EMC process for Authorisation
Railways perspective

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About the presenter

- Maya Petkova is a technical principal, EMC at Mott MacDonald.
- Convenor of the CENELEC working group on EMC between rolling stock and signalling for more than 10 years, responsible for the production of four European Norms
- Chairman of the EMC Support group to the Vehicle/Train CCS Interface Committee at the Railway Standards and Safety Board in UK and leading/ supporting several cross-industry initiatives with the Railway Partners organisation.

Introduction and Scope

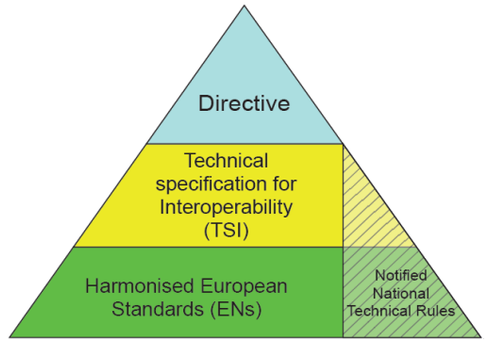
Part 1

- Regulatory framework for EMC applicable to the European Railways (including the UK), and their constituent subsystems.
  - Railway Interoperability Directive
  - Safety Directive
- Other directives (horizontal)
  - EMC Directive

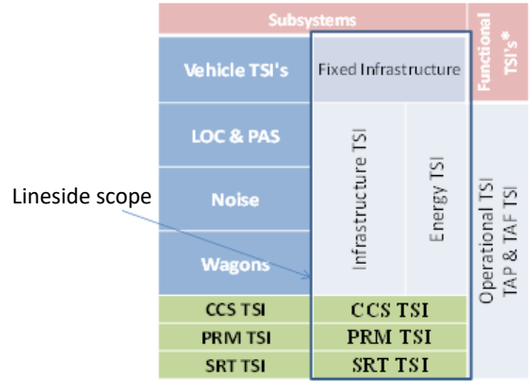
Part 2

- EMC project assurance works delivered by Mott MacDonald, which successfully applied the outlined requirements and processes

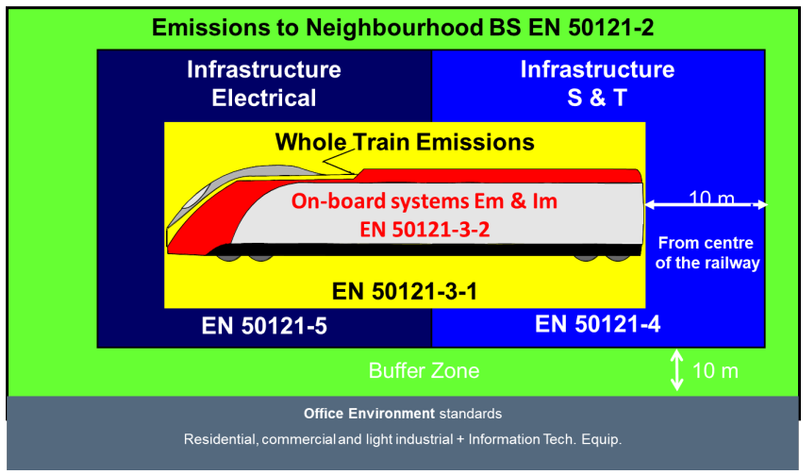
Interoperability and Standards



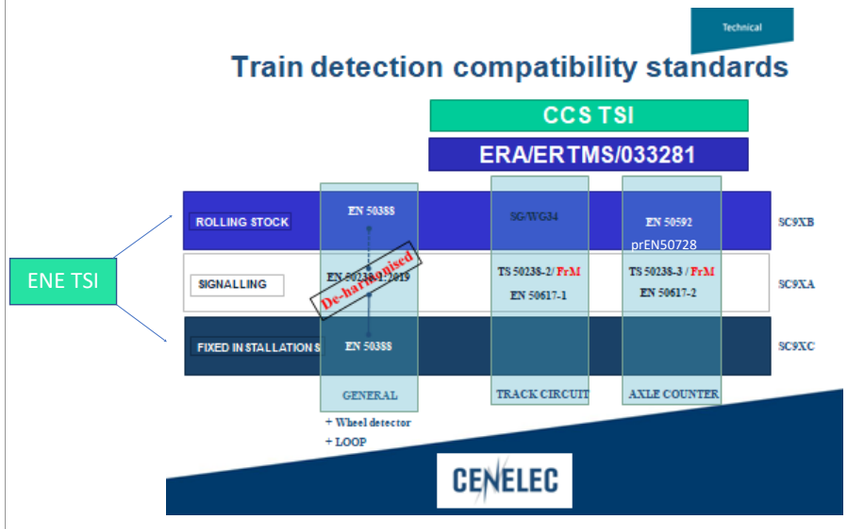
TSI's structural subsystems



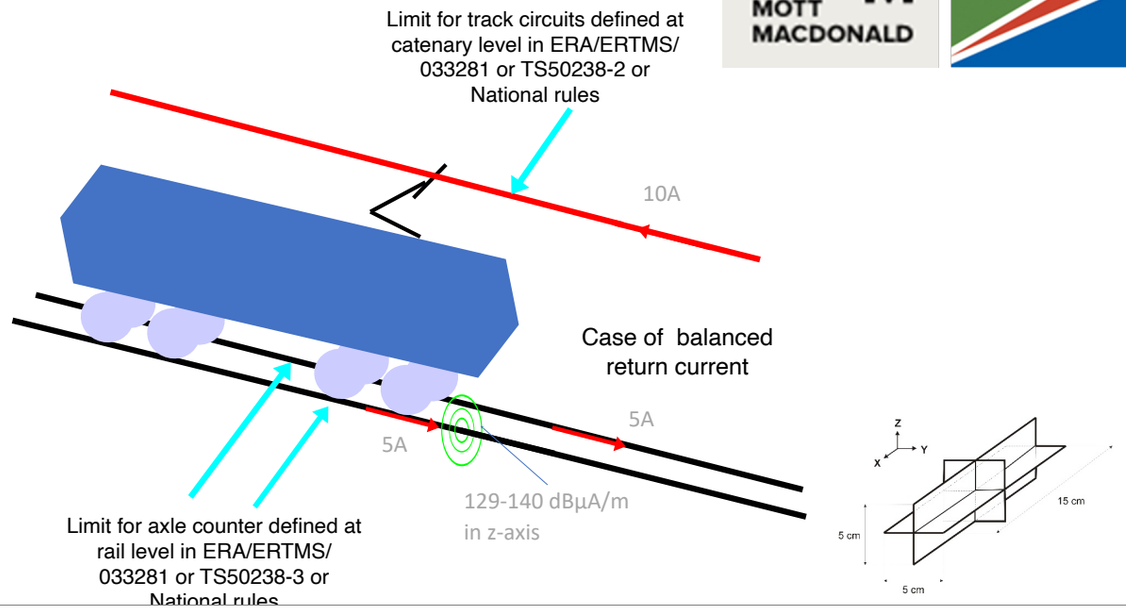
Railway Assurance under the EMC Directive



Compatibility standards in the scope of Interoperability – Subsystem Level



Limits definition under Interoperability

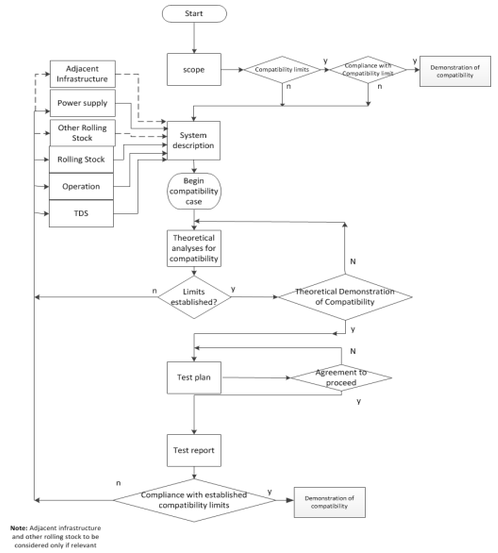


EMC process in the revised EN50238-1:2019

Universal
Coherent with TSIs

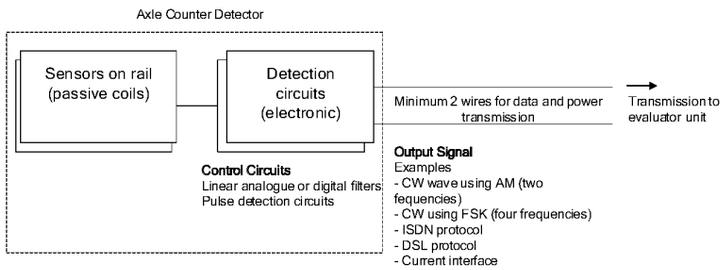
Route Compatibility

RIS 8270 – is it sufficient for EMC at route level? Can it be improved – the EMC SG at RSSB is proposing a guidance note / dedicated Appendix

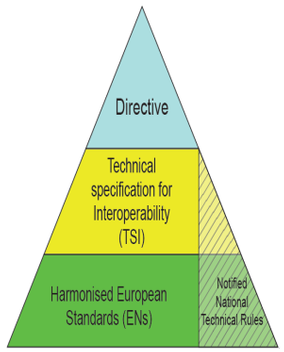


IEC standard

- **IEC 62427 - RAILWAY APPLICATIONS - COMPATIBILITY BETWEEN ROLLING STOCK AND TRAIN DETECTION SYSTEMS**
- **Based on EN50238-1:2019**
- **Some amendments to avoid ambiguity:**
  - **Wheel detectors v/s Axle counters**



National Technical Rules for Compatibility in UK



- **RIS-8270 Route Level Assessment of Technical Compatibility between Vehicle and Infrastructure**
  - Superseded GERT8270 issue 3
- **RIS-2715 - RST Rail Industry Standard on Rolling Stock Subsystem and Interfaces to AC Energy Subsystem**
- **RIS-0725 EMC of Train Detection Infrastructure with Rail Vehicles**
- Two main categories covered:
  - New/Modified & Legacy Track Circuits
- Not covered – the worst case most susceptible old
- Axle counters – by ERTMS/033281 (referenced in TSI CCS as 'Index 77)
- **GMGN2694 – New Guidance note**
  - **Transfer function between RST emissions on the AC Railway and Copper Lineside Telecoms circuits**
  - Guidance given on rolling stock electromagnetic energy emissions with reference to other RGSs, BS/EN50121 and NR line standards
  - Pointer to emerging results from research projects (Voltage resonance and compatibility requirements between RST and AC Electrification).

Challenges to implementing an effective EMC Assurance Process on the Railways

- Harmonisation of the rules - the different generations of technologies present on the railways
  - There are track circuits still designed 80-90 years ago when no electrification let alone modern traction utilising IGBT technology and multitudes of switching frequencies existed
  - There are new emerging requirements based on enhanced knowledge of the susceptibility of our existing train detection systems which RST manufacturers find sometimes extremely difficult to meet!
- Clarity associated with compatibility limits contributes to better understanding and more efficient EMC management
- In the past the situation involved a lot more effort on characterisation…

EMC Hazard analyses and CSM (Safety)

- Opportunities to integrate
  - UK process: Where a new system safety case or safety argument is being developed (e.g. when there is a change involving the risk of reduced availability, due to anticipated EMI), evaluate this in relation to the overall safety and performance risk to the railway. This evaluation shall encompass failures under both normal, fault and earth fault conditions as follows.
  - a) Evaluate compatibility of the new system under normal conditions against the limits from the appropriate EN standards. – *Valid Risk Acceptance Principle from CSM REA*
  - b) The new system shall not be affected by EMI from a train in normal or degraded conditions or by power supply disturbances. – *Could be by compliance with established limits (standards), by comparison with a reference system or through Explicit Risk assessment*
  - c) Any residual risk from interference to the new system, shall be quantified with respect to the availability of the whole railway system, without compromising established performance. The safety case or safety argument shall demonstrate that the safety risk associated with the installation(s) is tolerable so far as is reasonably practicable – *this may mean Operational Restrictions in the SMS of the Duty Holder*

Risk ranking for EMC

Integrated risk approach to EMC

- Demonstration of compatibility under EMC Directive is pass/fail – *all normal modes, specified environment*
- Compliance with standards and installation guidelines is normally adequate to ensure EMC
- Additional testing may be defined because of the critical nature of the equipment to the safety of the network
- Safety critical equipment - EMC risks should be considered for the worst case electromagnetic environments to verify acceptable performance:
  - specific areas in the network to be considered for the integration tests
- Numerical targets used in risk ranking relate not to EMI itself but to the frequency of occurrence of system faults, i.e. *degraded operation*

How do we relate EMC to safety?
*Slide:*RG Safety Plan target is global railway aspiration of risk for any part of the railway, e.g. a resignalling scheme, there is no overall model into which an assessment of its risks can be incorporated.
Conclusion: The holistic targets can only be met by using a holistic approach which is impossible to achieve in the existing commercial environment. In the absence of an overall model available to describe fully how each element of the railway system is intended to contribute to the long term objective, a detailed risk assessment must be performed to encompass all hazards and to demonstrate that that all reasonably practicable controls have been implemented.
Therefore the margin of acceptability of risk for a railway scheme must be made by individual detailed risk assessments. This is where the evidence of TSIs come since these can relate to individual systems or changes to railway. *Slide:* In other words, EMC is black and white (10^{-9} is more an academic figure and it's not possible to demonstrate practical evidence it's been met).
The achievement of EMC in the context of safety should be approached in a similar way to that necessary for safety related software as per IEC61508.

Commentary/Personal View

EMC is the responsibility of all duty holders:

- Infrastructure managers
- Manufacturers of safety critical equipment
- Train builders/operators
- Maintainers

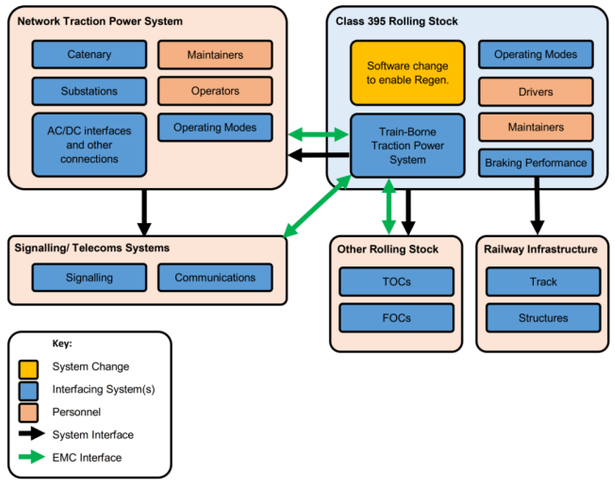
The bringer of change has the responsibility to achieve EMC and Safety but this requires the co-operation of all players throughout the process until final commissioning. Some verification tests can only be performed during final integration, due to the nature of the phenomenon.

<u>There is a growing need to maintain corporate knowledge!</u>

End of Part 1!

HS1 Regenerative Braking – Class 395

System overview and EMC interfaces



HS1 Regenerative Braking – Class 395

High level requirements

- Meeting regulatory requirements for EMC
  - UK EMC Regulations 2016
- Meeting railway specific HS1 EMC requirements
  - RIS-8270-RST (partially)
  - EE&CS Technical Requirements (HS1 specific)
    - HS1 Signalling System – track circuits and other train detection equipment
    - HS1 Telecommunications Systems
    - HS1 Radio Systems
    - Power Supply
    - Other Rolling Stock
    - Railway neighbours (e.g. NR, LU, etc)

HS1 Regenerative Braking – Class 395

Safety/operational (EMC) requirements

- Compliance with BS EN 50388, regarding regenerative braking
- Compliance with HS1 signalling system requirements – TVM 430, HVI and TI21
- Traction power requirements – e.g. harmonic distortion, injected/ consumed reactive power, power limits, other regen constraints
- Compliance with telecoms systems
- Compliance with radio systems – e.g. GSM-R, TETRA
- Compliance with UKPNS requirements regarding reverse power flow form regen braking
- Compliance with power factor requirements
- Compliance with BS EN 50121-3-1
- Compliance with requirements related with loss of regenerative braking function
- Compliance with requirements related with interaction with other rolling stock

HS1 Regenerative Braking – Class 395

Produced EMC evidence and close out (not comprehensive)

- Conducted Emissions EMC Test Report
- EMC Test Report
- Infrastructure Electrical and Electromagnetic Compatibility File
- EMC and Electrical Compatibility Safety Justification
- Assessment of the impact of Regenerative Braking on HS1 Protection System

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EMC compliance report

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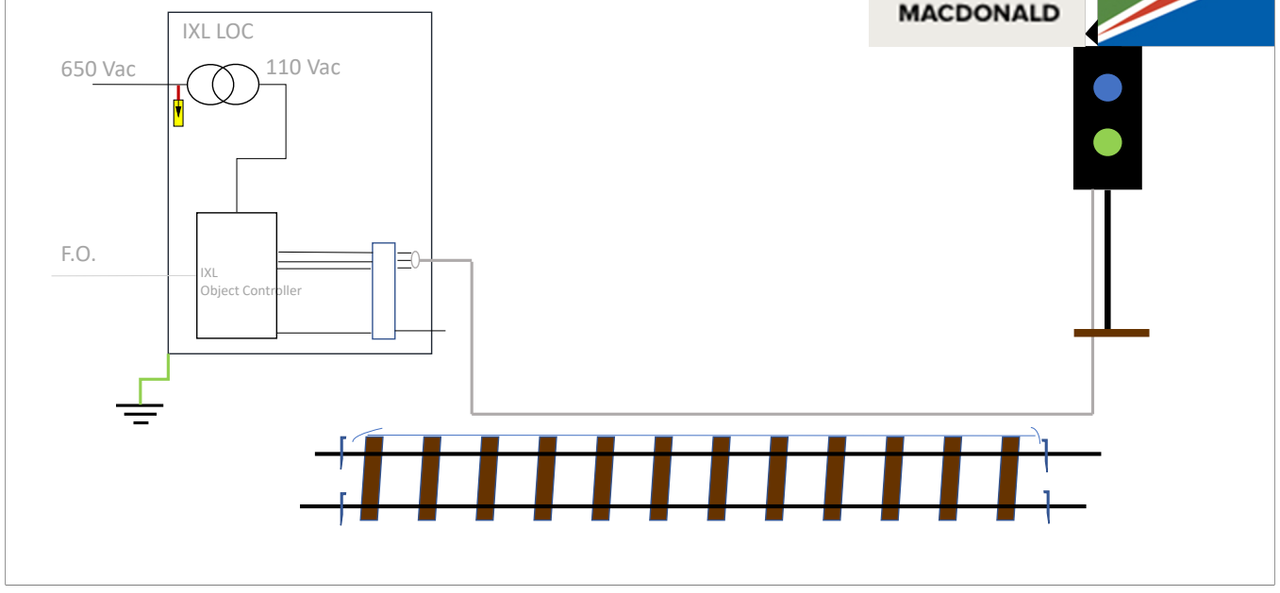
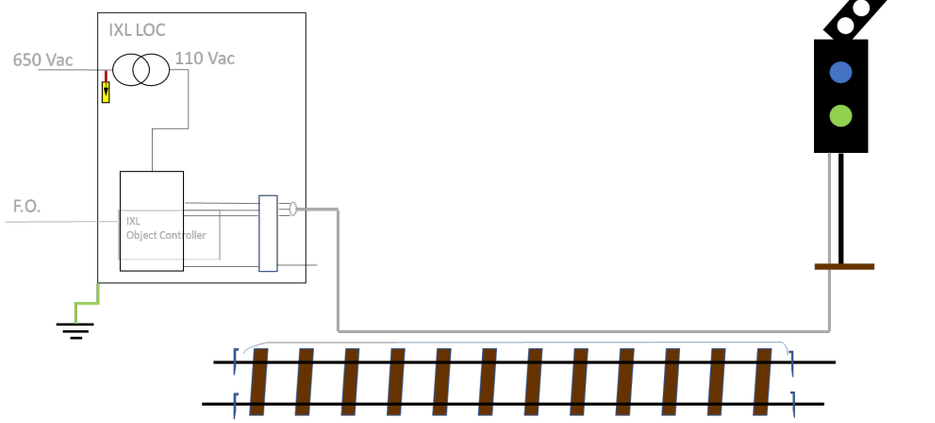
Sustainability benefits - Regen on HS1 line is saving enough energy annually to power more than 375 homes

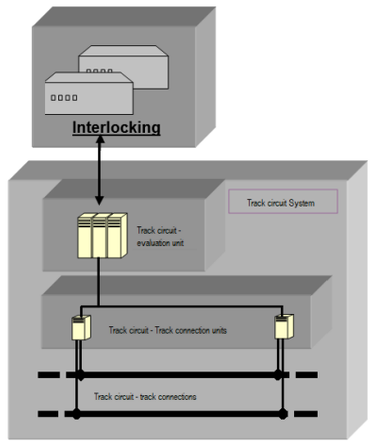
TPS Trackside - Existing Situation



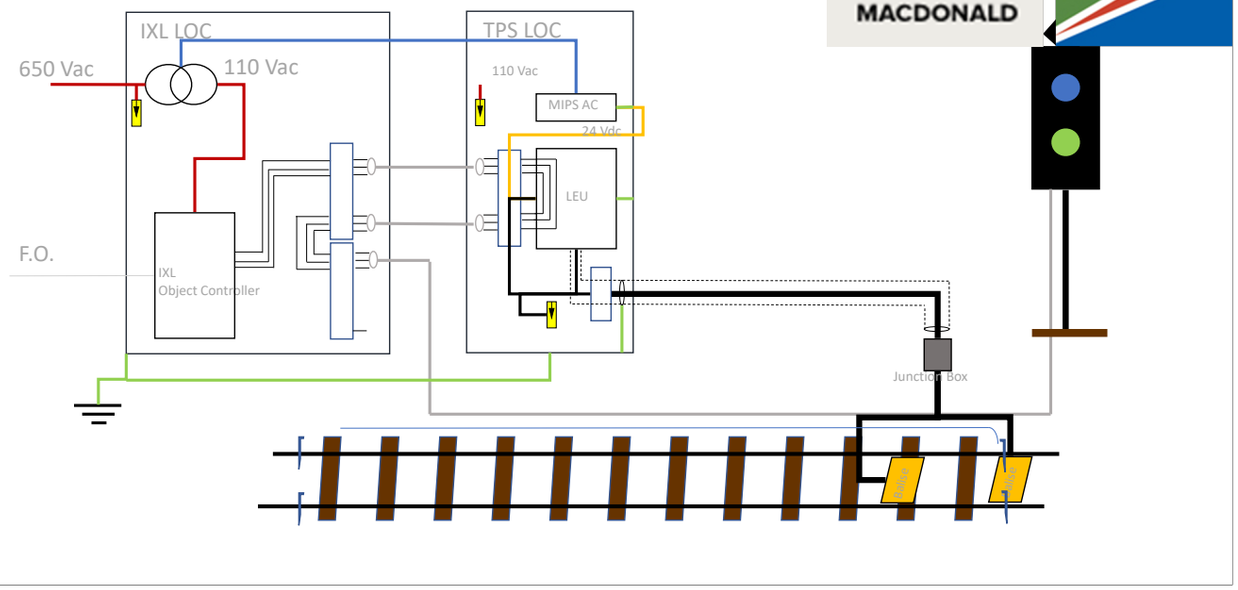
TPS Trackside - Existing Situation



Track circuit system



TPS Trackside - New LOC, balises, cabling



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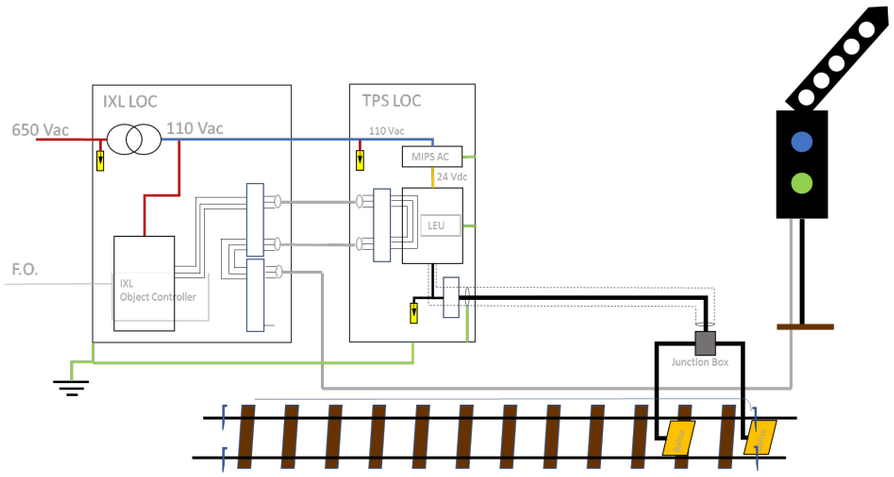
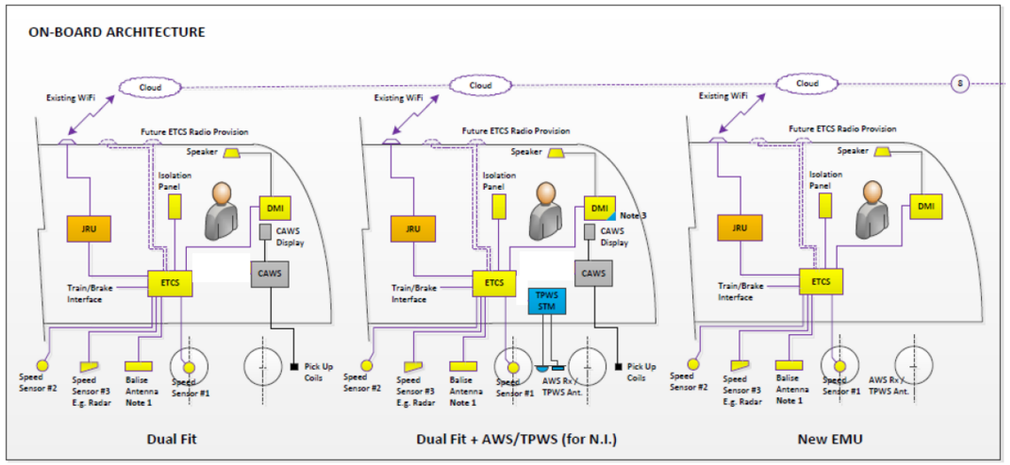


Trainborne Train Protection Systems



Test methodology to check immunity to ETCS telepowering fields - EN50617-2

Zone A
Impact of 27,095 MHz magnetic field on the sensor

Zone B
Impact of 27,095 MHz magnetic field on the sensor cabling, if it goes across the track

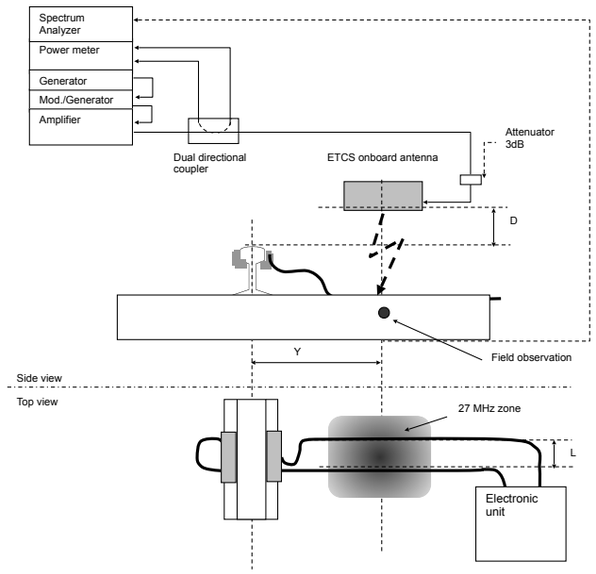
Zone C
Impact of 27,095 MHz magnetic field on the electronic trackside unit (product specific)

ETCS Telepowering field – frequency mask

Rail level:

The pulsed modulation is defined in UNISIG SUBSET-036 FFFIS at 10m distance from the antenna

Test set up for conducted immunity



The same test signals as defined in UNISIG SUBSET-036 FFFIS are proposed to be used at rail level

The test methodology can be applied to test compatibility between radiating ETCS trainborne cables and legacy cabling

Conclusions

- The presentation explains the complex mix of Railway legislation and standards that govern the EMC Compliance process
- The two examples featured in the presentation demonstrate the viability of the process for EMC defined in BS EN 50238-1 standard and its International twin standard IEC 62427.
- Clarity associated with compatibility limits contributes to better understanding and more efficient EMC management
- Application of state-of-the-art processes and definitions in our EMC Compliance processes drives efficiencies and contributes to the sustainability of the railway transport.

Thank you for
your attention

Q&A