

**Documentation Plan**

**Failsafe Network Multiplexer (FNMux)**

***Version. 0.1***

***Document ID:TE/FNMux/DP***

Approval History

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| --- | --- | --- | --- |
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| Name |  |  |  |
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| Date |  |  |  |

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| Version (x.y) | Date of Revision | Description of Change | Reason for Change |
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|  |  |  |  |

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# Preface

Fail-safe Network Multiplexer (FNMux) developed by Team Engineers (TE), is required to meet the Technical & Operational requirements of the RDSO specification “RDSO/SPN/11/2022” for transporting vital signaling information from interlocking to field using dual redundant OFC media in a fail-safe manner and driving the relays/end equipment in the field.

FNMux consists of the following functions

Exchange of vital signalling digital I/O information from interlocking to field using the dual redundant OFC

Driving the relays / end equipment in the field

For detailed explanation of each of the above functions and supporting functions refer RDSO Specification RDSO /SPN /211/2022, Effective Date: 24.11.2022 [Ref 1]

## Purpose

The purpose of this document is to define the “Documentation plan” for FNMux with the following details.

1. Life cycle phase wise Documentation Deliverables
2. Traceability of Documentation
3. ISO / QMS Related Documents

## Scope

The scope of documentation plan is to categorize the documentation needed in all phases of the development and provide them with an identification number that will be tracked, updated and configuration controlled throughout the life cycle of the project. This plan defines the base line for all documents that need to be tracked, version controlled and subject to configuration management.

FNMux System Documentation Plan shall be applicable to following Life Cycle Phases starting from Phase 1-Concept to Phase 11-Operation Maintenance and Performance Monitoring as defined in the EN 50126-1:2017 [Ref. 2]

## Acronyms and Abbreviations

|  |  |
| --- | --- |
| ABBREVIATIONS | DESCRIPTION |
| **ADAD** | Application Data Architecture and Design |
| **ADAVR** | Application Data/Algorithm Verification Report |
| **ADPP** | Application Data Preparation Plan |
| **ADRS** | Application Data Requirements Specification |
| **ADTR** | Application Data Test Report |
| **ADTS** | Application Data Test Specification |
| **APVR** | Application Preparation Verification Report |
| **CENELEC** | European Committee for Electrotechnical Standardization |
| **CM** | Commissioning Manual |
| **CMP** | Configuration Management Plan |
| **CPS** | Communication Protocol Specification |
| **CS** | Coding Standards and Guide lines |
| **CU** | Central Unit |
| **DP** | Document Plan |
| **EL** | Field Trial Records |
| **EN** | European Norm |
| **ESS** | Electronic Support System |
| **ESSR** | Electronic Support System Report |
| **FAT** | Factory Acceptance Test |
| **FMECA** | Failure Modes Effects and Criticality Analysis |
| **FNMUX** | Failsafe Network Multiplexer |
| **FRACAS** | Failure Reports and Corrective Actions |
| **FTA** | Fault Tree Analysis |
| **FTP** | Functional Test Procedure |
| **FTR-SL** | Functional Test Reports at System Level |
| **FTR-CL** | Functional Test Reports for Card Level |
| **FTS** | Fail Safety Test Specification and Report |
| **FU** | Field Unit |
| **GASC** | Generic Application Safety Test |
| **HAS** | Hardware Safety Analysis |
| **HDD** | Hardware Design Description |
| **HRS** | Hardware Requirements Specification |
| **HVR** | Hardware Validation Report |
| **HZA** | Hazard Analysis |
| **HZL** | Hazard Log |
| **IM** | Installation Manual |
| **ISO** | International Organization for Standardization |
| **MFPR** | Manufacturing Process Record |
| **MIP** | Manufacturing and Inspection Plan |
| **MM** | Maintenance Manual |
| **OSTR** | Overall Software Test Report |
| **OSTS** | Overall Software Test Specification |
| **PCCL** | Pre-Commissioning Check List |
| **PHA** | Preliminary Hazard Analysis |
| **PMP** | Project Management Plan |
| **QMS** | Quality Management System |
| **QP** | Quality Plan |
| **RAM** | Reliability Availability Maintainability |
| **RAMA** | RAM Analysis |
| **RAMP** | RAM Plan |
| **RDSO** | Research Design and Standards Organization |
| **RNDV** | Release Note and Deployment Plan |
| **RNVP** | Release Note and Validation Plan |
| **SAD** | System Architecture Description |
| **SADVR** | Software Architecture and Design Verification Report |
| **SCAD** | Source Code of Application Date |
| **SCMP** | Software Configuration Management Plan |
| **SCR** | Software Change Record |
| **SCTR** | Software Component Test Report |
| **SDM** | Software Deployment Manual |
| **SDP** | Supplies Development Plan |
| **SDR** | Software Deployment Records |
| **SDVR** | Software Deployment Verification Report |
| **SHITR** | Software/Hardware Integration Test Report |
| **SHITS** | Software/Hardware Integration Test Specification |
| **SIL** | Safety integrity level |
| **SIS** | Software Interface Specification |
| **SITR** | Software Integration Test Report |
| **SITS** | Software Integration Test Specification |
| **SIVR** | Software Integration Verification Report |
| **SMP** | Software Maintenance Plan |
| **SMR** | Software Maintenance Records |
| **SMVR** | Software Maintenance Verification Report |
| **SPI** | Serial Peripheral Interface |
| **SPN** | Specification Number |
| **SQAP** | Software Quality Assurance Plan |
| **SQAPVR** | Software Quality Assurance Plan Verification Report |
| **SRS** | System Requirement’s Specification |
| **SRSVR** | System Requirement’s verification Report |
| **SSCD** | Software Source Code and Supporting Documentation |
| **SSCVR** | Software Source Code Verification Report |
| **SSP** | System Safety Plan |
| **SSVR** | System Requirement’s Specification |
| **STS** | System Test Specification |
| **STVR** | Software Tools Validation Report |
| **SVR** | Software Validation Report |
| **TTL** | Traceability Table |
| **UM** | User Manual |
| **VAP** | Validation Plan |
| **VP** | Verification Plan |

Table 1: Acronyms and Abbreviations

## References

The following are the reference documents referred during the preparation of documentation plan for FNMux:

|  |  |  |
| --- | --- | --- |
| Reference No. | Document Title | Document Description |
|  | RDSO /SPN /211/2022,  Date Effective:24.11.2022 | Specification for Failsafe Network Multiplexer (FNmux). |
|  | EN 50126-1:2017  EN 50126-2:2017 | Railway Applications- Specifications and demonstration of Reliability, Availability, Maintainability & Safety. |
|  | 50128-2011+A1:2020 | Railway Applications-Communications, Signalling and processing systems-Software for Railway Control and Protection Systems. |
|  | EN 50129:2018 | Railway Applications-Communications, Signalling and processing systems- Safety Related Electronics Systems for Signalling. |
|  | EN50159:2010+A1:2020 | Railway Applications-Communications, Signalling and processing systems - Safety related communication in closed transmission systems. |
|  | RDSO/SPN/144/2012 | Safety and reliability requirement of electronic signalling equipment. |
|  | ISO 9001:2015 | Quality Management Systems – Requirements |

Table 2: References

## Relationship With Other Plans

### Software Configuration Management Plan for Configuration Management of Software Modules, software documentation, tools, and compilers.

### Project Management Plan for Overall project planning, organizational planning and risk management and risk mitigation.

### System Safety Plan for achieving overall Software Safety as per EN 50128:2011+A1:2020 [Ref 3], System safety as per EN 50129:2018 [Ref 4], EN 50159:2010 [Ref 5], RDSO specification RDSO /SPN /211/2022 [Ref 1], RDSO/SPN/144/2012 [Ref 6].

### RAM Plan for achieving overall systems Reliability, Availability and Maintenance requirements of FNMux as per EN 50126 [Ref 2]

### Independent Verification and Validation Plan for Verification and Validation of the system and software of FNMux as per SIL-4 requirement.

### The software quality assurance Plan, which covers the quality of Software design, development, installation, and commissioning as per internal QMS adhering to ISO: 9001:2015[Ref 7]

## System Overview

A picture containing text, screenshot, diagram, colorfulness

Description automatically generatedFail safe Network Multiplexer system consists of distributed multiplexer modules, connected in a network, constituting a network of fail-safe multiplexer modules for exchange of vital signalling information among fail-safe multiplexer modules.

The system architecture shall allow the formation of a scalable centralized unit of modules (FNmux Central Unit -CU) to concentrate I/O from the distributed field modules (FNmux Field Unit -FU). Furthermore, the network protocol and addressing technique adopted shall be such that any pair of vital modules, either in the central unit or in the field unit can be virtually connected from any point to any point. The FNMux Central unit shall also be able to communicate with Data Logger.

The main purpose of FNMux is to transfer vital signalling information from FU to CU and from CU to CU meeting SIL4

Figure 1: FNMux System Overview

# Documentation Plan

This section gives the detailed list of documents to be generated for FNMux system as per EN 50126[Ref 2] and EN 50128 [Ref 3]

## documents List as per each Life cycle phase of EN 50126 [Ref 2]

This section gives the detailed list of documents to be generated for FNMux system as per EN 50126[Ref 2]

| S. No | EN 50126 Life Cycle Phase | Document Name | Document ID |
| --- | --- | --- | --- |
|  | 01-Concept Phase | Documentation Plan | TE/FNMux/DP |
|  | 01-Concept Phase | Project Management Plan | TE/FNMux/PMP |
|  | 02-System Definition and Operational Context | Preliminary Hazard Analysis (PHA) | TE/FNMux/PHA |
|  | 02-System Definition and Operational Context | System Safety Plan | TE/FNMux/SSP |
|  | 02-System Definition and Operational Context | Quality Plan | TE/FNMux/QP |
|  | 02-System Definition and Operational Context | RAM Plan | TE/FNMux/RAMP |
|  | 03-Risk Analysis and Evaluation | Hazard Analysis | TE/FNMux/HZA |
|  | 03-Risk Analysis and Evaluation | Hazard Log | TE/FNMux/HZL |
|  | 03-Risk Analysis and Evaluation | RAM Analysis | TE/FNMux/RAMA |
|  | 04-Specification of System Requirements | System Requirements Specifications | TE/FNMux/SyRS |
|  | 04-Specification of System Requirements | System Requirements Verification Report | TE/FNMux/SyRSVR |
|  | 04-Specification of System Requirements | Verification Plan | TE/FNMux/VP |
|  | 04-Specification of System Requirements | Validation Plan | TE/FNMux/VaP |
|  | 04-Specification of System Requirements | System Test Specification | TE/FNMux/STS |
|  | 04-Specification of System Requirements | Configuration Management Plan | TE/FNMux/CMP |
|  | 05-Architecture and Apportionment of System Requirements | System Architecture Description | TE/FNMux/SAD |
|  | 05-Architecture and Apportionment of System Requirements | Hardware Requirement Specification | TE/FNMux/HwRS |
|  | 05-Architecture and Apportionment of System Requirements | Functional Test Procedure | TE/FNMux/FTP |
|  | 05-Architecture and Apportionment of System Requirements | Traceability Table | TE/FNMux/TTL |
|  | 06-Design and Implementation | Hardware Design Description | TE/FNMux/HDD |
|  | 06-Design and Implementation | Failure Modes Effects & Criticality Analysis (FMECA) | TE/FNMux/FMECA |
|  | 06-Design and Implementation | Fault Tree Analysis (FTA) | TE/FNMux/FTA |
|  | 06-Design and Implementation | Factory Acceptance Test Procedure | TE/FNMUX/FAT |
|  | 06-Design and Implementation | Hardware Safety Analysis | TE/FNMUX/HAS |
|  | 07-Manufacturing | Manufacturing Process Records | PROMSD/MFPR |
|  | 07-Manufacturing | Functional Test Reports for Card level | PROMSD/FTR-CL |
|  | 07-Manufacturing | ESS reports | PROMSD/ESSR |
|  | 07-Manufacturing | Manufacturing and inspection plan | TE/FNMUX/MIP |
|  | 07-Manufacturing | Functional Test Reports at unit/System level | PROMSD/FTR-SyL |
|  | 07-Manufacturing | Supplier Development Plan (SyS/Hw/Sw) | TE/FNMUX/SDP |
|  | 08-Integration | Installation Manual | TE/FNMUX/IM |
|  | 08- Integration | Commissioning Manual | TE/FNMUX/CM |
|  | 08- Integration | Pre Commissioning Check List | TE/FNMUX/PCCL |
|  | 09-System Validation | Generic Application Safety Case. | TE/FNMUX/GASC |
|  | 09-System Validation | Hardware Validation Report | TE/FNMUX/HwVR |
|  | 09-System Validation | Fail Safety Test Specification & Report | TE/FNMUX/FTS |
|  | 09-System Validation | Field Trial Records | PROMSD/EL |
|  | 10-System Acceptance | - | - |
|  | 11-Operation, Maintenance, and performance monitoring | User Manual | TE/FNMUX/UM |
|  | 11-Operation, Maintenance, and performance monitoring | Maintenance Manual | TE/FNMUX/MM |
|  | 11-Operation, Maintenance, and performance monitoring | Failure Reports and Corrective Actions | TE/FNMUX/FRACAS |

Table 3: List of Documents as per EN 50126

## documents List as per each Life cycle phase of EN 50128 [Ref 3]

This section gives the detailed list of documents to be generated for FNMux system as per EN 50128[Ref 3]

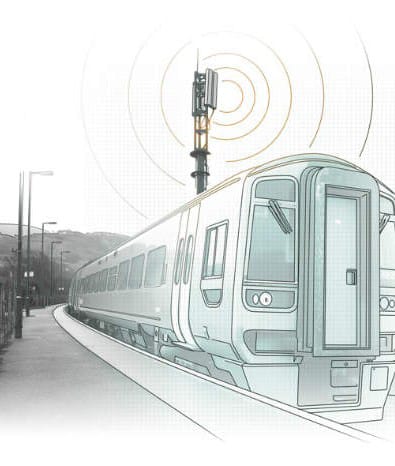
| S. No | EN 50128 Life Cycle Phase | Document Name | Document ID |
| --- | --- | --- | --- |
|  | Planning | Software Quality Assurance Plan | TE/FNMUX/SQAP |
|  | Software Quality Assurance Plan Verification Report | TE/FNMUX/SQAPVR |
|  | Software Configuration Management Plan | TE/FNMUX/SCMP |
|  | C Coding standards and Guide lines | TE/FNMUX/CS |
|  | Software requirements | Software Requirements Specification | TE/FNMUX/SwRS |
|  | Overall Software Test Specification | TE/FNMUX/OSwTS |
|  | Software Requirements Verification Report | TE/FNMUX/SwRSVR |
|  | Architecture and Design | Software Architecture & Design Specification | TE/FNMUX/SwAD |
|  | Software Interface Specification | TE/FNMUX/SwIS |
|  | Software Integration Test Specification | TE/FNMUX/SwITS |
|  | Software/Hardware Integration Test Specification | TE/FNMUX/SwHwITS |
|  | Software Architecture & Design Verification Report | TE/FNMUX/SwADVR |
|  | Communication Protocol Specification | TE/FNMUX/CPS |
|  | Component implementation and testing. | Software Source code and supporting documentation | TE/FNMUX/SwSCD |
|  | Software Component Test Report | TE/FNMUX/SwCTR |
|  | Software Source code Verification Report | TE/FNMUX/SwSCVR |
|  | Integration | Software Integration Test Report | TE/FNMUX/SwITR |
|  | Software/Hardware Integration Test Report | TE/FNMUX/SwHwITR |
|  | Software Integration Verification Report | TE/FNMUX/SwIVR |
|  | Overall Software testing/Final Validation. | Overall Software Test Report | TE/FNMUX/OSwTR |
|  | Software Validation Report | TE/FNMUX/ SwVR |
|  | Tools Validation Report | TE/FNMUX/SwTVR |
|  | Release Note | TE/FNMUX/RNDV |
|  | System configured by application data/algorithms | Application Data Requirements Specification | TE/FNMUX/ADRS |
|  | Application Data Preparation Plan | TE/FNMUX/ADPP |
|  | Application Data Test Specification | TE/FNMUX/ADTS |
|  | Application Architecture and Design | TE/FNMUX/ADAD |
|  | Application Preparation verification report | TE/FNMUX/APVR |
|  | Application Data Test Report | TE/FNMUX/ADTR |
|  | Source Code of application Data/Algorithm | TE/FNMUX/SCAD |
|  | Application Data/Algorithm Verification Report | TE/FNMUX/ADAVR |
|  | Software deployment | Software Release and Deployment Plan | TE/FNMUX/RNVP |
|  | Software Deployment Manual | TE/FNMUX/SwDM |
|  | Deployment Records | TE/FNMUX/SwDR |
|  | Deployment Verification Report. | TE/FNMUX/SwDVR |
|  | Software Maintenance | Software Maintenance Plan | TE/FNMUX/SwMP |
|  | Software Change Records | TE/FNMUX/SwCR |
|  | Software Maintenance Records | TE/FNMUX/SwMR |
|  | Software Maintenance Verification Report | TE/FNMUX/SwMVR |
|  | Software Assessment | Software Assessment Plan | N.A |
|  | Software Assessment Report | N.A |

Table 4: List of Document as per EN 50128

## Documentation Structure and Version Control

Documentation for each of the above-mentioned documents shall adhere to the CENELEC standard and shall be verified against a checklist provided in EN50126 [Ref 2], EN50128 [Ref 3] and EN50129 [Ref 4] documents.

Version control of all the documents maintained as per the procedure mentioned in Software Configuration Management Plan.

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