

Legacy Power
NEWS

Annual 2018



OVER 10000 **SIN119** INSTALLATIONS

RAISING THE STANDARDS

A closer look at Network Rail Standards

LEGACY PRODUCT FOCUS

Take an in depth look at a range of products

RETROFIT PRINCIPLES

The basis of a successful retrofit

CASE STUDIES

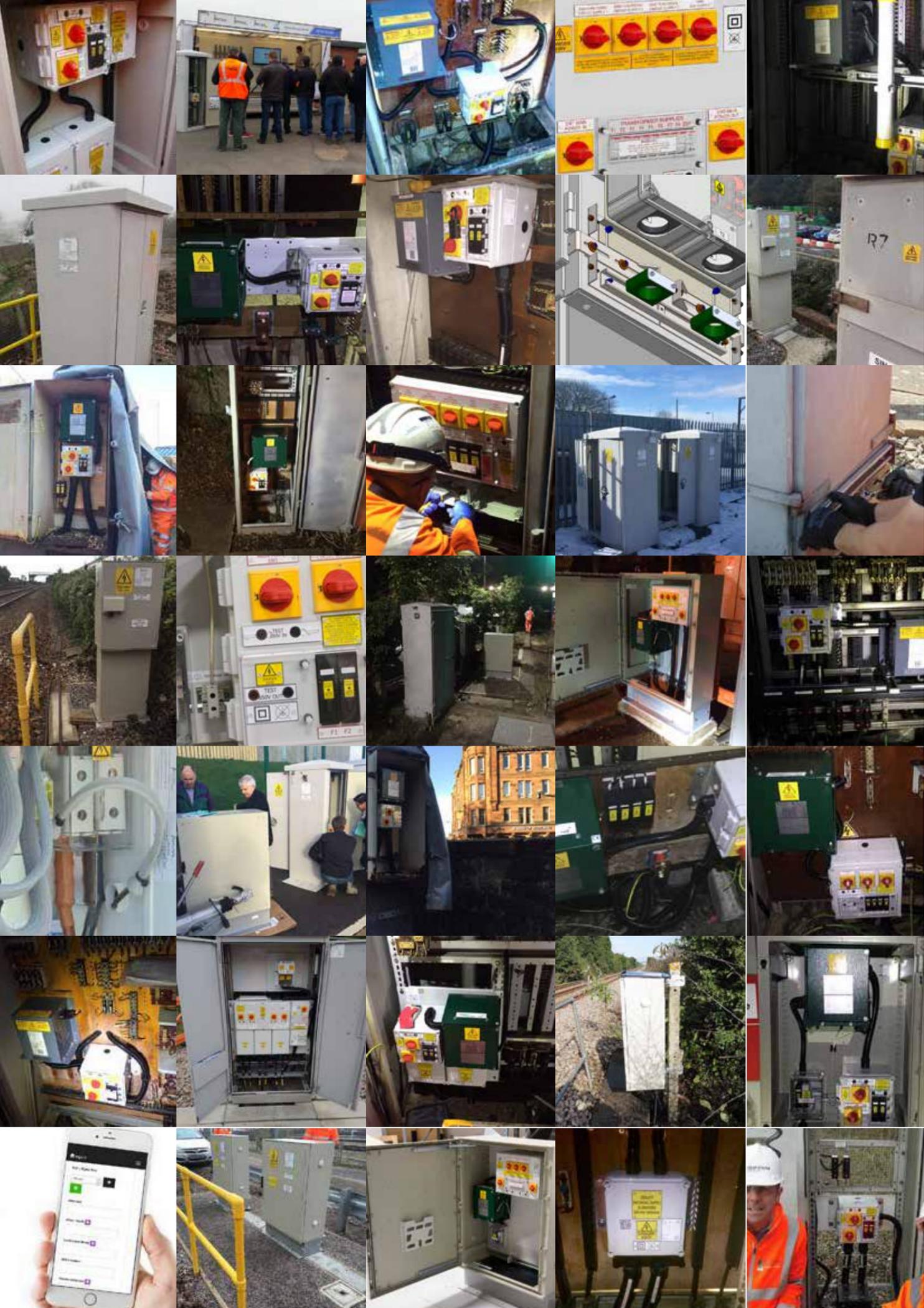
Over 1000 installations, here are a few of our favourites

TURNKEY PRINCIPLE

Survey to design and install

TECHNOLOGY

Current and future technologies



INTRODUCTION

To celebrate our 1000th Class II retrofit we would like to present our first Legacy Power News Annual, gathering together, examples, standards and methodology from recent signalling power supply upgrade success stories. The first annual tells the story from the beginning, responding to the SIN119 notification, looking at the Network Rail standards supporting this activity and the products and technologies available to deliver the compliance and a detailed look at the turnkey services available to roll out this work with minimal impact on the network.

We discuss lessons learnt and the expansion of the retrofit philosophy beyond SIN119 compliance, looking ahead to asset life extension, CP6 targets and proactive maintenance regimes.

The annual tells the full story behind the Legacy tracker tool and its vital role in delivering efficient first time retrofits. We have included a wide range of case studies providing an in-depth look at examples of retrofit works we have been involved across a wide range of Legacy case layouts. Additional studies include a product focus on key elements that will be utilised during your installation. We will also take a closer look at the use of Class II Annexe FSPs and composite cases.

Highlighted in our technology section is a range of new products and supporting Network Rail Standards. Current and new technologies will support the interface with existing Legacy power systems and create a network of monitoring solutions and fault location technology all looking to deliver greater resilience with minimal impact on the existing low voltage network. Much of this innovative technology will deliver significant safety and reliability improvements whilst also expanding capacity and mitigating widespread cable testing across the network.

Along with the Legacy Solutions Catalogue, the LPN Annual, can be used to both influence and support projects by explaining and discussing best practices and product selection. Our SIN119 demonstration vehicle has visited over 30 Network Rail and contractor sites across the country providing training on both surveying and product selections.

[We hope that you enjoy the LPN Annual and if you have any queries contact one of our retrofit experts.](#)

CONTENTS

<p>2-19</p> <p>NETWORK RAIL STANDARDS</p>	<p>46-61</p> <p>DELIVERED PROJECTS & CASE STUDIES</p>
<p>22-37</p> <p>PRODUCT FOCUS</p>	<p>64-73</p> <p>TURNKEY PRINCIPLES</p>
<p>40-43</p> <p>RETROFIT PHILOSOPHY</p>	<p>76-83</p> <p>TECHNOLOGY</p>



NR/L2/SIGELP/27409 issue 2



NR/L2/SIGELP/27410



NR/L2/SIGELP/27416



NR/L2/SIGELP/27417



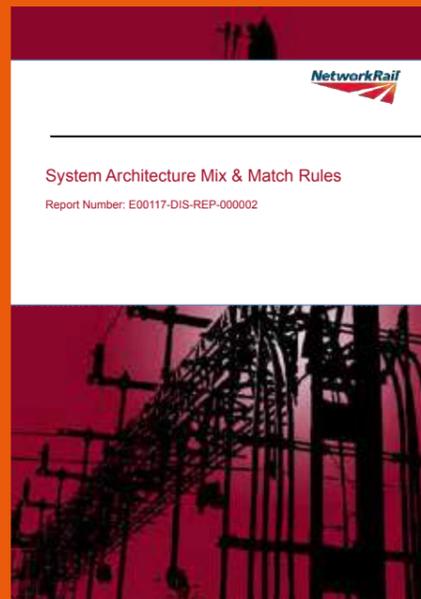
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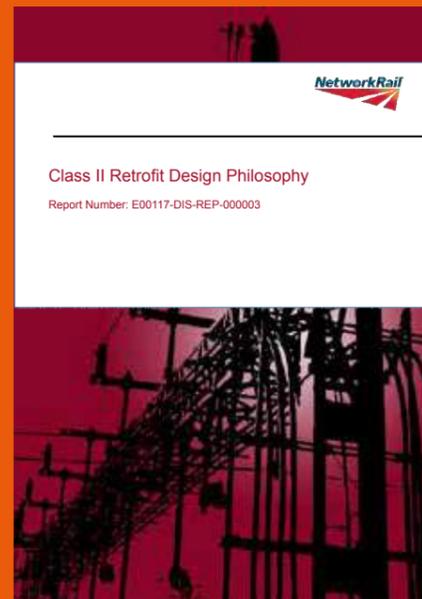
NR/L2/SIGELP/27725



NR/L2/SIGELP/27419



System Architecture Mix & Match Rules



Class II Retrofit Design Philosophy

NETWORK RAIL STANDARDS

- 4 NR/L2/SIGELP/27410 - Specification for Class II Based Signalling Power Distribution Systems
- 5-6 E00117-DIS-REP-000003 - Class II Retrofit Design Philosophy
- 7 E00117-DIS-REP-000002 - Class II System Architecture Mix & Match Rules
- 8-9 NR/L2/SIGELP/27409 Issue 2 - Product Specification for Functional Supply Points (FSP)
- 10 NR/L2/SIGELP/27417 - Signalling Power Distribution Diagrams
- 11 NR/L2/SIGELP/27725 - Insulation Monitoring and Fault Location Systems for use on Signalling Power Systems
- 12-15 NR/L2/SIGELP/27416 - Alterations to Signalling Power Systems

To support the use of Class II and the technology delivering IT power supplies, Network Rail have delivered a range of standards covering FSPs, DITA, Insulation Monitoring and alterations to signalling power systems. These standards provide a wealth of information and application based diagrams to support designers and the integration with existing Legacy power supplies. Within the sections of the Legacy Power News Annual 2018, we have looked to highlight the relevant standards and some key points within the standard helping to deliver the Class II retrofit solution.

RAISING THE STANDARDS

Class II for Legacy Installations

Any integration of Class II equipment into legacy installations shall comply with the requirements specified in NR/L2/SIGELP/27410.

Class II Retro-Fitting

When retro-fitting factory made Class II equipment or components into apparatus housings on legacy installations. Consideration shall be given to space availability, non-disruptive installation, and poor legacy practices and components.

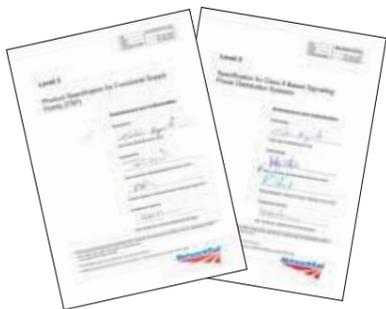
The FSP04 legacy circuit configuration may be considered as an alternative to an FSP01/02 where space constraints prohibit the installation of larger FSP switchgear assemblies. Examples of these are shown below.

FSP Switchgear Assembly Types

Type	Distribution Topology Power Supply	FSP Supply Architecture
FSP04 (Legacy)	Single end fed (or sub-fed from main distribution centre)	Suitable as a direct replacement for existing isolation or fusing arrangements within legacy installations

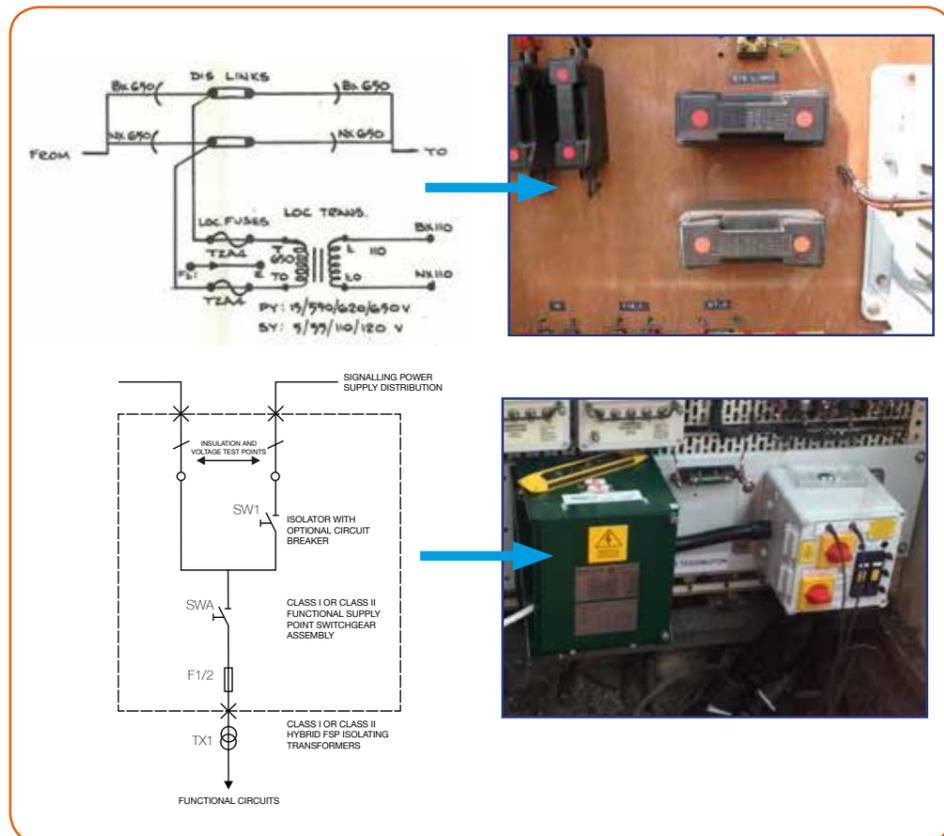
FSP04 switchgear assemblies may be part of a stand-alone self-contained apparatus housing or integrated (co-located) with signalling equipment

TYPICAL EXAMPLE OF LEGACY CIRCUIT



To support the installation of Class II within legacy locations, the Micro FSP has been developed to align with the FSP04 circuit and when used in conjunction with the range of integrated backplates provides a solution for constructable Class II in legacy locations.

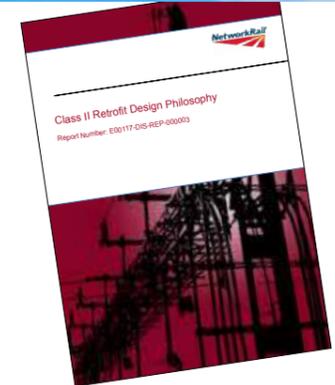
The new standards continue to support and drive the development of new Class II designs. This allows greater flexibility in design and implementation across all signalling power projects.



Class II Retrofit Design Philosophy

The E00117-DIS-REP-000003 report specifies the requirements and constraints for the introduction of Class II based equipment into legacy signalling power distribution installations, to reduce the risk of electric shock at FSPs and/or signalling apparatus housings.

The report E00117-DIS-REP-000003 should be read in conjunction with E00117-DIS-REP-000002 "System Architecture Mix and Match Rules".



Sub System Modification Requirements

4.1 Principal Supply Point (PSP)

- 4.1.1 The PSP distribution switchboard shall be fitted with an Insulation Monitoring System in accordance with requirements of BS7671 Regulation 411.6.3.1 for IT type power supplies. Where individual feeders are segregated into separate circuits at the PSP, an Insulation monitor shall also be fitted for each feeder. In addition, an insulation monitor shall also be fitted on the secondary of each Distribution Interface Transformer Assembly (DITA) or existing booster transformer assemblies.
- 4.1.2 Local earth target impedance of PSPs and DITA shall be in accordance with E00117-DIS-REP-000004 "Earth Resistance Calculation Methodology".

4.2 Functional Supply Point (FSP)

- 4.2.1 To reduce the probability of insulation failure in the FSPs to a reasonable level the following steps shall be taken:
 - Class II FSP switchgear to NR/L2/SIGELP/27409 Issue 2 shall be installed.
 - The distribution cable shall be encased in insulating split/solid conduit in accordance with BS EN 61386-23 for a minimum of 2 metres from the termination point. The conduit system shall be durably fixed in place with insulated fixings.
 - Internal distribution voltage signalling power wiring in the FSP shall be encased in insulating split/solid conduit. The conduit system shall be durably fixed in place with insulated fixings.
 - The signalling transformers and transformer rectifiers shall be replaced with Class II Hybrid Isolating Transformers in accordance with NR/L2/SIG/30007.
 - Any sub-distribution cable feeding adjacent signalling apparatus housings in the same signalling location area shall be provisioned with insulating split conduit or replaced with C2 cable in accordance with RT/E/PS/00005 or enhanced unarmoured cable in accordance with NR/L2/SIGELP/27409 Issue 2.
 - Cable Consumables (Glands, Joints, Terminations etc.) that maintain Class II integrity shall be installed in place of existing consumables.
- 4.2.2 Where the distribution cable is not suitable for re termination into the new Class II FSP switchgear it shall be cut back by a minimum of 2 meters and jointed using a cast resin joint in accordance with BS EN 50393 and tailed in using enhanced unarmoured cable to NR/L2/ELP/27408. Provision of split conduits where cable to NR/L2/ELP/27408 is used will not be necessary.
- 4.2.3 A family of FSP switchgear assemblies shall be used that fits space constraints presented by legacy installations.
- 4.2.4 Class II switchgear assemblies within any FSP shall comply with the requirements of NR/L2/SIGELP/27409 Issue 2. Only equipment that is product approved in accordance with NR/L2/EBM/029 shall be installed.

RAISING THE STANDARDS

4.3 Signalling Transformers and Transformer Rectifiers

- 4.3.1 The replacement of transformers and transformer rectifiers with Class II hybrid transformers further reduces the probability of insulation failure. Where transformers are replaced, an impact on the distribution voltage profile on the secondary connections shall be computed for compliance with relevant signalling standards. Transformers to NR/L2/SIG/30007 have a different electrical performance characteristic that may affect the distribution voltage profile.
- 4.3.2 An impact assessment shall be made to confirm that mechanical support arrangements are adequate for transformers that conform to NR/L2/SIG/30007. The weight of transformers due to low inrush requirements specified in NR/L2/SIG/30007 may be significantly higher than legacy transformers constructed to the legacy specification BR 924 A. NOTE: A new range of lightweight aluminium wound transformers, which may match the weight of legacy BR 924 A transformers whilst meeting the performance requirements of NR/L2/SIG/30007, are under development.

4.4 Site Applied Double or Reinforced Insulation

- 4.4.1 Where supplementary insulation in accordance with BS7671 Regulation 412.2 is applied on existing installed equipment having basic insulation, the resulting degree of safety, equivalent to that achieved with provision of equipment in accordance with NR/L2/SIGELP/27409 Issue 2 and NR/L2/SIGELP/27410, shall be afforded.
- 4.4.2 Supplementary insulation applied on external surfaces of location cases, or where location cases are re-skinned, shall have a dielectric strength in accordance with NR/L2/SIGELP/27409 Issue 2. Where this method is used, in conjunction with safe isolation methods, an assessment shall be made on the likely impact on the reliability and performance of signalling equipment to perform at higher internal temperatures, due to the thermal insulation effects of external coatings.

4.5 Distribution Interface Transformer Assembly (DITA) Requirements

- 4.5.1 The DITA is described in report E00117-DIS-REP-000002 "System Architecture Mix and Match Rules"
- 4.5.2 here a DITA transformer is installed in a circuit the transformer shall be considered as a 'load' in the circuit from which it is supplied and the 'source' for the circuit it supplies. Because the DITA becomes the new source, circuit protection shall to be installed at the output of the DITA as protection for the downstream circuit.
- 4.5.3 The DITA will also prevent the insulation monitoring system at the PSP from supervising the circuit downstream of the point of installation therefore additional insulation monitoring shall be provided for the downstream circuit.
- 4.5.4 Downstream protection of a DITA shall be designed to integrate with low prospective fault currents in a distribution system and high current peaks from signalling equipment typically from transformers, points motors etc.
- 4.5.5 A DMT protection device will monitor the current in the circuit and will trip if it exceeds a pre-set current for a pre-set time. This allows the operating characteristic of the device to be tailored to match the load, overload and fault withstand characteristics of the circuit. This is particularly useful in legacy installations where the fault current is limited due to long cable lengths.
- 4.5.6 Where DMT protection devices are installed they shall coordinate with downstream and upstream protection.

4.6 "Booster" Transformer Installations

- 4.6.1 Existing installation with a Class I booster transformer (not to be confused with a 25kV OLE Booster Transformer), which acts as step-up transformer, shall be replaced with Class II hybrid DITA.

System Architecture Mix & Match Rules

Report number E00117-DIS-REP-000002 sets out the system strategy together with the design and installation requirements and constraints for reduction of electric shock risk at FSPs.

4 Class II Assemblies

- 4.1.1 The installation of Class II equipment, either in part or full, into legacy signalling power distribution networks shall consider the implications on existing protective measures, so as to ensure that the safety of an individual installation or distribution feeder is not reduced. Legacy networks may comprise Class I IT-individual, IT-individual and grouped (inter-mixed on the same distribution feeder), IT-collective, TN and TT electrical systems.
- 4.1.2 The introduction of Class II equipment in legacy FSPs shall be in accordance with NR specification NR/L2/ELP/27410 "Specification for Class II Based Signalling Systems" and E00117-DIS-REP-000003 "Class II Retrofit Design Philosophy".
- 4.1.3 The application of Class II equipment, with an unarmoured cable distribution feeder to every FSP, would allow compliance with BS7671 to be achieved, for that feeder, provided that the existing cables have appropriate mechanical protection. Compliance with BS7671 would not be achieved if any Class I power distribution equipment remains on that feeder.
- 4.1.4 Replacement of fuse protection on the PSP feeders with electronic-based over-current protective devices would allow the sensitivity and selectivity of the protection scheme to be improved as shown in Figure 3. This would allow reduction of short-circuit disconnection times and hence reduce the risk of thermal degradation of aged cables.
- 4.1.5 Introduction of Class II equipment throughout a feeder can be undertaken as a stand-alone exercise. It is not necessary to convert all feeders from a PSP at the same time.

NOTE: A new range of "Micro" FSP switchgear is currently under development with TRL of 7/8, which meets the specific space constraints associated with legacy FSPs.

NOTE: A new range of Light Weight Aluminium Wound Transformers is currently under development with TRL of 7/8 which may match the weight of legacy BR 924A transformers but will meet the performance requirements of NR/L2/SIG/30007.

NOTE: A new range of Plug & Play cable connections is currently under development with TRL of 7/8 which may ease and reduce the installation time.



RAISING THE STANDARDS

NR/L2/SIGELP/27409 Issue 2

9.4.1 Class II retro-fitting

When retro-fitting factory made Class II equipment or components into apparatus housings on legacy installations, consideration shall be given to space availability, non-disruptive installation, and poor legacy practices and components.

The FSP 04 legacy circuit configuration may be considered as an alternative to an FSP01/02 where space constraints prohibit the installation of larger FSP switchgear assemblies.

650V Sub-Distribution

The radial circuit FSP 04 offers a compact, cost effective solution for 650V sub-distribution on radial feeders. The Micro FSP 04 provides single or double transformer supply isolation and protection within signalling apparatus cases or annexe FSPs.

New Installations

The Micro FSP 04 offers a compact 650V unit within new signalling locations on sub-distribution circuits. The unit can be installed within standard BRS/SM 440 barwork in conjunction with a hybrid Class II signalling transformer. Alternatively the integrated Micro FSP and transformer assembly plate offers further cost savings in site installation and testing by providing a fully factory tested 650V / 110V unit.

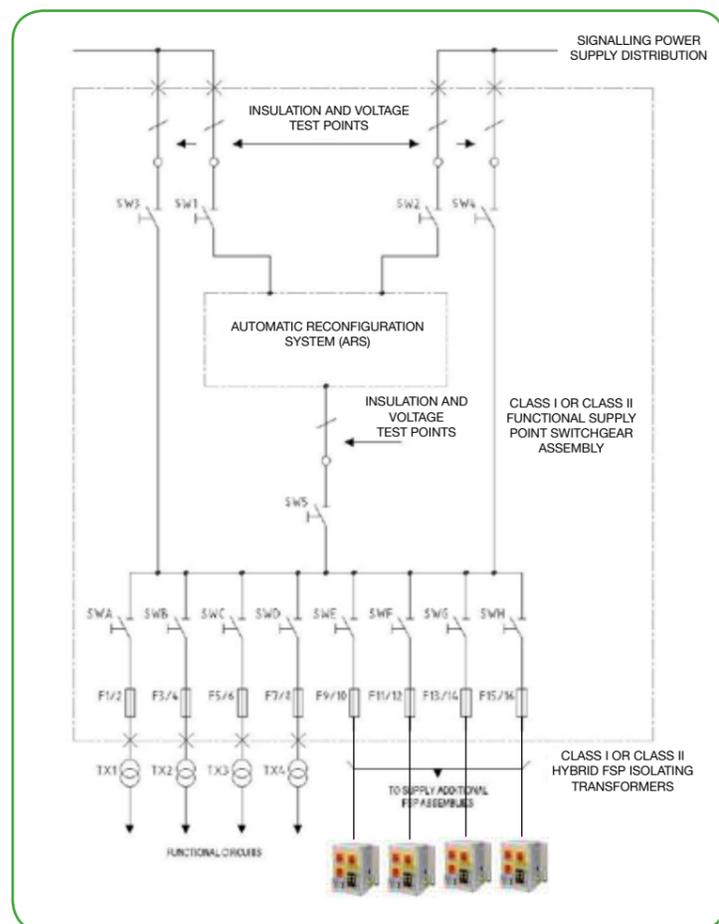
For more information on the fully integrated iLECSYS/Camlin Signet FSP03 please contact us on 01442 828387 or email enquiry@ilecsysrail.co.uk

FSP Switchgear Assembly Types

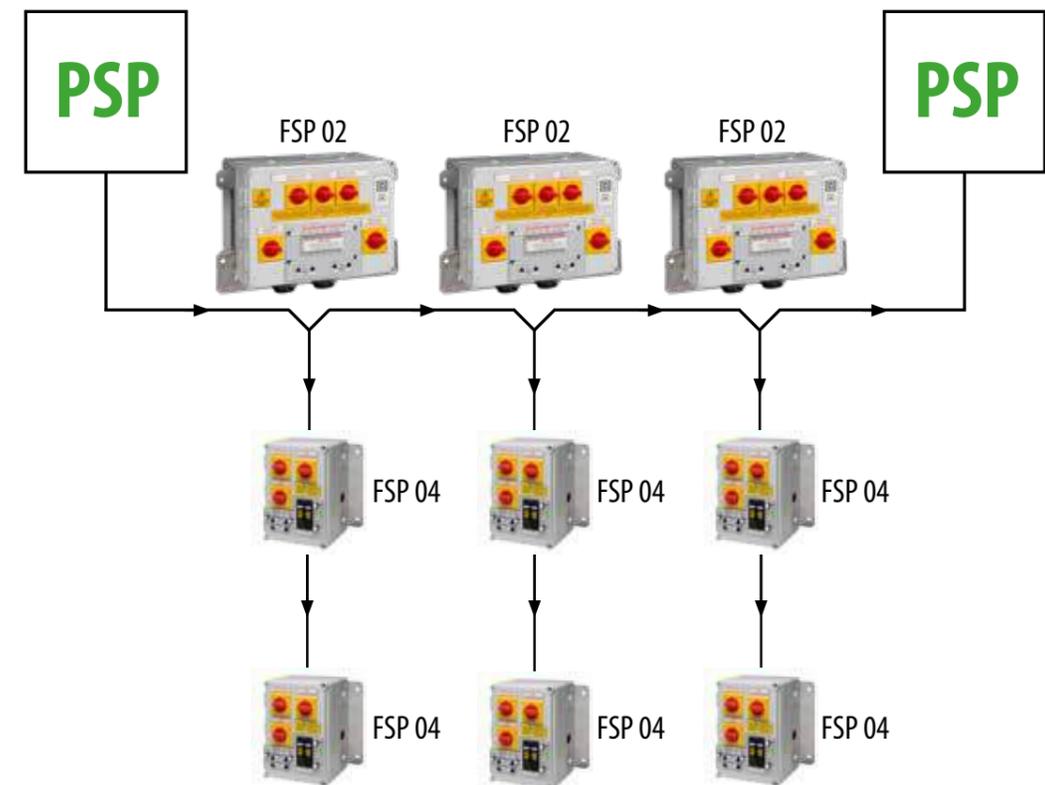
Type	Distribution Topology Power Supply	FSP Supply Architecture
FSP 04 (Radial)	Single end fed (or sub-fed from main distribution centre)	Suitable as a direct replacement for existing isolation or fusing arrangements within legacy installations

FSP04 switchgear assemblies may be part of a stand-alone self-contained apparatus housing or integrated (co-located) with signalling equipment

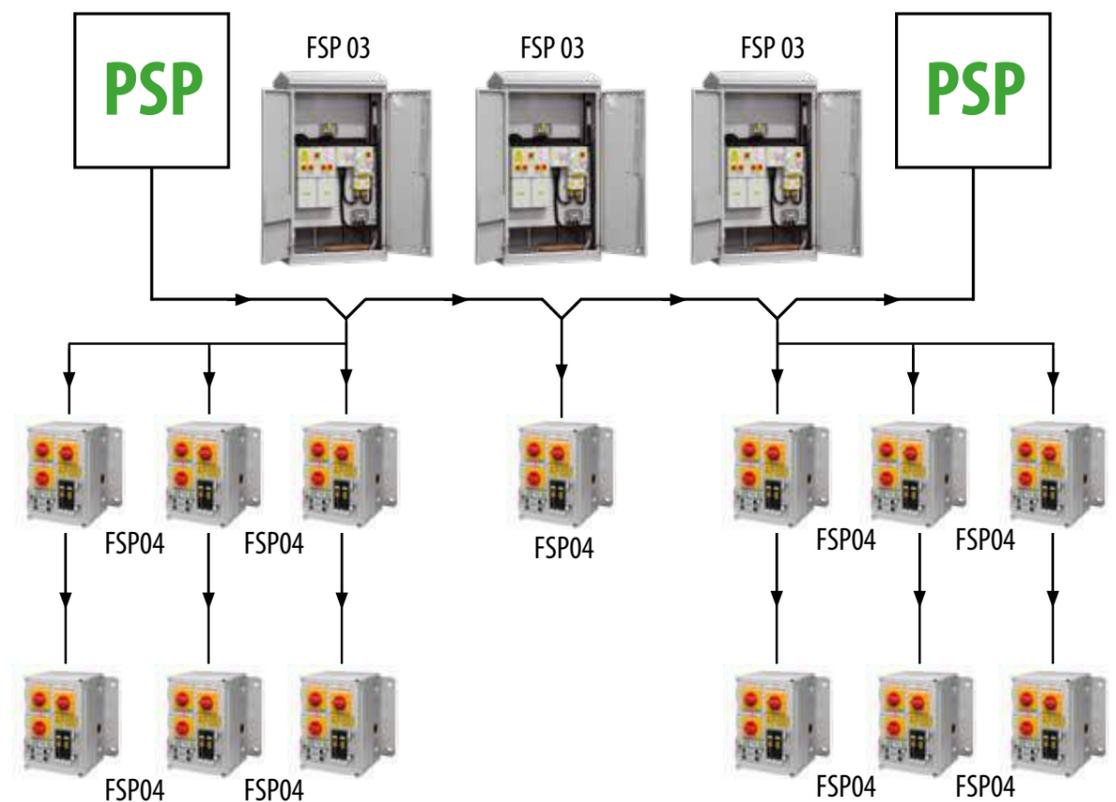
Figure A.2 - Typical FSP 03 arrangement with Sub-distribution radial feed using Micro FSP 04s



Manual Reconfigurable Circuit using Micro FSPs for Sub-Distribution



Auto-Reconfigurable Circuit using Micro FSPs for Sub-Distribution



RAISING THE STANDARDS

Signalling Power Distribution Diagrams

The standard NR/L2/SIGELP/27417 sets out the detailed requirements for the provision, management and maintenance of signalling power supply network drawings and associated documentation, to enable safe isolations for any purpose, including:

- Stage-work
- Entry into service
- Operational planning
- Maintenance
- Fault finding
- Signalling possession planning
- Emergency shut-down works
- Recoveries

The drawings will also facilitate asset management, system alterations and new works.

4 Legacy Diagrams

Signalling power distribution drawings and associated documentation shall include the information necessary to enable safe isolations, comprising as a minimum:

- All electrical sources (incoming supplies) showing rated nominal voltage, with locations having an additional supply from a secondary source clearly identified;
- Substation or PSP;
- Standby supply arrangements;
- Distribution circuits;
- FSPs at signal boxes, interlockings, location cases, etc., Showing location identities;
- Supply transformers and transformer rectifiers with unique identities;
- Busbars and over-current protective devices, up to and including the 110 V location input fuses;
- All switching and isolation points, uniquely referenced with appropriate labelling on the equipment, with any safety interlock or bypass systems;
 - Normally open switches or links identified with a note;
 - Distribution spur feeders;
 - Manual and automatic reconfiguration systems with switching sequence details to allow isolation of cable sections to prevent different supplies from different points of the grid being commoned together to be identified; and
 - Subsystem interfaces to 120 V d.c. or 110 V a.c. supplies, including multi-core distribution.



Insulation Monitoring and Fault Location Systems for use on Signalling Power Systems

The purpose of the standard NR/L2/SIGELP/27725 is to define Network Rail's requirements for Insulation Monitoring Devices/ Systems (IMDs) and Insulation Fault Location Systems (IFLSs).

2 Scope

This standard defines Network Rail's requirements for IMDs and IFLSs for use on Isolated Terra (IT) Electrical Systems where the nominal system voltage does not exceed 1000 V a.c. or 1500 V d.c. for the following applications:

- The interface between the Principal Supply Point (PSP)/Auxiliary Supply Point (ASP) and the Functional Supply Point (FSP);
- The interface between an FSP and another FSP;
- The interface points along a distribution feeder where a Distribution Interface Transformer Assembly (DITA) or Booster or Isolation Transformer has been installed;
- Signalling Functional Circuits (a.c. and d.c.);
- Traction derived power supplies interfacing with Principal Supply Point (PSP)/Auxiliary Supply Point (ASP);
- Standby generator supplies interfacing with Principal Supply Point (PSP)/Auxiliary Supply Point (ASP);

NOTE 1: The nominal voltages used on SPSs are: 110 V; 230 V; 400/440 V and 650 V a.c. The nominal voltages for Signalling Functional Circuits are typically 110/140 V a.c. 50/120 V d.c.

NOTE 2: Boundaries between subsystem elements are detailed in NR/L2/SIGELP/27416.

The following integrated systems and sub-systems are specified:

- Integrated solutions for the deployment of IMDs and IFLSs using a Tier 1, Tier 2 or Tier 3 architecture
- The interface of IMDs and IFLSs with Intelligent Infrastructure Systems.

IMDs and IFLSs as specified in this specification may also be used in other railway LV applications, e.g. car park charging points, tunnel lighting, traction transformer to PSP distribution, etc.



RAISING THE STANDARDS

Alterations to Signalling Power Systems

NR/L2/SIGELP/27416 defines the functional and electrical requirements to be applied when undertaking alterations to existing Signalling Power Systems (SPSs). The standard defines the requirements and provides guidance on the following areas:

- System Context of an SPS and its sub-systems;
- Alteration Design Principles;
- Alteration Development Process Activities.

5.5.2 Introduction of Class II/Hybrid Equipment into Legacy Systems

The installation of Class II/hybrid equipment either in part or in full into legacy signalling power distribution systems shall not adversely affect the safety of any individual installation or distribution feeder.

NOTE 1: Legacy systems may comprise Class I IT individual, IT individual and grouped, intermixed on the same distribution feeder, IT collective TN and TT electrical systems. Connecting Class II/hybrid equipment and breaking the continuity of CPC in a TN system, as might happen when inserting Class II equipment, will adversely affect safety.

NOTE 2: The presence of 2- or 3-core armoured cable in intermediate sections of a legacy system reduces the safety of the circuit. Primarily this is because the fault current path, in the event of fault to the cable armour, will be via the local earth electrodes. The resistance of these electrodes is likely to be such as to limit the fault current to a level below that which will achieve operation of the over-current protective device. Thus, protection against indirect contact may not be provided and a dangerous touch voltage may remain on the cable armour and at the apparatus housing at both ends of the armoured cable section.

5.5.2.1 Full Class II/Hybrid Integration with Unarmoured Cable Installations

When applying Class II/hybrid to all SAHs on a feeder the requirements of NR/L2/SIGELP/27410 shall apply. The introduction of Class II/hybrid equipment into a limited number of SAHs reduces the risk of electric shock at those installations provided the requirements defined in NR/L2/SIGELP/27410 are applied.

NOTE 1 Compliance with BS7671 will not be achieved for protection against electric shock unless Class II equipment is fitted to all apparatus housings on a feeder.

NOTE 2 Introducing new enhanced unarmoured cable would be fully compatible and would improve safety where aged cables are replaced.

5.5.2.2 Class II/Hybrid Integration with CPC Based Installations

The requirements defined in NR/L2/SIGELP/27410 shall apply.

NOTE The insertion of unarmoured cable would disconnect the CPC downstream of the insertion from the PSP and remove the protection against second earth fault in the cable sections and apparatus housings. This is applicable to both IT and TN systems.



5.5.2.3 Class II/Hybrid Integration with Distributed TT Installations

When introducing Class II/hybrid into TT installations the requirements of NR/L2/SIGELP/27410 shall apply.

NOTE 1: This has the effect of transforming a TT electrical system into an IT system.

NOTE 2: Distributed TT installations on signalling power systems are normally characterised by the following arrangements:

- a) an earthed referenced supply from the distribution transformer at the PSP,*
- b) two-core unarmoured cable interconnecting all the FSPs within the apparatus housings,*
- c) connection of exposed conductive parts at the apparatus housing to a local earth*

NOTE 3: The current path in the event of a fault will be via the local earth electrodes. The resistance of these electrodes is likely to be such as to limit the fault current to a level below that which will achieve operation of the over-current protective device. Thus, protection against indirect contact may not be provided and a dangerous touch voltage may remain on the apparatus housing in the event of an earth fault; this is not acceptable. Please refer to section 5.4.1.1 of this specification.

5.5.2.4 Class II/Hybrid Integration within TN Installations

When introducing Class II/hybrid into TN installations the requirements of NR/L2/SIGELP/27410 shall apply.

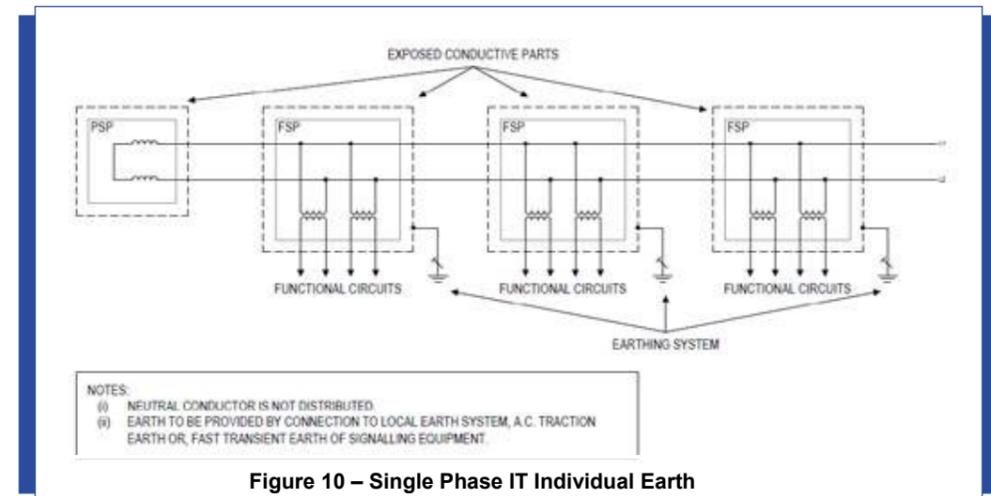


Figure 10 – Single Phase IT Individual Earth

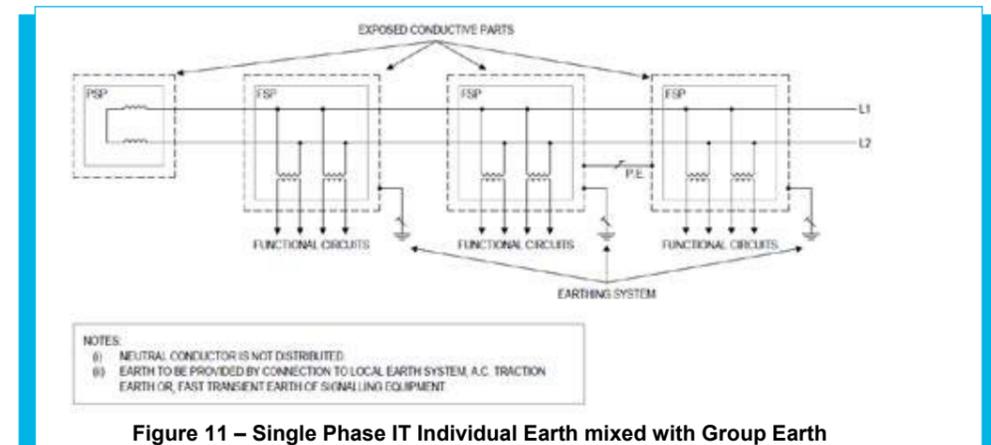
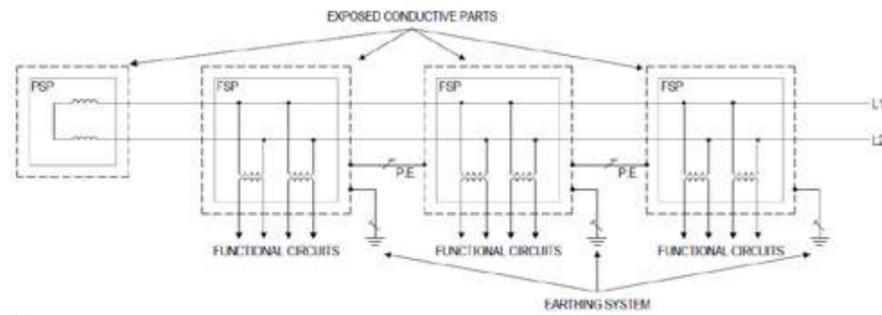


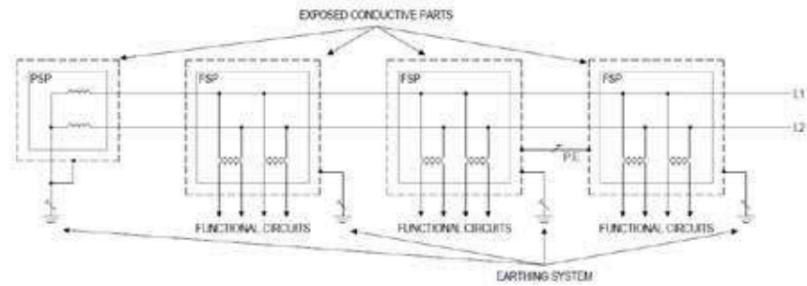
Figure 11 – Single Phase IT Individual Earth mixed with Group Earth

RAISING THE STANDARDS



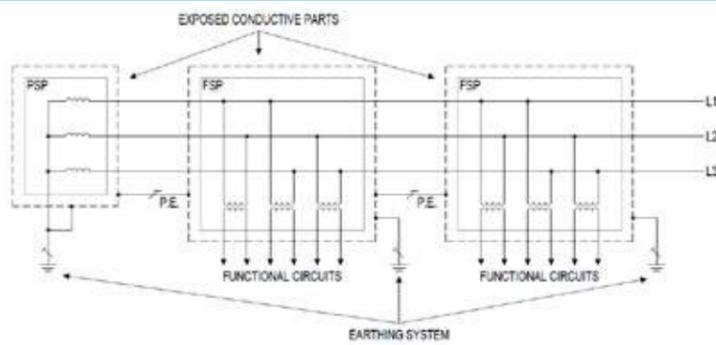
- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) PROTECTIVE EARTH (P.E.) PROVIDED BY THIRD CORE OF CABLE.
 - (iii) EARTH TO BE PROVIDED BY CONNECTION TO LOCAL EARTH SYSTEM, A.C. TRACTION EARTH OR, FAST TRANSIENT EARTH OF SIGNALLING EQUIPMENT.

Figure 12 – Single Phase IT Collective Earth



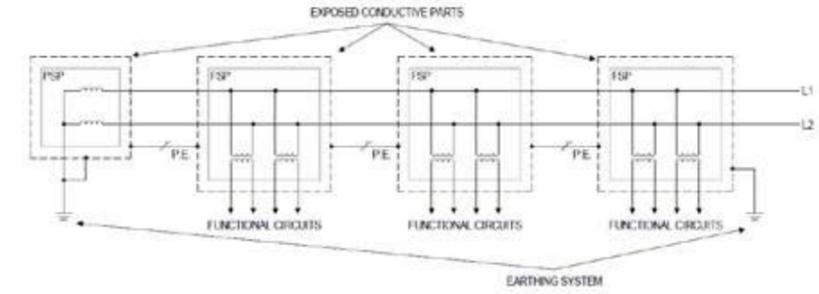
- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) PROTECTIVE EARTH (P.E.) IS PROVIDED VIA THE CABLE ARMOUR.
 - (iii) EARTH TO BE PROVIDED BY CONNECTION TO LOCAL EARTH SYSTEM, A.C. TRACTION EARTH OR, FAST TRANSIENT EARTH OF SIGNALLING EQUIPMENT.

Figure 13 – TT Earth using armoured or unarmoured cable



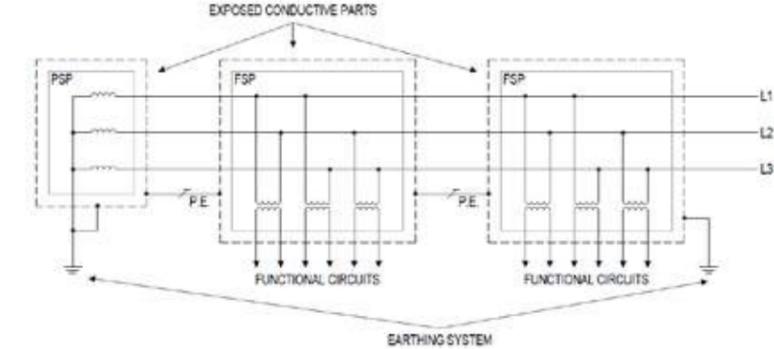
- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) EARTH TO BE PROVIDED BY CONNECTION TO LOCAL EARTH SYSTEM, A.C. TRACTION EARTH OR, FAST TRANSIENT EARTH OF SIGNALLING EQUIPMENT.
 - (iii) PROTECTIVE EARTH (P.E.) IS PROVIDED BY SEPARATE C.P.C.

Figure 14 – Three Phase TN with 3c Armoured cable and separate CPC



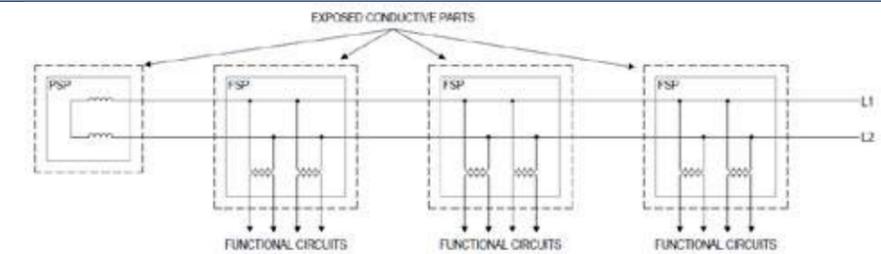
- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) PROTECTIVE EARTH (P.E.) IS PROVIDED VIA THIRD CORE OF THE CABLE.
 - (iii) EARTH TO BE PROVIDED BY CONNECTION TO LOCAL EARTH SYSTEM, A.C. TRACTION EARTH OR, FAST TRANSIENT EARTH OF SIGNALLING EQUIPMENT.
 - (iv) EARTHING OF FSP IS OPTIONAL.

Figure 15 – Single Phase TN Earth using 3c Armoured Cable



- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) EARTH TO BE PROVIDED BY CONNECTION TO LOCAL EARTH SYSTEM, A.C. TRACTION EARTH OR, FAST TRANSIENT EARTH OF SIGNALLING EQUIPMENT.
 - (iii) PROTECTIVE EARTH (P.E.) IS PROVIDED BY FOURTH CORE OF THE CABLE.
 - (iv) EARTHING OF FSP IS OPTIONAL.

Figure 16 – Three Phase TN using 4c Armoured Cable with Integral CPC



- NOTES:
- (i) NEUTRAL CONDUCTOR IS NOT DISTRIBUTED.
 - (ii) CLASS II, DOUBLE OR REINFORCED INSULATION IS PROVIDED BETWEEN EXPOSED CONDUCTIVE PARTS AND PHASE CONDUCTORS.

Figure 17 – Single Phase IT Class II Based

RAISING THE STANDARDS

Network Rail have issued a new standard defining the requirements for earthing NR/L2/SIGELP/27418.

Key requirements in the standard include:

- **Designers Risk Assessment**
- **Target Earth Values**
- **Detailed Surveys**
- **Constraints**
- **Electrode Selection Tool**
- **Buried Service Records**

Ref: NR/L2/SIGELP/27418

Title: Design, Installation and Testing of Earthing in Signalling Power Systems

Purpose	Scope	What's New / What's Changed and Why
This specification details the design, installation, construction, testing and commissioning requirements for safety earthing systems to limit touch voltage potentials on exposed conductive parts forming part of signalling power systems, to meet the requirements of BS EN 50122-1.	This specification applies to new or added safety earthing systems to apparatus housings, which include signalling apparatus housings (SAHs), location cases (LOCs), functional supply points (FSPs), relocatable equipment buildings (REBs) and relay rooms whose power is supplied by signalling power systems using an IT electrical system. The requirements for the design and installation of earthing systems in this specification may also be applied to the following: <ol style="list-style-type: none"> Safety earthing systems forming part of a TN or TT electrical system; Safety earthing systems for the armour forming parts of armoured BS 5467 or BS 6346 cable when used as part of an IT electrical; Safety earthing systems for power sources distributing IT electrical systems, normally comprising principal supply points and distribution interface transformer assemblies (DITAs) in either Class I or Class II signalling power distribution systems, in accordance with NR/L2/SIGELP/27410. 	<p>This specification details the design, installation, construction, testing and commissioning requirements for safety earthing systems to limit touch voltage potentials on exposed conductive parts forming part of signalling power systems. The standard specifies the following:</p> <ul style="list-style-type: none"> • Design of safety earthing systems; • Restrictions on the installation of safety earthing systems; • Requirements for designer's risk assessment; • Requirements for buried services assessment; • Calculation of maximum permissible earth resistance value; • Earthing installation constraints; • Earthing product requirements; • The requirements for installation of earthing systems; • Testing of earth resistance of safety earthing systems; • As-built drawings and updating of Network Rail records <p>The specification is supported by modules that give guidance on the following:</p> <ul style="list-style-type: none"> • Earth electrode installation process; • Earth mat installation process; • Template earthing construction drawings; • Earthing testing methods; • RDU scanner selection. <p>The standard also includes a form for use in planning such work.</p> <p>The calculation of maximum permissible earth resistance value is set out in the following standard: NR/L3/SIGELP/27420-Target Earth Calculation Methodology for Signalling Power Systems.</p>

This section will focus on section 5, **Design of Safety Earthing Systems**.

This section discusses current distribution systems, what effects can earthing have on signalling, designers risk assessments, soil resistivity and the stability of earthing systems.

Earthing Systems Currently Being Used

- IT Electrical System** An electrical distribution system having no direct connection between live parts and earth, but with the exposed conductive parts of the installation being earthed.
- 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.
- 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 of the source.

5.1 Identification of the distribution system

The following are typical electrical systems used in signalling power systems across the UK railway network:

- Single-phase, IT individual with 2-core unarmoured cable throughout;
- Single-phase, IT individual mixed with IT-group, with 2-core unarmoured cable mixed with either 2-core or 3-core armoured cable;
- Single-phase, IT collective with 3-core armoured cable installed as part of signalling and E&P renewals programmes from 2008 to 2014;
- Single-phase, TT with 2-core unarmoured or armoured cable;
- Three-phase, TN with 3-core armoured cable with a separate circuit protective conductor (CPC);
- Single-phase, TN with 3-core armoured cable;
- Three-phase, TN with 4-core armoured cable with an integral CPC;
- Single-phase, Class II signalling power distribution systems designed and installed in accordance with NR/L2/SIGELP/27410.

Circuit Protective Conductor (CPC)

A protective conductor connecting exposed conductive parts of an apparatus housing and its local earth electrode to other apparatus housings and their local earth electrodes, to create a low-resistance earthing system.

RAISING THE STANDARDS

5.2 Restrictions on the installation of safety earthing system

5.2.1 Secondary effects on signalling

Earthing should not be provided in installations where there is any risk of secondary effects on the signalling control systems. Such locations may include the following:

- Location cases with vital single-cut external line circuits;
- Location cases having circuits which use earth returns;
- Any location which has earthed track circuit surge protection without intervening galvanic separation of the electrical signal (for example a tuning unit).

The earthing decision flowchart in Appendix A (see below) provides further guidance.

5.2.3 Buried services

No driven earth electrode system shall be installed where there is a significant risk of striking buried services, or where the risk of striking buried services cannot be managed.

5.2.4 Civil structures

No driven earth electrodes shall be installed where ground penetration may not have been intended by design, e.g. bridges, viaducts, etc.

5.2.5 Corrosion

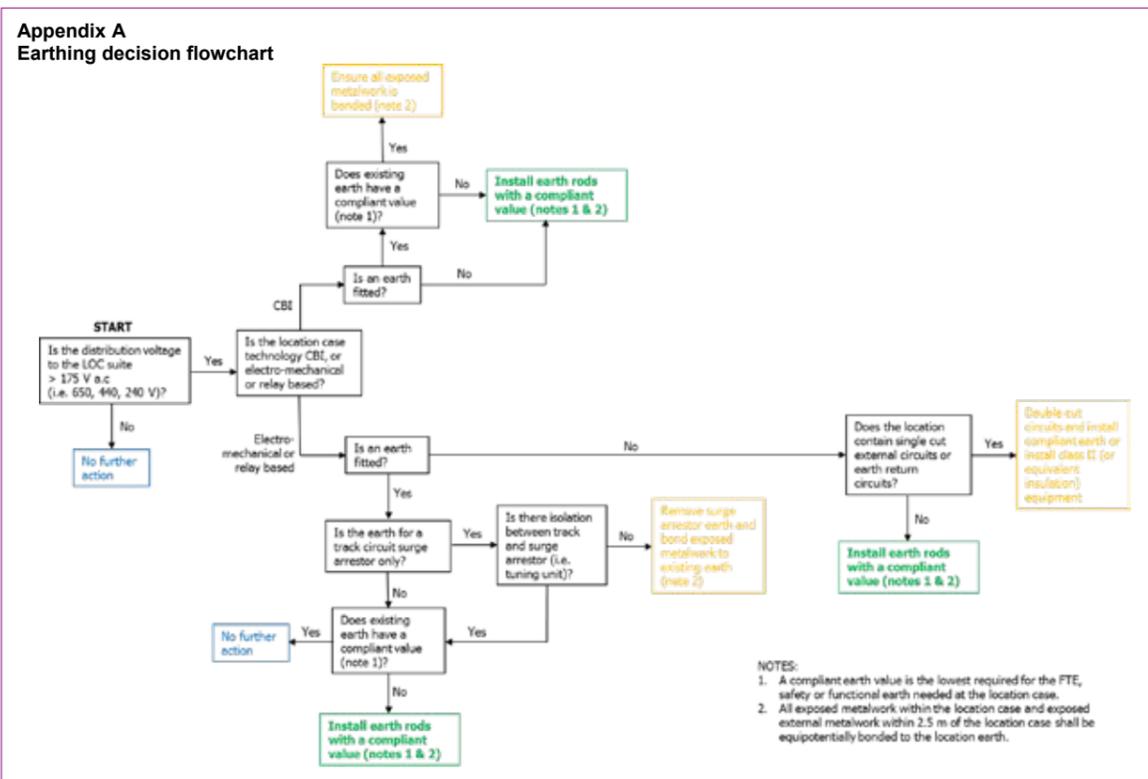
No earth electrodes shall be installed where earthing systems could be subjected to significant corrosion, where mid-life refurbishment to maintain the target value will become an unreasonable maintenance burden. This may be the case in coastal areas.

5.3 Designers risk assessment

A designer's risk assessment shall be undertaken as part of the earthing system design activity. It shall consider all the risks associated with design, installation and testing of safety earthing systems. It shall include identification of safety risks and mitigation measures adopted in the proposed design as per the Construction (Design and Management) Regulations 2015 and in accordance with NR/L2/OHS/0047.

Below is a list of some of the risks identified (note that this list is not exhaustive):

- Secondary risk of earthing on functional signalling equipment; Appendix A (previous page) has a flow chart indicating the process to be followed for mitigating these risks;
- Presence of generating stations, substations, railway traction feeder stations and track sectioning cabins (detailed in Section 2.1.3 of GK/RT 0053);
- Risk of corrosion due to stray d.c. Current in the vicinity of d.c. Electrified tracks;
- Risk of touching the conductor rail in d.c. Electrified areas, causing electrocution;
- Risk of electrocution from overhead line equipment (OLE) in a.c. Electrified areas;
- Location-specific constraints, such as non-availability of accurate buried services information leading to risk of hitting buried services during installation of safety earthing;
- Risk of undermining the track by digging - consideration should be given to relevant critical rail temperature procedures to be followed if necessary;
- Risk of hitting buried cables;
- Railway installation features and topography (tunnels, embankments, cuttings, viaducts, etc.) That may preclude certain types of installation at certain sites;
- Risk of corrosion from the soil affecting the asset life;
- Risk of the soil around the safety earthing system drying out;
- Risk of poor connection developing in the safe earthing system due to vibration at trackside locations.



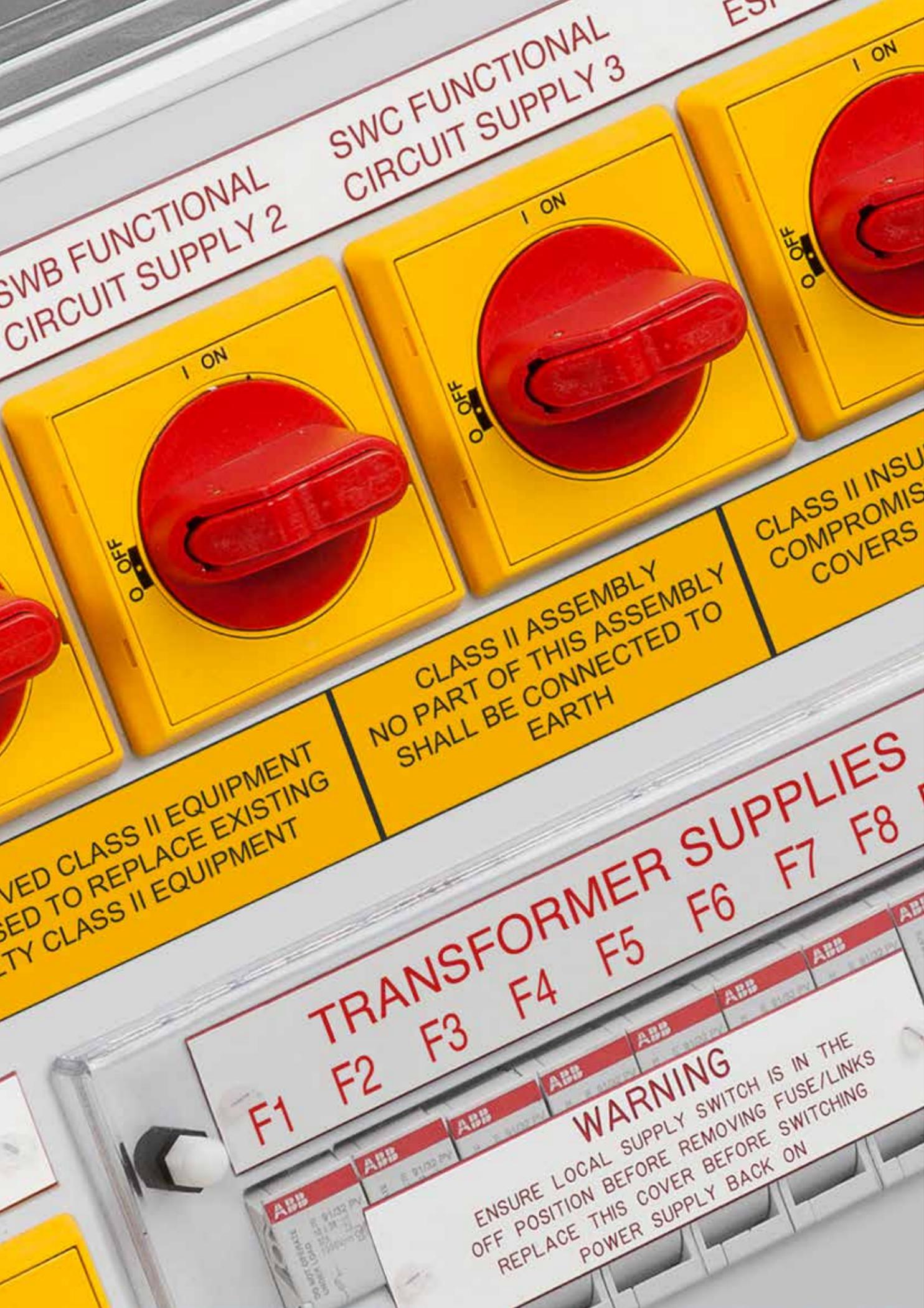
5.2.2 Signalling communication systems

The following locations shall be excluded from consideration as choice of sites for an earthing system for telecommunications equipment, unless controls are in place to limit the touch and body voltages to those set out in section 9 of BS EN 50122-1:

- Locations within 100m of generating stations, substations (25kV or higher voltage) or traction feeder stations, in accordance with GK/RT 0053;
- Locations within 50m of track sectioning cabins, return conductor or rail connections, in accordance with GK/RT 0053.

In addition, cable sheath earthing systems shall not be located within 25m (but preferably 50m) of SAHs.

NOTE: The signalling power supply often includes telecoms equipment to support monitoring and control. The above constraints apply when the safety earth is also used as a functional earth for this telecoms equipment.



PRODUCT FOCUS

- 22-23** Legacy Solutions Catalogue
- 24-26** PADS Approved Glands & Conduits
- 28-31** PADS Approved Connection Boxes
- 32-33** Pre-Wired Integrated Backplates
- 34-37** It's a Game Changer - Annexe FSP

The 'Product Focus' section of the LPN Annual 2018 takes an in-depth look at a range of products pivotal in the delivery of a successful retrofit installation. We take a look at the integration of 4C Aluminium and Copper cable via the use of Class II Connection Boxes, the use of conduit and glands on existing Legacy feeder cables, the benefits of utilising a pre-wired backplate assembly and an in depth focus on the Annexe FSP assembly and the cost savings related to this.

Product Focus

Legacy Solutions



Legacy Solutions Catalogue

PURPOSE

To support the SIN19 and Legacy Upgrade programme, iLECSYS Rail have produced a project specific Legacy Solutions catalogue. The catalogue aims to provide an in depth look at the range of products available. The catalogue contains all of the product and accessories to complete a successful retrofit installation. The catalogue is broken into sections to allow for easy navigation. Products include: Micro FSP04's, Connection Boxes, Annexe FSPs, Integrated backplates, Transformers, Earthing equipment and cable protection products. Dimensional drawings and circuit examples are included for all Micro FSPs. All assemblies are designed to provide safe isolation and distribution of circuits as part of Network Rail's Class II based signalling power distribution systems in accordance with NR/L2/SIGELP/27410 Issue 2. When used in conjunction with the LPN Annual this can prove to be a very powerful tool when planning and implementing your project.

KEY FEATURES

- The largest range of PADS approved products on the market all in one catalogue.
- Complete range of cable accessories, including conduit, glands and fittings in support of Network Rail Standard NR/L2/SIGELP/27421 and NR/L2/SIGELP/27422.
- On top of an impressive range of Class II products, iLECSYS Rail also stock a comprehensive collection of earthing products.
- Datasheets for all ATL Eco-Rail® Aluminium and Copper Transformers and transformer rectifiers, including recommended fuse ratings and unit dimensions.



Full range of Micro FSP04's including all PADS numbers and technical information. Micro FSP04's have been designed to conform with NR/L2/SIGELP/27416 (Specification for Alterations to Signalling Power Systems).



PADS Approved connection boxes for use with 4C aluminium and copper cable as well as stud terminal versions. Connection boxes are commonly used for the sub-distribution of 650V spur feeders.



A closer look at pre-wired backplate assemblies and configurations. Backplates are available for full and half width location cases. More information can be found in our Integrated backplates 'Product Focus'



PA05/06087



PA05/05344



PA05/06436



Comprehensive range of ATL Eco-Rail® aluminium and copper transformers. The use of the aluminium transformer range can result in a 45% reduction in costs and a 60% reduction in Co2 emissions. The award winning ultra low inrush, maintenance free, energy saving range is fast becoming the number one solution for retrofits and new installations.



Earthing components must offer both a low resistance to earth and have excellent corrosion resistance as they will be buried in the ground for many years. The range of earthing products from iLECSYS Rail includes earth bars, rods, plates, clamps and inspection pits which are all designed in line with BS7340.



A complete range of conduit, glands and fittings in line with NR/L2/SIGELP/27421 and 27422. Location specific cable kits are available to ensure that you have all of the correct equipment for each location.

Product Focus



KEY FEATURES

The Conduits and Glands provides an enhanced protection between existing legacy feeder cable routes and the MICRO FSP assembly as part of Class II 650V insulated switchgear assembly fitted inside a standard Network Rail apparatus case.

The range of products can also provide an enhanced level of cable protection on new feeder projects.

Conduit glands and reducers allow of a range of matches size components to suit all feeder cable sizes and types. Elbow or 90° glands allow for guided conduit routes between switchgear and Class II transformers.

End of line Conduit gland assemblies provide both rodent and environmental protection to the feeder cable routes within existing trough routes.

A range of light and heavy duty conduit clips provide lateral and lineal support for both feeder cables and functional circuit connection.

Heavy duty clamp blocks are provided for feeder cable support in conjunction with the lower LOC cleat bar.

The range of conduits have been tested to 3.5kV, in addition these provide high mechanical and ingress protection levels for all 650V cabling within the apparatus case.

PADS Approved Glands & Conduit

PURPOSE

To provide enhanced cable protection in Class II installations within signalling power supply applications. The conduit and glands will interface with all types of FSP in accordance with Network Rail standards NR/L2/SIGELP/27409 issue 2 & NR/L2/SIGELP/27410 for the Switching and distribution of 650V Signalling power systems.

The components are used within the signalling power distribution system located within Network Rail apparatus case BRS-SM440, Annexe or REB. The units are designed to provide compliant Class II constructibility within a defined mechanical frame or backplate.

Certificate of Acceptance PA05/06425

Manufacturer: PMA AG (PART OF ABB GROUP) Issue: 1 Valid From: 10-07-2015

Insulated Flexible Conduits, Mating Glands and Accessories.

Product Description

- Flexible Insulating Conduits, Standard and Divisible, with a dielectric withstand of 3.5kV, in accordance with NR/L2/SIGELP/27421 Issue 1, Product Specification – Flexible Conduits for Class II Based Signalling Power Distribution Systems.
- Conduit Glands in accordance with NR/L2/SIGELP/27422 Issue 1, Product Specification – Cable Glands for use in Class II Based Signalling Power Distribution Systems.

The product range comprises:

- Standard flexible insulating conduits;
- Divisible (split) flexible insulating conduits;
- Mating Glands (Straight, 90° and 45°);
- System supports (clips and clamps);
- Fibre washers

Product Image

Scope of Acceptance

Full Acceptance

Insulating conduit system with a minimum dielectric strength of 3.5kV. For use in new and upgraded Signalling Power Distribution Systems in accordance with NR/L2/SIGELP/27410 Issue 2.

Refer to Users Conditions for further information and constraints of use.

Network Rail Acceptance Panel (NRAP) hereby authorises the product above for use and trial use on railway infrastructure for which Network Rail is the Infrastructure Manager.

Authorised by:

Vanessa Cumine Product Acceptance Specialist Alex Buchinger Head of Power Distribution HV/LV (Acting)

PA05/06425

Certificate of Acceptance PA05/06433

Manufacturer: Interflex S.L. Issue: 1 Valid From: 23/08/15

Distributor (UK): ILECSYS Rail Ltd.

Insulated Flexible Conduits, Mating Glands and Accessories.

Product Description

The product certificate comprises:

- Flexible Insulating Conduits in accordance with NR/L2/SIGELP/27421 Issue 1, Product Specification – Flexible Conduits for Class II Based Signalling Power Distribution Systems.
- Conduit Glands in accordance with NR/L2/SIGELP/27422 Issue 1, Product Specification – Cable Glands for use in Class II Based Signalling Power Distribution Systems.

The product range comprises:

- Standard flexible insulating conduits;
- Straight mating glands;
- 90° mating glands;
- Conduit sealing system;
- System supports (clips and clamps);
- IP68 sealing washers and O-rings.

Product Images

Scope of Acceptance

Full Acceptance

Insulating conduit system with a minimum dielectric strength of 3.5kV, for use in new and upgraded Signalling Power Distribution Systems constructed in accordance with NR/L2/SIGELP/27410 Issue 2.

Network Rail Acceptance Panel (NRAP) hereby authorises the product above for use and trial use on railway infrastructure for which Network Rail is the Infrastructure Manager.

Authorised by:

Vanessa Cumine Product Acceptance Specialist Jerry Morling Head of Signalling Alex Buchinger Head of Power Distribution HV/LV (Acting)

PA05/06433



Conduit glands are threaded directly into MICRO FSPs or removable gland plates



All external connections to MICRO FSPs and Class II Hybrid Transformers must be made using approved conduit and gland components



With larger sizes the conduit is secured within the gland using fixing clips



These clips are located within the gland body and lock across the helix in the conduit



The combined gland and compression fitting is then tightened up to make the internal compression seal on the outer cable sheath



This shows an M63 reducer and M50 conduit gland secured within the removable gland plate

CABLE CONNECTION

Incoming & outgoing cables are installed in accordance with NR installation handbook and in accordance with NR/L2/SIGELP/27410. Glands are to be suitably selected to maintain the IP integrity of the assembly.

These components must be in accordance with NR/L2/SIGELP/27421 & 22.

PRODUCT OPERATION

The conduit gland assemblies are designed to interface with both split and solid conduit types. The Glands are mounted directly or via thread reducers into the FSP. After cable alignment the conduit is secured within the gland using the internal support ribs. IP68/69 O-rings are available for enhanced environmental performance. Cable clip or clamp blocks are secured to the existing internal bar work or mounting plates via Stainless steel fasteners.

Blanking plugs are provided on all Class II switchgear, these are 25mm diameter and designed to accept the M25 in line or elbow conduit glands for outgoing functional circuit supplies.

Corresponding 25mm entries will be found on the primary winding connection boxes within all manufacturers Class II transformers.

End of Line Compression Gland

The anti-rodent end of line conduit gland MUST be located on all legacy feeder cable prior to the placement of conduit over the cable and location within the trough route. The compression gland must be placed in the trough route at a minimum distance of 2m. This provides a complete seal on the cable, protection from rodents and protection against water ingress. This also allows for the safe termination of Non-CPC active armouring within the conduit.



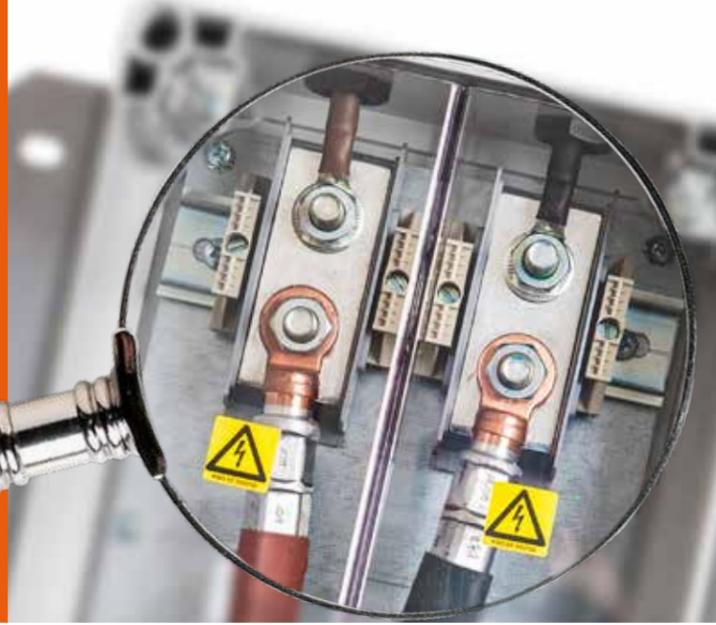
“The Micro FSP is a fantastic, cost effective solution to a difficult problem. The Micro FSP can be installed very safely, quickly and easily replacing many various types of non-compliant switchgear. The components used within the Micro FSP are high quality, robust and manufactured to the highest specification possible. Terminating the signalling power cables can be easily achieved along with installation of Class II approved glands and associated copex. The Micro FSP can be installed in less than 30 minutes as demonstrated during installation works at Bury St Edmunds thus allowing a Class I FSP to be converted to Class II compliance in less than a minimal time-frame”

Michael Ewart

Head of Signalling & Power
The Giffen Group



Product Focus



KEY FEATURES

- The Class II Connection Box range provides an interface between existing/new legacy feeder cable layouts and the Micro FSP assembly as part of Class II 650V insulated switchgear assembly fitted inside a standard Network Rail apparatus case.
- The Connection Box range features a rugged, pre-threaded, removal gland plate. This allows for easy access for large pre-lugged cables.
- The Class II Connection Boxes can be installed on-site using flexible conduit and glands.
- The assembly weighs approximately 5kg and has an overall ingress protection rating of IP54. The design of the assembly is to provide segregation between terminals for external conductors and their associated functional unit and to restrict access to main feeder isolators.
- The enclosures have two levels of access, the front panel and the inner terminal shrouds.

PADS Approved Connection Boxes

PURPOSE

To support the interface between existing/new legacy cable installations and the installation of 4 Core feeder cable on new projects. The Connection boxes will interface with FSP 01 single end fed, FSP 02 Dual end fed and FSP 04 Legacy Circuit device in accordance with Network Rail standards NR/L2/SIGELP/27409 iss 2 & NR/L2/SIGELP/27410 for the Switching and distribution of 650V Signalling power systems. The assembly is designed to be fitted inside standard Network Rail apparatus case BRS-SM440, Annexe or REB as part of Class II based Signalling Power Distribution System in accordance with NR/L2/SIGELP/27410.



All Connection Boxes have been pre-fitted with removable gland plates to assist in the connection of incoming/outgoing cables



Cables are either directly mounted within the tunnel terminals, fitted with bi-metallic pins and located within the tunnel connections.



Terminals can then be clamped using a torque driver to the appropriate torque setting. If connecting pre-lugged cable the same principal applies.



External connections to the Micro FSP unit must be made using approved conduit and gland components.



Incoming/outgoing feeder cables are tightened in place using approved conduit and glands. Glands can be attached to the pre-threaded plate without the need for locknuts.



Internal shrouds are to be refitted. These are secured in place with captive fastening to prevent loss on-site. The shroud provides a segregation between terminals within the box.



PA05/06087

Part No.	Description	Image	Catalogue No.
FSP-CRCS00	Power Block Classic, Enhanced range 20x40 30mm Connection Box (200Wx200Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Tunnel terminals suitable for Copper (Cu) or Aluminium (Al) Cables 2C or 4C 8-16mm ² . Approximate Weight 840g.		001009129
FSP-CRCS120	Power Block Classic, Enhanced range 20x40 140mm Connection Box (200Wx140Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Tunnel terminals suitable for Copper (Cu) or Aluminium (Al) Cables 2C or 4C 35-120mm ² . Approximate Weight 740g.		001009130
FSP-CRCS20-30	Power Block Classic, Enhanced range 20 30mm Connection Box for lapped cables (200Wx200Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Stud terminals suitable for Copper (Cu) Cables 2C 30mm ² Max. Approximate Weight 840g.		001009131
FSP-CRCS20-120	Power Block Classic, Enhanced range 20 120mm Connection Box for lapped cables (200Wx200Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Stud terminals suitable for Copper (Cu) Cables 2C 120mm ² Max. Approximate Weight 740g.		001009132
FSP-CRCS40-30	Power Block Classic, Enhanced range 40 30mm Connection Box for lapped cables (200Wx200Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Stud terminals suitable for Copper (Cu) Cables 4C 30mm ² Max. Approximate Weight 8 340g.		001009133
FSP-CRCS40-120	Power Block Classic, Enhanced range 40 120mm Connection Box for lapped cables (200Wx200Hx132Dmm) Class II connection unit with a removable gland plate pre-machined with a M3 tapped entry hole. Fitted with Stud terminals suitable for Copper (Cu) Cables 4C 120mm ² Max. Approximate Weight 7 340g.		001009134

PA05/06087



PRODUCT OPERATION

The assemblies designated Class II connection boxes are designed to interface with Micro FSPs for both legacy and new build Class II signalling power circuits. The units are intended to form part of the Network Rail Class II based signalling power distribution system in accordance with NR/L2/SIGELP/24710.

The Power Block assembly is electrical equipment that is designed for use by skilled or instructed persons suitably qualified & approved to work on the system.

The Power Block Class II Connection box is designed to be fed from 2 or 4 wire 650VAC supply/s at a nominal 50Hz (+/- 1%). The supply/s are connected to the FSP unit via form 4A segregated terminal blocks which are designed to accept a range of 2 or 4 core legacy cables in addition to standard range of 2 core enhanced unarmoured Cu cables size between 6 and 120mm². Cable termination is to be in accordance with NR/L2/SIGELP/27410. The cable is connected directly to the shrouded terminals typically (T1, T2 and T3, T4) without the need for crimped lugs. Cable termination is to be in accordance with NR/L2/SIGELP/27410 iss 2.

The torque setting for the feeder terminals shall be 12 Nm (6-50mm² - KE61), 20Nm (16-95 mm² - KE62), 20 Nm (35-95mm²), 30 Nm (120² - KE63).

Feeder supplies are terminated within the connection box and then re distributed via flexible conduit and glands in accordance with NR /L2/SIGELP/27421& 22 to the MICRO FSP. Both the Connection box and Class II MICRO FSP are fully tested class II items. The assemblies must be configured using the approved components and in line with NR Class II Standards NR/L2/SIGELP/27409.2 and 10.2.



Product Focus



Installed Integrated Backplates

Winnersh

Teddington

Legacy Location Pre-Wired Integrated Backplates

A comprehensive range of pre-wired integrated FSP plates are now available to support the installation of Class II within legacy location cases. Key benefits are the reduction in construction, testing time and the space assessment within the existing case. The range of plates all conform to BRS-SM440 dimensions and are available in full and half width options. They are ideally suited for more modern locations with Unistrut barwork or Admiralty tray type construction. They are supplied with mounting stand-offs and a number of pre-punched holes for heater re-location.

Pre-lugged 120mm² 4 core aluminium cable? Not a problem! An extended range of plates can be fitted with Connection boxes allowing for the interface of pre-lugged legacy cable and 4 core types. The CB boxes are fully pre-wired and tested to allow a swift retrofit of Class II with only Lug connections and Nx/Bx terminations to complete.



Pictures on Opposite Page

Top Left: Winnersh, Full width integrated plate with FSP04/PL-CII/1SW-SL50 and 500VA Hybrid Transformer.

Top Right: Teddington, Full width integrated plate with FSP04/PL-CII/1SW-SL50 and 500VA Hybrid Transformer.

Bottom Left: Yoker, Half width integrated plate with FSP04/PL-CII/1SW-SL/BS, 500VA Hybrid Transformer and 2 x FSP-CII/CB/4C-120 (to interface with 4C 95mm Al Cable).

Middle Right: Anniesland, Half width integrated plate with FSP04/PL-CII/1SW-SL/BS, 500VA Hybrid Transformer and 2 x FSP-CII/CB/4C-120 (to interface with 4C 95mm Al Cable).

Bottom Left: Bury St Edmunds, Half width backplate with FPP04/PL-CII/1SW-SL95.

Yoker

Anniesland

Bury St Edmunds

IT'S A GAME CHANGER!

iLECSYS Rail are proud to be working in collaboration with Giffen Group and Network Rail on the Western Tranche Power Renewals program. The first Class II Annexe FSP has been installed at Newton Abbot and successfully commissioned following an impressive 1 hour 40 minute installation. By using the Annexe FSP on the Western Power Renewals program it has saved an incredible £2.8 Million on the total cost.

The integrated FSP assembly has been designed to offer a Class II retrofit able solution to an existing suitable apparatus housing. It will provide Class II 650 / 110V supply for signalling equipment. The unit requires minimal civils work to install, offers a substantial cost saving against a traditional metal location case and provides a separate E&P asset. The assembly features a high efficiency Aluminium transformer, Class II Micro FSP04, full Class II enclosure and a range of mounting options.

SIN119 Legacy Upgrades

The Annexe FSP offers SIN119 programs a cost effective, Class II solution that delivers a separate asset with minimal civils costs. It also provides a unit that can deliver Class II in locations with challenging access. The unit requires less than 4 hours site time including, survey, correlation, installation and commissioning. The unit de-risks any existing cases where retrofit using Micro FSPs may impact on internal signalling equipment. With a great deal of prep work carried out in day work, the unit allows for minimal site possession time. A B2 type cable is used to connect between the Annexe unit and the existing Nx/Bx terminals. The Annexe FSP can accommodate both legacy and FGT type feeder cables including aluminium type when used in conjunction with Bi-Metallic pins.

A range of lightweight high efficiency transformers deliver 110V in a range of options from 500VA to 3KVA and multiple windings of twin and quad types. Outgoing 110V terminals or fuses can be provided to suit the power design.

"The FSP Annexe has solved numerous issues including reducing cost, de-risking the project, reducing isolation and possession times along with reducing the overall length of the project. The FSP Annexe can be installed safely, quickly and very easily as a two man job without the need for any civils works. The FSP Annexe is the ideal solution to create a compliant signalling power distribution system to modern day standards. The total time spent trackside including, surveying, correlation of 650V, preparation, installation & commissioning of 650V/110V cables was 4 hours"

*Michael Ewart, Operations Director
Giffen Group*



Check Out Our Annexe FSP Install Video on YouTube. Simply search for iLECSYS Group, scan the QR code or visit <https://www.youtube.com/watch?v=GnAqgDYoeNw>



Annexe FSP - External

IP55 Rated Breather
The Annexe enclosure is pre-fitted with two ventilation devices.

• 3-Point LOCKING System
• High Security shrouded pad-lockable handle assembly

• Fully customisable pre-fitted labelling



GFRP Enclosure & LOC case mounting bracket.

- Full Composite Enclosure
- IP66 Rated
- IK10
- C3 Shock and Vibration Tested
- UV Resistant
- Lightweight (29-64kgs)
- 40 Year Asset Life

• Aluminium, Nylon coated cable cover concealing cable and cable cleat bar.
• Anti cable theft deterrent.

• Removable IP66 Rated Drainage Plug

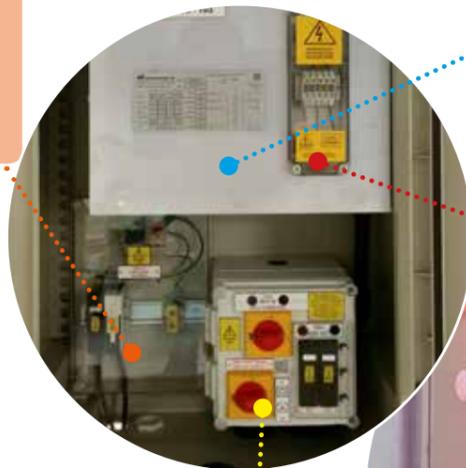
Annexe FSP - Internal

110V output terminals or fuse links Pre-fitted. Protective shroud or Class II enclosure depending on version

Class II Hybrid Transformer

- Aluminium open framed Tx / Tj (1KVA - 3KVA) and cased Tx (500VA)
- Multiple secondary winding options
- Energy efficient
- Lightweight

Class II hybrid or full Class II Tx connections. Functional Tx screen connection.



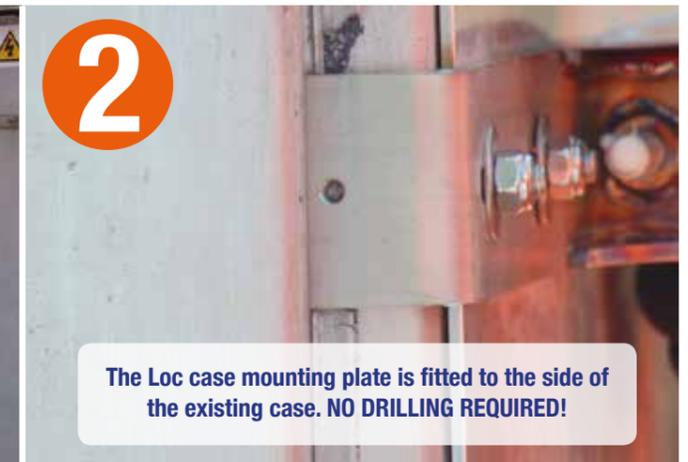
Micro FSP Switchgear

- Suitable for all Micro FSP04 and FSP02 types
- Fully PADS Approved
- 650V Power IN/OUT test points with protective shroud cover
- Pad-lockable isolation switches
- Interface with Al/Cu cables up to 120mm²

Pre-machined cable entries for 650V / 110V cable input/output



1 Ensure location case exterior is Free of any dust and loose debris.



2 The Loc case mounting plate is fitted to the side of the existing case. NO DRILLING REQUIRED!



3 Loc mounting plate is ready to accept Annexe FSP.



4 The pre-assembled cable cleat bar is to be fitted at the bottom of the Loc case.



5 The Annexe FSP mounting bracket and vibration mounts are pre-assembled and factory tested.



6 Once the Loc case bracket is secured, the Annexe can be comfortably lifted into place without the need for any additional lifting equipment.



7 Once attached to the Loc bracket the Annexe is secured using M6 x 25 set screws.



8 The install is completed by the fitment of a lightweight Nylon coated Steel cover below the Annexe FSP.



RETROFIT PHILOSOPHY

40-41 Keeping Costs Down

42-43 Collaborative and Smart Working

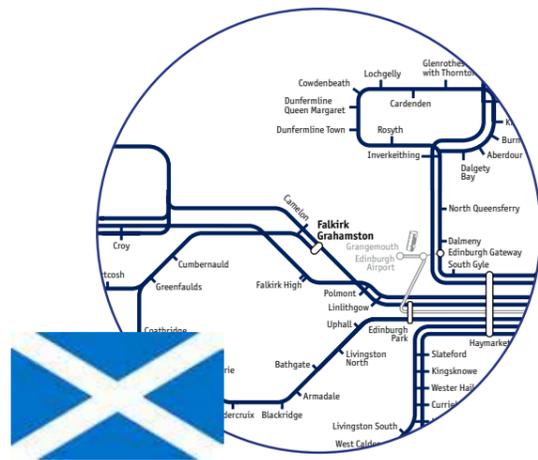
The basic philosophy behind retrofitting Class II within a legacy signalling location is the principle of being able to remove and replace within the foot print, the existing 650v links and associated Tx wiring and Signalling Tx with a Class II MICRO FSP and associated Hybrid Tx.

Considerations are timescale available , current design and space constraints and the delivery of a robust Survey and design package to support the optimum equipment selection and Install .

This section of Legacy Power News Annual 2018 looks to examine and illustrate the retrofit principles and to demonstrate the significant cost benefits in using the retrofit option. We would always stress this is the first option for consideration in any power upgrade project whether is be SIN 119 compliance, resilience work or Signalling power upgrades.

When all the operation considerations are taken into account the option to retrofit is a significant cost and safety benefit over large numbers of new FSP cases.

**Keeping Costs
DOWN!**



Why outlay thousands of pounds on new FSPs? That was the message to the Siemens team working on the Stirling-Dunblane-Alloa Project in 2017.

Every year thousands of pounds are spent in producing and installing new FSPs on the rail network. This was the case at Grangemouth Junction in 2017 where the normal method and route was being followed. Timescales and deadlines were driven by the installation and laying of new FGT 2 Core 95mm² Copper cable. A new iLECSYS DITA (Distribution Interface Transformer Assembly) was also installed at Grangemouth Junction midway down the new feeder. This allowed for the de-markation between the Fouldubs branch and Mainline. Following a successful training session with the iLECSYS Rail team the decision was taken that the existing signalling location should be retained and that the only element that needed updating to Class II was the existing switchgear, terminals and transformers housed within.

iLECSYS proposed that following survey interrogation that all of the sites could be retrofitted saving on average of £8,000 per site. Due to a lot of the sites having multiple existing Legacy transformers, the decision was taken to use a quad output (4x350VA) transformer where possible. This would result in only having to install one transformer instead of three and maximise on space savings. This was also achievable due to existing low loadings on the transformers. This was particularly beneficial where more than one TX was present in the original LOC, why spend money on individual transformers when a multi winding TX can be utilised!



Starting from scratch. In some circumstances the quickest way to retrofit was to remove all of the existing equipment and re-build the location case. In this instance the install time was still kept to an impressive 2 hours 10 minutes.



The larger Micro FSP complete with ESP was used on all installations. The larger tunnel terminals allowed for direct connection with the new Copper 2C 95mm² FGT cable.



Above: Fouldubs Signal Box.
Right: DITA installed at Fouldubs



12 Sites 6 Shifts!

Now the decision had been made to use Micro FSPs and multi-winding transformers, the next step was to ensure that the works could be carried out in a timely manner. iLECSYS Rail supported the installations by producing a step-by-step method statement for each location. Important information regarding the removal and installation of the new equipment was captured and included in the method statement. Due to the nature of the installs, in some circumstances additional barwork was required to accommodate the new equipment. This additional information was gathered in advance and included in the method statement. All of the information was able to be collated from a very robust initial survey produced by the Siemens Rail team. After an extended night shift training session with a focus on preparation, the Siemens delivery team went on to carry out some superb work in completing this retrofit project well within possession timescales.

For the first 8 installations an iLECSYS Rail member of staff was on-site during the installation to assist with any queries and help with preparation support. From an initial 2 hours 40 minutes, retrofit times were driven down to an impressive 1 hour and 25 minutes. This was all achievable by using the same commissioning team and familiarity with the equipment.

"The guidance from iLECSYS when embarking on this project was essential and allowed our installation team to develop a thorough understanding of the challenges when carrying out Class II retrofit works. The iLECSYS product range is well developed and allowed us to develop a retrofit solution for a variety of LOC configurations instead of installing separate FSP LOCs"

Paul White - Siemens Rail Automation Limited Mobility



COLLABORATION WORKS!

Collaborative and smart working between Amey Consulting and iLECSYS Rail Ltd

As part of the Thameslink programme to provide improved journey times and increase the number of trains through the core (Central London), several Signalling Power supplies require upgrading.

On behalf of Network Rail, Amey Consulting in Birmingham have been working on the East Midlands Signalling Power Supply Reliability and Improvement works. The requirement of Network Rail is to improve the reliability for passengers along the Midland Main Line, from St. Pancras at 0 Mile post to Bedford at the 50 mile post and allow the passage of 24 trains per hour through the core (Central London). The proposal to make changes to the timetable have been scheduled for 2020. This meant the timescales to design and build the upgrades to the Signalling Power Supplies were very constrained.

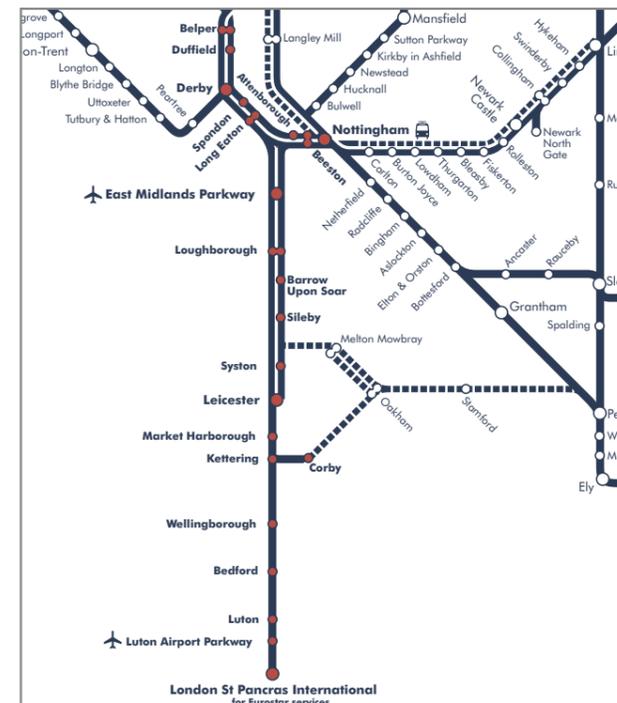


All existing trackside signalling apparatus housings contain legacy class I equipment such as fuses, switchgear, internal two-core legacy cabling, transformers and transformer-rectifiers. The condition of the existing assets is life expired and degraded. The purpose of this work was to improve safety of personnel and mitigate Network Rail maintenance costs, because the new Class II equipment to be installed in the trackside enclosures is more resilient to earth faults and conforms to the requirements of current Network Rail Standards. The upgrade will also help with alleviating the costs associated with train delay minutes caused from the poor condition of the existing signalling power feeders. The availability of line closures to carry out the construction was also very limited which presented challenges with installing the new switchgear within the existing signalling equipment housing in the available possessions. Amey Consulting proposed to retro-fit all new Class II switchgear to the pre-existing frame within each signalling apparatus housing. The complexity of the task required Amey Consulting to provide the Amey Construction team with a complete methodology and constructability package to allow the installation to be carried out quickly and efficiently. This is where Amey Consulting and iLECSYS successfully collaborated. Amey Consulting and Construction had been invited to several practical demonstrations and CPD's for the iLECSYS product range and the best fit solutions for our needs. iLECSYS devoted time to looking through our designs with us and confirming our designs specified the most suitable equipment

and methods of installation to achieve a successful design and build project delivery. Throughout the design process, iLECSYS have been very helpful in providing all the necessary data sheets, schematics and certificates of conformity for their products. We have also been working closely with iLECSYS to plan the procurement and delivery by the use of their Tracker tool. This allowed Amey to align the construction programme and delivery of equipment in a logistical and practical manner. The collaborative working between Amey Consulting and iLECSYS has proven to be very effective. Not only has this collaborative working allowed Amey to select the most suitable equipment with associated accessories, it has also given Amey an extensive bank of knowledge on the components available for a retro-fit solution.

The three core values that we have at Amey Consulting are, to put people first by improving the services they use on the railway, delivering a great service to our client Network Rail and creating the best solutions by working collaboratively with our client, suppliers and manufacturers.

Abdul Rehman Savant, IEng, MIET – E&P CRE for the East Midlands Signalling Power Project for Amey Consulting



iLECSYS Rail are proud to be working in collaboration with Amey Consulting and Network Rail on the retrofit upgrade works on the Midland Mainline. Using Amey Consultings robust signalling schematics and designs we have together been able to formulate a full location specific list of equipment well in advance of the works. Such informative sets of designs and excellent quality survey data allowed us to really examine each location and confidently recommend the most cost effective solution. The training sessions and regular communication has allowed for both companies to fully understand each others needs. The use of a shared tracker will allow for commissioning dates to be shared ensuring a timely delivery of equipment resulting in successful volume installations.

Lewis Westbury - iLECSYS Rail Business Development Manager



DELIVERED PROJECTS & CASE STUDIES

- 46** CONSTRUCTIBLE CLASS II
- 47** PADS APPROVED MICRO FSP
- 48-49** GREEN LIGHT FOR CLASS II AT WESSEX
- 50-51** NORTH AND SOUTH OF THE CLYDE
- 52-53** IN PREPARATION OF DERBY REMODELLING
- 54-55** KEEPING THE MAINTAINER HAPPY!
- 56** CASE STUDY - TEDDINGTON
- 57** CASE STUDY - BURY ST EDMUNDS
- 58** CASE STUDY - LIME STREET
- 59** CASE STUDY - ASHBURYS
- 60** CASE STUDY - REIGATE

The case study and delivered projects section looks at a selection of projects and installations iLECSYS Rail have been involved in. We have captured some vital before and after images to illustrate the best use of space and products available. Installations cover a range of LOC case layouts and discuss the challenges faced and chosen solutions.

We take a look at the reasons behind certain product selections and the circumstances as to why certain products were preferred over others. Also what factors are involved in choosing not only the best product but considerations of any impacts on the final installation.



Constructible Class II

The plate configurations will support the full range of approved MICRO FSPs when used in conjunction with the ATL Class II Transformers.

These units are aimed to simplify the design process for constructing Class II within legacy location cases. The plate sizes will align to the existing standard dimensions within half and Full location cases and are supplied with a set of M8 fixings to adapt for certain types of internal case supports.

The configured Class II 650/110V plate

assemblies come fully factory tested. A QR Quick reference code shows information such as; PADS number, part number and weight. This can also be linked to a site specific schematic. In this instance each plate assembly is marked externally with the LOC number.

The pre-configured plate reduces site construction time as well as reducing time for testing. It also reduces risk in terms of product clash on the night. Pre-punched holes can be provided for existing legacy equipment such as heaters and fuse holders.



PADS Approved Micro FSPs

The Smallest Footprint
Micro FSP on the Market
Available from Stock

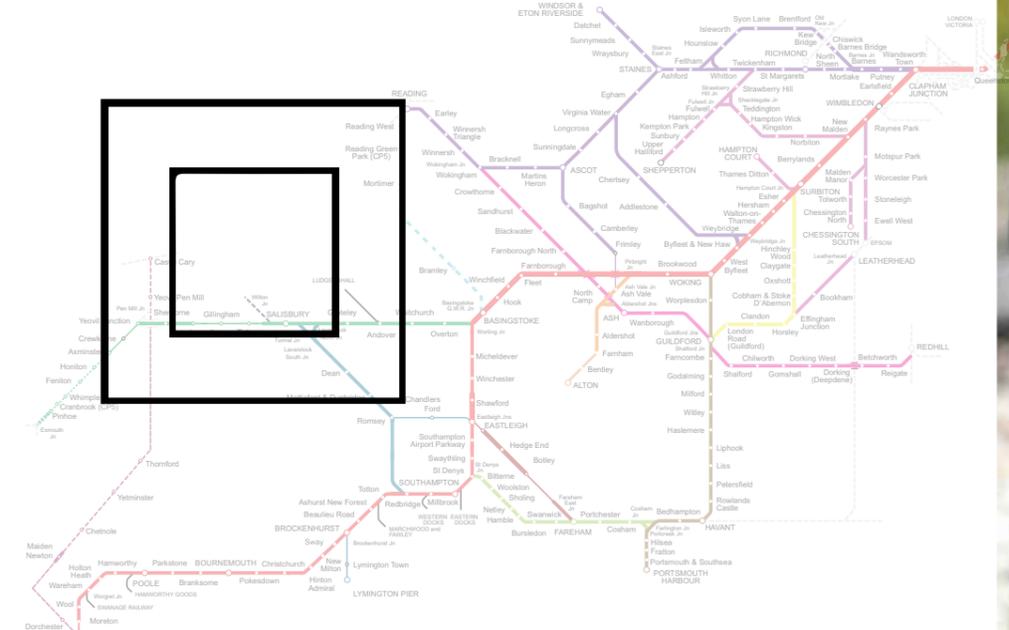
iLECSYS Rail have designed and manufactured a range of Micro FSP switchboxes which have full PADS approval from Network Rail for use on the UK Rail infrastructure.

The Micro FSP solution allows Network Rail to integrate Class II low voltage distribution within an existing signalling location. The safe isolation and enhancement is achieved by the removal of ingoing/outgoing fuse carriers and replacing them with one of the range of Class II Micro FSPs. iLECSYS Rail has understood and taken on board the possibility of numerous different Legacy location case layouts and have designed over 20 variants to allow fitting within the original Legacy switchgear footprint. Micro FSPs can be mounted directly onto the existing Legacy backboard using universal brackets or can be fitted onto a specially designed mounting plate to interface with existing bar-work inside the LOC. Included in the PADS certificate is a range of Class II connection boxes that accommodates 95% of incoming/outgoing feeder cable types. For example: This means that if your incoming feeder is a 2 Core Al or Cu pre-lugged and your outgoing feeder cable is 4 Core Al or Cu both connections can be made into a connection box thus interfacing with a Micro FSP.

Products can be hand carried to site and installed with ease.

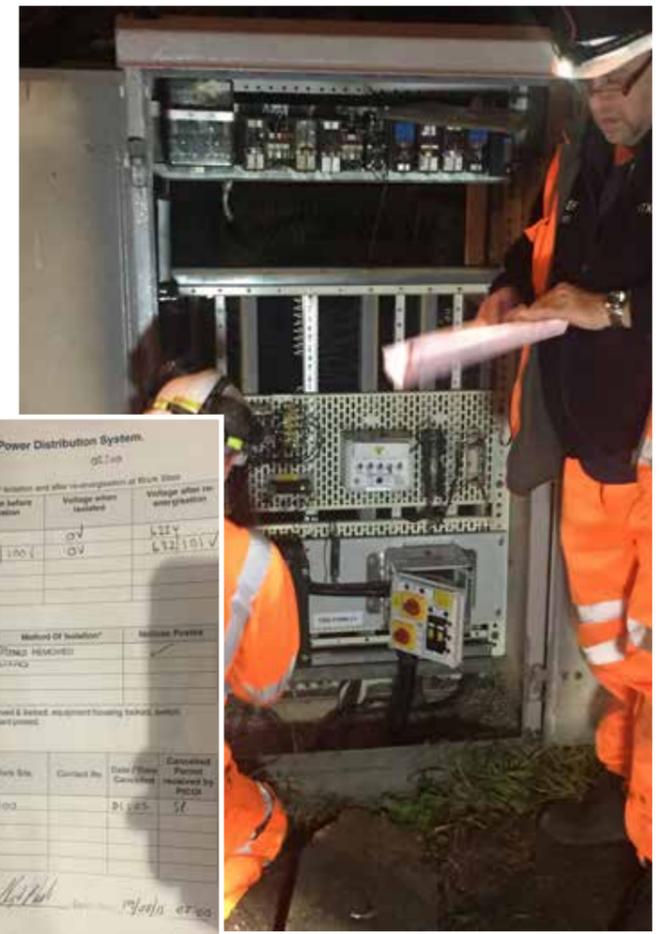
Enhancement products such as rodent protection conduit and environmentally sealed glands will allow the new unit to have a higher level of reliability. To further enhance the system, a Class II high efficiency aluminium transformer is fitted in place of the original. This will now provide greater efficiency to the signalling circuit, sustainability and improved reliability, completing the full Class II 650V installation.

Following on from Micro FSPs and Class II transformers, iLECSYS Rail have designed a range of Integrated solutions allowing for complete isolation of 650V power from the existing LOC cabinet. The Integrated solution consists of any one of the Micro FSP range in conjunction with a Class II transformer, mounted on a PADS approved pre-assembled backplate or within a PADS approved enclosure. The NEW Class II enclosure can then be mounted directly onto the end of the existing apparatus case or adjacent to it. This solution offers a reduction in mechanical handling. The enclosed integrated unit provides a fully separated E&P asset that will speed up testing and commissioning of Class II feeders.



Frimley

Using a pre-assembled Class II integrated assembly, the end of line site at Frimley was completed without issue. The pre-tested plate assembly mounts directly over the original admiralty tray used to mount the legacy fuses.



Pre work for the site included the attachment of the mounting pillars and assessment of the heater relocation. A range of pre punched holes are provided on the integrated plate for optional heater location, another time saver on the night...

Permit to Work on Signalling Power Distribution System.

Work Site: Monitoring Points

Monitoring Points	Voltage before isolation	Voltage when isolated	Voltage when re-energised
A. F101	415 V	0 V	415 V
B. F102	415 V	0 V	415 V
C.			
D.			
E.			

Method of Isolation

Place	Isolation	Method of Isolation	Isolation Points
F101	415 V	POWER REMOVED	ISOLATED

Approved by: [Signature]

GREEN LIGHT for Class II at Wessex

Bagshot

Based on a number of factors including existing case equipment condition, space available for a new base and the possession time scale benefits of larger scale prep works, a separate Class II pedestal was installed.

The pedestal was installed in a 4 hour possession on the 17th-18th August.



Permit to Work on Signalling Power Distribution System.

Work Site: Monitoring Points

Monitoring Points	Voltage before isolation	Voltage when isolated	Voltage when re-energised
A. F101	415 V	0 V	415 V
B. F102	415 V	0 V	415 V
C.			
D.			
E.			

Method of Isolation

Place	Isolation	Method of Isolation	Isolation Points
F101	415 V	POWER REMOVED	ISOLATED

Approved by: [Signature]

Bookham

An opportunity was taken to re-use an existing on site case in good condition, a Class II MICRO FSP replaced legacy switchgear and the TX was replaced with a legacy bracketed ATL Class II Transformer.

Construction was carried out on the night, aided by a pre manufactured FSP backplate to align with the space availability within the existing runs of Beta duct.





glasgow
strathclyde

North of the Clyde!

The pre-lugged aluminium cables feeding the location case was found to be in good condition, therefore the design was progressed using the Micro FSP and Integrated transformer backplate. The plate allowed for integration with the PADS approved Connection Boxes. This allowed for simple installation and interface with existing cable.

Before



Yoker

During

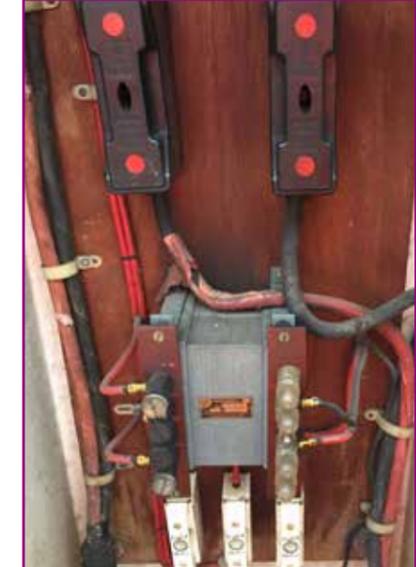


After



NORTH & SOUTH OF THE CLYDE!

Before



Port Glasgow

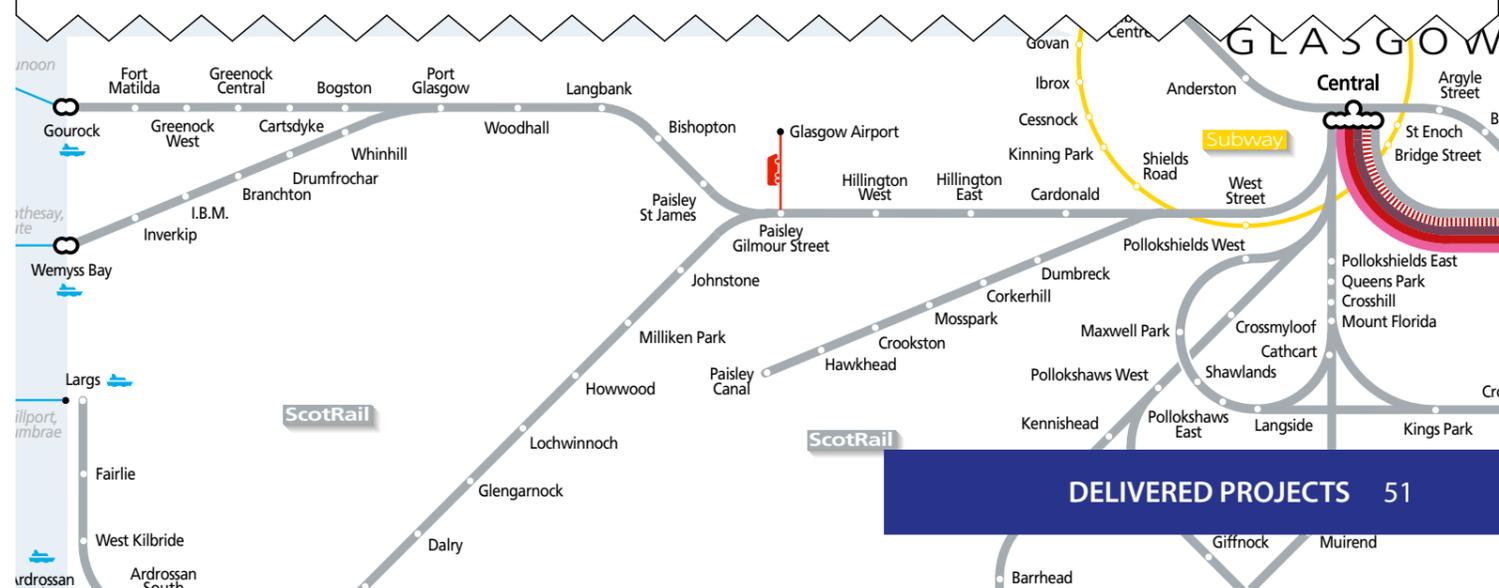
After



Greenock West

South of the Clyde!

The Inverclyde route currently have a number of legacy locations with external annexes for the housing of 650V equipment. The old equipment was swapped out for Class II Micro FSP 04 switchgear and Class II hybrid transformers, all internal earth bonding completed and the location made SIN 119 compliant.



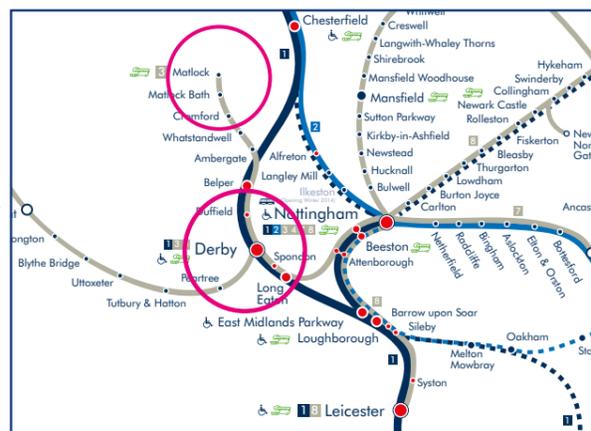
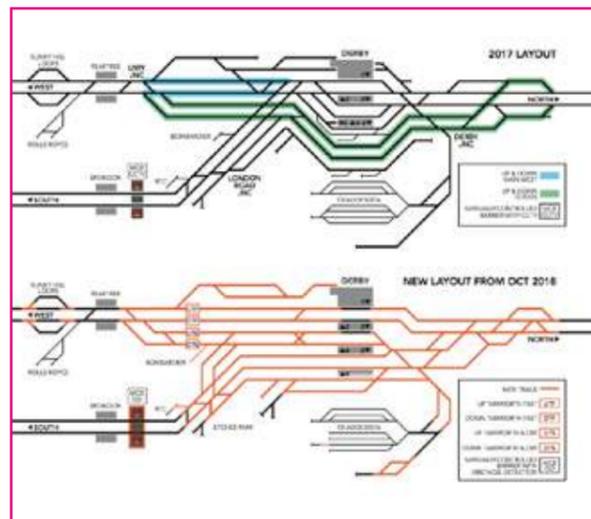


LEGACY UPGRADES IN PREPARATION FOR DERBY REMODELLING

iLECSYS Rail are proud to be working with Network Rail East Midlands Works Delivery team on the upgrades of existing Legacy equipment in preparation for Derby remodelling and resignalling.

The £198 million project in the Derby station area is proceeding towards construction phase. The new layout will deliver a radical reconfiguration of the track layout in the Derby station area, covering London Road Junction, Derby North Junction, Derby LNW Junction and Derby St Mary's Junction and the provision of an additional through platform.

Originally opened in 1840 as a single platform station, Derby quickly became a pivotal hub of routes in the East Midlands area. Capacity was later increased by the addition of an island platform (2 and 3) in 1869, followed by a further island -Platforms 4, 5 (bay) and 6 - in 1881. This increase created the basis of the mechanically signalled track layout that continued through to the introduction of power signalling in 1969, when the layout was rationalised. Since the rationalisation passenger numbers have grown significantly. In 1969, there were eight passenger movements per hour off peak across the junction at London Road. By 2017, this had grown to eighteen, with the station used by 3,766,902 passengers.



The majority of the resilience retrofit works have been carried out around the Matlock, Chellaston and Weston areas. New Class II 650V signalling power supply equipment has replaced non compliant existing Legacy equipment.

LEGACY POWER UPGRADES

In preparation of the works around the Derby area it was decided that the existing 650V Legacy signalling power supply equipment was proving to be both unreliable and non compliant. The decision was made to replace the existing terminals and transformers with new compliant Class II equipment. The remit being that a solution was needed that was able to be retrofitted in minimal time without impacting other equipment located in the existing cases.

Other challenges where larger existing 2C 95mm² cable was being reused was that the termination boxes were sited on the rear signalling side of a number of cases. A solution was needed that would be able to mimic the exact existing layout of the case.

iLECSYS' pre-wired backplate solution has proven to be a brilliant replacement for the existing equipment. The majority of Legacy equipment was mounted using wooden sub-plates mounted on dexion barwork. Where smaller 16-25mm² 2C cable was present the BP250 full width backplate was supplied pre-wired, assembled and tested complete with PADS approved Class II Micro FSP04 and Class II hybrid transformer. In situations with the larger cable, an additional rear connection box was assembled to the new sub-plate. By using this innovative solution installation times were kept to a minimum and often installations were carried out in under 1 hour and 45 minutes.

In instances where the existing wooden sub-plate could not be removed do to other existing equipment and cabling, the new equipment was mounted directly to it.

BEFORE



AFTER



KEEPING THE MAINTAINER Happy

Keeping the key point of disconnection on long feeder cables.

iLECSYS Rail have designed and manufactured a range of solutions to replace existing joint/link boxes. Joint boxes have been used on the rail network for a number of years and can predominantly be found in areas where long feeder cables are present. The joint box allows for long feeds to be segregated allowing for sectioned isolation and more importantly, in the event of a fault, a smaller section of cable to repair or replace.

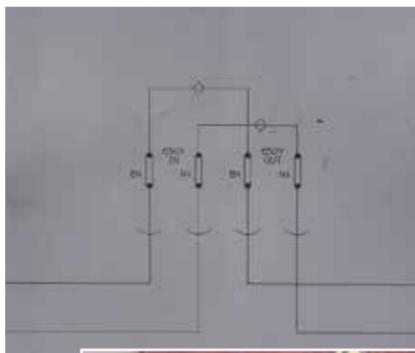
Joint boxes have also been used to split feeders. This can be particularly useful where a main feeder splits off to a branch line or sub-distributes to a remote location case.

The feeling is that non compliant joint boxes can be replaced by a simple resin joint although this is not always the case. By taking away segregated points of isolation you are not only taking away the maintainers point of isolation but potentially introducing another point of failure. Often feeders have been subject to load ratings and optimum voltages. If you remove a joint box in the middle of a 2 mile feeder then you have to be sure that the feeder will not be subject to any voltage drop over the longer distance. iLECSYS joint boxes can be mounted to existing stakes saving on any civils works. If the existing stake can not be reused then for complete safety a lightweight, sturdy GRP post can be installed.

Joint Boxes are available with Micro FSP04s and FSP02s. Connection boxes can also be installed for use with large feeder cables and, if applicable, sub distribution cabling.



Existing joint/link boxes often contain a set of fuse carriers (the example above shows an extra set of fuses for a branch spur feeder). These are usually housed in a smaller steel enclosure mounted to an existing concrete or metal post. These existing enclosures provide an pivotal role in the isolation of feeder cables and segregated isolation.



iLECSYS Rail have designed and manufactured a range of joint boxes that replicate the existing circuitry design. Joint boxes consist of a Micro FSP housed in a PADS approved GRP enclosure. These fully Class II joint boxes can be mounted to both existing and new posts using the innovative post bracket system.

IMAGES:

The images above show a new joint box mounted onto an existing concrete post. This version contained 3 connection boxes and a Micro FSP04. The larger connection boxes at the bottom accommodated the existing 95mm Aluminium Legacy cable whilst the smaller connection box provided sub 650V distribution to an adjacent feeder.



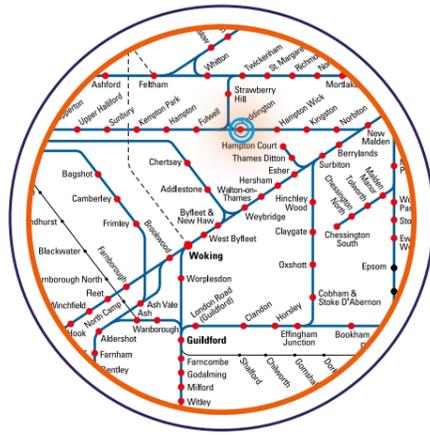
CASE STUDY Teddington

Remit
To retrofit a Class II Integrated Backplate into an existing high priority location case. To identify requirements and develop working methods for a safe and efficient installation.

Constraints
To integrate Class II within the existing legacy location whilst retaining the admiralty tray supporting the signalling circuit ducting.

Solution
Using the integrated Legacy backplate mounted on pre-fitted M8 studs allowed for a rapid fitment of the Class II equipment.

Conclusion
The installation was made Class II in less than two hours with minimal mechanical work within the case. The pre-tested Class II integrated plate assembly saved valuable site time in wiring and testing.



CASE STUDY Bury St Edmunds

Remit
To retrofit four Class II Micro FSPs into existing Legacy location cases. To identify requirements and develop working methods for a safe and efficient installation.

Constraints
Reduce electrical risk, remove mechanical handling, consider existing cable and switchgear condition and internal dimensional constraints.

Solution
Develop an innovative Micro FSP unit to replace existing LOC and line links. Switchgear was installed in a swift and timely manner during an overnight possession as well as adding extra protection to existing cables via conduit and glands.

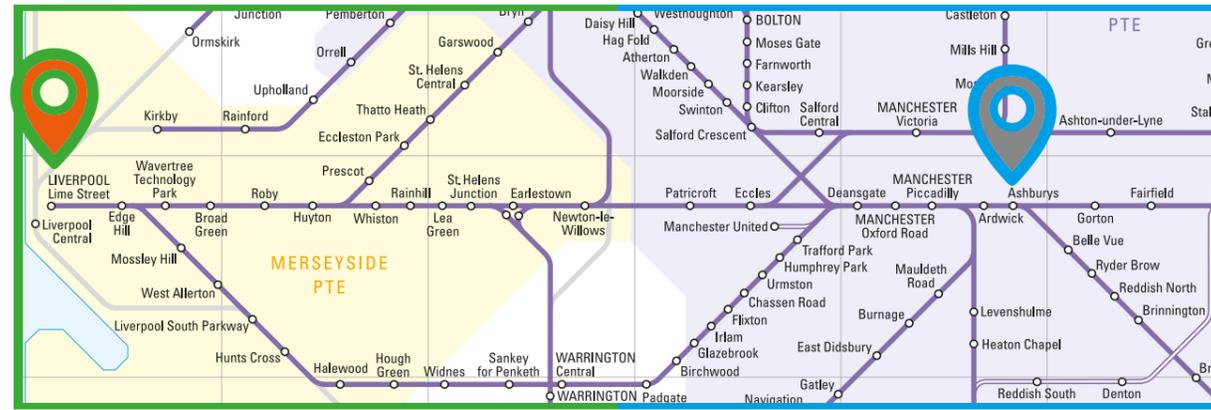
Conclusion
The project was the first of its kind and was delivered on time with no delays and at a reduced cost. Introducing a Class II solution to the Legacy circuit has increased electrical safety surrounding the 650V distribution within the location. A significant improvement was measured at the local Bender Protection monitor after the install.



New and old cable. Legacy Al cable on the right interfacing with new Cu unarmoured cable on the left



CASE STUDY LINE STREET



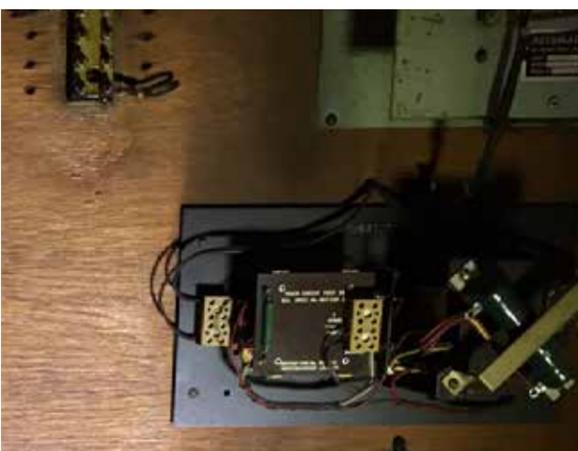
CASE STUDY ASHBURYS

Remit
To provide a new Class II signalling Power supply within the existing signalling location backboard.

Constraints
To survey and provide constructable Class II Micro FSP and transformer within the legacy switchgear footprint.

Solution
Install Micro FSP and Hybrid Class II transformer on the existing backboard without disruption to any internal signalling equipment.

Conclusion
An effective constructional survey ensured an efficient, neat installation providing Class II compliance within the existing case. Flexible conduits and glands were installed together with the appropriate cleats to complete the installation. Network Rail LNW Works Delivery completed a successful survey and installation of what is the most cost effective Class II solution available.



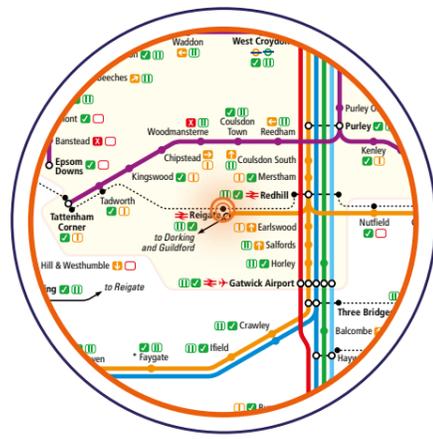
Remit
To provide a Class II compliant 650V power supply to match the existing power layout in this multiple location site.

Constraints
Cases A, B & D all contained 650V switchgear and isolation transformers, case D contained 3 Class I transformer rectifiers. Existing cable routes and backboards had limited space therefore careful survey measurements were taken.

Solution
Equipment was selected to replicate the functionality of the existing 650V switchgear, footprints for each piece of equipment was verified and conduit routing was established.

Conclusion
All Class II equipment was installed in line with the detailed survey carried out by LNW Works Delivery and supported by iLECSYS Rail.

CASE STUDY REIGATE



Remit
To provide a new Class II signalling Power supply to provide compliant 650V to existing signalling locations.

Constraints
To provide a non-conductive enclosure for switchgear and 3kVA signalling transformers in a public access area.

Solution
Install a new generation of composite signalling and FSP apparatus case (PA05/06490).

Conclusion
The GRP apparatus case proved to be a successful and viable solution to safely locating the 650V signalling power supply equipment into a public access area. The external case requires no earth bonding, offers a high insulation resistance value and a reduced maintenance regime.



Innovation from



The first ever Aluminium transformer Technology
Now approved for use on the Railways.

“The award Winning”
eco-rail Aluminium technology is the only
Approved solution for copper elimination,
Class II New & Legacy installations



- **The Lightest approved product**
- **The smallest in its class**
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- **45 % Reduction in Energy Costs**
- **60% Reduction in Co2 emissions**
- **Legacy Compatibility**
- **Ultra Low Inrush**



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TURNKEY PRINCIPLES

64-65 WHAT'S THE TRUE COST OF CORRECT DESIGN WORKS

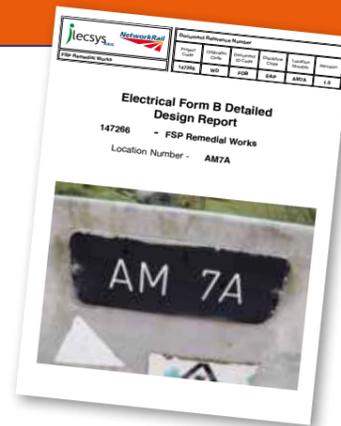
66-67 FAST TRACK TO SUCCESS

68-70 SIN119 CLASS II SURVEY TRAINING

71 LOC CASE SURVEYING MADE EASY

Probably one of the most important and relevant sections in the Legacy Power News Annual 2018 is the Turnkey principles section. In this section we look at the benefits and cost savings involved in producing a robust survey package. The importance of a strong survey document can often be overlooked, however this can prove to be the most pivotal driving force in delivering a successful, on-time installation. We take a look at training sessions delivered across the country and highlighted the relevance to each route and their chosen strategy. The costs of not getting all of the survey information first time can be substantial. The survey package can also influence any design decisions and product selections later down the line. iLECSYS training sessions highlight the critical importance of preparation and rehearsal. This alongside a robust design and survey ensures a first time every-time installation.

A Key Element to Retrofit Success!



It has been proven that a successful retrofit installation is often driven by a set of robust designs and methodology. Driven by a robust survey output and wide range of product solutions the retrofit design process and Form B need to capture and deliver the full story behind the installation works. iLECSYS Rail's design packs include a detailed method statement capturing the preparation, removal of Legacy equipment and install of Class II FSPs and transformers. This article will take a look at each element of the design and retrofit documentation process and how the supporting survey and product information links together. The key end goal is to provide a robust document illustrating the new equipment and its user interface. G110 non-conceptual with correlation has been the chosen method in most cases for this retrofit program.

G110 Non-Conceptual Reds & Greens

One of the key drivers behind the upgrade of existing Legacy location cases is that the design work can be carried out under a G110 non-conceptual design package. This method allows for the modification of existing layouts or high resolution LOC prints. This method is also much more cost effective as a full electrical design is not required. The G110 mark ups form part of the site specific Form B or Method statement. LOC prints and records handed back also contain a copy of the G110 Reds and Greens mark ups. Existing records can be retrieved through EB or by using LOC print images gathered from the survey report.

Form B and CRE Checking

A site specific Form B detailed design report is available which outlines important details including preparation works and installation method. The Form B is based on survey output data sited on the Legacy Project Tracker.

The Form B outlines scheme details and best practices, full existing site details and access points are put together in a robust document. Form B's are provided to the relevant departments and install teams in advance of the installation. This allows teams to familiarise themselves with both the location and existing case layout. Equipment O&M manuals are also included for an in-depth insight to the product specifications and guidelines.

By including this level of detail it allows both the project management and installation team to have a clear insight and vision as to how the works will be carried out. It also eliminates any issues that may be faced during the install. The team can confidently approach the install using the step-by-step install procedure.

The Form B also includes designers risk assessment, Guidance notices, IDC/IDR certificate and DRN comments. Prior to issue the Form B will be sent to the CRE and DPE for checking and signing.

Signalling and E&P CRE & IDC

This process will involve the completion of an Interdisciplinary Check (IDC) with both the signalling and E&P CRE via telecom or video conference.

Layout/Profile Sheet

Driven from the G110 non conceptual design is the production of updated profile sheets and layout drawings for the existing case. The layout sheets are based on the exact layout instead of being driven by a generic layout design. Information will include: new switchgear and transformer equipment, recommended fuse ratings and amended equipment list removing old redundant equipment and replacing with new part numbers and description.

Records Hand-back

The final element will include the full records hand-back to Network Rail and the Maintainer. Updated records will be passed back to EB for reissuing.





SIN119 CLASS II Survey Training!

Some Vital Points to Capture When Carrying Out Your Survey!



For the past 3 years the iLECSYS Rail team have been providing Class II survey training to Network Rail Works Delivery teams and contractors. From Preston to Ashford, we have been covering the country visiting 11 sites in total giving Class II survey training to RAMs, project managers, project planners, engineering managers and engineers.

The training outlines best practice when surveying for Class II solutions in legacy location cases. The sessions last for approx an hour and a half and can accommodate 20 people. A video goes through an actual SIN119 survey and points out the key features and things to look out for when conducting your Class II survey.

One of the key topics discussed is the use of a GoPro camera. The camera that is now available on i-store is the perfect tool to use when carrying out surveys. The small lightweight camera can be attached to either a hard hat or strapped to the chest leaving your hands free to manoeuvre. The GoPro, capable of taking video and photos, is perfect for capturing not only the interior of the LOC but also the exterior and surrounding area. In the footage we have seen, as well as getting information on the LOC, a walk-through video between locations has been captured.

This allows for a virtual walk-through from the comfort of a warm office! By using this method it also captures things that may have been missed on the initial survey including, trough route condition, foliage, access points and potential hazards. This footage can then be stored and reused for any other works that might be carried out along the same stretch.

We have created a survey form that points out some of the key features that needs to be captured. This form differs from the standard earthing form with a greater emphasis on the data needed to assist in the selection of Class II equipment. The training video also discusses vital elements that need to be captured. It's usually obvious that a standard full width barwork should meet Network Rail's standard of 892mm but remembering to check the depth from barwork/backboard to the LOC door is vital. You don't want to be showing up on the night and suddenly realising that the Micro FSP you have selected doesn't fit. Or maybe it does but the 8mm holes you have drilled into the backboard have just pierced the existing Betaduct or relays on the signalling side! Remembering to get good quality pictures of the LOC schematics will be one of the biggest drivers in selecting the right Micro FSP, Annexe FSP or standalone solution. By realising that you are dealing with 4C Aluminium cable, this will drive the need for a connection box. By capturing all of the relevant information at the initial stage this will in turn lead to LOC cases being revisited, a smoother installation and less time on track saving both time and money!

Take a look at page 70 to see a selection of sites where the iLECSYS Rail team has visited across the UK.



Want the iLECSYS Rail Team to visit your area for a training seminar then please don't hesitate in contacting lewis@ilecsys.co.uk or call us on 01442 828387

A YouTube video player interface for a video titled "SIN 119 CLASS II SURVEYING". The video thumbnail shows a person in orange safety gear. The video player shows a screenshot of a survey form with a red circle and arrow highlighting a specific section. Below the video player is a red YouTube play button icon and a QR code.

Our Class II SIN119 survey training video can be found on YouTube. Simply search iLECSYS Group, scan the QR code or visit <https://www.youtube.com/watch?v=TXXwlfvA9gU>



Finniaston Glasgow



Croft Street Preston



Marshgate Depot Doncaster



Tuebrook Liverpool



NR Operating Centre Rugby



Bletchley Bucks



Lewisham SUB London



Network Rail CED Ashford



Three Bridges Crawley



Elstree Hertfordshire



Basingstoke ROC Hampshire



LOC Case Surveying Made Easy!

Have you tried our online Legacy project tracker?

The iLECSYS Rail online Legacy project tracker has been up and running for the past 6 months and has proved to be a valuable asset in surveying and product selection whilst upgrading Legacy locations. The database was originally designed as an internal tracking system to allow us to upload and keep track of on-going surveys. This system allowed for us to keep track of specific details relating to individual location cases.

This surveying tool has rapidly developed into a powerful tool as to which individuals can upload and input survey results instantly. Information ranging from miles and yards to GPS location can be entered. Once the information is uploaded our experts can analyse the results and determine what product/s is needed.

When registering you can assign yourself to a group. Adding yourself to a group allows for you to see what other people in the group have uploaded. Once you have uploaded your details for each location you have the ability to go back at a later to update any information. For example; If you know that your existing cable is copper 50mm but you are unsure as to whether the ends are pre-lugged, this information can be edited at a later date. This surveying tool is available on application at no cost.

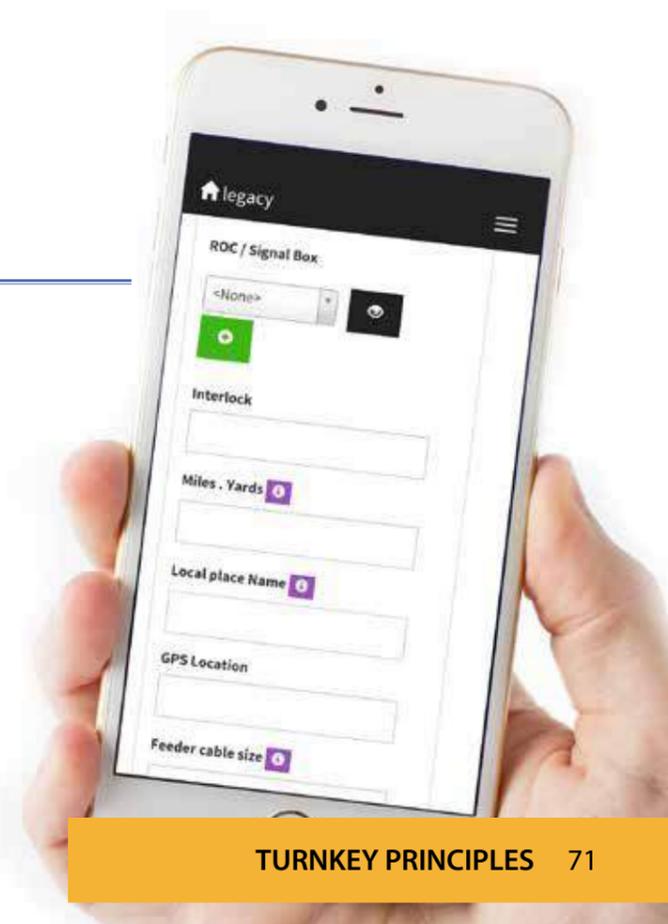
Please visit legacy.ilecsysrail.co.uk where you are able to sign up and explore the benefits of using the online tracker.

Enter Your Survey Results Anytime Anywhere

The Legacy project tracker has been optimised for use on mobile phones and tablets making it convenient to upload your survey results anytime anywhere.

Photos can be uploaded direct from your gallery saving you time in transferring these to your desktop computer.

The user friendly interface has been designed with you in mind, drop down lists and hints and tips mean that time spent inputting survey information and time spent trackside can be kept to a minimum.



Never use a hand-held or hands-free phone, or programme any other mobile device, while driving.

NetworkRail





TECHNOLOGY

76-79 DITA - THE GAME CHANGER

80-81 A CLOSER LOOK AT CABLEGUARDIAN®

82 BENDER RS4

83 SCHNEIDER VIGILOHM

As an output of the NR workstream to delivery new the supporting Standards mentioned earlier, a range of new technology has been developed to allow intelligent interface between Class II IT systems existing Legacy feeders . Much of this development has been based around the management and maintenance of existing signalling power feeders, key issues such as feeder division and optimisation, reliability and capacity and the ongoing requirement to test and verify cables.

The DITA offers many benefits outlined in this section and explained in depth with NR/SIGELP /24719 and the ilecsys DITA guide. The fault location systems and IMD technology offers the scope to mitigate against countrywide feeder cable testing.

Continuous monitoring and the significant safety benefits of Class II switching offers the scope to make a technology overlay onto the existing network providing asset extension and maintainability with minimal network disruption and delivered in an incremental fashion.

DITA... The Game Changer

“Be careful of what you wish for as you might get it all” In the case of the DITA, it answers all the questions, solves many of the challenges and delivers a whole range of benefits that align to providing interface, management and resilience in Signalling power supplies.

TECHNOLOGY

Using the proven Class II Switchgear developed to deliver Network Rails new signalling projects and provide upgrades to existing legacy systems the DITA builds on the success gained in safety, system reliability and user interface. In recent years Network Rails Class II product and system standard have helped to deliver a new generation of Signalling power supply products.

Alongside this has been a revolution in Transformer technology, the use of Aluminium windings, low inrush, high efficiency, reliability and ease of user interface has resulted in a significant range of Class II and Hybrid Transformers.

This range is an unprecedented new generation of full Class II power transformers that exceed the minimum requirements of Network Rail specifications with ground breaking benefits. Utilizing on board eco-rail® technology which is fast becoming the preferred solution on the railways. The DITA range of transformers are a pioneering technology that deliver the lightest, most compact and environmentally friendly solution available. This range have been developed with Network Rail and deployed to support their DITA and other key strategic improvement schemes such as copper elimination, inrush reduction and sustainability charter targets to reduce carbon emissions throughout the network.



DITA Complete with 5kVA TX

KEY FEATURES

- The Full Class II DITA transformer offers seamless integration and tested/proven thermal rise compatibility with NWR standard apparatus housings and associated equipment.
- The ability to reset or Boost various distribution voltages.
- Galvanic Isolation and capacitance decoupling of feeder circuits.
- Facilitate Class I legacy to Class II feeder integration aligned to NR/L2/SIGELP/27419.
- Full Class II designation prevents the need for expensive earthing surveys and bonding where adopted.
- Inrush characteristics across the whole range of less than 5 times Full load system current.
- A stable of power ratings from 5 - 40KVA with single and dual output multi voltage configurations to cover all regional distribution voltages.
- Lightweight aluminium windings and connection technology eradicate the use of expensive and fast exhausting copper reserves to support sustainability.
- Unmatched efficiency delivering enhanced asset life in excess of 400,000 hrs continuous operation.

Waiting in the wings the supporting act is a range of insulation monitoring and fault location technology that will support the DITA intelligence and allow it to become a strategic management tool in the network of LV Signalling Power Feeders.

Boost capability within the Tx tapings allows for multiple benefits when looking to support long feeder distances as well as offering cable reduction possibilities.

All this technology needs some careful packaging and the newly approved GFRP Apparatus case does just that, the twin skin material allows for significant thermal movement while managing solar gain and temperature spikes. The case construction is tested to over 50kV Insulation resistance and therefore provides a very safe environment for the 650V, mitigating against earth bonding the case this allows for only a moderate earth value to support the IMD device in Class II applications.



Guide Bridge East
Courtesy of Siemens Rail Automation

STANDARDS NR/L2/SIGELP 27419

Network rail have issued this DITA Standard with a view to providing an easy step by step guide to identifying, prescribing and implementing DITA in a wide range of feeder scenarios. The standard has allowed designers to understand and then support the specification of DITA on projects as well as giving a benchmark to the supply chain.

Other supporting NR documents including “System Architecture Mix and Match rules and Class II Retrofit Design Philosophy help to understand the DITA USPs. A recent Standard NR/L2 /SIGELP 27416 Modification of legacy power supplies help to complete the supporting NR documents providing an outline and some examples of where DITA can be used to great effect. Finally, TECM (Target earth Calculation model), this allows designers to establish target values and feeder sub-division lengths, this helps to establish the key locations where DITA will support the network.

SUPPLY CHAIN ENGAGEMENT

Riding on the massive success of Class II over recent years the DITA is a further opportunity to expand the product range and integration possibilities, it is an ideal project for collaboration as no single supplier can offer the entire product. This collaboration is the key to the success of taking DITA to the market place, as a product that may be considered new and novel, the DITA requires some robust support from the supply chain to aid design and specification, to demonstrate a wide range of features and benefits , to understand fully and align with the examples set out by Network Rail and finally to offer the optimum product for the application. The opportunity that DITA offers to Network Rails current infrastructure is substantial; the key to unlocking that potential is early engagement and a real in-depth understanding of the whole system benefits. The wide range of suppliers and collaborators will ensure the success of this innovation, as projects take up the DITA and realise its true potential to deliver the solutions to many unanswered questions.



DITA Assemblies are supplied with large connection boxes to allow for the integration of 2C and 4C Cu and Al cable up to 150mm. A 3 core connection box is available for use with existing Class I Legacy cable. Connection boxes allow for the safe segregation of Class I and New Class II FGT cable

LEGACY CHALLENGES

The current Network Rail LV network is dominated with Class I IT systems, many of these have long feeders with significant numbers of FSPs on each feeder, all the usual infrastructure challenges exist including, challenging earthing conditions, cable theft and damage, rodent attack and demanding maintenance conditions. One goal here would be to have a more manageable network, smaller feeders, better fault location, advanced programmable protection systems and controllable interfaces between system architecture, if all the above sounds like a challenge you may be facing then look at the DITA.

DITA PAYBACK

As will all new assets there has to be a cost driver, with regards to the DITA this can come in many guises, providing a definitive and controlled demarcation between Class I and Class II can be a costly business if it requires the removal and replacement of large amounts of existing infrastructure, the DITA will allow this interface to happen when you want it. The twin output options allow for feeder optimisation, leaving you in control of cable sizes according to load. Dividing up the network into smaller portions will have a significant benefit in fault location, maintenance and re-establishing the operational railway. The DITA offers a significant opportunity to new signalling projects by allowing a legacy interface without costly replacement of existing assets, the legacy interface can be selected based on the optimum start and finish rather than a widespread or compete feeder renewal.

The DITA switchgear assembly allows for the integration of new Class II 2 Core and 4 Core FGT cable as well as offering a Class I interface for 3 core and armoured legacy systems. The large termination enclosures have been designed in line with BS BS5372:1997 and to facilitate the use of aluminium cable and the PADS approved bi-metallic pins or lugs. This supports Network Rail's Copper Elimination Challenge thereby further reducing material costs. Cable sizes up to 150mm 2 core and 4 Core aluminium and copper cable can be accommodated.

CONCLUSION

There is a unique set of circumstances opening up on the existing rail network, necessity is driving change, challenges are outlined in NR Innovation targets and supported by a range of new SIGELP Standards, products like DITA are an outcome of one of these challenges.

In delivering solutions to this challenge the supply chain has a significant part to play in delivering the technology improvements, cost savings and collaboration that is critical to meeting CP6 targets. Riding on the success of Class II, products such as DITA make up a basket of products to deliver are more resilient Signalling power backbone for the growing demand on the infrastructure.



DITA

CERTIFICATE OF ACCEPTANCE: PA05/06430
DISTRIBUTION INTERFACE TRANSFORMER
ASSEMBLY IN ACCORDANCE WITH NR/L2/SIGELP/27419

- Supporting Network Rail standard NR/L2/SIGELP/27416 and TECM (Target Earth Calculator Model)
- On-board Eco-rail® Technology from ATL Transformers - Innovative aluminium wound Class II DITA transformers with single or dual output windings up to 40kVA
- Housed in GFRP apparatus case (PA05/06490)
- Compatible with 2C and 4C aluminium and copper cable
- Range of insulation monitoring devices available with optional fault location (please note IMD requires an earth bond)

Contact us now for a copy of our unique DITA guide

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INTRODUCING CABLEGUARDIAN® FOR DETECTION AND LOCATION OF ELECTRICAL CABLE FAULTS



CableGuardian is comprised of two complementary technologies; an insulation monitoring device and built-in time-domain reflectometer (TDR) with a difference. The insulation monitoring device is Viper Innovation's V-LIM. Proven in the harsh conditions of the subsea oil and gas industry, the V-LIM not only monitors the insulation resistance of the system but also capacitance, line voltage, current, frequency, power and power factor. This information gives the viewer a greater understanding of the status and integrity of the electrical cable as well as the nature and location of any fault. If that's not enough, what really sets CableGuardian apart from the rest is its ability to have multiple units on the system, which measure without conflicting or interfering with one another.

The unique connection method of CableGuardian ensure that the system to locates the short section of cable in which the fault is located. This cable length monitoring of both cable and conductor condition is realising an additional benefit over and above decreased fault location time and remote asset condition monitoring. The unique proprietary connection methodology further avoids system unavailability by allowing the hardware to be installed without de-powering the signalling power distribution equipment.

Sources within Network Rail are reporting that CableGuardian has the potential to eliminate the five-year testing regime required of the NR/L2/SIGLP/50000/MODA (Inspection and Maintenance Periodicities (including risk based maintenance criteria) Signalling Power Distribution Equipment above 175 Volts), the compliance date of which is 7th December 2018, and is a key success criteria of the CableGuardian trials.

The second technology within CableGuardian ensures that the live conductors are continuously monitored, and locates with 98% accuracy, short circuits, open circuits and intermittent faults using an innovative Spread Spectrum Time Domain Reflectometry (SSTDR) capability. Traditional TDR, while being the accepted method of fault finding, has its limitations, one of which is the inability to be used on a cable whilst it is powered. This poses a considerable disadvantage to users as traditional testing carries a risk of introducing new, service-affecting failures to the system. What sets Viper's CableGuardian apart is the use of Spread Spectrum TDR which is a foundation of cellular phone communications and is used to transmit small, but nevertheless, recognizable signals in high noise environments. SSTDR can be operated on energized wires because the Spread Spectrum signals can be isolated from the host system noise and activity. Small impedance changes caused by known conditions, such as connectors and loads, as well as inherent system noise can be ignored. Unplanned events such as hard or intermittent faults are reported. Live monitoring means that events, such as vandalism or theft of cables, can be alarmed and logged as they happen and, importantly, the exact location of such an event is instantly made available via the CableGuardian user interface. By combining Spread Spectrum with TDR, the result is a significant breakthrough in monitoring and locating real-time changes in live electrical circuits.

The interactive web portal will enable you to identify and locate a potential failing cable. CableGuardian is able to pinpoint the location of any electrical short, open, or transient failure with 98% accuracy. CableGuardian returns data via 4G, trackside fibre, or standard wired ethernet communications networks. It also has GPS integrated so asset position can be confirmed.

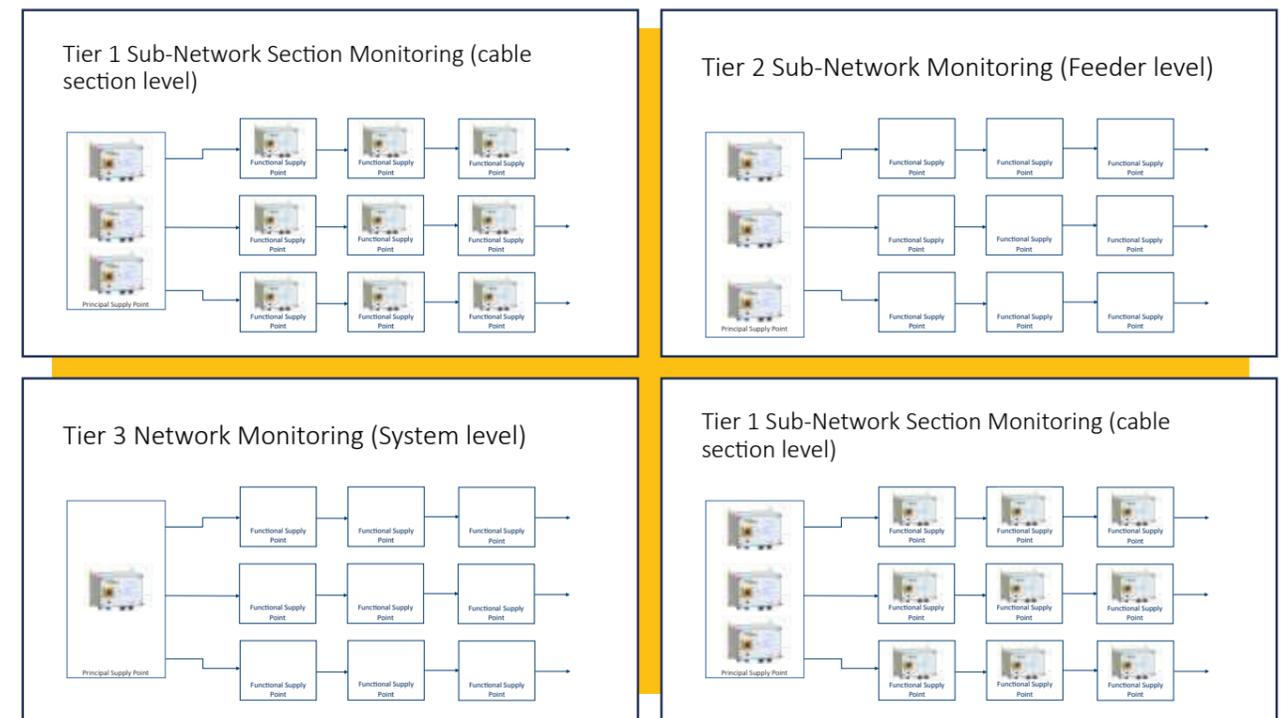
The end user receives not only health and status monitoring of cables, but fault location information in order to direct maintenance engineers for cable repairs or preventative maintenance. As well as the commercial and performance considerations, CableGuardian has positive implications for health and safety risks to both maintenance personnel and the public by ensuring that failing cables are identified and alarmed well before they reach a state where there is a safety risk or total failure.



The system may consist of a single CableGuardian unit (Tier 3 monitoring as defined in NR/L2/SIGELP/27725) or a system of multiple CableGuardian units (Tier 2 or Tier 1), depending on the system monitoring requirements and the level of monitoring and fault location granularity desired. Each CableGuardian unit transmits data, via a secure internet connection, to the remotely hosted CableGuardian Data Storage and Analytics System which analyses it, monitors degradation and determines the location of faults on the live power network. The results are displayed clearly, at a glance, on an interactive web portal. Master Users have full control to set the CableGuardian alarm thresholds which send alerts direct to key personnel via:

- Interactive web portal
- Email
- Text message
- Automated voice message

Future developments of CableGuardian include a "Prognostic Analytics" package which utilises Machine Learning (Artificial Intelligence) algorithms to provide an enhanced level of predictive fault monitoring, detection and location, to further support risk and condition based maintenance.



RS4

SIGNAL POWER FAULT DETECTION SYSTEM

Advanced intelligent insulation monitoring equipment is a proven tool for safeguarding critical signalling power systems within the rail network, and enables predictive maintenance and efficient fault-finding to minimise disruption and aid the smooth running of rail services. Bender RS2 and RS3 rail signalling integrated insulation monitoring and earth fault location equipment is fully approved by Network Rail, and sets the standard for safeguarding and monitoring the performance of signalling power supplies.

The new and improved RS4 device is based on the earlier variants proven in use by Network Rail delivering vital information on the status of power supplies. Smaller and more compact in size the RS4 will be supplied tested and ready for easy 'plug and play' installation and commissioning alongside existing power infrastructure systems up to AC650V.

It has enhanced sensitivity for 'first fault' location (100 kilohms). It also measures capacitance, voltage and frequency delivering data within the standard display options to provide more information to help assess the health of the system.

It is simpler to install and commission, and incorporates GSM-enabled data loggers equipped for real time communication with the rail system's Intelligent Infrastructure delivering immediate notification of insulation faults which are identified by the system.

The ability of RS4 to identify fault locations more precisely means maintenance teams can respond rapidly, enhancing safety and reducing downtime costs. Another advantage is that they are easily interchangeable with the present RS3 and RS2 units to upgrade performance at an affordable cost.

The enhanced RS4 will meet the new standards being introduced for rail safety and assurance within Network Rail's requirements for Insulation Monitoring Devices/Systems (IMDs) and Insulation Fault Location Systems (IFLSs).

Bender UK Managing Director Gareth Brunton explains: **"Our equipment enables customers to plan their intervention around their business needs – intelligent monitoring to deliver intelligent maintenance and minimise disruption to the rail network. We are continually seeking to upgrade the performance of our RS systems to respond to the needs of our customer base and help them to comply with the latest regulations. "RS3/4 continually checks the health of the power system, and immediately notifies the Intelligent Infrastructure via the GSM capability if that status changes, indicating a fault or a problem in the making. The customer can address the fault immediately or plan maintenance intervention.**

"Bender UK's field trials to prove the effectiveness of the RS system in one case led the maintenance team to a trackside cable which was glowing hot because of an earth fault that could have resulted in serious disruption to the network."

The new RS4 is just part of the huge Bender rail offering which includes power quality meters, insulation monitoring devices and monitoring software for rolling stock, signal power, points heating and trackside use.



Essential reliability made simple

PA05/06372



Your operations cannot stop. A service interruption is just not an option. An IT earthing system allows your electrical distribution system to continually operate, even in the presence of an insulation fault, without endangering people or property. Required as part of an IT earthing system, an insulation monitoring device (IMD) detects the initial fault so you can make repairs before a second fault triggers protective devices that halt operations.

Even though IMDs are mandatory in IT earthing systems, not all IMDs are equivalent. IT earthing systems are often considered complex and difficult to install. Vigilohm has changed that by combining the increased energy availability, improved safety, and reduced risk of fire and explosion you expect, with the simplicity you need.

Advanced Features for today's industry

Trusted for over 50 years, Vigilohm sets the standard for IMD reliability and simplicity.

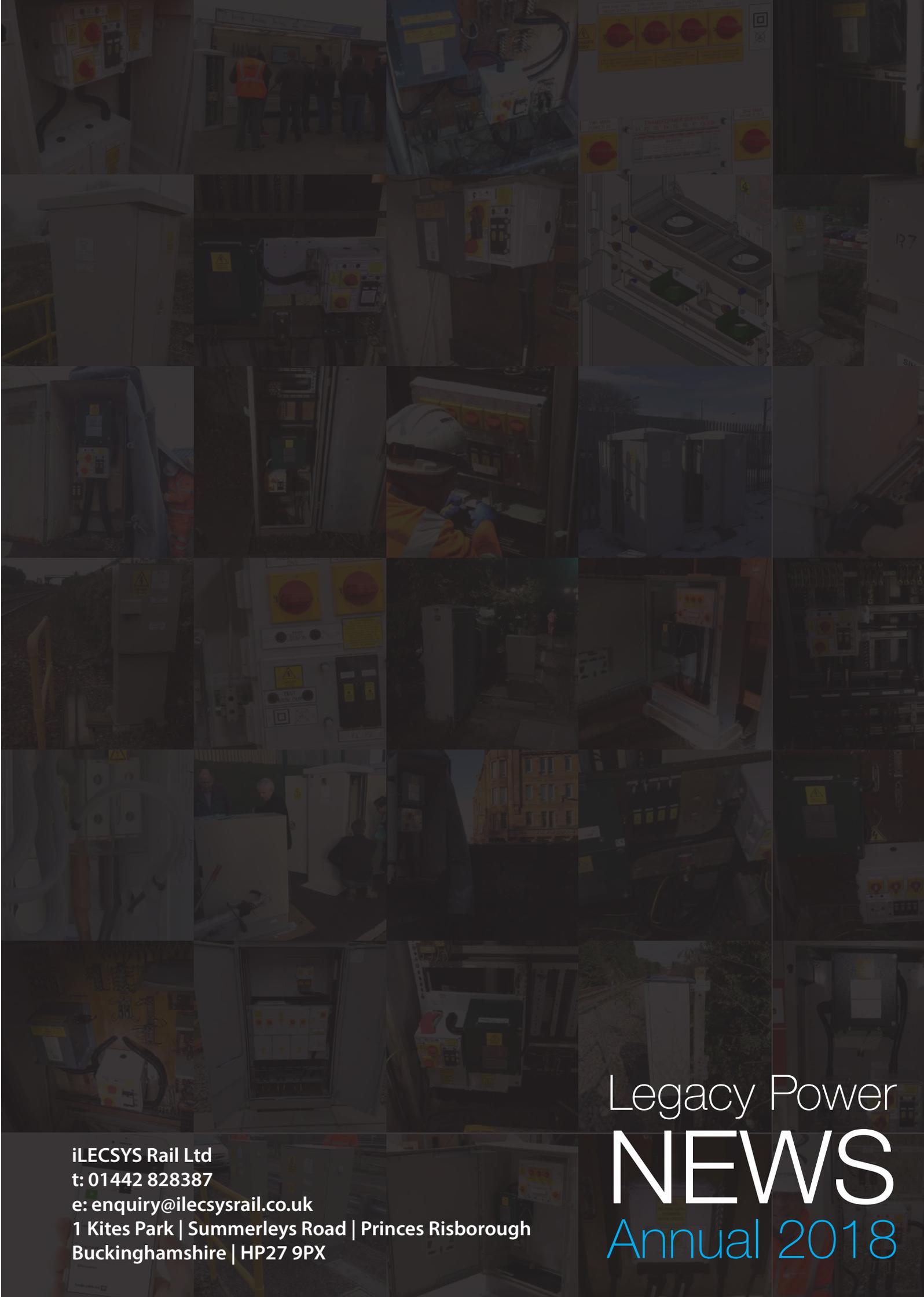
- Simple ordering, operation and installation
- Synchronicity with modern, communicating ungrounded electrical distribution networks
- Compliance with international standards
- Seamless integration into complete solutions
- Exclusive measurement of leakage capacitance
- Increased property life by enabling preventive and corrective maintenance operations

Flexibility to protect any business

Vigilohm IMDs fit the needs of many industries, including specialized facilities like hospitals, where additional standards for safety and service continuity must be met. Choose among Vigilohm IMDs for low voltage monitoring applications where manual fault detection or simple and efficient automatic fault location is needed. Or choose the most advanced fault locator (XM300+XL308/316), to fulfill the most demanding applications. They meet international standards for IT earthing applications and differ in the size of network they monitor. Select features such as communications ability, alarm logging, insulation trending and measured value display. Vigilohm IMDs offer din rail and panel mounting options, and the Vigilohm IM10, IM20, IM400 and XM300 offer compatibility with AC and DC control and power electrical networks. Vigilohm IM20, IM400 and XM300 are designed to cope with highly perturbed electrical networks with power electronics devices such as inverters, variable speed drives, rectifiers and active filters.

For more information scan the QR code to download the Vigilohm datasheet alternatively contact on 01442 828387 for more information





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Legacy Power
NEWS
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