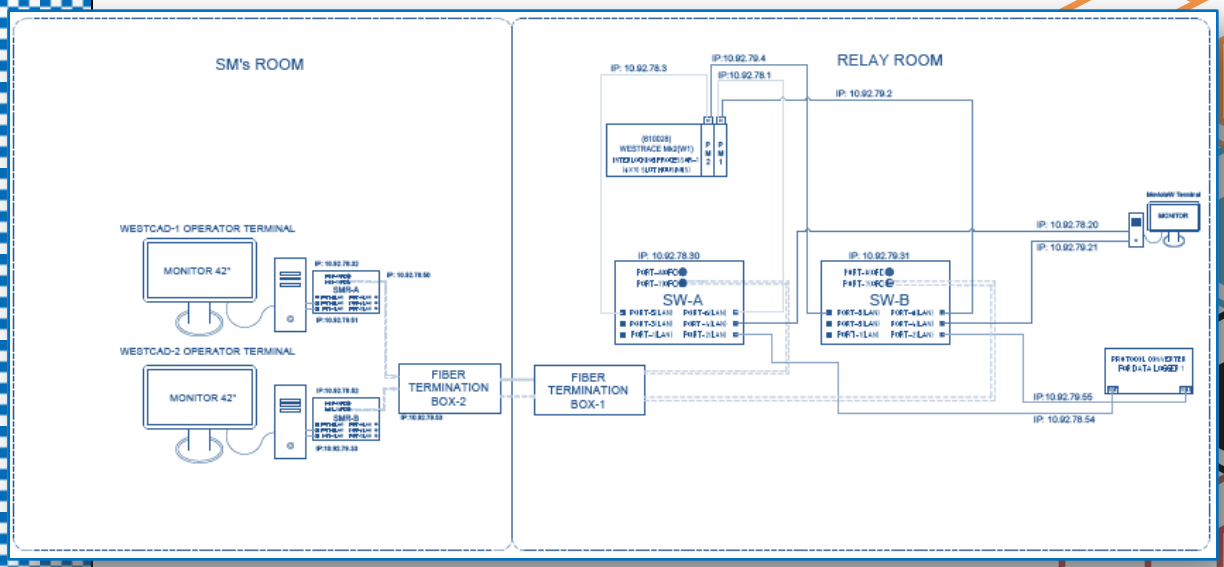
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**GOVERNMENT OF INDIA**
**MINISTRY OF RAILWAYS**

# Handbook on
# Cabling & Networking requirements in Electronic Interlocking installations




**CAMTECH/S&T/2023-24/C&N-EI/ 1.0**
**January 2024**
**End Users : Signal Engineers of Indian Railways**

An ISO 9001-2015 Certified Organisation
उच्च अनुरक्षण प्रौद्योगिकी केन्द्र
EXCELLENCE IN MAINTENANCE

**Indian Railways**
**Centre for Advanced Maintenance Technology,**
**Maharajpur, Gwalior (M.P.) 474005**

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# Cabling & Networking requirements in Electronic Interlocking installations

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# Foreword

To overcome the limitations of mechanical and relay based interlocking systems, microprocessor based electronic interlocking systems have been introduced on Indian Railways similar to that in the advanced countries of Europe and America. Over the years, population of Electronic Interlocking installations in Indian Railways has grown considerably. Installation of Electronic Interlocking system involves various stages like preparation of wiring, cabling & networking details, power supply details, earthing planning, interlocking testing etc. As cabling/wiring & networking forms the nervous system of an EI installation, specified wires and cables are required to be used for proper functioning of the system. EI systems are based on manufacturer's designs, hence the wiring and cabling standards of OEM are to be followed apart from Railway Board and RDSO guidelines.

CAMTECH has prepared this handbook to disseminate the information on cabling and networking of Electronic Interlocking installations. References from Railway Board and RDSO are provided at appropriate places. I hope that this handbook will be useful for the guidance of Signal Engineers of Indian Railways concerned with the planning and installation of Electronic Interlocking system. I wish them all the success.

**CAMTECH Gwalior**

**Jitendra Singh**
**Principal Executive Director**

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# Preface

Electronic Interlocking system is a microprocessor based system which requires different types of wires and cables for interconnection of various modules and accessories. The EI system consists of various modules and equipments such as modems, relays, Visual Display Unit (VDU), Control cum Indication Panel (CCIP), Central Processor Unit (CPU), Power supply unit (PSU), Object Controllers (OC), Vital & Non-Vital Input/Output cards, Maintenance PC, Data logger etc. which are required to be interconnected for proper communication of commands. The wiring, cabling and networking requirements depend upon the configuration of EI i.e. centralized or distributed system as well as manufacturer's design.

CAMTECH has made an effort to cover all the information on cabling and networking requirements for EI system by preparing this handbook. Apart from general guidelines in reference to Railway Board letters and RDSO Technical Advisory Notes, a separate section consisting of wiring and cabling practices of Kyosan K5BMC EI has been provided in the handbook.

We are sincerely thankful to S&T Vertical RDSO and M/s TVM Signalling & Transportation Systems Pvt. Ltd. (KYOSAN), Bangalore who have provided valuable inputs for preparing this handbook. Since technological upgradation and learning is a continuous process, you may feel the need for some addition/modification in this handbook. If so, please give your comments on email address dirsntcamtech@gmail.com or write to us at Indian Railways Centre for Advanced Maintenance Technology, In front of Adityaz Hotel, Airport Road, Near DD Nagar, Maharajpur, Gwalior (M.P.) 474005.

**CAMTECH Gwalior**

**Triambak Tiwari**
**Director (S&T)**

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# Table of Contents

Electronic Interlocking installations ..... ii
End Users : Signal Engineers of Indian Railways ..... ii
Foreword ..... iv
Preface ..... vi
Amendments & Revisions ..... x
Disclaimer & Our Objective ..... xi
Section I ..... 1
Cabling & Networking requirements in ..... 1
Electronic Interlocking installations ..... 1
1.1 Introduction ..... 1
1.2 EI System Configuration ..... 1
1.2.1 Centralized System Configuration ..... 2
1.2.2 Distributed System Configuration ..... 4
1.3 RDSO guidelines on cabling & wiring practices for EI installation ..... 5
1.3.1 Extracts from RDSO TAN No. STS/E/TAN/3006 dated 02.11.2012 ..... 5
1.3.2 Extracts from RDSO TAN No. STS/E/TAN/3012 Ver. 3.0 dated 28.06.2021 ..... 8
ANNEXURE I ..... 13
RDSO Drawings ..... 13
Section II ..... 19
Cabling & Networking requirements in K5BMC Electronic Interlocking installation ..... 19
2.1 Introduction ..... 19
2.2 Modules of the K5BMC Electronic Interlocking system ..... 19
2.3 Indoor Equipments to be connected with K5BMC EI ..... 27
2.4 Outdoor Equipments/Circuits to be connected with K5BMC EI ..... 27
2.5 Configurations of K5BMC EI System ..... 29
2.5.1 Centralized System Configuration ..... 29
2.5.2 Distributed System Configuration ..... 32
2.6 Floating Earth concept in K5BMC Electronic Interlocking System ..... 36

2.7 K5BMC Earthing Arrangement ..... 38
2.8 Guidelines for OFC connectivity between EI equipments in Distributed architecture ..... 40
2.9 Guidelines for OFC connectivity between EI equipments in Centralized architecture ..... 40
2.10 Guidelines for power supply distribution and connectivity ..... 40
2.11 Guidelines for EI Rack & Relay Rack installation ..... 43
2.12 Guidelines for provision of Laddering ..... 45
2.13 EI Sub Rack Installation ..... 46
2.14 EI Rack Cable Routing & Wiring ..... 46
2.15 Relay Rack Cable Routing & Wiring ..... 51
2.16 Networking of MTCs in K5BMC EI ..... 53
ANNEXURE II ..... 56
Details of Cables/Wires & accessories used in K5BMC EI Rack Wiring ..... 56
References ..... 59
CAMTECH Publications ..... 60

# Amendments & Revisions

The amendments/revisions to be issued in future for this report will be numbered as follows:

CAMTECH/S&T/2023-24/C&N-EI/1.0 # XX date .....

Where "XX" is the serial number of the concerned amendment/revision (starting from 01 onwards).

| Sr. No. | Date of issue | Amendment/Revision | Remarks |
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**All Technical information and guidelines are latest at the time of publishing and are subjected to change due to technology updates and requirements**

# Disclaimer & Our Objective

## Disclaimer

*It is clarified that the information given in this handbook does not supersede any existing provisions laid down in the Signal Engineering Manual, Railway Board and RDSO publications. This document is not statuary and instructions given are for the purpose of guidance only. If at any point contradiction is observed, then Signal Engineering Manual, Telecom Engineering Manual, Railway Board/RDSO guidelines may be referred or prevalent Zonal Railways instructions may be followed.*

## Our Objective

*To upgrade Maintenance Technologies and Methodologies and achieve improvement in Productivity and Performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability and Utilisation.*

*If you have any suggestion & any specific comments, please write to us:*

**Contact person : Director (Signal & Telecommunication)**
**Postal Address : Centre for Advanced Maintenance Technology, Opposite Hotel Adityaz, Near DD Nagar, Maharajpur, Gwalior (M.P.) Pin Code – 474 005**

**Phone : 0751 - 2470185**
**Fax : 0751 – 2470841**
**Email :** dirsntcamtech@gmail.com

# List of Figures

*Figure 1 : Block Diagram of Centralized System Configuration of EI* ..... 3
*Figure 2 : Block Diagram of Distributed System Configuration of EI* ..... 4
*Figure 3 : Typical Bonding &Earthing connections drawing no.SDO/RDSO/E&B/002 of RDSO Specification no. RDSO/SPN/197* ..... 14
*Figure 4 : Generic Bonding & Earthing scheme for MLK II Electronic Interlocking as per Rly. Bd. L. No. 2010/SIG/SGF/EI (Ansaldo) dated 22.06.2011* ..... 15
*Figure 5 : Generic Power Distribution Scheme (110 V DC Supply) for Electronic Interlocking System* ..... 16
*Figure 6 : Configuration of Electronic Interlocking in Distributed Installation* ..... 17
*Figure 7 : Card mounting arrangement in front side of LK7- C Logic Sub Rack* ..... 21
*Figure 8 : LK7- C Logic Sub Rack front view* ..... 21
*Figure 9 : Cards mounting arrangement in rear side of LK7- C Logic Sub Rack* ..... 22
*Figure 10 : LK7- C Logic Sub Rack rear view* ..... 22
*Figure 11 : Block diagram for interconnections between motherboard and various cards in LK7- C Logic Sub Rack* ..... 23
*Figure 12 : Cards mounting arrangement in front side of EP5 Sub Rack* ..... 23
*Figure 13 : EP5 Sub Rack front view* ..... 24
*Figure 14 : EP5 Sub Rack rear view* ..... 24
*Figure 15 : Mounting view of cards (Front) in case of MMIF2 full mounting* ..... 25
*Figure 16 : Front view of Journal Module* ..... 26
*Figure 17 : System Configuration of Journal Module* ..... 26
*Figure 18 : Block diagram showing connections of indoor equipments to K5BMC EI* ..... 27
*Figure 19 : Block diagram showing connections of outdoor equipments to K5BMC EI* ..... 28
*Figure 20 : K5BMC EI Centralized System Configuration* ..... 31
*Figure 21 : K5BMC EI Distributed System Configuration* ..... 35
*Figure 22 : Arrangement of floating earth in K5BMC EI* ..... 37
*Figure 23 : Connection of Earth wire to Earth Bus Bar* ..... 38
*Figure 24 : Perimeter Earthing for K5BMC EI* ..... 39
*Figure 25 : A view of K5BMC EI Rack & Data logger installation* ..... 44
*Figure 26 : A view of K5BMC Relay Rack installation* ..... 44
*Figure 27 : Laddering arrangement in K5BMC EI* ..... 45
*Figure 28 : Provision of POM in Main EI Rack* ..... 46
*Figure 29 : Cable routing in EI Rack* ..... 47
*Figure 30 : Cable Routing EI Rack - Front view* ..... 48
*Figure 31 : Cable Routing EI Rack - Rear view* ..... 49
*Figure 32 : LKC7 Sub Rack Power wiring separation* ..... 50
*Figure 33 : EP5 Sub Rack Power Wiring separation* ..... 50
*Figure 34 : Relay Rack Cable routing* ..... 51
*Figure 35 : Termination of wires in Relay Rack* ..... 52
*Figure 36 : Relay Rack without relays* ..... 53

*Figure 37 : Diagram showing connectivity of MTCs among various stations and headquarters* ..... 54
*Figure 38 : MTC connectivity through optical to ethernet converter using OFC cable.* ..... 54

# Section I
# Cabling & Networking requirements in Electronic Interlocking installations

## 1.1 Introduction

An Electronic Interlocking installation consists of various hardware modules and peripherals such as Central Processor, Relay Racks, Operator Panel or VDU, Object Controllers, Data logger, Maintenance Terminal etc. All such modules are to be interconnected to maintain communication among them for operation of field gears as per the interlocking logic. These require various types of indoor cables and wires as per their compatibility with different equipments. Field gears are also required to be connected with EI through various types of outdoor cables. The above information is required during the planning stage of EI installation as per the yard layout and EI system configuration. Before going to the details of cabling and networking requirements we shall first understand the types of EI System Configurations.

## 1.2 EI System Configuration

There are two types of system configurations used in Electronic Interlocking installations depending upon the yard layout and number of routes:

- Centralized
- Distributed

In reference to Railway Board's letter no. 2003/SIG/G/5 dated 28.04.2016 following policy directives were issued on type of interlocking to be adopted at stations provided with centralized operation of points and signals:

| Sr. No. | Type of station | Average no. of Routes | Type of interlocking to be provided |
|---|---|---|---|
| 1 | (a). "C" class Station<br>(b). Mid-section Interlocked LC gates<br>(c). IBS/IBH<br>(d). Stations on Double Line section without loop and with one emergency X-over and/or siding<br>(e). Stations on single line Sections with one loop<br>(f). Automatic Block Signalling | Up to 10 | Electronic Interlocking |

**Table of Contents >**

| Sr. No. | Type of station | Average no. of Routes | Type of interlocking to be provided |
|---|---|---|---|
| | with/without Mid-Section Interlocked LC gate | | |
| 2 | Way-Station & Small Junction Stations | 10 to 50 routes | Electronic Interlocking linked to Signal Control centre if required |
| 3 | Big stations and Major Junction stations | 50 to 500 routes | Electronic Interlocking with Distributed Architecture and/or Object Controllers |
| 4 | Very large stations/Junction Stations | More than 500 routes | Route Relay Interlocking with metal to metal type relays<br>OR<br>Electronic Interlocking with Distributed Architecture and Object Controllers |

**Revisions:**

As per Railway Board's letter no.2020/SIG/18/EI/GEN dated 25.11.2021, it has been decided that Relay based Interlocking system may be provided with approval of PCSTE for all items at serial no. 1.

For item at Sr. no. 3 above, as per Railway Board's letter no.2021/SIG/25-Conf/5/SSC dated 26.02.2021 in reference to Special Signal Standards Committee (SSC) meeting for Electronic Interlocking held on 20.02.2021, "Centralized EI should be provided upto 100 routes; however PCSTEs may take a final decision of distributed architecture based on maintainability and complexity of yard."

The details of Centralized and Distributed System Configurations are given in following paragraphs.

### 1.2.1 Centralized System Configuration

- This is the conventional system configuration in signalling systems design & installation.
- In centralized system configuration, both the Centralized Interlocking Unit (CIU) & Electronic terminals are installed in a same room.
- Field gears are connected to Electronic terminal via relays installed inside the relay room. Copper cables are used to carry the information from Electronic terminal to field gears through relays, cable terminations. Hence

- Bigger cabin size required to accommodate signalling and power equipment placement to control complete yard.
- Copper cable requirement is more to run main and tail cables.

- Due to fixed central cabin location, repeater relays are needed to be provided where the distance between cabin and gear location is more.

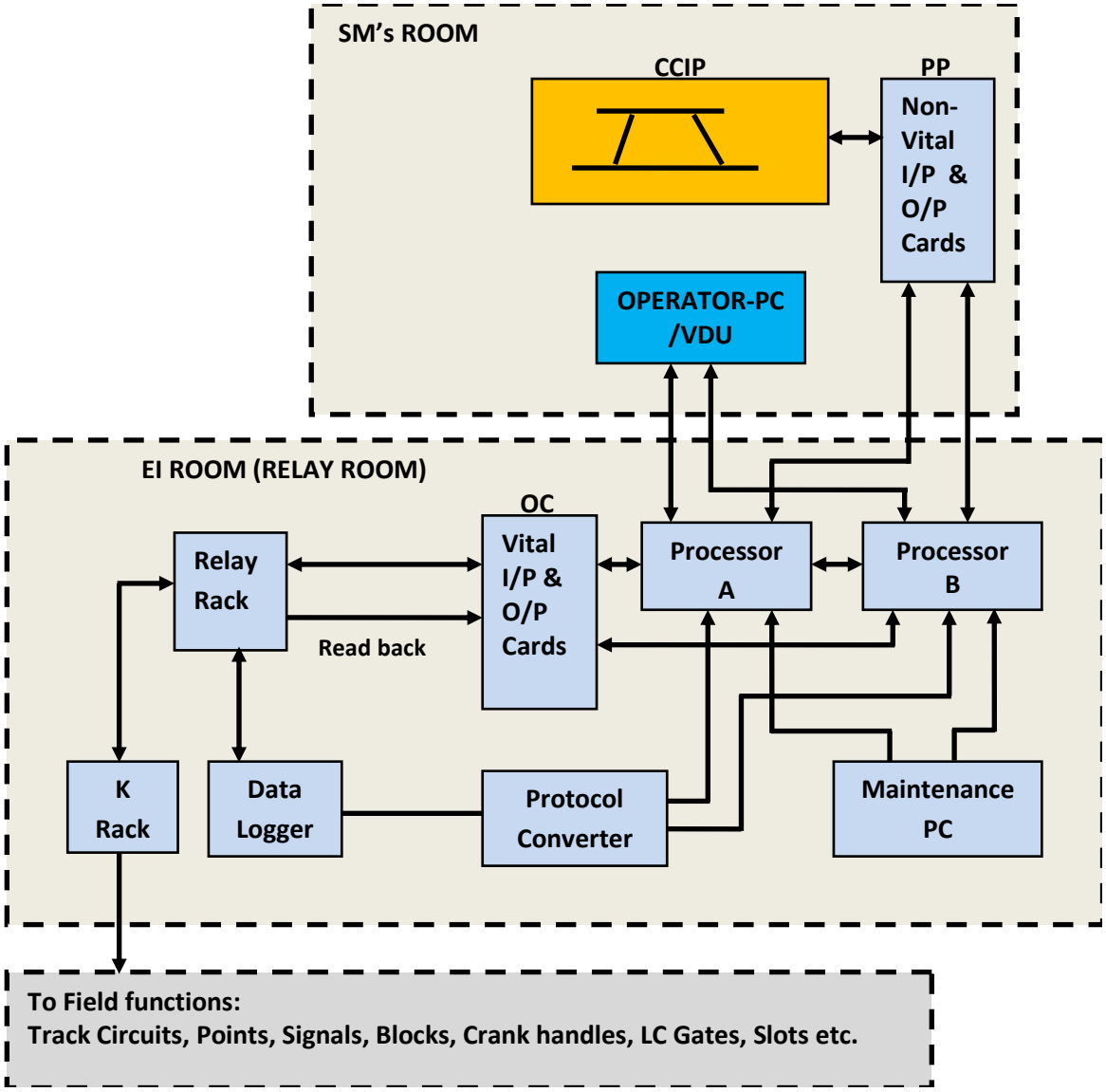



***Figure 1 : Block Diagram of Centralized System Configuration of EI***

**Table of Contents >**

### 1.2.2 Distributed System Configuration

- In distributed configuration, station yard will be segregated into multiple zones, corresponding zones signalling gears will be controlled by multiple Electronic terminals placed in respective cabins/relay rooms.
- In distributed system configuration, Centralized Interlocking Unit and Electronic terminals pertaining to central zone are installed in central relay room/central cabin.
- Electronic terminals corresponding to other zones will be installed in respective end cabin relay room (For example East, South cabin).

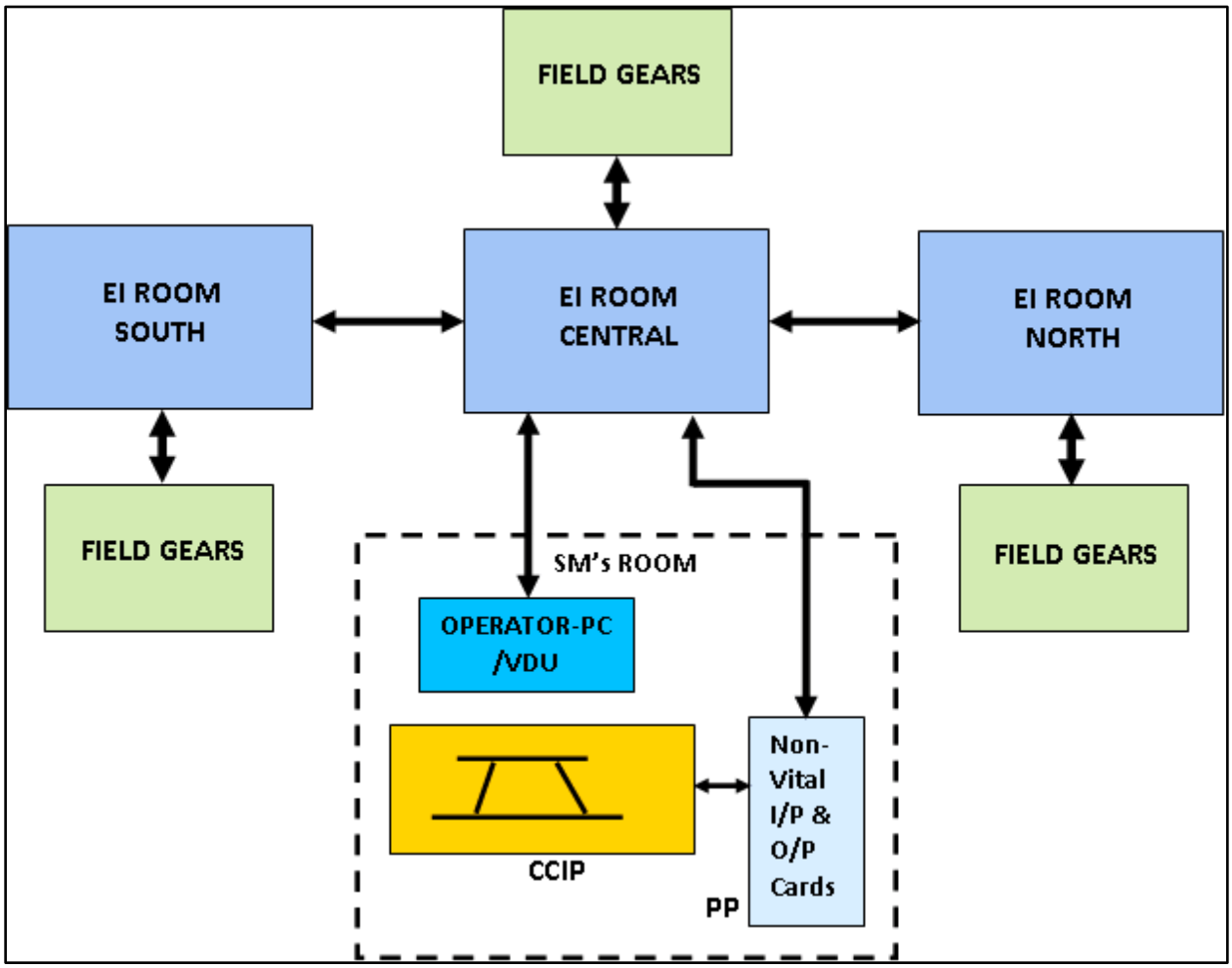



***Figure 2 : Block Diagram of Distributed System Configuration of EI***

- Single mode optical communication is used to exchange information between Electronic Terminal and Centralized Interlocking Unit.

- Field gears are connected to the Electronic terminal via relays installed inside the respective relay rooms/cabins.
- The usage of copper cable is reduced between Central Building & Cabin. Also, central cabin size can be reduced due to sharing of signalling yard into multiple cabins. But copper cables of main & tail cables are used between relay room/cabins to field gears through relays, cable terminations.
- Additional number of relay room building and its land acquisition requirement
- Power systems (IPS) and backup arrangement shall be provided in multiple cabins etc.
- Due to fixed cabin locations, repeater relays are needed to be provided where the distance between cabin and gear location is more.

## 1.3 RDSO guidelines on cabling & wiring practices for EI installation

RDSO has issued guidelines on installation practices of Electronic Interlocking based on the feedback received and experience gained from various zonal railways. These are in the form of Technical Advisory Notes (TANs) issued from time to time. These instructions shall apply to cabling and wiring including earthing & surge protection in Electronic Interlocking installation and should be followed for further improving the reliability of EI installation. The relevant parts of these TANs are reproduced below for guidance:

### 1.3.1 Extracts from RDSO TAN No. STS/E/TAN/3006 dated 02.11.2012

A generic drawing of for implementation of Earthing & Bonding scheme for electronic Interlocking (Ansaldo make MLK II – now Hitachi) was prepared which is available in Annexure I. (Ref.: Railway Board Letter no. 2010/SIG/SGF/EI (Ansaldo) dated 22.06.2011 & RDSO letter No. STS/L/SSI/CA/US&S dated 26.07.2011).

Equipotential bonding of all the equipments is an essential requirement for effective lightning and surge protection. As such, RDSO/SPN/197# incorporates detailed guidelines for provision of Equipotential Busbar and bonding of signalling equipments and SPDs.

The earth connections to the perimetric ring earthing for all the items shall be made using the shortest possible path.

The Bonding Ring Perimetric (BRC) can be terminated on the walls without crossing the doors and windows. However, all the equipments shall be connected to BRC using the shortest possible path.

All earth bonds, cables, wires etc. must be as short and straight as possible to maintain low inductance. This is essential for surge protection devices to work properly.

Ideally, there should only ever be one point of entry from external environment into equipment room for all cables, e.g. power, signalling, telecommunication.

All earth bonds, cables and wires are classifies as “dirty” and must not run through cable trays carrying “clean” signalling and “clean” power circuits.

Conductors entering the building could be carrying lighting currents or voltage transient and are considered to be “dirty”. Internal conductors after the earth bonding point, and surge protection where appropriate, are considered “clean”. All other circuits should be classified as “clean” and “dirty” and segregated accordingly.

The wires of all circuits including power circuits should be twisted or at very least bundled ensuring that for every “B” there is the complimentary “N” in the twist or bundle and for every “BX” there is the complimentary “NX” in the twist or bundle. All wiring twisted wherever possible so opposite poles are always in close proximity.

**#Guidelines for connection of Equipotential Earth Bus Bar as per para 8.5 of RDSO Specification no. RDSO/SPN/197:**

**Equi-potential Earth Busbar and its connection to equipments & Surge protection devices in the Equipment room:** Refer Annexure I, ***Figure 3*** - Typical bonding connections drawing no.SDO/RDSO/E&B/002.

**Equi-potential earth busbars**

a. There shall be one equi-potential earth busbar for each of the equipment room i.e. IPS/Battery charger room and EI/Relay room. The equi-potential earth busbars located in individual rooms shall be termed as Sub equi-potential busbars (SEEB). The equi-potential earth busbar located in the IPS /Battery charger room and directly connected to Class ‘B’ SPDs and the main earth pit shall be termed as Main equi-potential earth busbar (MEEB).

b. The EEBs shall have pre-drilled holes of suitable size for termination of bonding conductors. The EEBs shall be insulated from the building walls. Each EEB shall be installed on the wall with low voltage insulator spacers of height 60mm. The insulators used shall have suitable insulating and fire resistant properties for this application. The EEBs shall be installed at the

height of 0.5m from the room floor surface for ease of installation & maintenance. All terminations on the EEBs shall be by using tinned copper lugs with spring washers.

**Bonding Connections**

To minimize the effect of circulating earth loops and to provide equi-potential bonding, "star type" bonding connection is required. As such, each of the SEEBs installed in the rooms shall be directly connected to MEEB using bonding conductors. Also, equipment/racks in the room shall be directly connected to its SEEB. The bonding conductors shall be bonded to their respective lugs by exothermic welding.

All connections i.e routing of bonding conductors from equipments to SEEB & from SEEBs to MEEB shall be as short and as direct as possible with min. bends and separated from other wiring. However, connection from SPD to MEEB shall be as short as possible and preferably without any bend.

Materials and dimensions of bonding components for connection of individual equipments with equipotential bus bar and earth electrode shall be as given below:

| **Component/Bonding** | **Material** | **Size** |
|---|---|---|
| Main equi-potential earth busbar (MEEB) | Copper | 300X25X6 mm (min.) |
| Sub equi-potential earth busbar (SEEB) | Copper | 150X25X6 mm (min.) |
| Individual equipments to SEEB using tinned copper lugs with stainless steel nut and bolts | Multi-strand single core PVC insulated copper cable as per IS:694 | 10 Sq.mm. |
| SEEB to MEEB using tinned copper lugs with stainless steel nut and bolts. | Multi-strand single core PVC insulated copper cable as per IS:694 | 16 Sq.mm. |
| Surge protection devices (SPDs) to MEEB using tinned copper lugs with stainless steel nut and bolts. | Multi-strand single core PVC insulated copper cable as per IS:694 | 16 Sq.mm. |
| MEEB to main earth electrode | Multi-strand single core PVC insulated copper cable as per IS:694 (Duplicated) | 35 Sq.mm. |
| Main earth pit to other earth pit in case of loop earth. | Copper tape<br>OR solid copper round conductor | 25X2 mm. or 8 mm. dia. |

## 1.3.2 Extracts from RDSO TAN No. STS/E/TAN/3012 Ver. 3.0 dated 28.06.2021

**(i) Power Supply arrangement:**

(a) The 110 volt DC supply from IPS room to EI rack shall be provided with duplicated cable with suitable gauge so as to ensure that voltage drop in cable shall not be more that 1.0 volt from integrated power supply (IPS).

***Reason:***
*Duplicated cable is provided from IPS to EI to have redundancy of power supply connection to equipment and to prevent failure due to rat cut or any other damage.*
*Cable voltage drop is restricted to 1 volt to avoid overloading of cable & also ensure correct AWG, quality wires.*

(b) The DC-DC converters provided for Electronic Interlocking system shall be segregated for 'A' & 'B' systems along with segregation of cabling and termination for power supply up to DC-DC converters, for all the converters & shall be in N+1 configuration. It is advised that reliable DC-DC converters as advised by OEMs shall be considered for better reliability. (Tentative Power Supply Sketches are placed in Annexure I, ***Figure 5*** & ***Figure 6***– RDSO Drawings)

***Reason:***
*This is provided for the better supply arrangement with redundancy for main/standby EI system to get high availability and reliability so that in case of failure of one set of DC-DC converter whole EI equipment will not shut down.*

(c) The DC-DC converter shall be installed near to EI rack or in the EI rack itself to avoid the line drop. The line drop shall not be more than 0.5volt.

***Reason****:*
*To avoid high drop in line voltage, so that full operating voltage is available to the system.*

(d) The location of DC-DC converter shall be made in such a way that the 110V DC power supplies wires do not run and cut across other cables in the Electronic Interlocking room and this cable shall be treated as dirty cable and segregated from other clean wiring.

***Reason****:*
*To avoid induced surges from the incoming power supply of 110 VDC, in other indoor wiring, cables of 110 VDC shall be taken in completely segregated way in the Electronic Equipment Room.*

(e) Power supply for VDU PC/Panel processor module installed in the SM room shall be provided from 110V DC (from EI or IPS room) with duplicated cable arrangement. This shall have separate suitable DC-DC converter in N+1 configuration.

***Reason****: It is seen normally that 12V/24V power supply is directly taken from IPS room to Station Master's room which are normally more than 25 meters away. This lead to lot of voltage drop in cables as well as in heating of the cable. The N+1 configuration of DC-DC converters provide extra redundancy to panel processor.*

(f) 24 V or 110 V DC supply for fan shall be fed with separate external (from IPS) supply, which should be completely isolated from Electronic interlocking supply and same shall be provided with fuse.

***Reason****:*
*This is to avoid effect of inductive loading of DC-DC supply of main EI equipment which normally results in resetting of the system and also avoids failure of DC-DC converters in case the fan become short-circuit.*

(g) 230V AC supply for VDU Monitor shall be provided through separate inverter (Input voltage 24V DC nominal from IPS and output 230V AC, pure sine wave along with SPD) shall be provided at SM room with redundant arrangement. Inverter's 230V AC input cable shall be unplugged.

***Reason****:.*
*This is to avoid effect of lightning on 230V AC supply which is taken from IPS or EI room and eliminates the requirement of power cable for 230V AC supply between IPS room to SM room.*

**(ii) Communication arrangement:**

(a) The panel processor shall be preferably housed inside the control cum indication panel (CCIP) and shall be connected with EI on OFC cable in redundant manner in separate duct pipe to avoid failure due to cutting of optical fibre cable.

***Reason****:*
*By accommodating Panel Processor inside the CCIP, space in the station master room can be saved and it also avoid the placing S2 rack for PPM.*

*Communication connection shall be made with OFC to avoid failure due to lightening & increase reliability of system.*

(b) It is advised that the EI to VDU, CPU to CPU (in case of distributed system), EI to Object Controller (in case of distributed system) & EI to Panel Processor Module connectivity shall be planned with OFC cable to avoid damage due to surge and lightening. The optical modem shall be of industrial grade with operating temperature range of 0 to 70˚C.

(c) The communication line between the CPU's, CPU to PPM, CPU to OC and VDU shall be provided in the ring system (Redundant manner) to avoid failure due to loss of communication. The OFC and other network shall be provided with NMS (network Management System).

***Reason****:*
*To avoid the failure of system due to loss of communication due to single cut, maintain high reliability & availability of system.*

**(iii) Earthing arrangement: (For all EI's except Kyosan make K5BMC EI)**

It is advised that the Earthing drawing circulated vide RDSO's TAN STS/E/TAN/3006 dated 02.11.2012 shall be followed for protection from lightning (Refer Annexure I- ***Figure 4***). The following shall also be ensured by authorized Railway Officials before commissioning:

(a). Class A protection shall be ensured on top of the building.

(b). Copper tape (Bonding ring conductor) as per drawing mounted on insulated stand-off is provided to cover the maximum area in the Relay room, Power room & Equipment room and the connection to equipment shall be made at the nearest point.

(c). As far as possible, Railways shall make attempt to provide earthing in such a way that it can cover most part of the building. This is to ensure that earth resistance shall be less than 1ohm at the equipment.

(d). The buried earth conductor shown as copper can be of GI type to avoid theft.

(e). The interlinking of all Relay racks, as well as EI racks shall be ensured.

(f). All the cable trough and ladder shall be earthed properly.

(g). Provision of the relevant Surge Protection Device (SPD) for the power supplies used for Electronic Interlocking systems shall be ensured. During many cases, it was noticed that the proper earth connections in the SPDs was missing which renders SPD as functionless, hence, the same shall also be ensured.

(h). It shall be ensured that front and back doors of all cabinets using copper braid with shortest path to earth bus bar in equipment room.

***Reason**:*
*A good earthing arrangement provides better protection of electronic system against lightening and surges. The above drawing has been made considering for provision of good earthing system for Electronic Interlocking.*

**(iv) Wiring Practice:**

(a) The input, output, data and power supply cable shall be routed indifferent cable troughs separated with a gap of minimum 6 to 8 inches.

***Reason**:*
*This is one of the most important items to be taken care of in EI installations. The EI output cables as well as power supply and other dirty cables generated lot of electromagnetic interferences, which if passed to input cable of EI results in repeated resetting and failure of EI system.*

(b) The input and output cables (RDSO approved) of EI shall be twisted to minimize EMI & EMC effect.

(c) The fuse terminals are to be fixed with proper fuse rating marking, fuse number and should be of indicative type.

(d) The lightning and surge protection devices shall be installed as per concerned Electronic Interlocking installation document.

(e) It is observed at many installations that wire ends are not properly crimped with correct size of lugs & loose connections are found at the terminals end. It is to be ensured and verified thoroughly at site minimum by Assistant officers' level.

(f) Separation of 110V DC and other external power supply from the internal 12V/24V/50V DC power supply in the relay room by placing them in separate trough/ladder.

***Reason**:*
*The 110V DC/external power supply wires run in outdoor field also and thus are highly susceptible for induction of surges, and if 12V/24V/50V DC input power supply has been placed in the same trough, this will have transmission of surges from external supply wires to the input power supplies resulting in damage to the equipments.*

(g) Voltage monitoring cables to the data logger shall also be placed in a different trough which does not have any internal power supplies.

***Reason:***
*It must be understood that external power supplies particularly 220V AC monitoring wires are highly susceptible to the lightning surges as this is a completely non-protected circuit, hence, all voltage monitoring circuits of data logger shall be considered as dirty and should not be placed with internal power supply or other cables of Electronic Interlocking.*

**Table of Contents >**

# ANNEXURE I

# RDSO Drawings

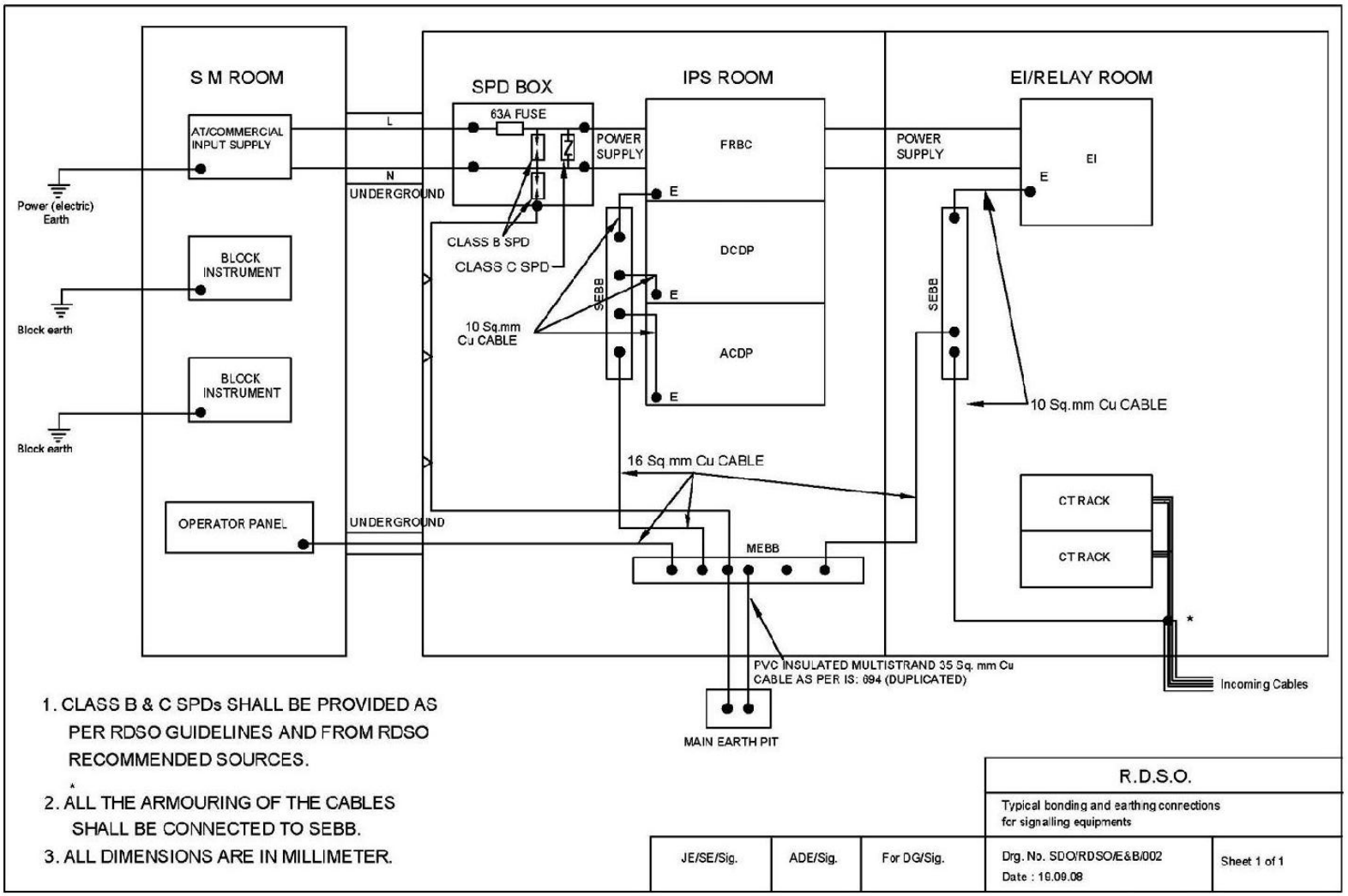



***Figure 3 : Typical Bonding & Earthing connections drawing no.SDO/RDSO/E&B/002 of RDSO Specification no. RDSO/SPN/197***

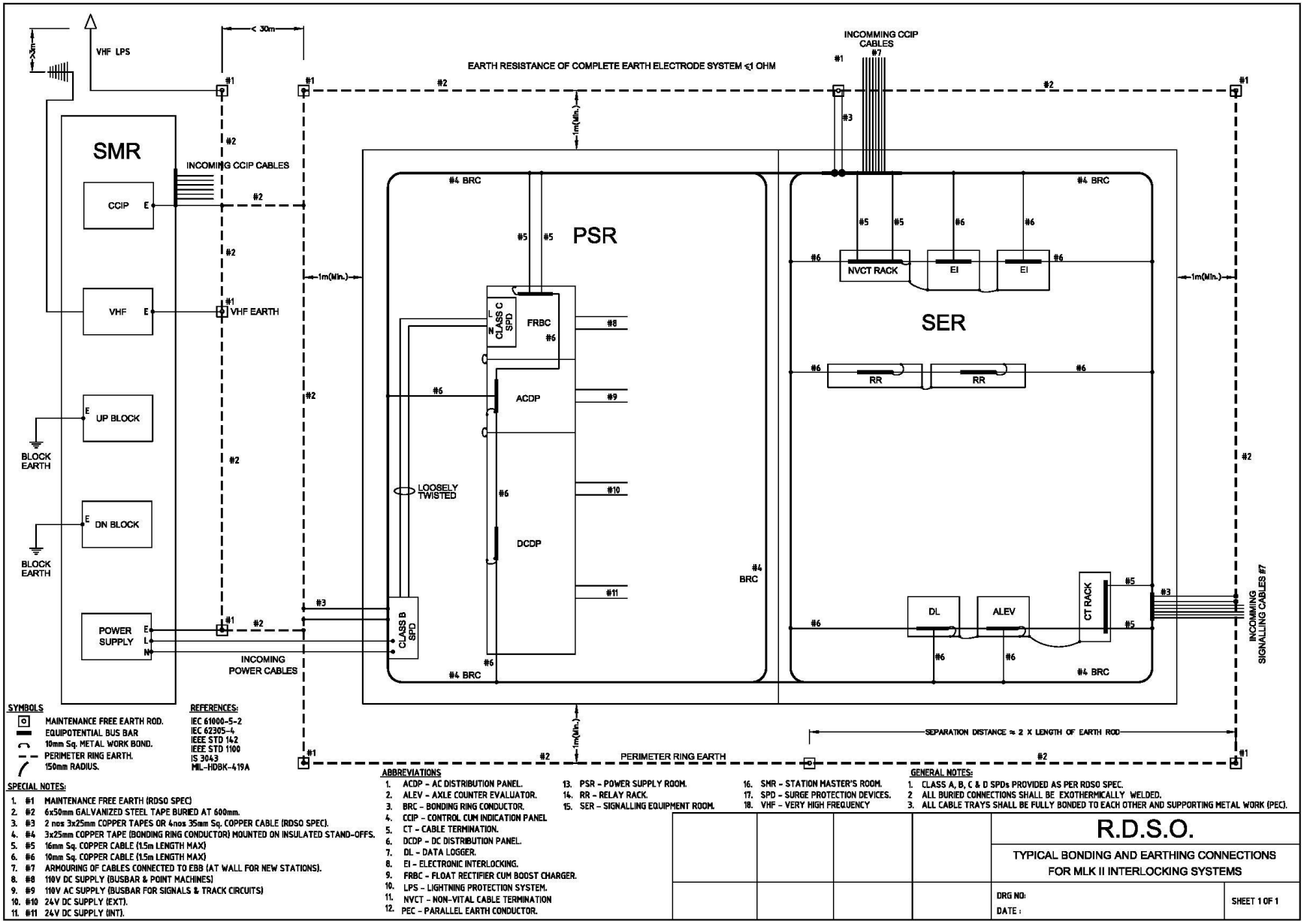



***Figure 4 : Generic Bonding & Earthing scheme for MLK II Electronic Interlocking as per Rly. Bd. L. No. 2010/SIG/SGF/EI (Ansaldo) dated 22.06.2011 & RDSO /STS/E/TAN /3006 dated 02.11.2012***

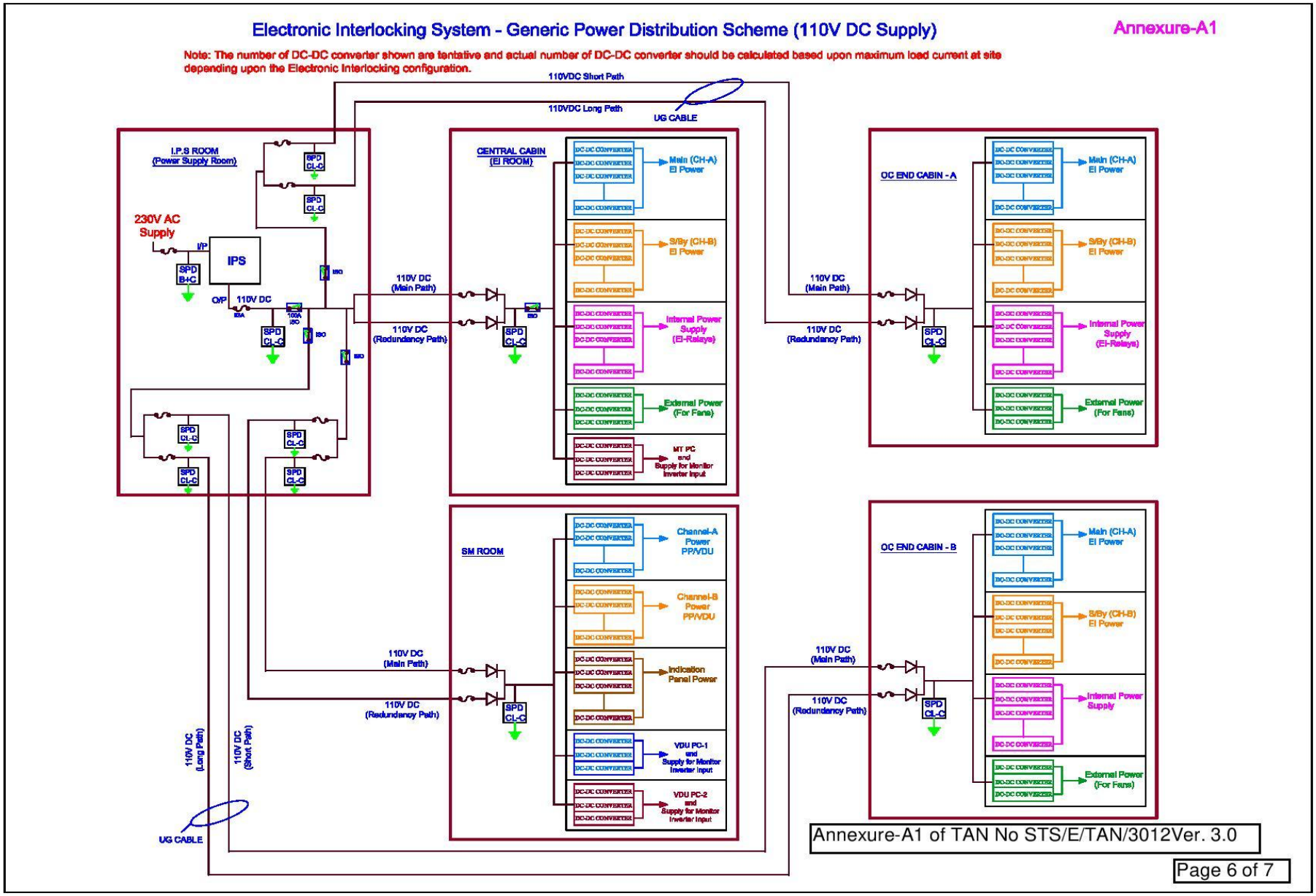



***Figure 5 : Generic Power Distribution Scheme (110 V DC Supply) for Electronic Interlocking System***

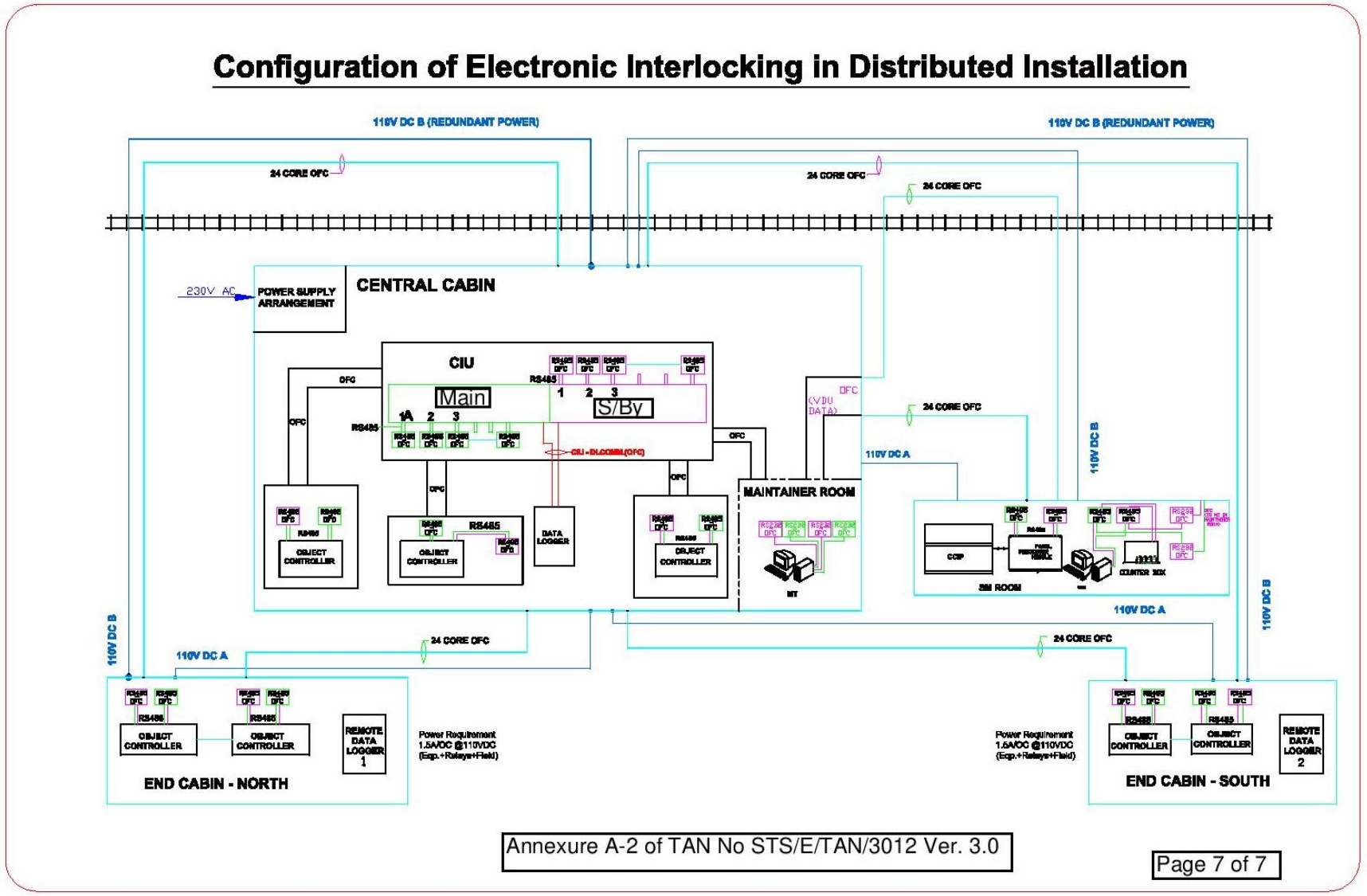



*Figure 6 : Configuration of Electronic Interlocking in Distributed Installation*

**Table of Contents >**

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# Section II
# Cabling & Networking requirements in K5BMC Electronic Interlocking installation

## 2.1 Introduction

The following topics are covered in this section:

- K5BMC EI Hardware Overview
- K5BMC Centralized and Distributed Architecture.
- Equipments to be interconnected in indoor with K5BMC EI
- Equipments to be interconnected in outdoor with K5BMC EI.
- Cabling & Networking Requirements in Centralized Architecture
- Cabling & Networking Requirements in Distributed Architecture
- Networking of MTC in K5BMC EI.
- Guidelines to be followed in designing a Cabling and Networking plan for K5BMC EI
- Types of Cables used in networking among various devices such as VDU, Data logger, Maintenance PC, Protocol converter, EI Processor etc.

## 2.2 Modules of the K5BMC Electronic Interlocking system

Before assessing the requirements of cabling and networking, let us first go through the brief overview of K5BMC Electronic Interlocking system.The K5BMC Electronic Interlocking system consists of following modules:

**(1) Domino based Control cum Indication Panel (CCIP)/Operator Panel Console (OPC)**

CCIP or OPC is the Man-machine interface of EI Equipment. It is a normal operating panel consisting of dominos as used in PI/RRI.

**(2) Maintenance Terminal Console (MTC)**

MTC contains CPU with INIO Card, Monitor and Printer. MTC is used for on line real time fault finding of EI system. MTC is also used for EI to Data Logger connectivity and real time clock synchronization.

**(3) Operator Panel Console (OPC)/Visual Display Unit (VDU)**

OPC or VDU contains CPU with INIO Card, Monitor and Printer. It is used for online real time operation of panel and is alternate to Domino panel.

**Note:**

An Electronic Interlocking installation may consist of Domino type Control Panel or OPC with VDU Monitor or both as per the policy of Zonal Railways.

However as per RDSO's Report on Standardization of Typical Circuits for EI (Report No. SS/155/2019/2022) Ver.2.0 dated 29.03.2022, all future EI installations shall be provided with dual VDU and therefore no provision in standardized logic has been kept for CCIP working.

**(4) Interlocking Logic Module consisting of LK7- C Logic Sub Rack**

The Logic sub-rack is an enclosure arrangement which contains a mother board. The various cards of the module are accommodated in both front and rear side of the motherboard. The Motherboard is designed in such a way that both front and back side cards can be accommodated. The mother board is used to accommodate various kinds of PCB and it allows communication with one another through VME (Versa Modular Euro card) Bus.

The Logic sub-rack has following cards:

(i) F486-4I Fail-safe CPU Card (Executes interlocking functions)

(ii) FSIO Interface for Electronic Terminal Transmission and Fail-safe Driver Card (Abnormality relay, system control, maintenance personal computer I/F)

(iii) FSIO-EX Interface Card for Electronic Terminal Transmission

(iv) IPU6C Logic power Supply Card (Input DC 24V, output DC 5V and DC 24V)

(v) FIO7-[P] E/O Converter for Electronic Terminal Transmission and Maintenance Terminal Transmission E/O Connector Card (ET-NET:31.2 Kbps, MTC: for serial transmission)

(vi) EXTFIO7P Electronic Terminal Transmission E/O Converter Card (ET-NET 31.2Kbps)

(vii) DID Station ID Input and Intersystem I/F Card

**Other additional cards**

(i) IC Card

IC card is a compact flash disk. It is a memory to store the data that achieves interlocking functions (Executive Software & Application software).

(ii) VHSC Card

**Table of Contents >**

It is used for communication between one logic processor to another logic processor. If the yard have more than 200 routes, then two logic subracks are required. Two VHSC cards are provided for redundancy. Every sub rack has two VHSC cards and HSC_SUB cards.

(iii) HSC-SUB Card

It is used for electrical to optical (E/O) communication between logic sub racks. It will work with VHSC as combined card.

**Arrangement of cards in LK7- C Logic Sub Rack**

System 1 System 2

| 1 2 | 3 4 | 5 | 6 | 7 | 8 | 9 | 10 | | 11 12 | 13 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IPU6C | F486-4I | FSIO | FSIO-EX | VHSC | VHSC | Vacancy | Vacancy | | IPU6C | F486-4I | FSIO | FSIO-EX | VHSC | VHSC | Vacancy | Vacancy |

***Figure 7 : Card mounting arrangement in front side of LK7- C Logic Sub Rack***

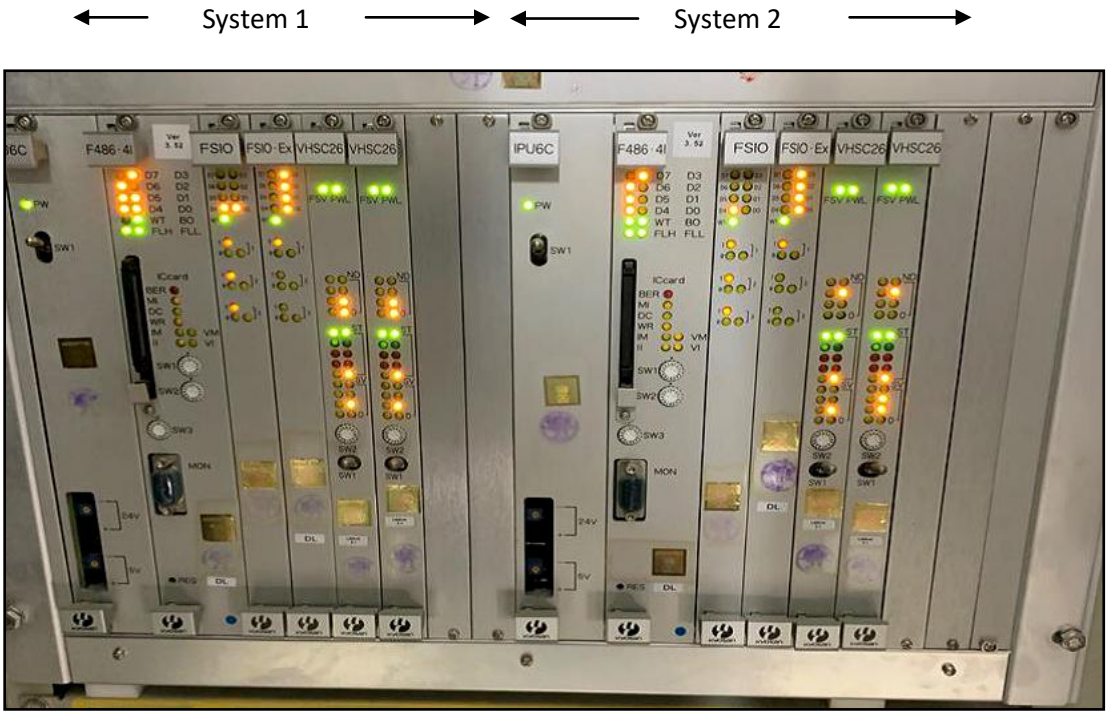



***Figure 8 : LK7- C Logic Sub Rack front view***

System 2 ← → System 1

| 17 | 16 | 15 | 14 | 13 | 11 12 | 10 | 9 | | 9 | 8 | 7 | 6 | 5 | 3 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vacancy | Vacancy | HSC SUB | HSC SUB | EXTFIO7P | FSIO – 7 [P] | DID | | | Vacancy | Vacancy | HSC SUB | HSC SUB | EXTFIO7P | FSIO – 7 [P] | DID | |

***Figure 9 : Cards mounting arrangement in rear side of LK7- C Logic Sub Rack***

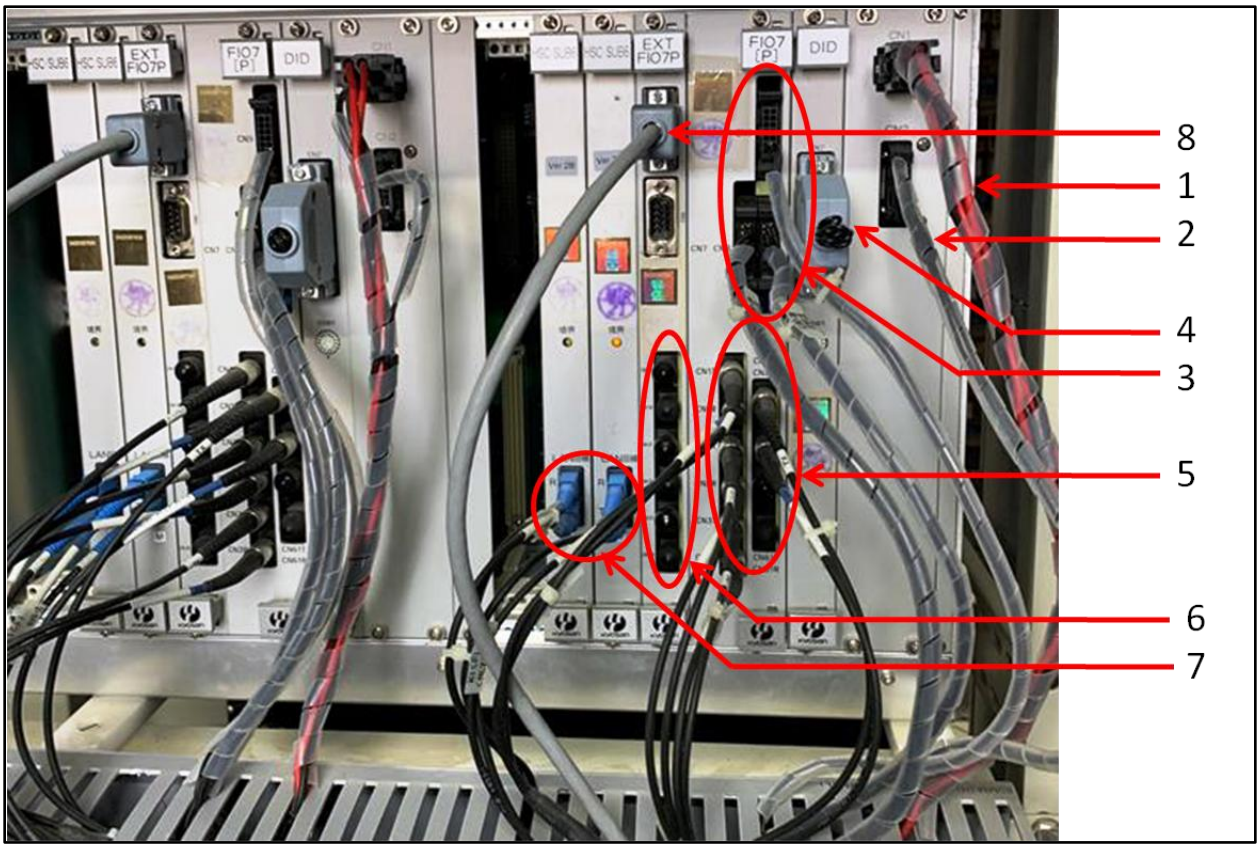



***Figure 10 : LK7- C Logic Sub Rack rear view***

In reference to ***Figure 10*** above

1. IPUC6C Power Supply Card – Main Power Supply is given through 1.5 Sq mm Red & Black wires.
2. Health Status Monitoring -through 0.5 mm black colour cable.
3. Fail safe Input/Output for diagnostics purposes.
4. DID Card with 25 Pin connector. Each Hexa decimal code will be converted into DID connection.

**Table of Contents >**

5. FIO7 Card has 5 channels. First 3 channels are used for vital communication, fourth is used for MTC communication and fifth is reserved. FIO7 ports are made with FC Connectors. Multi Mode OFC cables are used.
6. EXTFIO7P Card has 3 channels. First two channels are used for VDU purpose and last one is reserved.
7. HSC SUB Card has OFC Cable connection for one Logic Sub Rack to another Logic Sub Rack. Single mode OFC Cables are used.
8. This connector is used for data logger purposes.

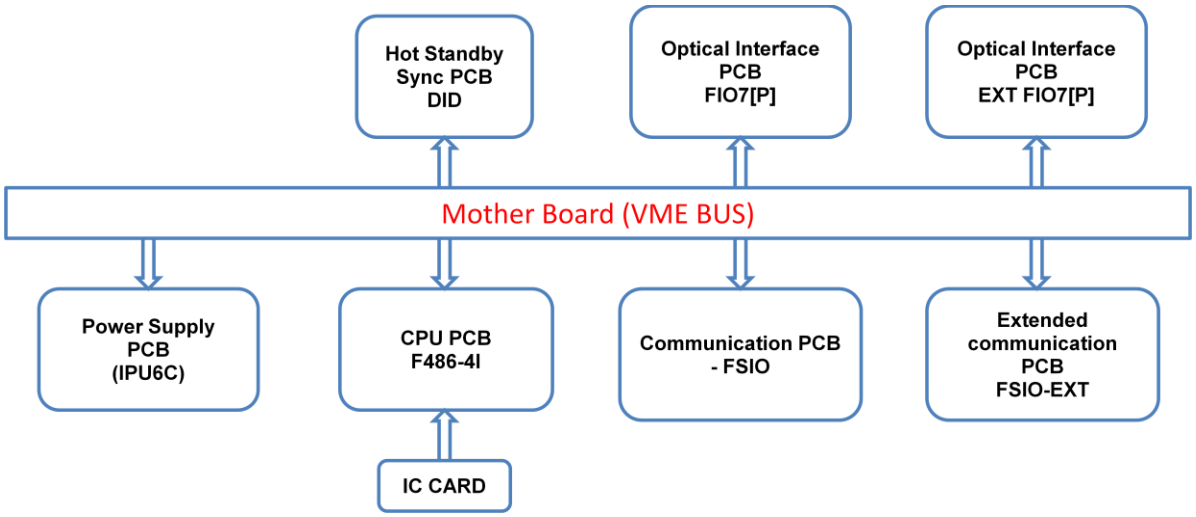



***Figure 11 : Block diagram for interconnections between motherboard and various cards in LK7- C Logic Sub Rack***

**(5) Electronic Terminal Module consisting of EP5 Sub Rack and EM6 Sub Rack**

**(A) EP5 Sub Rack (Vital I/O Module)**

EP5 Sub rack is associated with vital input/output function such as Object Controller and consists of following cards:

(i) PIO2-LOG Electronic terminal that controls parallel input output interface Card.

(ii) LINE2B Terminal block power supply and electronic terminal transmission line E/O converter Card

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LINE2B for System1 | LINE2B for System2 | PIO2-LOG for System 1 | PIO2-LOG for System 2 | PIO2-LOG | PIO2-LOG | PIO2-LOG | PIO2-LOG | PIO2-LOG | PIO2-LOG | PIO2-LOG | PIO2-LOG |

***Figure 12 : Cards mounting arrangement in front side of EP5 Sub Rack***



***Figure 13 : EP5 Sub Rack front view***



***Figure 14 : EP5 Sub Rack rear view***

**(B) EM6 Sub Rack (Non-Vital I/O Module)**

EM6 Sub rack is associated with non-vital input/output function such as CCIP.

EM6 Sub Rack (Non-Vital I/O Module) consists of following cards:

(i) MMIF2 Electronic terminal that controls man machine I/F Card

(ii) LINEM2 Man-machine I/F Card power supply and electronic terminal E/O converter Card.

**(C) Other cards:**

(iii) **INIO2 Personal computer and Electronic Interlocking Logic Card transmission Card** (Two types for operator console and maintenance console).

INIO2 is a communication card to connect Logic Sub Rack with Personal Computer, for Operator and Maintenance Console. These cards will be connected to PC through ISA bus.

**Table of Contents >**

**(iv) SPHC-TT Optical Branch Card**

SPHC-TT is a splitter card. It is used to divide one communication Optic line into 2 optic lines. The Input channel of the card will be connected to the MT channel of Logic sub rack. Out of 2 output channels one will be connected to maintenance PC & the other one will be connected to the ZNIO2 card of journal module.

**(v) SPHC-PW Power supply for Optical branch Card**

SPHC-PW is the power supply card for SPHC-TT and SPHC-PA.

It will convert the 24VDC input to 5VDC output.

**(vi) SPHC-PA Card**

SPHC – PA is a optical converter card.

It will convert the Multimode optic communication into single mode optic communication and vice versa. Normally SPHC – PA will be used in distributed type Interlocking.

**(vii) Watch Dog Timer Relay**

This relay will continuously monitor the Peripheral errors of the Logic system. System 1 and System 2 will have separate relay for Monitoring the system errors.

**Arrangement of cards in EM6 Sub Rack**

| 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 | 9 | 10 | | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LINEM2 for System1 | LINEM2 for System2 | MMIF2- for System 1 | MMIF2 for System 2 | MMIF2 | MMIF2 | | MMIF2 | MMIF2 | MMIF2 | MMIF2 | | MMIF2 | MMIF2 | MMIF2 | MMIF2 |

***Figure 15 : Mounting view of cards (Front) in case of MMIF2 full mounting***

**(5) Journal Module consisting of following cards:**

(i) ZPEN3 Program processing card for Journal Module

(ii) ZNIO2 I/F card between Logic Module and Journal Module

(iii) ZSIO2 I/F card between Protocol Converter and Journal Module

(iv) KDD172-KY48-2 Journal Module Power Supply Card (Input DC 24V, output DC 5V and DC 12V)

***Note:***

*Journal Module was used in older versions for data logger. In new versions it is not used. The data logger is assessed through FIO7 (P) card directly.*

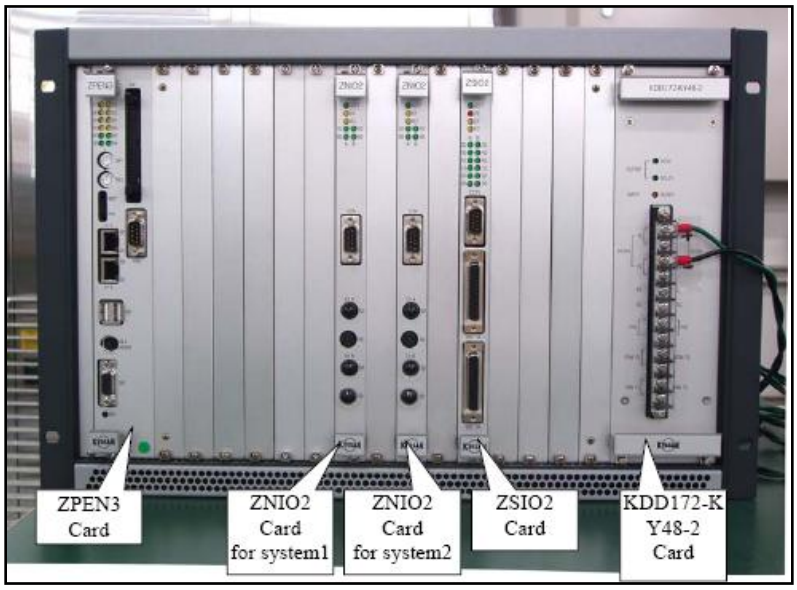



***Figure 16 : Front view of Journal Module***

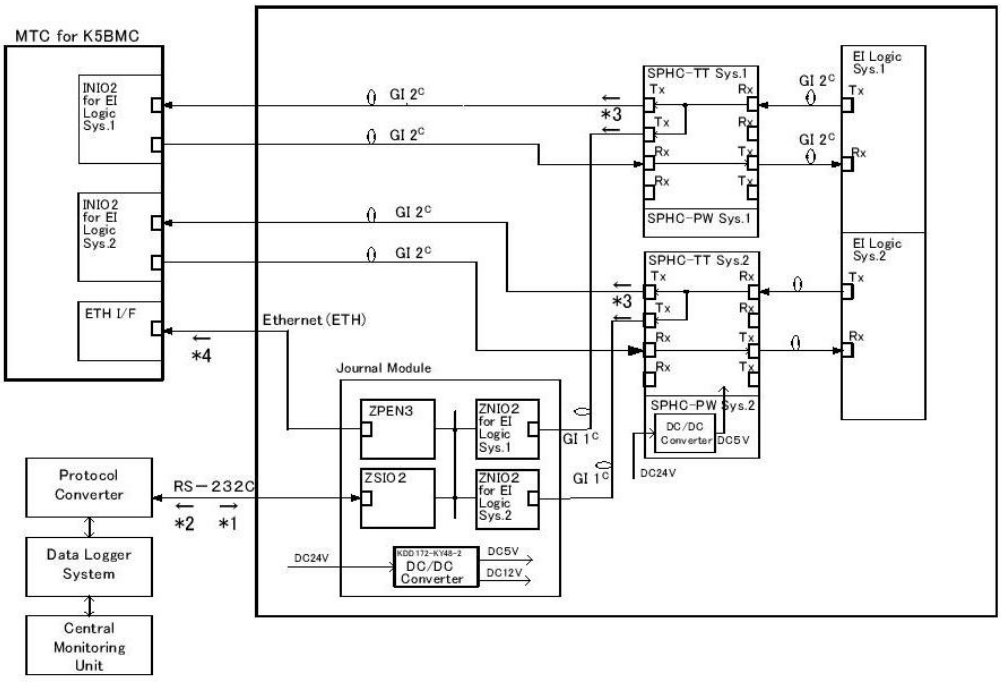



***Figure 17 : System Configuration of Journal Module***

## 2.3 Indoor Equipments to be connected with K5BMC EI

The following indoor equipments shall be connected with the Logic Sub rack LK7 of K5BMC EI:

- Operator Console (OPC) or Visual Display Unit (VDU)
- Control Cum Indication Panel (CCIP) (If provided) through EM6 Sub Rack
- Maintenance Console (MTC)
- Data Logger
- Relay Rack through EP5 Sub Rack
- Cable Termination Rack (CTR) through EP5 Sub rack and Relay Rack

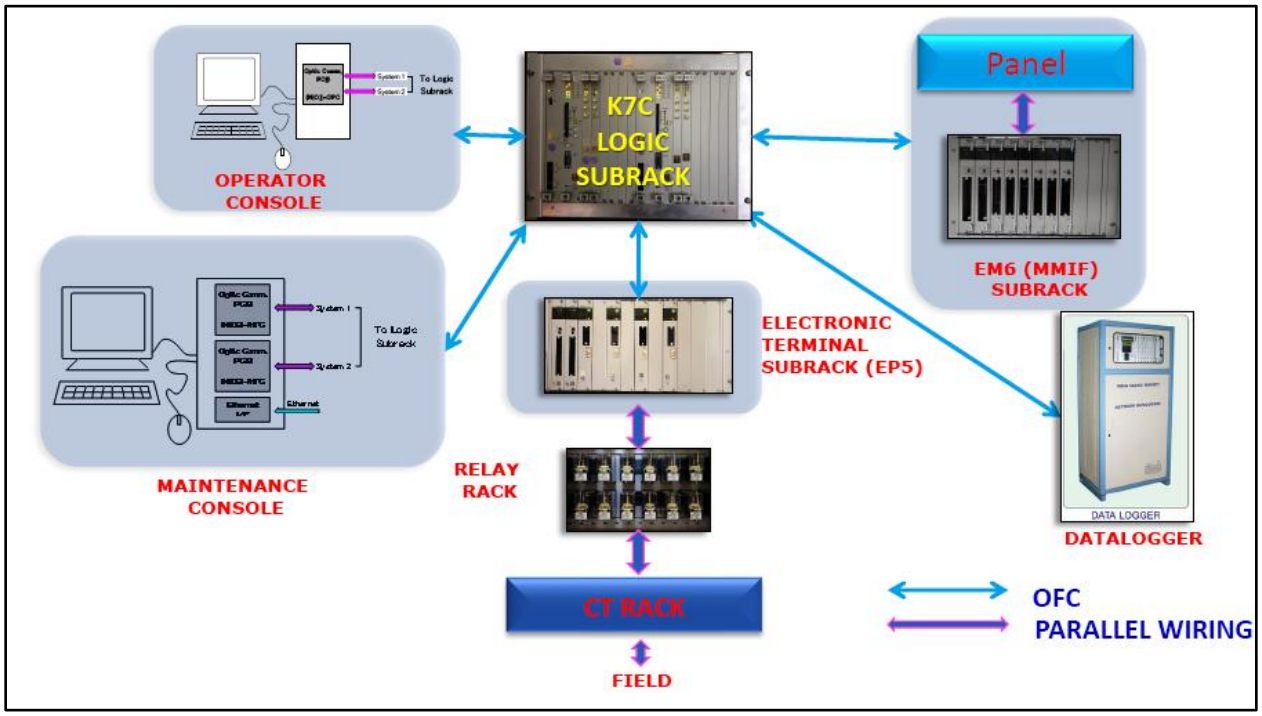



***Figure 18 : Block diagram showing connections of indoor equipments to K5BMC EI***

## 2.4 Outdoor Equipments/Circuits to be connected with K5BMC EI

The following outdoor equipments/circuits are normally connected with K5BMC EI through CT Rack in a signalling installation:

- Signals
- Points
- Track Circuits
- Axle Counters

**Table of Contents >**

- Block Instruments
- Electric Lifting Barriers
- Crank Handle Control Circuits
- Inter Cabin Control/Slot Circuits

There may be other equipments also in addition to the above as per requirement.

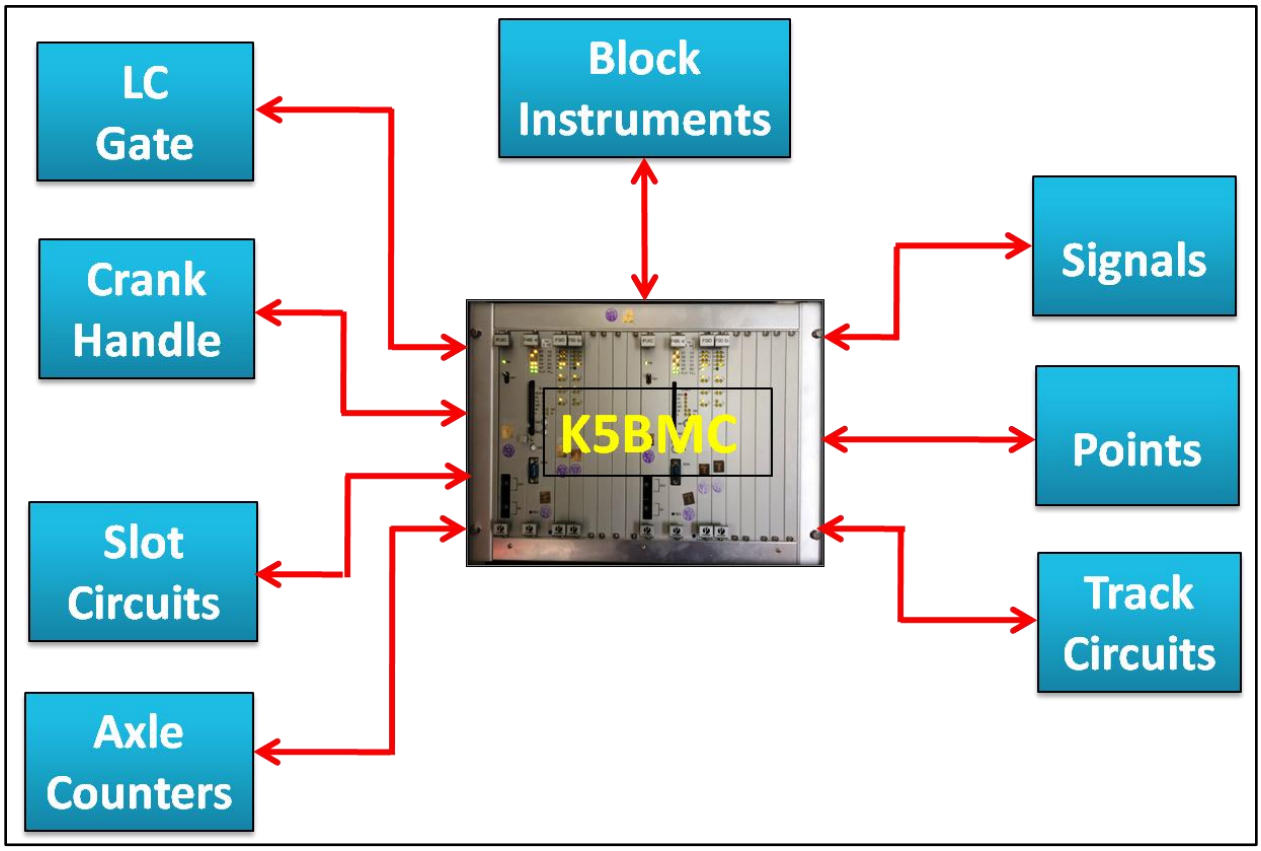



***Figure 19 : Block diagram showing connections of outdoor equipments to K5BMC EI***

## 2.5 Configurations of K5BMC EI System

As explained in previous section, there are two types of configurations which are used in K5BMC EI installations:

Centralized & Distributed

### 2.5.1 Centralized System Configuration

In this configuration all the hardware is installed at a central location i.e station building.

The following is the distribution of hardware:

**EI Room**

(i) Central Interlocking Unit (CIU) or LK7 Logic Sub Rack –System 1 & System 2

(ii) Electronic Terminals – EP5 Sub Rack (Vital I/O Module) – System 1 & System 2

(iii) Relay Racks

(iv) Cable Termination Racks (CTR)

(v) Journal Module

(vi) Protocol Converter

(vii) Data logger

(viii) Other accessories like Fibre Management System (FMS), Splitter cards, DC-DC Converter etc.

**SM Room**

(i) EM6 Sub Rack (Non-Vital I/O Module)

(ii) Control Cum Indication Panel (CCIP)

(iii) Operator Panel Console (OPC) or Operator VDU

(iv) Other accessories like Fibre Management System (FMS), DC-DC converter etc.

**Maintenance Room**

(i) Maintenance Console (MTC)

(ii) Data logger PC

**Details of cabling & interconnections**

A typical arrangement of Centralized System Configuration of K5BMC EI is given in ***Figure 20.***

In K5BMC Centralized configuration, Logic Sub rack has fibre connection (Multi mode duplex fibre patch cord) to EP5 Input/Output Sub Rack. Further EP5 Input/Output Sub Rack has copper

cable connection to relay rack. From relays the connection goes to Cable Termination Rack (CTR) and which in turn is connected to outdoor field gears through copper cables.
For data logger the connection is taken through splitter card (SPHC-TT). If Journal Module is used, then the connection is done from SPHC-TT to Journal Module with OFC cable. Journal Module is connected to Protocol Converter through RS232 Serial Link which further connects to data logger. From data logger the connection goes to data logger PC again through RS232 Serial Link.

Alternatively if Journal Module is not used then FIO7(P) card of Logic Sub Rack has a serial port (DB9) which can be used for extending communication to data logger. This port is connected to one serial to optical converter which in turn is connected to another optical converter, from where it goes to data logger protocol converter. Then the protocol converter is finally connected to data logger.

FIO7(P) channel of Logic Sub rack is dedicated for Maintenance Console (MTC) hence it is connected directly to Maintenance Console PC through SPHC-TT using Multi mode duplex fibre patch cord.

The Centralized architecture shown in Fig. consists of CCIP as well as VDU as K5BMC supports both. If CCIP is available then logic sub rack in EI room to EM6 sub rack in SM room is connected through multi mode OFC cable between FMS1 & FMS2, shown in Green (Main) colour and Blue (Redundant) colour in the Fig. Then from EM6 sub rack the CCIP is connected using copper cable.

Operator VDU is standby for CCIP. Operator VDU in SM Room is also connected with logic sub rack in EI Room through multi mode OFC cable. Both Logic Sub Rack System 1 and System 2 are connected to CCIP as well as Operator VDU.

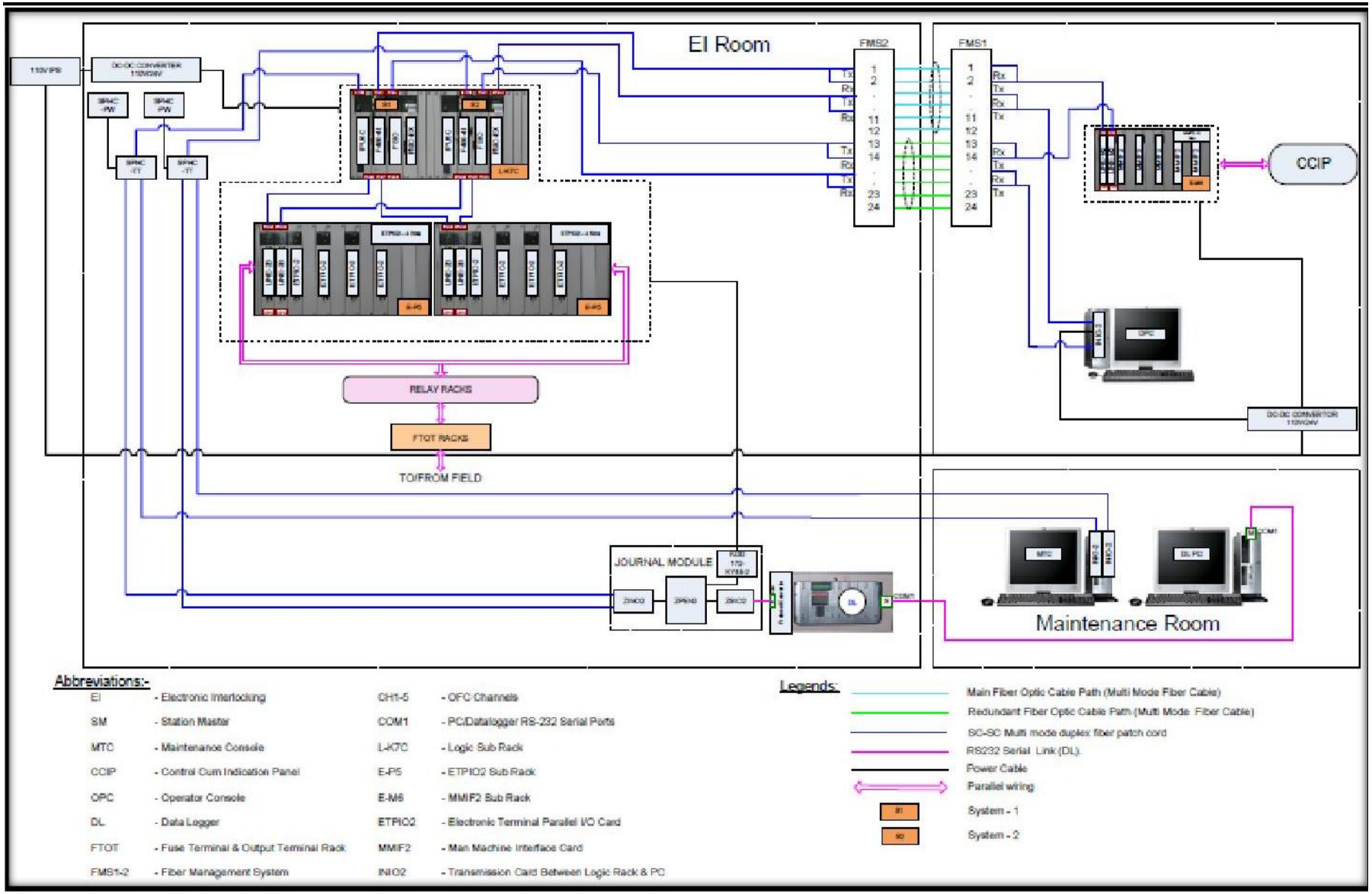



***Figure 20 : K5BMC EI Centralized System Configuration***

### 2.5.2 Distributed System Configuration

In this configuration the hardware associated with EI is distributed in different zones to achieve minimum control distance of field gears. In the configuration given in ***Figure 21*** there are a Central Relay Room/EI Room, Maintenance Room & SM Room in Station building and two Relay Huts RH1 & RH2 at different locations from where the respective signalling zones are controlled.

The following is the distribution of hardware:

**Central Relay Room/EI Room**

(i) Central Interlocking Unit (CIU) or LK7 Logic Sub Rack –System 1 & System 2

(ii) Electronic Terminal – One EP5 Sub Rack (Vital I/O Module)

(iii) Relay Racks

(iv) Cable Termination Racks (CTR)

(v) Journal Module

(vi) Protocol Converter

(vii) Data logger

(viii) Other accessories like Fibre Management System (FMS), Splitter cards, DC-DC Converter etc.

**SM Room**

(i) Dual Operator Panel Console (OPC) or Dual Operator VDU

(ii) Other accessories like Fibre Management System (FMS), DC-DC converter etc.

***Note:***
*Here EM6 Sub Rack (Non-Vital I/O Module) is not required as CCIP is not used.*

**Maintenance Room**

(i) Maintenance Console (MTC)

(ii) Data logger PC

**Relay Hut 1**

(i) Electronic Terminal – Two EP5 Sub Racks (Vital I/O Module)

(ii) Relay Racks

(iii) Cable Termination Racks (CTR)

**Table of Contents >**

(iv) Other accessories like Fibre Management System (FMS), Splitter cards, DC-DC Converter, Single mode to Multi mode OFC Converter etc.

**Relay Hut 2**

(i) Electronic Terminal – Two EP5 Sub Racks (Vital I/O Module)

(ii) Relay Racks

(iii) Cable Termination Racks (CTR)

(iv) Other accessories like Fibre Management System (FMS), Splitter cards, DC-DC Converter, Single mode to Multi mode OFC Converter etc.

**Details of cabling & interconnections**

Assuming the distance between RH1/RH2 and Central Relay Room to be in the range of 2 to 5 Km, multi mode OFC cable cannot be used. Hence communication between RH1/RH2 and Central Relay Room is to be established by using single mode OFC cable. But since the system is compatible with multimode fiber, multi mode to single mode converter in relay room and single mode to multi mode converter in relay huts are to be used.

All other communication modes like data logger, SM Room, VDU are same as that in Centralized System Configuration such as:

- Logic Sub rack to EP5 Sub rack - Multi mode duplex fiber patch cord
- EP5 Sub rack to Relay rack – Copper cable
- Relay Rack to outdoor field gears through CTR – Copper cable

For data logger-

<u>If Journal Module is used</u>

Logic Sub rack to Journal Module through Splitter card (SPHC-TT) –Multi mode duplex fiber patch cord.

Journal Module to Protocol Converter - RS232 Serial Link.

Protocol Converter to Data logger PC through data logger - RS232 Serial Link.

<u>If Journal Module is not used</u>

DB9 port on FIO7(P) card of Logic Sub Rack to data logger- Multi mode duplex fiber patch cord. (This port is connected to one serial to optical converter which in turn is connected to another optical converter, from where it goes to data logger protocol converter. Then the protocol converter is finally connected to data logger.)

Data logger to Data logger PC - RS232 Serial Link

Logic Sub rack in Relay Room to dual VDU in SM Room through Fiber Management System (FMS) - Multi mode duplex fiber patch cord

Logic sub rack System 1 & System 2 both are connected to dual VDU.

Similar to Centralized system, FIO7(P) channel of Logic Sub rack is connected directly Maintenance Console PC through SPHC-TT using Multi mode duplex fibre patch cord.

Logic Sub rack in Relay Room to EP5 Sub rack in Relay Hut 1 – Single mode duplex fiber patch cord using Multi mode to Single mode converter and vice versa, shown in Green (Main) & Blue (Redundant) colour in the Fig. between FMS1 & FMS2, FMS3 & FMS5 and FMS2 & FMS4.

Other connections in Relay Hut 1 like EP5 Sub rack to field gears through Relay Racks and CTR are same as that in Central Relay Room. Same applies to connections of Relay Hut 2 also.

The cabling & networking requirements of Centralized and distributed system configurations can be summarized as given below:

| **From** | **To** | **Type of cable** | **Remarks** |
|---|---|---|---|
| LK7-C Sub rack | EP5 Sub rack (Vital OC) | Multimode OFC | Applicable to both Centralized and Distributed System Configuration |
| LK7-C Sub rack | EM6 Sub rack (Panel) | Multimode OFC | |
| LK7-C Sub rack | Journal Module (Data logger) | Multimode OFC | |
| LK7-C Sub rack | OPC (PCINIO/ INIO2) | Multimode OFC | |
| LK7-C Sub rack | MTC (PCINIO/ INIO2) | Multimode OFC | |
| LK7-C Sub rack | SPHC –TT | Multimode OFC | |
| Central EI Room | End cabin | Single mode OFC | For Distributed System Configuration |
| MTC Networking EI Room | HQ | Single mode OFC | Applicable to both Centralized and Distributed System Configuration |
| MTC Networking EI Room | HQ | E1 network OFC | |
| Data logger Networking EI Room | HQ | Single mode OFC | |

**Note:**

(i) Multi mode OFC patch cords are to be provided in required length 3 m, 5 m or 25 m depending upon the placement of racks.

(ii) Single mode OFC (24 Core) outdoor cable is to be used for distributed configuration.

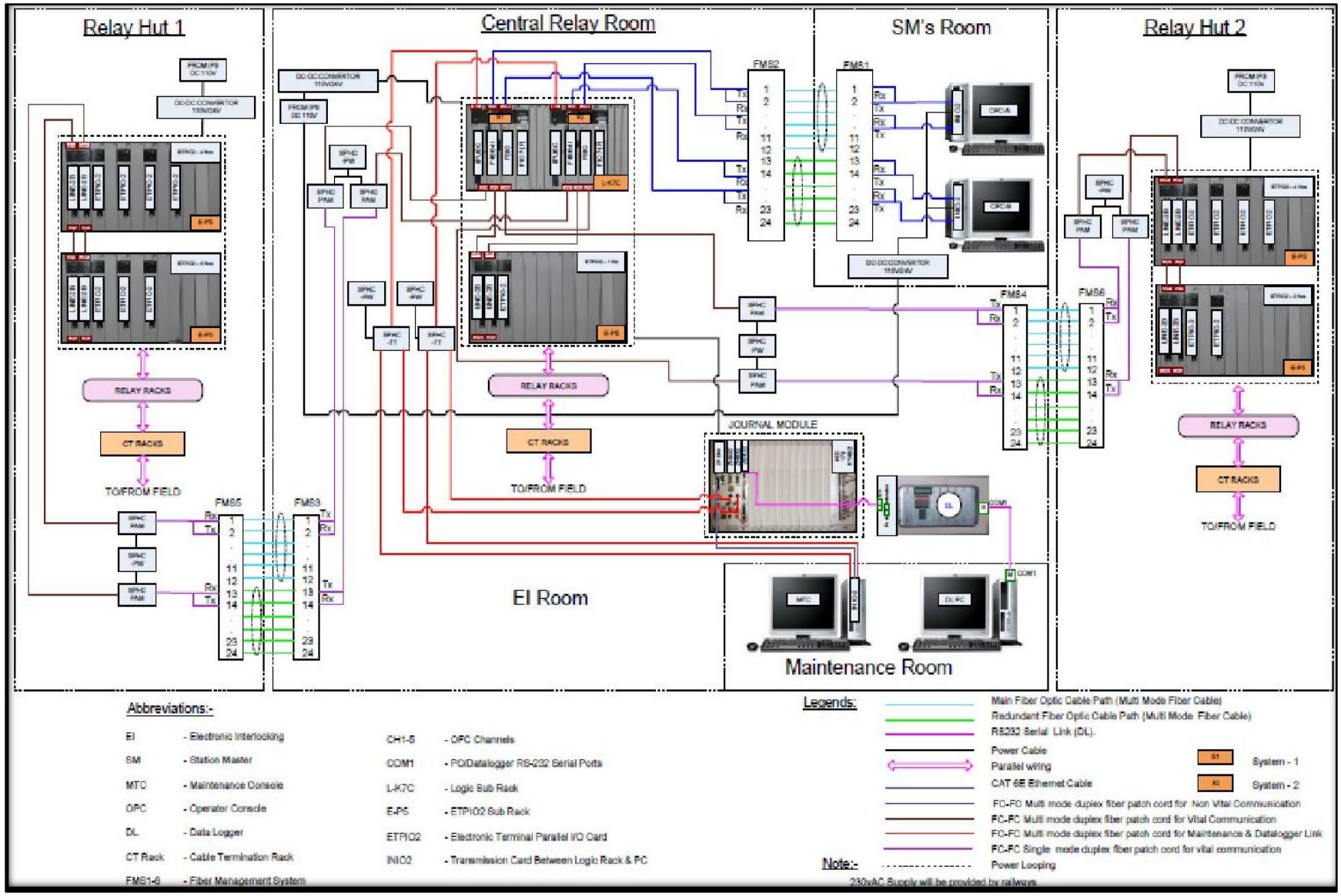



***Figure 21 : K5BMC EI Distributed System Configuration***

## 2.6 Floating Earth concept in K5BMC Electronic Interlocking System

K5BMC EI system works on floating earth system. The system is not connected to the earth directly; however earthing is required externally as per RDSO guidelines for prevention of lightning surges from entering the system. K5BMC Rack, Relay Rack and Cable Termination Rack (CTR) are kept floating and not connected to earth. In reference to ***Figure 22***, there are five main parameters which form the basis of floating earth system:

**(i) Power Supply**

110 V DC is given to Surge Protection devices (Class C SPD). After SPD the supply goes to DC-DC Converter which has transformer isolation. The 110 V DC is converted into 24 V DC. If any surge from input side of the power supply comes then it has to pass through Class C SPD and after that it has an isolation of DC-DC Converter. Hence if any surge comes it should be earthed through SPD. For this to happen, the SPD is required to be connected to earth.

**(ii) Field Gears**

Feed to the field gears comes from relays and CT Rack. Hence isolation through relays is available for field gears. If any surge comes, it will affect only relays and not the EP5 Sub rack (Vital Input/Output Module).

**(iii) Earthing of outdoor cable armour**

Since cables are coming from the outdoor, armour of these cables should be earthed.

**(iv) Use of OFC cable**

All the communication in K5BMC is optical communication, hence no converter is needed. As all the internal communication wiring is on OFC cable, there is no possibility of surge coming inside the system.

**(v) In house isolation**

For each sub rack, rubber beading is provided at the base which is in contact with the ground. Moreover poly oxide material is provided between main and sub rack hence there is no continuity between main rack and sub rack. If the surge comes in the main rack, it will not reach the sub rack.

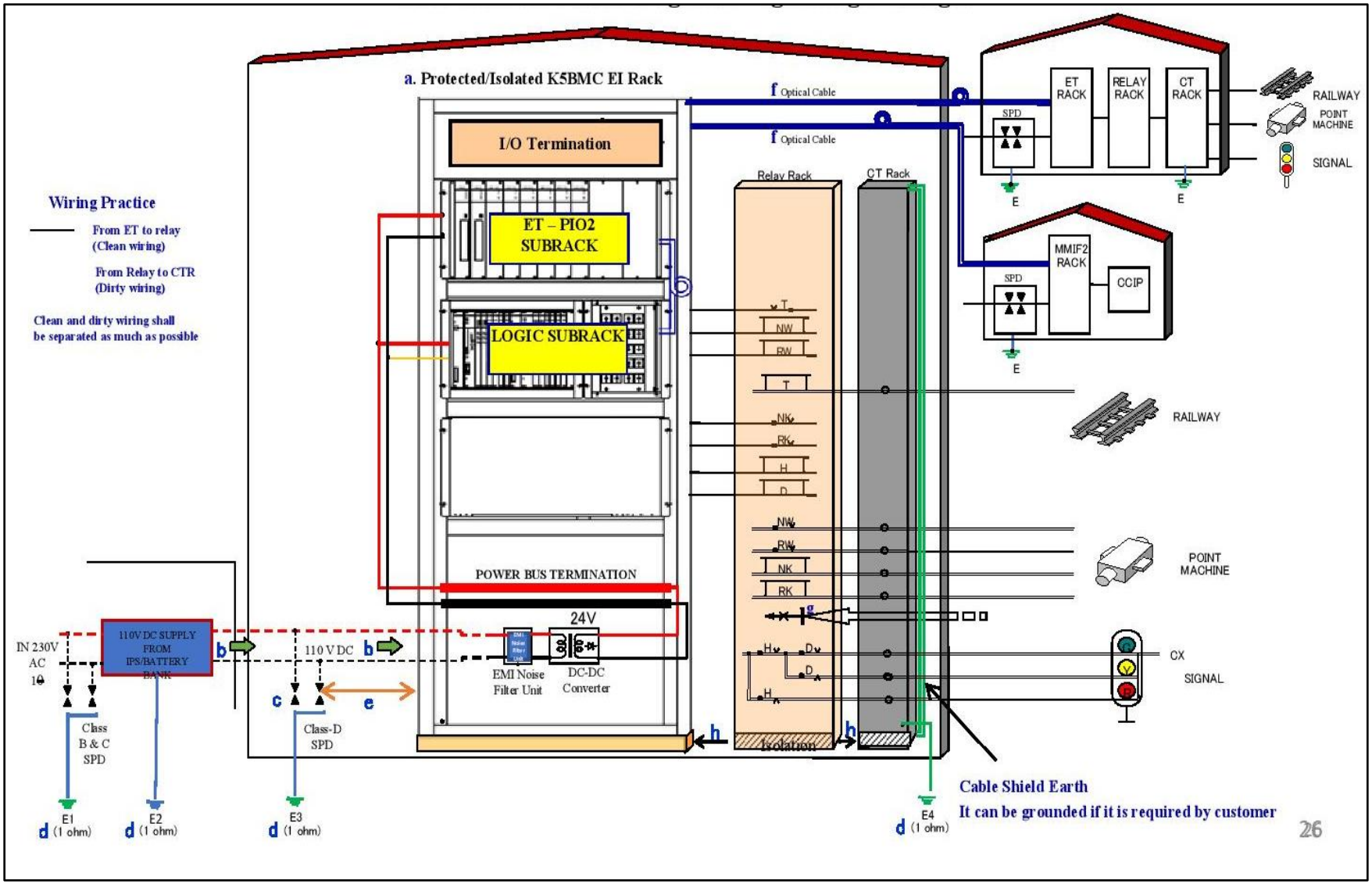



***Figure 22 : Arrangement of floating earth in K5BMC EI***

## 2.7 K5BMC Earthing Arrangement

Earthing is done as per RDSO TAN/3006 & RDSO Specification No. RDSO/SPN/197.

In ***Figure 24*** K5BMC EI racks, Relay Racks and CT Racks are not connected to earth. Similarly CCIP/VDU in SM Room and MTC in Maintenance Room are not connected to earth. Only armours of incoming outdoor cables are connected to earth. SPD is also connected to earth.

**Class A protection**

Class A protection for the building shall be connected to a separate earthing system which may consist of one or more earth pits. This earthing system shall be interconnected with EI system's Ring earthing systems.

**Earth Bus Bar (EBB) & Ring Earth**

The ring earth for EI building shall be done as per the drawing shown in ***Figure 24*** for perimeter earthing. The Earth Bus Bar (EBB) shall be provided separately for EI room, IPS room & Panel Room at 300 – 500 mm from the floor level using 25 mm x 3mm copper strip. Each of these EBBs should be separately connected to the perimeter ring earth. One Sub-Earth Busbar shall be provided in Maintainer's room connected to the perimeter ring earth. (Ref.: Para 8.5.1 of RDSO Specification no. RDSO/SPN/197). ***The Earth wire coming from SPD or cable armour shall be connected to EBB by welding. Nuts & bolts should not be used to connect earth wire with EBB.*** (Ref.: Para 8 of RDSO STS/E/TAN 3006 dated 02.11.2012)



***Figure 23 : Connection of Earth wire to Earth Bus Bar***

**Isolation of CT Rack**

Earthing of cable armour on CT Rack shall be done in such a manner that the **CT Rack does not get earthed**. This is essential as in case of Kyosan make K5BMC EI, where earthing of Relay Racks and EI Logic Rack is not done to avoid surge. However, it also needs to be ensured that CT Rack is not having any leakage with earthing arrangement (cable shielding earthing) by adding appropriate insulation materials. Isolation between racks/walls and ladders shall also be ensured.

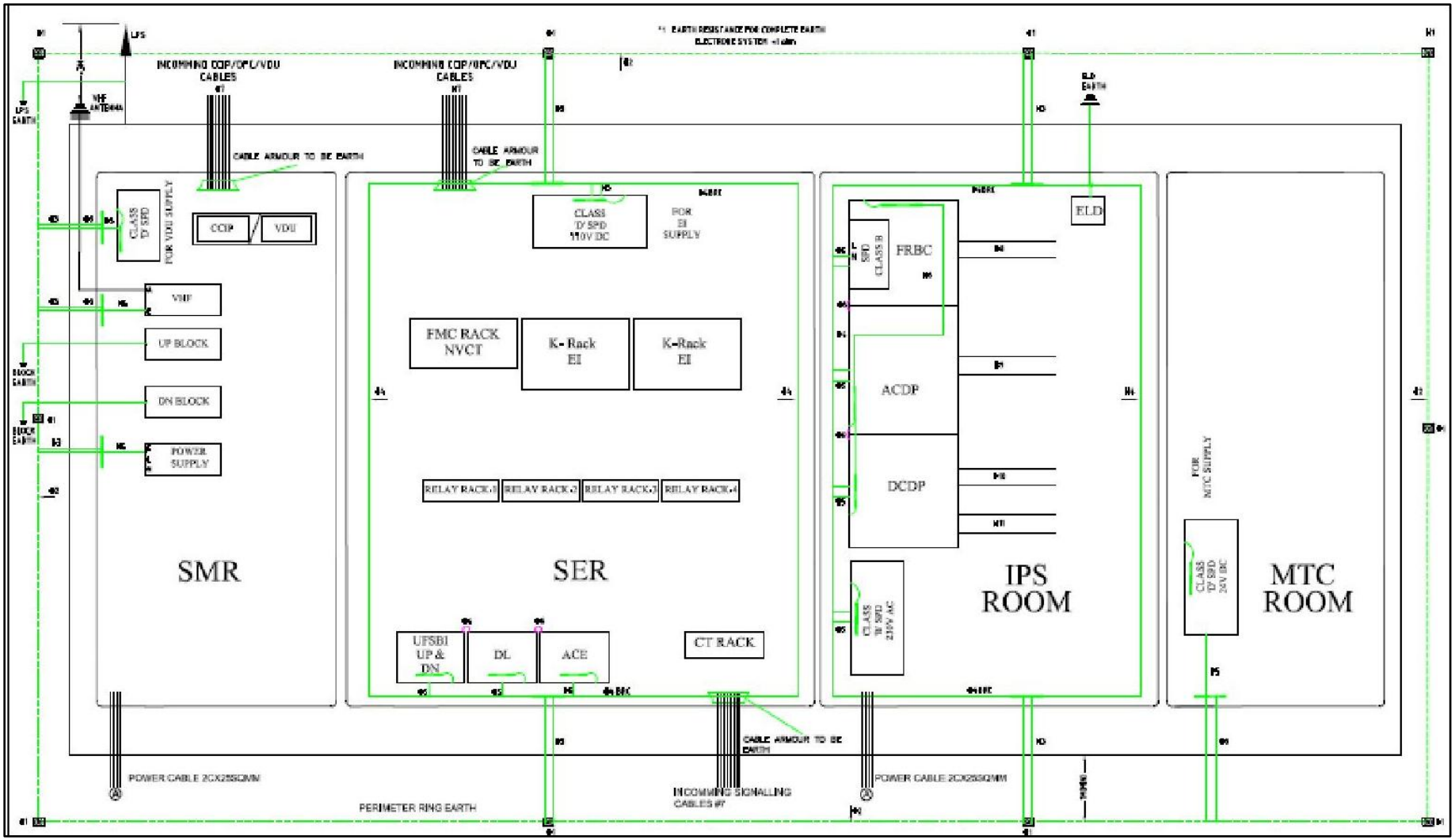



***Figure 24 : Perimeter Earthing for K5BMC EI***

## 2.8 Guidelines for OFC connectivity between EI equipments in Distributed architecture

In case of "Distributed architecture" or "Centralised architecture with different building" the OFC Connectivity for EI shall be through armoured OFC. Redundant diversified OFC path shall be provided i.e. two separate armoured OFC cables are required to be provided and both the cables should have different paths.

OFC shall be terminated in a separate Communication Rack in the central EI rooms.

Armour of the OFC should be earthed to room Earth Bus Bar (EBB) at the entrance of the building in central location and distributed locations.

## 2.9 Guidelines for OFC connectivity between EI equipments in Centralized architecture

In case of "Centralised architecture" for EI and sub racks in same building, unshielded OFC shall be used.

Between "FMS in Station Master Room/MTC Room" and "Electronic Terminal sub-rack for MMIF2 /PC", unarmoured OFC patch cord should be used with necessary protection such as spiral tube.

For OFC Connectivity from EI Logic sub-rack to Electronic Terminal sub-rack for PIO in same EI Room unarmoured patch cord shall be used.

However, necessary protection arrangements such as spiral tube shall be adopted to avoid cable damage/cut.

## 2.10 Guidelines for power supply distribution and connectivity

**(A) Power Supply Distribution**

There are four options for power supply distribution:

(i) Main IPS at Central Location and Mini IPS at distributed locations with 110V DC supply extended to distributed locations from Central IPS using diversified cables.

(ii) IPS at all locations with 230V AC supply extended to distributed locations from Central location using diversified cable.

(iii) IPS at all locations with 230V AC supply from Auxiliary Transformer at all location.

(iv) Chargers and batteries supply concept is used for power supply arrangement.

**Table of Contents >**

***Note:***
*For all the four options above, redundant power supply (110 V DC + 110 V DC) in two cables with copper conductor size 16 sq mm is to be provided between:*

*Power/IPS Room & EI Room*

*Power/IPS Room & Relay Room*

*Power/IPS Room & SM Room*

*Power/IPS Room & MTC Room*

**(B) 110 V DC & 24 V DC Supply connectivity to EI**

110V DC input supply from IPS to be terminated through class 'D' SPD before entering the EI Logic Rack. 110V DC input supply cables from IPS to SPD in relay room shall be provided with redundant diversified path. {Ref.: Para 2.1(a) of RDSO STS/E/TAN/3012}

For System-1, 110V/24V DC-DC Converter (N+1) to be used for EI Logic Rack and serial to optical converter for Data logger connectivity. {Ref.: Para 2.1(b) of RDSO STS/E/TAN/3012}

For System-2, 110V/24V DC-DC Converter (N+1) to be used for EI Logic Rack and serial to optical converter for Data logger connectivity. {Ref.: Para 2.1(b) of RDSO STS/E/TAN/3012}

For Electronic Terminal sub-rack for PIO, 110V/24V DC-DC Converter (N+1) to be used for LINE2B.

For Electronic Terminal sub-rack for PIO, 110V/24V DC-DC Converter (N+1) to be used for ET-PIO2.

110V/24V DC-DC converter (N+1) separately for System 1 & 2 to be provided for Multimode to single mode OFC converters mounted on Communication Rack.

110V DC input power supply cables to DC-DC converter (N+1) shall not be mixed with output 24V DC.

***Note:***
*For all power supplies within EI Room, 1.5 sq mm wires (Red & Black) should be used.*

Separate SPD box for Communication Rack shall be installed. Make sure that 110V DC input supply for Communication Rack shall be tapped from SPD box at the input side.

***Note:***

*The SPD shall be mounted as near as possible from EI Logic Rack/ Communication Rack and length of the earth wire between SPD and BRC strip shall not exceed 1.5 Metres. The earth wire between SPD and BRC strip shall be of size 6 sq mm.*

Ensure that the power cable routing of the DC 110V power supply from IPS shall not be mixed with any other wiring.

Health status of DC-DC converter provided for EI Logic Rack and Communication Rack and health status of communication device (Multi – Single converter) shall be monitored by reading potential free contact directly to ET-PIO2.

**(C) 24 V DC Supply connectivity to OPC in SM Room**

Separate DC-DC converters in (N+1) configuration for A VDU and B VDU shall be housed in suitable enclosure in Station Master Room.

110V DC input supply for the same shall be taken separately from the 110V DC Bus Bar of IPS and terminated through 'D' class SPD.

**(D) 24 V DC Supply connectivity to CCIP in SM Room**

Separate DC-DC converter in (N+1) configuration for Electronic Terminal sub-rack for MMIF2 shall be housed in suitable enclosure in Station Master room.

110V DC redundant input supply for the same shall be taken separately from the 110V DC Bus Bar of IPS and terminated through 'D' class SPD

**(E) 24 V DC Supply connectivity to MTC in Maintainer's Room**

The DC-DC converter in (N+1) configuration shall be housed in suitable enclosure in Maintainer room.

110V DC input supply for the same shall be taken separately from the 110V DC Bus Bar of IPS and terminated through 'D' class SPD.

**(F) VDU/MTC Monitor Supply**

FRMC Healthy Indications to be shown in VDU. Accordingly changes to be included in MTC for fault identification purpose up to OFC level also.

VDU/MTC Monitor supply shall be provided from 230VAC distribution supply along with UPS or 110VAC IPS supply.

Supply cable shall not be mixed with other cables.

Monitors shall be mounted with proper isolations.

**Table of Contents >**

**Note:**
Cables for power supplies should run directly from Power/IPS Room to other rooms without any junction in between as given below:

Power/IPS Room & EI Room

Power/IPS Room & Relay Room

Power/IPS Room & SM Room

Power/IPS Room & MTC Room

**(G) Separation of different cables**

Separation of I/O cables, Power supply cables, communication cables inside the EI room shall be as per latest TAN (Para 2.5 of STS/E/TAN/3012 dated 10.08.2016) issued by RDSO.

**(H) Guidelines for Data Logger networking & wiring**

**Networking**

Data Loggers at all the locations shall be networked using OFC only.

**Wiring**

Check that Data loggers are kept in EI rooms and any input cables to Data logger shall be separated from I/O cable.

Analog monitoring of EI supply of 24V and 110V DC taken out of the EI DC-DC converters not to be wired in Datalogger.

However, for health monitoring of EI DC-DC Converter shall be achieved by using potential free contacts.

110V DC Input for EI shall be monitored directly from IPS using the same path for other external supply to Data logger.

Unarmoured OFC patch cord to be used between serial to optical converter between EI Logic Rack and DL protocol converter.

## 2.11 Guidelines for EI Rack & Relay Rack installation

Following precautions shall be observed:

It must be ensured that there shall be enough space between two racks to ease the maintenance.

EI rack and relay rack shall be erected as per the approved room floor plan and the erection shall be rigid to the floor.

**(A) EI Rack Erection**

K5BMC EI rack installation is shown in ***Figure 25.*** It is a double door rack which is erected on rubber beading at the bottom. On top of the rack, isolators are provided on which ladders are placed for running of wires and cables. The main EI rack is completely isolated from its sub racks by providing Poly Oxide Material (POM).




***Figure 25 : A view of K5BMC EI Rack & Data logger installation***

**(B) Relay Rack Erection**

Relay Racks are erected over tripods. Insulators are placed between tripods and Relay Racks as shown in ***Figure 26***. Relay Racks are not required to be earthed in K5BMC EI installation.

**(C) Data logger Erection**

Data logger is erected in the same way as that of EI Rack and Relay Rack.




***Figure 26 : A view of K5BMC Relay Rack installation***

## 2.12 Guidelines for provision of Laddering

Laddering arrangement is a very important element for cable routing and wiring in EI installation as it decides the way in which cables are going inside and coming out of the racks, and the way in which the sub racks, relay racks and CT racks are interconnected. The following are to be ensured during laddering:

- Ladders shall be isolated from racks and wall by Insulators, rubber bush & hylam sheet.
- Ladder width shall be 2/3rd of rack width and it is to be ensured that it carries fewer amounts of cables & wires to avoid bends / damages.
- Ladder supports are to be provided for every 3 meters to have good mechanical strength.
- As per Para 2.5 of RDSO STS/E/TAN/3012, all Input, output, power and data cables are required to be segregated. Thus all power cables, I/O cables & interconnection wires shall have different ladders. Where it is not possible, these cables are to be separated at least by 6 inches gap.
- Ladders shall not be earthed.
- Ladder arrangements shall be defined through shortest & safest path at site.
- Once laddering job has been completed, fix the cable tray (troughs) on the ladders as required and provide the correct size rubber beading for all holes in the cable trays.

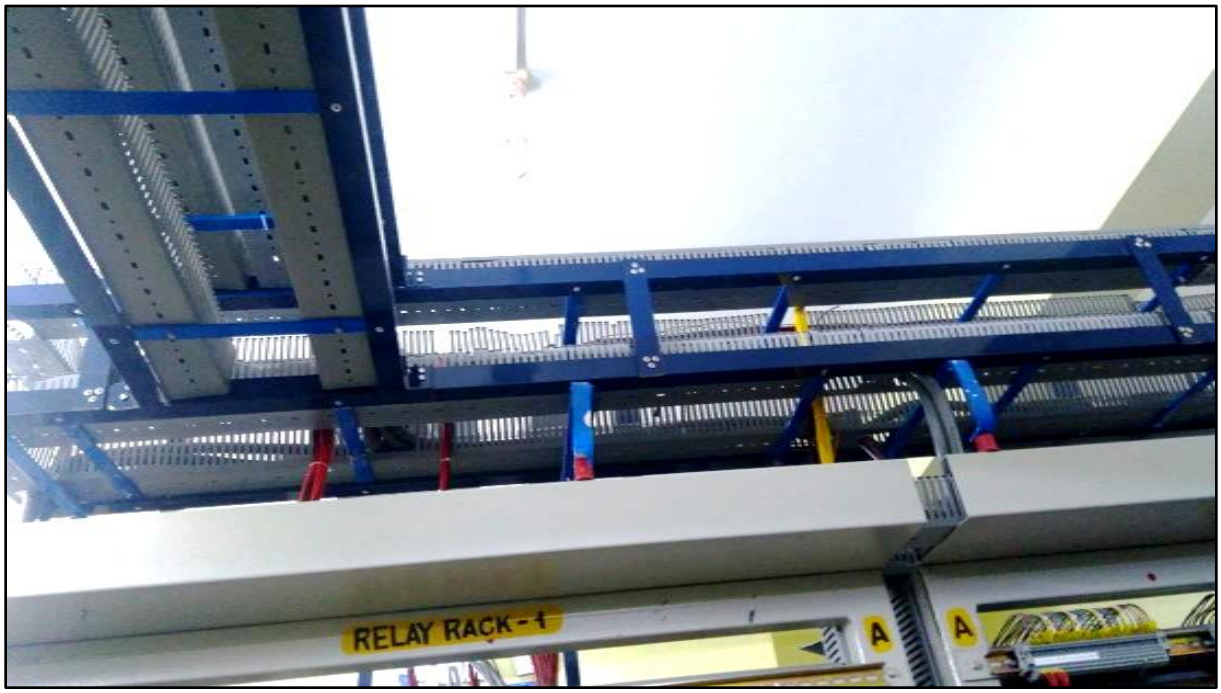



***Figure 27 : Laddering arrangement in K5BMC EI***

***Note:***

*As per latest practice, two tier ladders are being used for cable routing & wiring. It consists of two ladders placed one above the other as shown in Fig. Both ladders have two troughs each. The four types of wires for input, output, power and data are laid in different troughs as per following scheme:*

*Ladder 1 – Input & Output wires*

*Ladder 2 – Power & Data logger wires*

## 2.13 EI Sub Rack Installation

The placement for installing the EI sub- racks and other peripheral devices in main EI rack such as Logic sub-rack, ET sub-rack, journal module, splitter cards, watchdog timer relays, DC-DC convertors, FMS trays, terminals and connecters shall be as per the station specific interface circuits.

Before fixing the sub racks in the main EI rack/ SM's operating panel, POM materials (front side support, backside support and bottom support) are to be fixed with EI rack as shown in Fig.



***Figure 28 : Provision of POM in Main EI Rack***

## 2.14 EI Rack Cable Routing & Wiring

In the Fig. front and rear views of K5BMC EI Rack are shown. The following modules/sub racks are shown in ***Figure 30***:

- EP5 Sub Rack (Vital I/O Module)
- LK7 Logic Sub Rack
- Watchdog Timer Relay

**Table of Contents >**

- Splitter Card
- DC – DC Converter

The following guidelines for routing of wiring are to be followed:

The wiring plan is to be designed in such a way that 110 V DC and 24 V DC wires do not get mixed Refer ***Figure 29.***

110 V DC wires are to be entered from one side (Shown in VOILET)

24 V DC wires are to be entered from other side (Shown in PINK & RED)

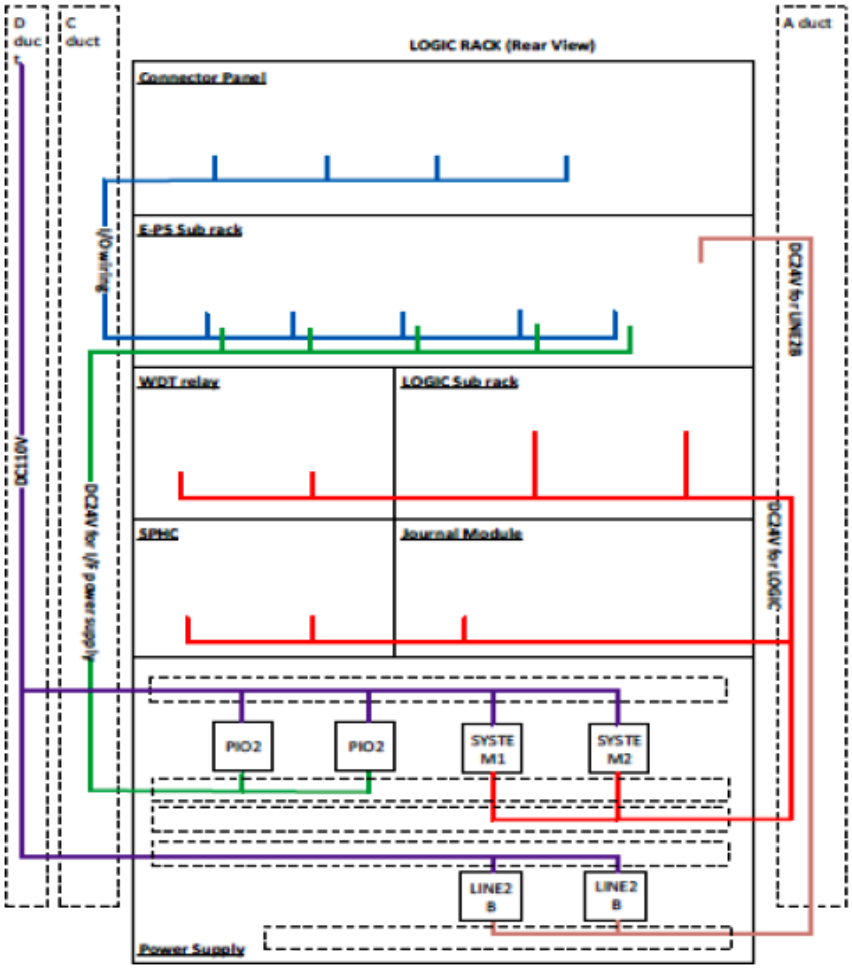



***Figure 29 : Cable routing in EI Rack***

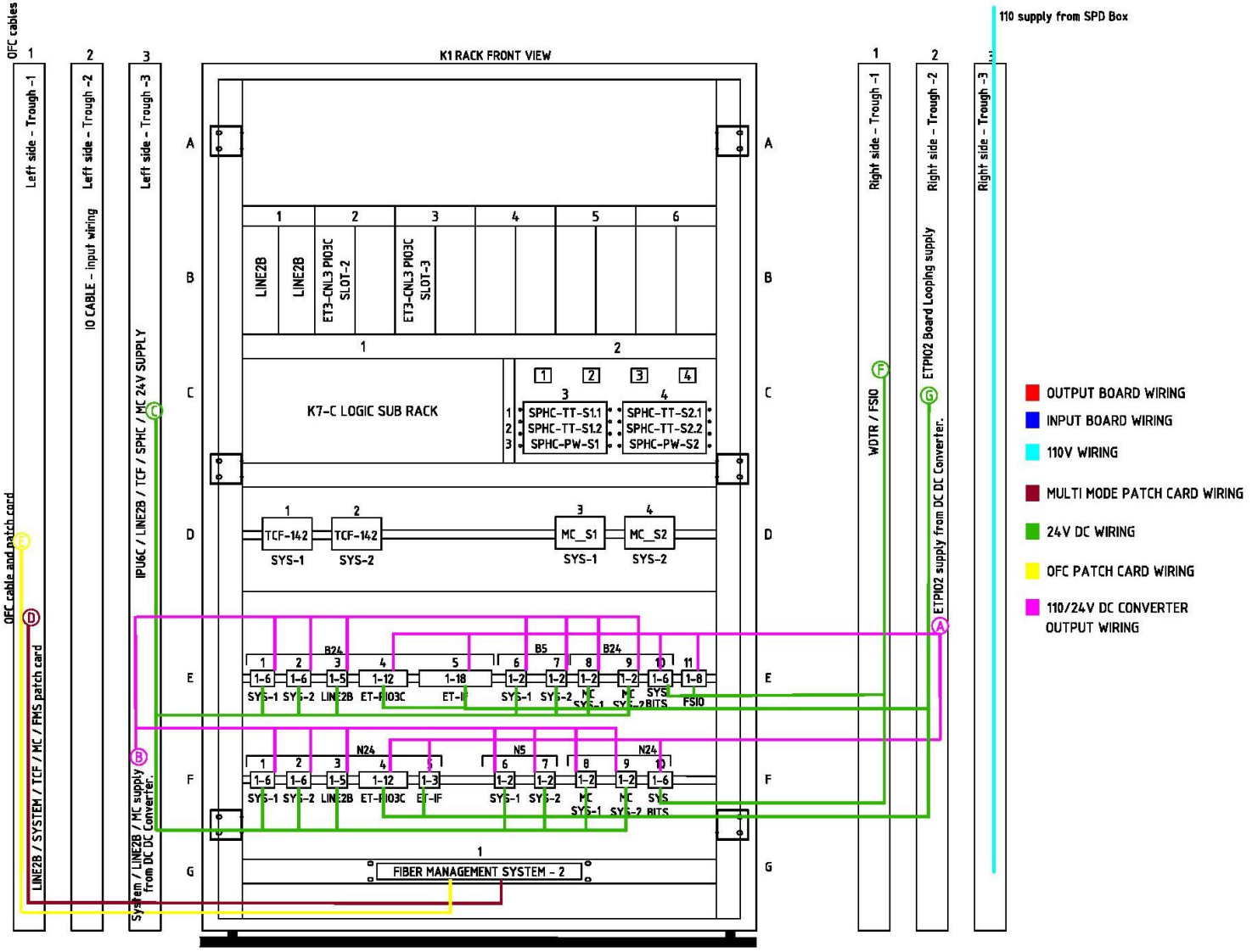



*Figure 30 : Cable Routing EI Rack - Front view*

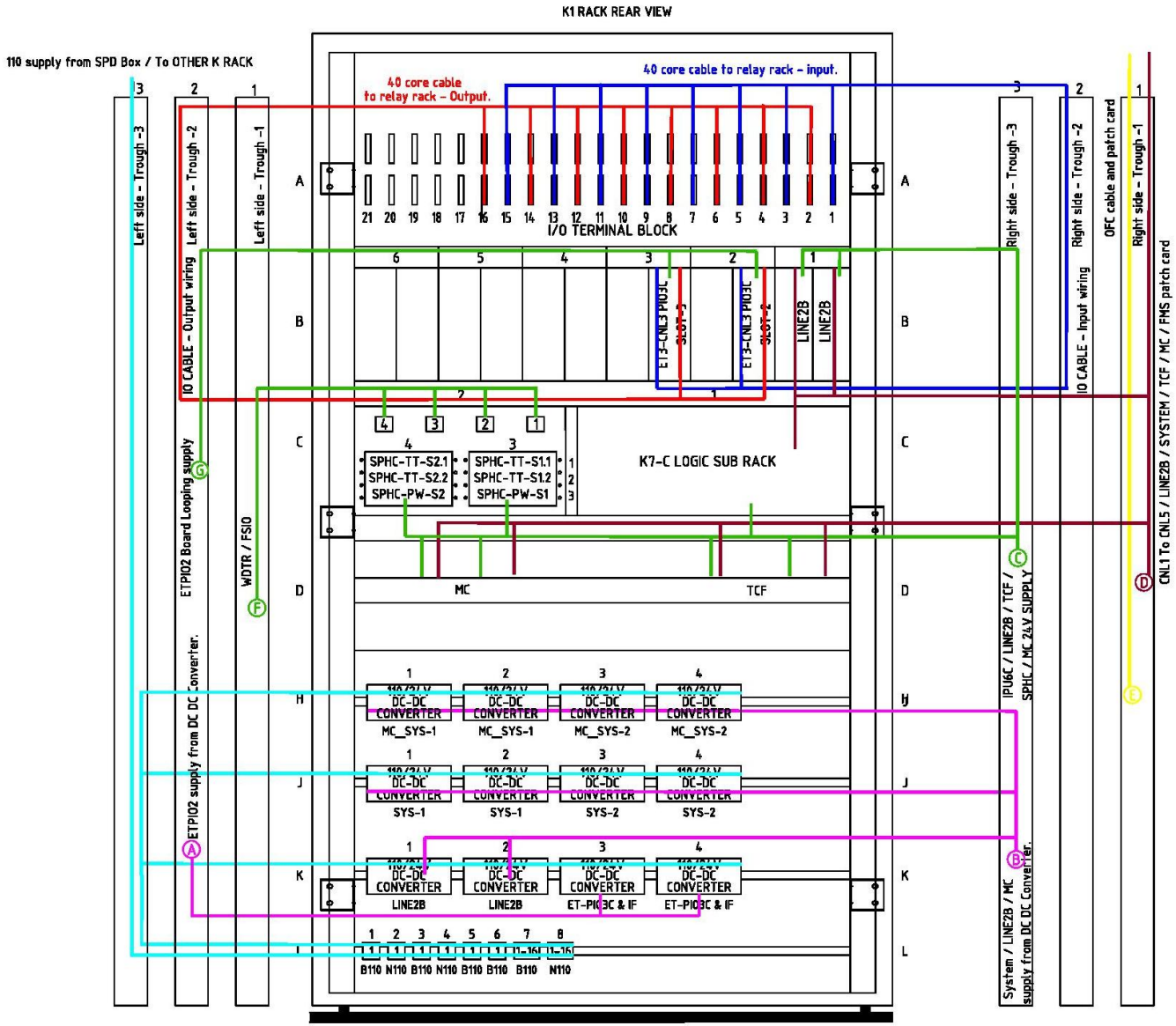



***Figure 31 : Cable Routing EI Rack - Rear view***

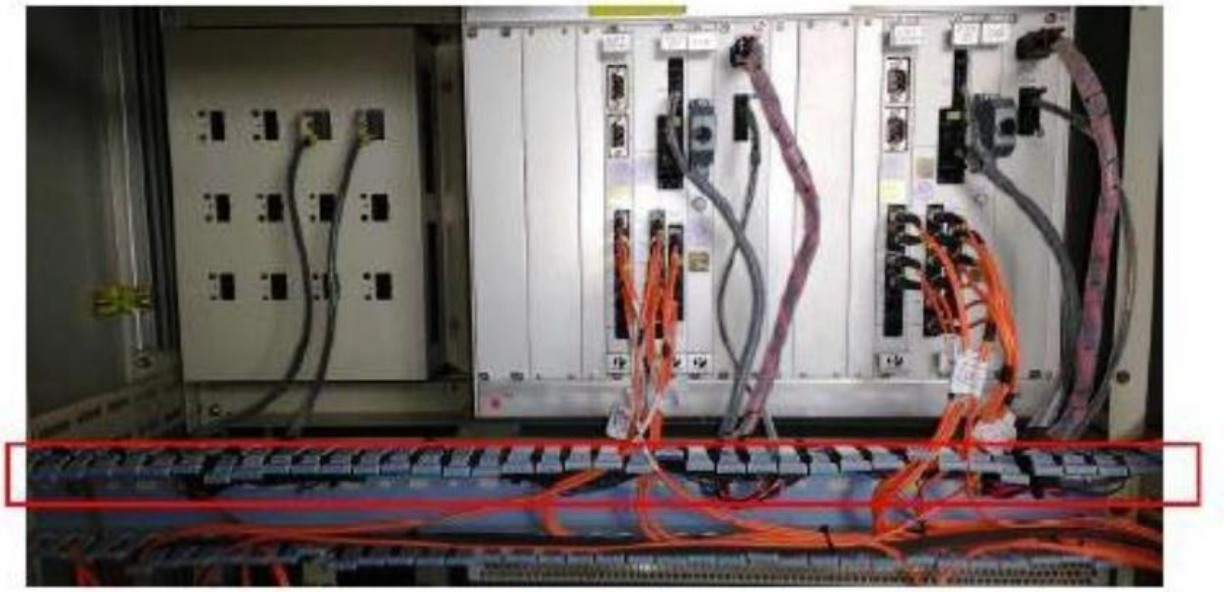


***Figure 32 : LKC7 Sub Rack Power wiring separation***

In ***Figure 32*** above, 24 V DC Power (top) and patch cords (bottom) are used in the same trough but segregated.




***Figure 33 : EP5 Sub Rack Power Wiring separation***

In ***Figure 33*** above, 24 V DC LINE2B Power supply and patch cords are coming from the same trough (right hand side) but segregated.

I/O cables run in separate trough (bottom).

**Table of Contents >**

## 2.15 Relay Rack Cable Routing & Wiring

In reference to ***Figure 34***, I/O cables (shown in RED colour) coming from K5BMC are taken in left side trough of Relay Rack.

Cable coming from CT Rack and miscellaneous cables (shown in BLUE colour) are taken in right side trough of Relay Rack.

Similarly for connection to relays:

I/O cables from K5BMC and cables coming from CT rack are segregated by running in different paths as shown in Fig. (shown in RED & BLUE colours).

***Note:***

*Fire heat & sync cables are not recommended to be used either in K5BMC Rack or Relay Rack. If at all required to be used then those can be provided in CT rack trough. In any case these should not be mixed with EI supply, since these carry 24 V DC EXT supply which is not a 'clean' supply. If it is mixed with EI supply wires, it can lead to failures.*

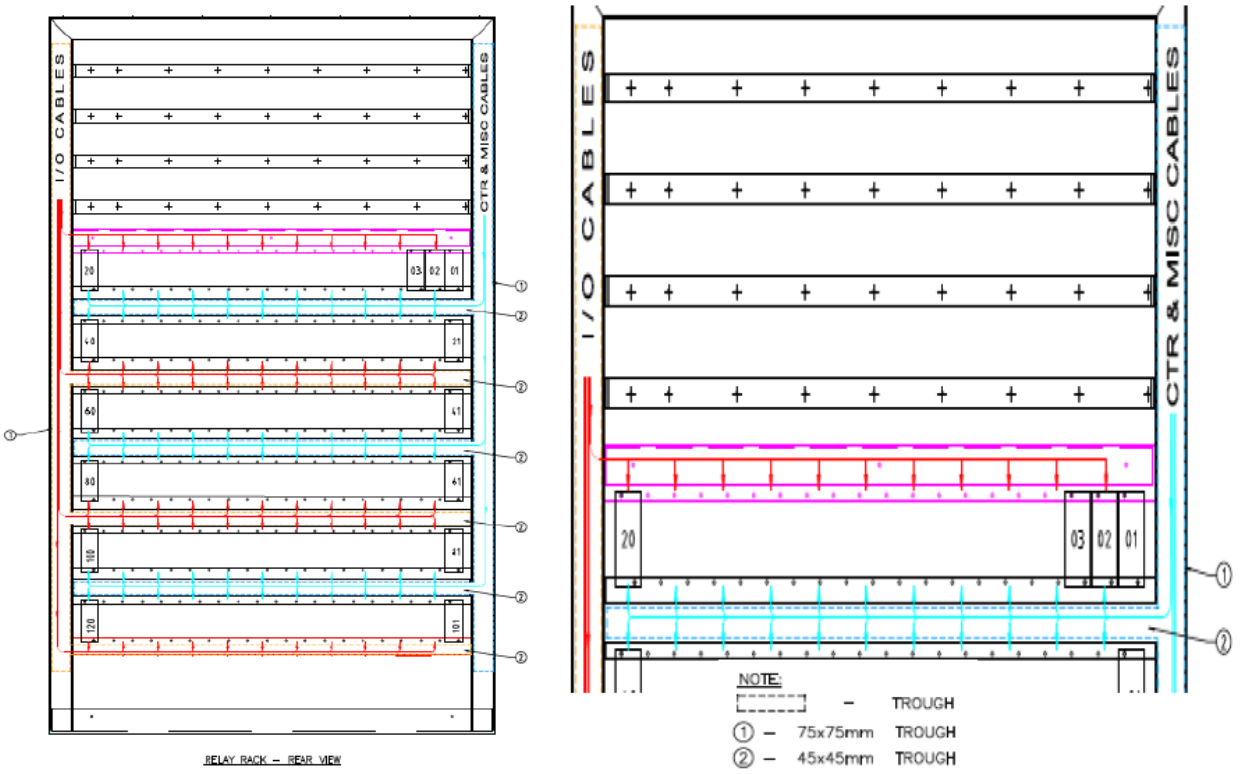



***Figure 34 : Relay Rack Cable routing***

An actual installation of Relay Rack is given in ***Figure 35.*** the details of which are as given below:

A Row – Input wires termination

B Row – Output wires termination

C Row – Power Supply (+) ve

D Row – Power Supply (-) ve

E to I Row are 6 rows for Relays

14 relays are provided in each row. (a gap of 1 relay is provided after each pair of 2 relays).

In this way a total of 84 relays can be provided in 6 rows. Although overall capacity of Relay Rack is 120 Relays.




***Figure 35 : Termination of wires in Relay Rack***

**Table of Contents >**

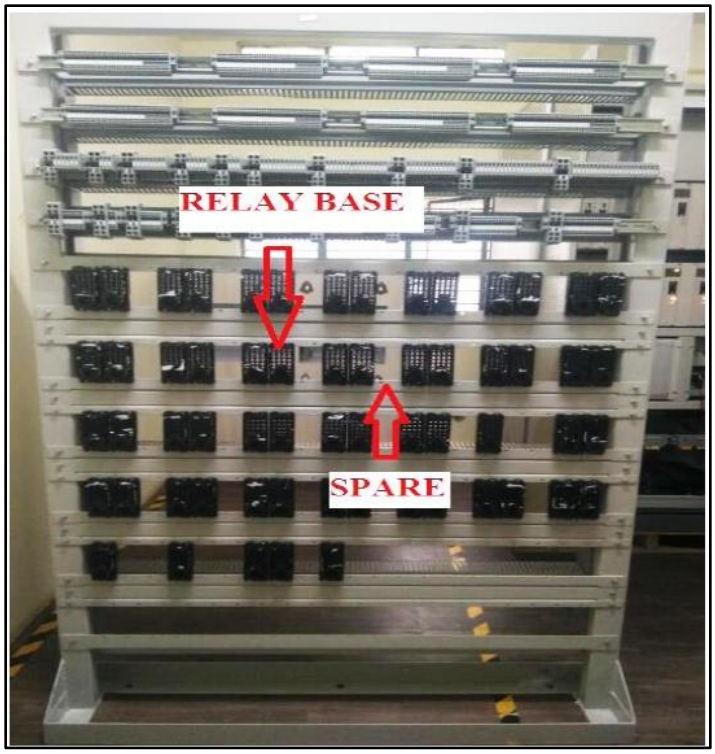



***Figure 36 : Relay Rack without relays***

## 2.16 Networking of MTCs in K5BMC EI

In K5BMC EI, networking can be done for MTC. A typical networking done for MTCs of stations in North East Frontier Railway is shown in ***Figure 37***. The Headquarter is at Maligaon. Railnet connection (shown in dotted RED) is used from Zonal HQ (Maligaon) to 5 Divisional HQ stations –Alipurduar, Katihar, Rangia, Tinsukia & Lumding. The Divisional HQs are further connected to other stations under their jurisdiction through Railnet. The information of these stations can be accessed through Zonal HQ (Maligaon) provided all the stations are having K5BMC EI installations. From Divisional HQs to stations, Railnet connection or Dark Fibre connection is required.

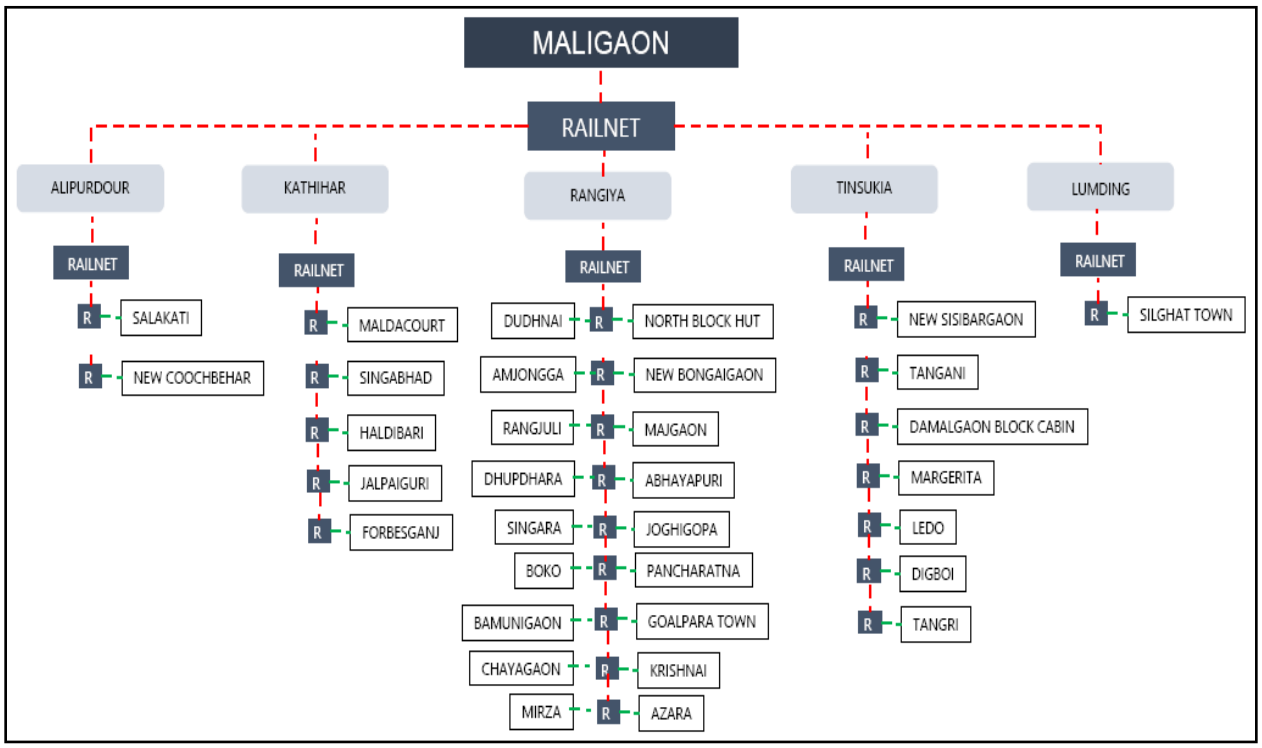



***Figure 37 : Diagram showing connectivity of MTCs among various stations and headquarters***

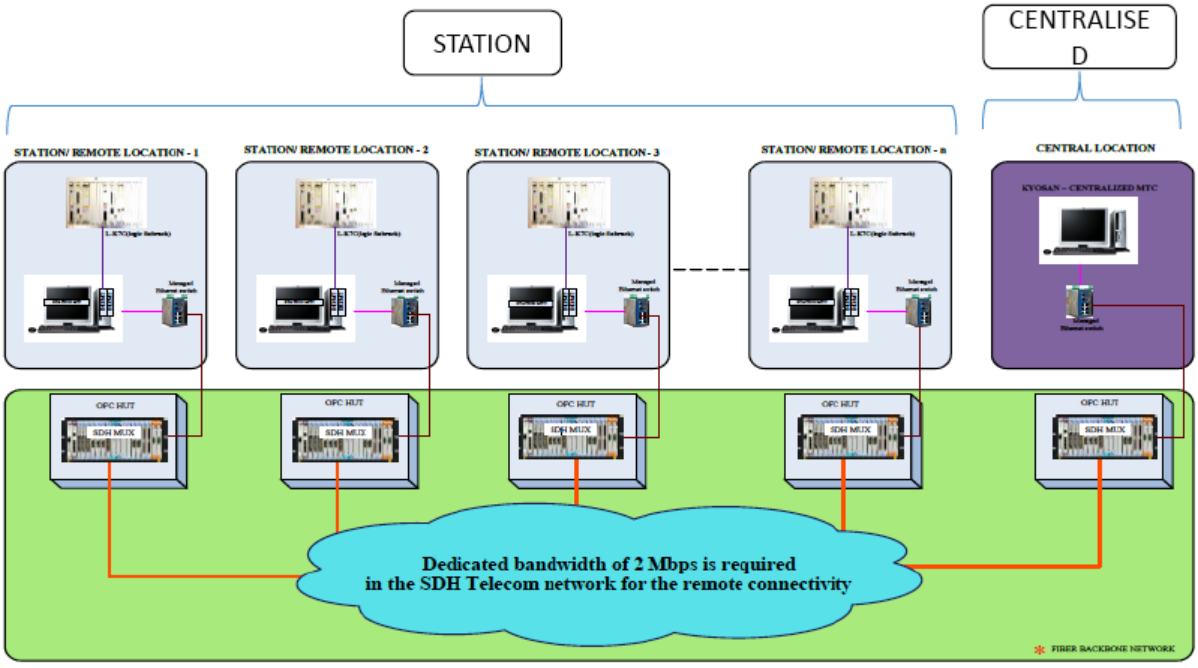



***Figure 38 : MTC connectivity through optical to ethernet converter using OFC cable.***

**Table of Contents >**

- For MTC networking different converters are used.
- For normal EI to EI connection Ethernet connection is used.
- For MTC if E1 is used then E1 to Ethernet Converter is used.
- If OFC cable is used then Optical to Ethernet Converter is used.
- It depends upon the media availability provided by railways.

## ANNEXURE II

## Details of Cables/Wires & accessories used in K5BMC EI Rack Wiring

**(Ref.: K5BMC Installation Procedure ver. 03 dated 24.08.2023)**

| #No. | Description | Usage |
|---|---|---|
| #1 | 3 CORE SHEILDED SERIAL BELDON CABLE | A) Communication between Datalogger to Datalogger PC.<br>B) From Serial to Optical converter to SSI Protocol converter. |
| #2 | 2 PAIR TWISTED SHELDED CABLE. | -- |
| #3 | 5 PAIR TWISTED SHELDED CABLE | From FSIO to optical to serial converter. |
| #4 | SPARE | -- |
| #19 | SPARE | -- |
| #20 | 16/0.16mm (0.32 Sq.mm) WIRE (RED COLOUR) | A) ET-PIO2 board to I/O terminal (K-Rack)<br>B) connection from MMIF board to Panel terminal |
| #21 | 16/0.16mm (0.32 Sq.mm) WIRE (BLUE COLOUR) | A) ET-PIO2 board to I/O terminal (K-Rack)<br>B) connection from MMIF board to Panel terminal |
| #22 | 16/0.16mm (0.32 Sq.mm) WIRE (BLACK COLOUR) | ET-PIO2 board to K-Rack's I/O terminal (positive side) |
| #23 | 16/0.2mm (0.5 Sq.mm) WIRE (RED COLOUR) | A) LINE-2B/DC-DC Converters/FRMC to – Rack's<br>I/O terminals.<br>B) connection from I/O terminal (Relay Rack) to relay coil (positive side)<br>(C) Relay coil to Relay Rack's I/O terminal (negative side) |
| #24 | 16/0.2mm (0.5 Sq.mm) WIRE (BLUE COLOUR) | Loop wire between relay contacts |
| #25 | 16/0.2mm (0.5 Sq.mm) WIRE (BLACK COLOUR) | connection from ET-PIO2 board to K Rack's I/O terminal (negative side) |
| #26 | 40 CORE (0.6 sq.mm) SIGNALLING CABLE | Connection from K Rack's I/O terminal to Relay Rack terminals |
| #27 | 24 CORE (0.6 sq.mm) SIGNALLING CABLE | From CTR to SM room / IPS room |
| #28 | 30/0.25mm (1.5 Sq.mm) WIRE "TWISTED PAIR RED/BLACK" WITH "RD" BEING +VE AND "BK" BEING -VE | -- |
| #29 | 30 CORE (1.5 sq.mm) SIGNALLING CABLE | From CTR to SM room / IPS room / To field (Location box) |
| #30 | 16/0.2mm (0.5 Sq.mm) WIRE (YELLOW COLOUR) | A) Relay contact to data logger digital board.<br>B) Loop wiring between relay contacts |
| #31 | 16/0.2mm (0.5 Sq.mm) WIRE (GREY COLOUR) | A) power supply fuse to relay contact (positive side)<br>B) Relay contact to CTR (positive side) |

| #No. | Description | Usage |
|---|---|---|
| #32 | SPARE | -- |
| #33 | SPARE | -- |
| #34 | 16/0.2mm (0.5 Sq.mm) WIRE "TWISTED PAIR RED/BLACK" WITH "RD" BEING +VE AND "BK" BEING -VE | Relay contact to CTR |
| #35 | 16/0.2mm (0.5 Sq.mm) WIRE "TWISTED PAIR BLUE/BLACK" WITH "BL" BEING +VE AND "BK" BEING -VE | CTR to Relay contact (Optional) |
| #36 | 30/0.25mm (1.5 Sq.mm) WIRE (RED COLOUR) | A) 110V DC Point power supply fuse to relay contact (Positive side).<br>B) Relay contact to CTR (Positive side).<br>C) Between power distribution box terminal and Surge suppressor (positive side) |
| #37 | 30/0.25mm (1.5 Sq.mm) WIRE (BLACK COLOUR) | A) 110V DC Point power supply fuse to relay contact (Negative side).<br>B) Relay contact to CTR (Negative side)<br>C) Between power distribution box terminal and Surge suppressor (Negative side) |
| #38 | 56/0.3mm (4 Sq.mm) WIRE (RED COLOUR) | From power distribution box terminal and Communication rack terminal (positive side) |
| #39 | 56/0.3mm (4 Sq.mm) WIRE (BLACK COLOUR) | From power distribution box terminal and K-rack terminal (negative side) |
| #40 | 56/0.3mm (4 Sq.mm) WIRE (GREEN COLOUR) | For rack-to-rack Earthing Looping. |
| #41 | 30/0.25mm (1.5 Sq.mm) WIRE (GREEN COLOUR) | -- |
| #42 | 16/0.2mm (0.5 Sq.mm) WIRE (GREEN COLOUR) | Earth connection within the same rack. |
| #43 | 80/0.4mm (10 Sq.mm) WIRE (RED COLOUR) | From power distribution box terminal and Relay Rack terminal (positive side) |
| #44 | 80/0.4mm (10 Sq.mm) WIRE (BLACK COLOUR) | From power distribution box terminal and Relay Rack terminal (Negative side) |
| #45 | 80/0.4mm (10 Sq.mm) WIRE (GREEN COLOUR) | Earth connection from Earth busbar to Individual rack. |
| #46 | 101/0.45mm (16 Sq.mm) WIRE (GREEN COLOUR) | Earth connection between Main Earth busbar to Sub Busbar. |
| #47 | 101/0.45mm (16 Sq.mm) WIRE (RED COLOUR) | Power supply connection from IPS / Power Rack to Power Distribution Box terminal (positive side) |
| #48 | 101/0.45mm (16 Sq.mm) WIRE (BLACK COLOUR) | Power supply connection from IPS / Power Rack to Power Distribution Box terminal (Negative side) |
| #49 | 25 sq.mm WIRE (GREEN COLOUR) | Earth connection from Earth pit to main busbar. |
| #50 | 25 sq.mm WIRE (RED COLOUR) | From IPS room to Power rack or CTR (Positive |

| #No. | Description | Usage |
|---|---|---|
| | | side). |
| #51 | 25 sq.mm WIRE (BLACK COLOUR) | From IPS room to Power rack or CTR(Negative side). |
| #52 | 35 Sq.mm WIRE (GREEN COLOUR) | Earth connection from Earth pit to main busbar. |
| #53 | 35 Sq.mm WIRE (RED COLOUR) | From IPS room to Power rack or CTR(Positive side). |
| #54 | 35 Sq.mm WIRE (BLACK COLOUR) | From IPS room to Power rack or CTR(Negative side). |
| #55 | SPARE | -- |
| #74 | SPARE | -- |
| #75 | FUSE TERMINAL WITH INDICATION 24V DC WAGO FUSE PART NO.281-611/281-541 | -- |
| #76 | FUSE TERMINAL WITH INDICATION 110V AC/DC WAGO FUSE PART NO.281- 611/281-418 | -- |
| #77 | NON-DISCONNECT TERMINAL 2.5 Sq. mm WAGO TERMINAL TYPE PART NO.280-901 | -- |
| #78 | NON-DISCONNECT TERMINAL 16 Sq. mm WAGO TERMINAL TYPE PART NO.283-901 | -- |
| #79 | SPARE | -- |
| #80 | SPARE | -- |
| #81 | 3 CORE POWER CABLE 5A RATING | A) Communication between Datalogger to Datalogger PC.<br>B) From Serial to Optical converter to SSI Protocol converter. |
| #82 | 8 CORE SERIAL BELDON CABLE (GREY COLOUR) | A) Communication between Datalogger to Datalogger PC.<br>B) From Serial to Optical converter to SSI Protocol converter. |
| #83 | SPARE | -- |
| #84 | SPARE | -- |
| #85 | SPARE | -- |
| #86 | FC-FC MULTI-MODE FIBER PATCH CORD | Between Logic sub rack to PCINIO ET/MT, ET sub rack, EM6 Sub rack and SPHC TT |
| #87 | SC-SC SINGLE-MODE FIBER PATCH CORD | Between Media converter (Single mode to multimode) |
| #88 | ST-ST MULTI-MODE FIBER PATCH CORD | Between Media converter (optical to serial) |
| #89 | SPARE | -- |
| #90 | SPARE | -- |
| #91 | 2C (6 Sq.mm) OUTDOOR POWER CABLE | Based on the requirements station and field requirements |

# References


- Railway Board's letter no.2021/SIG/25-Conf/5/SSC dated 26.02.2021 in reference to Special Signal Standards Committee (SSC) meeting for Electronic Interlocking held on 20.02.2021.
- Railway Board's letter no.2020/SIG/18/EI/GEN dated 25.11.2021 for Interlocking at IBH, Relay Huts, Class-C stations etc.
- Railway Board's letter no. 2003/SIG/G/5 dated 28.04.2016 for Policy on type of Interlocking to be adopted at stations provided with centralized operation of. points and signals.
- Railway Board Letter no. 2010/SIG/SGF/EI (Ansaldo) dated 22.06.2011 for Recommended EMC compliant Earthing & Bonding of MICROLOK II Interlocking systems.
- RDSO letter No. STS/L/SSI/CA/US&S dated 26.07.2011 regarding Guidelines for improving the reliability of MICROLOK II EI.
- RDSO's Report on Standardization of Typical Circuits for EI (Report No. SS/155/2019/2022) Ver.2.0 dated 29.03.2022.
- RDSO Specification No. RDSO/SPN/197- Code of practice for Earthing & Bonding System for Signalling Equipments w.e.f. 04.07.2016.
- RDSO Technical Advisory Note No. RDSO/STS/E/TAN/3006 dated 02.11.2012 for Earthing & Bonding scheme for Electronic Interlocking.
- RDSO Technical Advisory Note No. RDSO/STS/E/TAN/3012 Ver. 3.0 dated 28.06.2021 for Guidelines regarding Technical System Application Approval for Electronic Interlocking Installation.
- K5BMC Installation Procedure ver. 03 dated 24.08.2023
- Presentation slides on K5BMC EI Installation practice – Cabling & Networking (Courtesy : M/s TVM Signalling & Transportation Systems Pvt. Ltd.,(KYOSAN), Bangalore.
- Maintenance Manual for K5BMC Electronic Interlocking System Ver. 3.


**Table of Contents >**

# CAMTECH Publications

CAMTECH is continuing its efforts in the documentation and up-gradation of information on maintenance practices of Signalling & Telecom assets. Over the years a large number of publications on Signalling & Telecom subjects have been prepared in the form of handbooks, pocket books, pamphlets and video films. These publications have been uploaded on the internet as well as railnet. For viewing/downloading these publications

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Table of Contents >




**INDIAN RAILWAYS**
**Centre for Advanced Maintenance Technology**
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