amber sidebar **and with the word “shall” or expressed as a direct instruction**.
- Accountability for the efficacy of these requirements lies with the Professional Head/Standard Owner, or their nominated Delegated Authority.
- Amber requirements are monitored for compliance.
- Deviations **may** be permitted. Deviations are approved by the Standard Owner or through existing Delegated Authority arrangements.
- Corrective actions shall be enforced if **non-approved** deviations are discovered through functional checks (e.g. engineering verification visits, audit or Operations Self-Assurance).

Green – *Guidance*

- Guidance is based on good practice. Guidance represents supporting information to help achieve **Red** and **Amber** requirements.
- Guidance shall be presented with a dotted green sidebar **and with the word “should” (usually in notes) or as a direct instruction**.
- Guidance is **not mandatory** and is not monitored for compliance.
- Alternative solutions may be used. Alternative solutions do not need to be formally approved.
- Decisions made by a competent person to use alternative solutions should be backed up by appropriate evidence or documentation.

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Issue record

Issue	Date	Comments
1	December 2011	First issue
2	February 2015	Incorporation of guidance on legacy systems and additional rules on the use of aluminium cables

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors where applicable from 6th June 2015.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 3 (Option Selection) to continue to comply with the issue of any relevant Network Rail standards current when GRIP Stage 3 was completed and not to comply with requirements contained herein, unless stipulated otherwise in the scope of this standard.

Reference documentation

2011-048	ERA safety case report for use of Class II equipment as protective measure against electric shock
2014-0710 Issue 4	Edif ERA safety case justification for fitment of pre-fabricated enclosures to protect against electric shock
BS 5467	Electric cables. Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 6231	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring
BS 6346	Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 7671	Requirements for electrical installations
BS EN 50122-1	Railway applications. Fixed installations. Electrical safety, earthing and the return circuit. Protective provisions against electric shock
BS EN 50262	Cable glands for electrical installations
BS EN 50267	Common test methods for cables under fire conditions
BS EN 50393	Test methods and requirements for accessories for use on distribution cables of rated voltage 0.6/1.0 (1.2) kV
BS EN 61386-23	Conduit systems for cable management. Particular requirements – flexible conduit systems
IEC 60417	Graphical symbols for use on equipment

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IEC 60949	Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects
NR/L2/ELP/21120	E & P records management process
NR/L2/RSE/100/05	Product introduction and change (formerly NR/L2/EBM/029)
NR/L2/SIG/11201	Signalling design handbook
NR/L3/SIG/11303	Signalling installation
NR/L2/SIG/30050	Signalling power circuit principles
NR/L2/SIGELP/27408	Product specification for signalling power distribution cables
NR/L2/SIGELP/27409	Product specification for functional supply points (FSP)
NR/L3/SIGELP/27418	Installation specification for earthing of signalling power systems
NR/L2/SIGELP/27419	Product specification for distribution interface transformer assemblies (DITA) for signalling power distribution systems
NR/L3/SIGELP/27420	Target earth calculation methodology for signalling power systems
NR/L2/SIGELP/27421	Product specification – flexible conduits for Class II based signalling power distribution systems
NR/L2/SIGELP/27422	Product specification – cable glands for use in Class II based signalling power distribution systems
NR/L2/SIGELP/27416	Specification for addition and alteration to signalling power distribution systems
NR/L2/SIGELP/27423	Product specification for connectors and joints for signalling power systems using aluminium cable
NR/L2/SIGELP/30007	Product specification for power transformers for signalling systems
NR/SP/ELP/21085	Specification for design of earthing and bonding systems for 25 kV a.c. electrical lines
NR/SP/ELP/27224	Specification for the installation of cable routes forming part of the traction distribution system
NR/SP/ELP/27242	Specification for electrical installations on rail premises
NR/SP/ELP/27243	Specification for signalling power supplies
NR/SP/SIG/11231	Signalling maintenance testing handbook
NR/SP/SIG/19812	Cross track cable management
NR/SP/SIG/30014	Signalling works testing handbook
NR/SPS/T001	Earth electrode testing (module of NR/L3/SIGELP/50001 Working on or near 650 V signalling power supplies)

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RT/E/PS/00005

Railway signalling cable (also referred to as NR/L2/SIG/00005 and NR/PS/SIG/00005)

SSI 8503

SSI applications manual – Earthing and bonding of solid state interlocking equipment

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1 Purpose

This document specifies the requirements for the design, installation, and testing of Class II based signalling power distribution systems on Network Rail managed infrastructure. This specification also includes requirements for the introduction of Class II equipment into legacy signalling power distribution systems to provide fault protection.

2 Scope

This specification defines system design requirements, constraints, protection, cable sizing strategy, earthing and bonding arrangements. It also includes installation and testing requirements for a Class II based signalling power distribution system.

The requirements in this specification are to be applied to new or altered Class II installations of a complete feeder originating from a PSP (not precluding ASP, SSP, DITA or other power source) using enhanced unarmoured cable.

The requirements in this specification may also be applied to legacy Class I feeders, which may comprise any of the following electrical systems:

- a) IT individual,
- b) mix of IT individual and IT grouped, or
- c) TT.

The modification and alteration of BS 7671 compliant signalling power distributions systems comprising IT collective or TN electrical systems is excluded from this specification.

NOTE 1: Only IT electrical systems form part of the risk assessment which supports the Class II safety case.

Functional circuits downstream of FSP isolating transformers are excluded from the provisions detailed in this specification.

3 System applications

FSP installations on the following electrical systems are covered by this specification:

- a) single-phase Class II signalling power distribution systems with 2-core enhanced unarmoured cable to NR/L2/SIGELP/27408;
- b) single-phase, IT individual with 2-core unarmoured cable;
- c) single-phase, IT individual mixed, with IT grouped with 2-core unarmoured cable, mixed with either 2-core or 3-core armoured cable;
- d) single phase, TT with 2-core unarmoured or armoured cable;
- e) single-phase, IT collective with 3-core armoured cable.

The following types of installation are excluded from this specification:

- a) single-phase, TN with 3-core armoured cable;

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- b) three-phase, TN with 4-core armoured cable with an integral CPC;
- c) three-phase, TN with 3-core armoured cable with a separate CPC.

4 Definitions

For the purpose of this standard, the following terms and definitions apply:

Apparatus housing	External weatherproof housing which may be referred to as a location case, signalling equipment housing, cubicle, shelter, container or building.
ARS	Automatic reconfigurable system.
Auxiliary supply point (ASP)	A scaled-down version of a PSP. Energy is distributed to supply signalling power distribution systems; however the functionality and capacity may be reduced.
Bonding (conductor)	A protective conductor providing equipotential bonding; as defined in BS 7671.
Class II based signalling power distribution system	Signalling power distribution system using Class II equipment and associated components.
Class II equipment	Equipment with basic insulation as provision for basic protection, and supplementary insulation as provision for fault protection, or in which basic and fault protection are provided by reinforced insulation, in accordance with IEC 61140.
Class II hybrid FSP isolating transformer	Transformer in which the primary side, including its terminals, meet the requirements for Class II and the secondary side meets the requirements for Class I, allowing ready access to the secondary tapplings for adjustment in service as defined in NR/L2/SIGELP/30007.
DITA	Distribution interface transformer assembly in accordance with NR/L2/SIGELP/27419. An assembly consisting of switchgear, isolating transformer, and protection and control unit (PCU).
DMT	Definite minimum time. This is an adjustable or programmable overcurrent setting found on a particular type of circuit breaker.
Enhanced unarmoured cable	A cable having increased insulation and sheath thickness intended to provide a degree of protection against crushing and impact damage as defined in NR/L2/SIGELP/27408.
Exposed-conductive-part	Conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails as defined in BS 7671.
Extraneous-conductive-part	A conductive part liable to introduce a potential, generally earth potential, and not forming part of the electrical installation as defined in BS 7671.

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Fault protection	For low voltage installations, systems and equipment, fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation. Indirect contact is contact of persons or livestock with exposed-conductive-parts which have become live under fault conditions as defined in BS 7671.
Full load current (FLC)	The maximum design current for a feeder under normal loading conditions as defined in NR/L2/SIG/30050.
Functional power circuits	A system including, but not limited to, protective devices, transformers, rectifiers, batteries, signalling bus bars and associated wiring fed from a functional supply point and feeding functional circuits.
Functional supply point (FSP)	The point that the power supply distribution system connects with an item of supplied equipment. May be co-located with signalling equipment.
IT system	An electrical distribution system having no direct connection between live parts and earth.
IT collective	An IT system in which all exposed conductive parts are earthed collectively. A collectively earthed FSP has its own local earth electrode system and all such FSPs on the same feeder have their earths interconnected via a continuous conductor, the circuit protective conductor (CPC).
IT grouped	A group (or grouped) earth FSP has its own local earth electrode system and a limited number of adjacent FSPs on the same feeder have their earths connected together.
IT individual	An IT system in which all exposed conductive parts are earthed individually. An individually earthed FSP has its own local earth electrode system.
Legacy system	Legacy systems rely upon local earthing electrodes at apparatus housings to provide electric shock protection in the event of a first earth fault.
Principal supply point (PSP)	The point of common connection of one or more electrical sources from which energy may be distributed. For the purposes of this document, references to PSP shall also include ASP and SSP.
Short circuit	A zero or low impedance phase-to-phase fault.
Signalling supply point (SSP)	A point of common connection of one or more electrical sources from which energy may be distributed, to supply signalling power distribution systems.
TN system	A system having one or more points of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to that point by protective conductors, as defined in BS 7671.
TT system	A system having one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source.

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5 System constraints and components

5.1 System overview

Fault protection in a Class II based signalling power distribution system is provided by the use of Class II equipment and associated components. Class II based signalling power distribution systems do not rely on automatic disconnection of supply triggered by earth fault current flow. Instead, fault protection is provided by the selection of suitable Class II equipment which, by its construction, provides the necessary degree of intrinsic safety with regard to electric shock.

NOTE 1: Red requirements are derived from the safety case for use of Class II equipment as a protective measure against electric shock in Signalling Power Distribution Systems. Deviation from these requirements would require a reassessment of the safety case as detailed in report 2011-048.

An overview of a typical Class II based signalling power distribution system is shown in Figure 1.

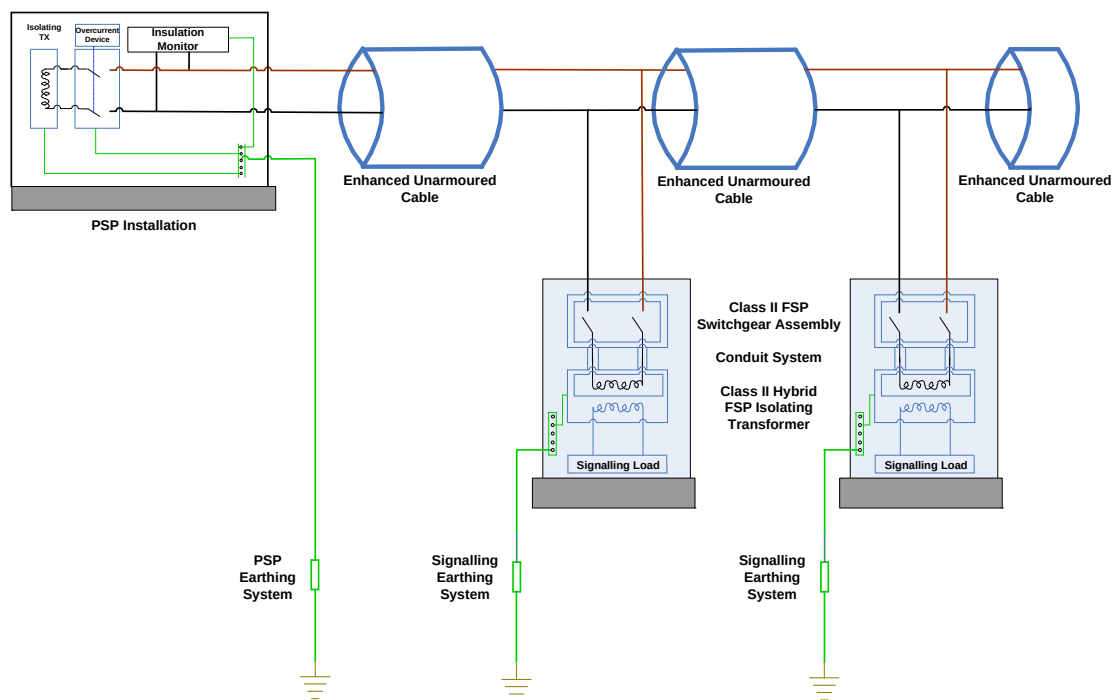


Figure 1 – Typical Class II based signalling power distribution system

NOTE 2: Legacy systems installed prior to year 2000 used 2-core unarmoured power cable to RT/E/PS/00005 or EPR rubber, with Class I FSP switchgear assemblies and FSP isolating transformers. Protection against fault protection may have been inadvertently provided by way of lightning protection with the use of earth electrodes. No provision was made for protection against second earth fault.

Class II based signalling power distribution systems differ from existing legacy systems in a number of ways:

- the use of enhanced unarmoured cable using PVC technology to provide protection against crush and impact damage;
- the use of Class II FSP switchgear assemblies;

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- Class II hybrid isolating transformers;
- cable containment of the distribution cables in signalling apparatus housings to provide fault protection;
- cable distribution management afforded by overcurrent protection and insulation monitoring in the PSP providing enhanced monitoring and protection against overcurrent and fire.

5.2 System components

A Class II based signalling power distribution system shall comprise the following subsystems:

- PSP equipment including distribution transformer, overcurrent protection devices and insulation monitoring equipment;
- cable systems:

- for new or altered Class II installations, enhanced unarmoured distribution cables including cable termination and glanding arrangements for transmission of low voltage power, or
- for legacy installations, this may comprise EPR / B2 cable in accordance with RT/E/PS/00005 or armoured cable in accordance with BS 5467 or BS 6346 with suitable mechanical protection encasing the cable;

- Class II FSP assemblies, depending on distribution topology, for managing and switching of Enhanced Unarmoured cable;
- Class II hybrid FSP isolating transformers including transformer rectifiers (T/Js) for providing functional power to circuits in accordance with NR/L2/SIG/30050;
- insulating conduit system encasing signalling power distribution cables in apparatus housings;

NOTE 1: Where signalling power distribution cables are enhanced unarmoured cables in accordance with NR/L2/SIGELP/27408 or C2 cables in accordance with RT/E/PS/00005, insulating conduit systems for additional mechanical protection are not required where the outer sheath is maintained up to the point of termination or glanding.

- suitable mechanical protection, consisting of insulating split conduit system covering legacy signalling power distribution cables as detailed in (b) above.

NOTE 2: PSP equipment is not required to be of Class II construction.

NOTE 3: Class II FSP assemblies may comprise distribution switches, overcurrent protective devices, distribution interface transformer assemblies (DITAs), insulation monitoring current transformers and devices, two-terminal overvoltage protection devices, auto-reconfiguration devices and internal wiring systems.